



The Role of the Medical Physicist and Clinical Engineer in the use and effects of Electromagnetic Fields in Hospitals

1. Introduction

The primary role of the medical physicist or clinical engineer with respect to this is to provide advice and guidance to the employer with respect to the effect of EM fields in the medical sector to ensure not only compliance with the relevant legislations but also patient safety.

In line with the introduction of the Control of Electromagnetic Fields at Work Regulations 2016¹ (The CEMFAW Regulations) employers have a duty to take all reasonable steps to prevent harm in the workplace arising from exposure to Electromagnetic fields (EMFs).

In addition to communications and RF identification applications seen in the workplace in general, higher power sources such as electrosurgery and diathermy units are frequently encountered and the medical physicist or clinical engineer has a key role in ensuring that such potentially hazardous sources of EMFs are identified, minimising exposure, the risk assessed, and advice on suitable control measures.

The Control of Electromagnetic Fields at Work Regulations 2016 cover the part of the electromagnetic spectrum ranging from static electric and static magnetic fields through to time-varying electric, magnetic and electromagnetic fields with frequencies up to 300 GHz.

2. Scientific contribution

The use of EMFs in the medical environment has increased significantly in the last decade. EMFs are used in medical equipment for diagnostic and therapeutic purposes. The CEMFAW regulations mean that the potential exposure of employees to EMFs now needs to be assessed with reference to action levels (ALs) and Exposure Limit Values (ELVs) for which the medical physicist or clinical engineer will play a key role. They will ensure that within the Trust

- Potentially hazardous sources of EMFs are identified
- The exposure of employees is quantified
- Controls are in place to minimise the risk arising from exposure to EMFs including a suitable risk assessment

It should be noted however that due to the nature of the work, employees working in the field of magnetic Resonance Imaging (MRI) such as the development, testing, maintenance and research using such equipment, the exposure limit stated in the CEMFAW Regulations do not apply. However, the employer must assess and document the risk and ensure any

exposure is as low as reasonably practicable and employees are protected against the health effects and safety risks associated with that exposure.

Although there is a significant body of scientific information relating to the use of these technologies, each hospital will have a unique set of criteria in which their staff and medical equipment are expected to work. Medical physicists and clinical engineers have a central role in the design and measurement of medical systems to ensure that they are fit for purpose in the individual environment. The Health and Safety at Work Act lays particular responsibility on Trusts to ensure that their working environments are safe. Scientific departments will undertake routine surveys of the electromagnetic environment to ensure that the Trust meets all of its legal commitments, both in terms of medical equipment safety and accuracy and the human exposure of their staff, patients and visitors. Medical physicists and clinical engineers will have expert knowledge in the use of electromagnetic fields in hospitals. EMFs in equipment have the potential to interfere or to be interfered with by other equipment. This whole area of scientific endeavour is still in an embryonic stage and hospital based staff are in a unique position to evaluate the issues and applications of these technologies. Staff will be expected to disseminate their knowledge through publication in scientific journals and presentations at conferences. In a rapidly changing and financially challenged world, it is important for patient safety and the general patient experience that knowledge gained in one environment is rapidly disseminated to others so that patient safety is maintained at all times. The medical physicist or clinical engineer will have access to a range of electromagnetic field measurement devices in order to conduct their research. As a minimum these should be a field survey meter and spectrum analyser.

3. Educational role

Many departments use EMFs in routine clinical practice for example surgical diathermy (electrosurgery) which utilises high power sources of electromagnetic fields. Many diagnostic tests are highly susceptible to interference effects from EMFs. Medical physicists and clinical engineers are involved with the education and training of staff in the use of these technologies and the mitigation of any issues surrounding their use. Staff will be expected to teach either on formal courses at undergraduate or postgraduate levels. A typical example would be in advising on the use of surgical diathermy with a patient who has an active implantable medical device and needs resection of a tumour in the breast. Advice to the cardiologist, surgeon and anaesthetist will be necessary to ensure a safe procedure for the patient.

4. Managerial role

With the increasing use of EMFs in the hospital, medical physicists and clinical engineers will be expected to write policies and procedures related to the clinical use of EMFs and the management of sources of EMFs in general to ensure not only that patient care is conducted in an optimal manner but also the safety of employees. They will advise Trust Health and Safety Committees on the issues surrounding the use and application of these technologies. They will investigate incidents, or potential incidents due to interference caused by EMFs and advise on their elimination. They will ensure that adverse incidents arising from interference are reported to an appropriate body such as the Medicines and Healthcare products Regulatory Agency (MHRA)

All new medical equipment has the potential to be subjected to interference from EMF sources. The relevant international standard – BS EN 60601-1-2: 2015 states that the responsibility for ensuring that no issues arise is a joint one between manufacturers and the user. It is important that users of equipment are made aware of any manufacturer's warnings regarding the potential for a device to create or suffer from interference. The medical physicist or clinical engineer will provide to management the necessary expertise to ensure that patient safety is not compromised. They will also advise on issues arising from occupational exposure to staff as indicated below.

Experts should advise on implications for electromagnetic interference owing to in-house maintenance or modification of equipment. For example, alterations to a metal case can degrade the shielding effectiveness of a piece of equipment.

All electrical/electronic devices including electronic medical devices have the potential to generate or to be susceptible to electromagnetic fields. The medical physics or clinical engineering expert should be asked to advise on any new building developments where medical devices will be used. Trusts should ensure that the siting of any new development will not cause electromagnetic compatibility issues which can be costly to rectify.

5. Human exposure advice

There is significant concern amongst the population about the immediate and long-term effects of electromagnetic fields on the human body. In general this relates to mobile phones and their base stations; however there are many other potentially hazardous sources within a hospital. Trusts will wish to assure their staff, patients and visitors, as well as local residents, that there are no issues with these devices or installations. The International Commission on Non-Ionising radiation Protection (ICNIRP)^{2,3} publish guidelines on the safe exposure limit values to EM fields and this guidance feeds through into the exposure limit values laid out in the CEMFAW regulations. The medical physicist or clinical engineer may not be an expert on the biological effects of many of these electromagnetic fields, but they will have specialist knowledge which can be used to assist the Trust in reassuring any enquirer of the safety of their systems. The local specialist should be able to demonstrate the safety of anyone who is on, or lives near to their site by measurement of the relevant field strength. They should compare these measurements to national and international guidelines to demonstrate a safe working and living environment. They will conduct surveys of the hospital site to ensure that electromagnetic fields in any area are within the limits of the CEMFAW regulations.

The local specialist should be consulted before the installation of any mobile phone base stations on the hospital site. They will then liaise with the base station supplier and ensure that the Trust is not placed at risk of litigation.

6. Electromagnetic interference investigation

Electromagnetic interference with medical equipment is not a new issue. Mains electricity has been a source of concern for many years and the local medical physicist or clinical engineer will be familiar with these problems. The increased use of wireless technologies has increased the likelihood of interference causing problems. Some medical devices have the potential to disrupt wireless communication systems, such as wireless LANs.

The local expert will conduct surveys of the hospital site to establish a baseline of electromagnetic fields and identify any potential sources of interference. They will be knowledgeable about the limits of immunity relevant to particular types of medical equipment and identify any areas of concern. With the increasing use of wireless networking for both medical and administrative data communications, the local expert will advise Information Technology Departments on the potential for interference to cause loss of packet data and slow or corrupt communications systems. They will devise strategies to minimise these risks and identify solutions when problems arise.

The medical physicist or clinical engineer will advise management, as mentioned above, on the compatibility of any selection of medical devices and their use in the hospital. They will ensure that the Trust maximises the financial benefit of purchasing new medical devices by ensuring that they are fit to be used in the location that the Trust desires and any controls if required are in place. There will be some types of equipment that cannot be used in areas where particularly sensitive diagnostic equipment is used. For instance, problems can occur when operating theatres, physiotherapy departments and departments undertaking sensitive physiological measurements are placed in close proximity. However electromagnetic field strengths tend to fall rapidly with distance so physical separation is often an effective solution.

7. Conclusions

Electromagnetic fields are a growing issue within healthcare establishments and following the introduction of the CEMFAW regulations all employers have a duty to protect their workers from EMF workplace exposure, as well as to address issues arising from electromagnetic interference. Hospitals need to be aware of, and deal with the various issues that surround new technologies introduced for patient care and that are present as part of the modern technological environment in which they operate. The medical physics and clinical engineering team provides the level of expertise that management requires ensuring that patients are treated in a safe and efficient manner; and employees are working in an EMF safe environment. The local experts will have a role in scientific investigation and education.

References

- 1. The Control of Electromagnetic Fields at Work Regulations 2016**
- 2. ICNIRP GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC, MAGNETIC AND ELECTROMAGNETIC FIELDS (UP TO 300 GHZ) HEALTH PHYSICS 74 (4):494-522; 1998**
- 3. ICNIRP Guideline on Limits of Exposure to Static Magnetic Fields**
<https://www.icnirp.org/cms/upload/publications/ICNIRPstatgdl.pdf>

Suggested further reading

1. Guidance on the measurement and use of EMF and EMC, IPEM Report 98, ISBN 978 1 903613 38 2, Edited by M Robinson, L Grant & J Reeves

2. Non-binding guide to good practice for implementing Directive 2013/35/EU Electromagnetic Fields, Volume 1 , Practical Guide, ISBN 978-92-79-45902-3 (Paper) 978-92-79-45869-9 (PDF), <https://op.europa.eu/en/publication-detail/-/publication/c6440d35-8775-11e5-b8b7-01aa75ed71a1>
3. Electromagnetic fields at work -A guide to the Control of Electromagnetic Fields at Work Regulations 2016, Health and Safety Executive, HSG281, <https://www.hse.gov.uk/pubns/priced/hsg281.pdf>

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Originally drafted by: Lindsay Grant, Martin Robinson, John Reeves

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