Working in electromagnetic fields with a cardiac pacemaker
Foreword

In most European countries, several thousand cardiac pacemakers are installed every year to treat heart diseases. Although the majority of patients are of retirement age, many workplaces have employees with a pacemaker. Often both the employer and the occupational health care personnel are uncertain about the risks related to using pacemakers in electromagnetic fields (EMFs). Therefore, the risk management of work-related EMF interference has given rise to a great deal of questions and discussion.

EMFs at workplaces are rarely so strong that they prevent an employee from continuing to work after pacemaker implantation. There are, however, some work situations that an employee with a pacemaker must avoid. This guide briefly describes what EMF disturbances are, where they may occur, and what kind of risk assessments can be carried out at the workplace.

The aim of this leaflet is to promote workers’ possibilities to continue employment in EMF work environments after the implantation of a cardiac pacemaker. A successful return to work requires co-operation between an employee, the employer and the treating physician. A personal risk assessment should be performed for workers with a pacemaker, taking into account the specific characteristics of the individual worker and the specific properties of the workplace.
Electromagnetic fields

EMFs are omnipresent wherever electricity is used. Electric fields are linked with electrical voltage-differences. Strong electric fields exist, for instance, under high voltage power lines.

Magnetic fields are linked with electric currents. High magnetic fields arise, for example, from welding and induction heating processes. Magnetic field strength attenuates rapidly as the distance from the source increases.
EMFs are produced by, for example, permanent magnets, electric tools, computers, radio- and television transmitters, mobile phones, medical devices and electronic article surveillance systems. In most cases, EMFs are not high enough to cause the malfunctioning of cardiac pacemakers.

**How EMFs affect people**

The biological effects of EMFs depend on the frequencies of the fields. Strong static and low frequency fields result in adverse effects on the central nervous system, whereas radiofrequency EMFs result mainly in local warming of the exposed body area. In the work environment, however, EMF exposure is seldom high enough to cause adverse health consequences.
How EMFs affect cardiac pacemakers

External EMFs can interfere with pacemakers and impair their function. Interference in pacemakers depends on field characteristics, technical properties and the settings of the pacemaker, users' individual capacities, and environmental factors. A common disturbance in a pacemaker results in transfer to noise mode, when the individual programmed settings of the pacemaker are cancelled and it continues to function on general settings. Usually, when this occurs for a short time only, this malfunction does not pose any danger to the patient.

Interference signals caused by EMFs can mimic the function of the heart, so that the pacemaker misinterprets the situation as normal and does not treat the real symptoms. Hence the pacemaker stops its pacing, even when the intrinsic rhythm is poor. This malfunction can be symptomless if the person's intrinsic rhythm is satisfactory. However, it may result in vertigo, unconsciousness and can even be life-threatening for a person who is totally pacemaker-dependent. An interference signal can also pose danger during an occurrence of an arrhythmia, especially for people with an Implantable Cardioverter-Defibrillator (ICD), which may fail to treat potentially fatal arrhythmias.

A pacemaker can also misinterpret interference signals, resulting in unnecessary therapy treatment. This is a common disturbance in ICDs: they may recognize an external signal as a life-threatening cardiac arrhythmia and treat it by producing an electric therapy shock. This shock is usually painful and may even cause a real arrhythmia. Other pacemaker malfunctions are also possible, although more improbable.
Generally, all disturbances disappear as the distance from the interference source increases. The best way to prevent electromagnetic interference in cardiac pacemakers is to avoid staying close to devices emitting high EMFs. In the case of pacemaker interference, it is important to immediately move away from the EMF source. Depending on the severity of the disturbance, it is advised to contact the pacemaker clinic.
Modern pacemakers are well protected against electromagnetic fields. An important factor concerning the interference susceptibility of pacemakers is electrode lead polarity. Nowadays, bipolar electrode leads are most commonly used, with two electrodes at the end of the lead. This system endures EMF interference better than a unipolar configuration.

Interference sensitivity may also depend on which side of the chest the pacemaker generator is located. Left side implantation of a unipolar pacemaker is more sensitive to external EMF disturbances than a right side implantation. Electrode leads of ICDs are always bipolar. In some cases, an implantation may have been made in the abdominal area, in which case the pacemaker can be exceptionally sensitive to EMF interference.
Return to work after a pacemaker implantation

Electromagnetic fields only rarely hinder return to work after pacemaker implantation. There is often uncertainty about the existing EMFs at workplaces; hence it is important to carry out a risk assessment for an employee with a pacemaker.

Risk assessment and risk management are an important part of safety operations at workplaces. This may be a simple process in work environments with no strong sources of exposure. For example, at offices, the risk assessment is carried out and documented most often by an evaluation of EMF sources, and EMF measurements are not needed.

However, in industries that use strong electric currents, a risk assessment is usually accompanied by EMF measurements and potential other necessary measures to ensure safety. In work environments with strong EMFs, implantable medical device users should be warned by appropriate warning signs. In industrial environments, however, different leakage and conduction currents resulting from wrongly connected and unearthed electrical devices may be more harmful to the proper operation of a pacemaker than EMFs. Interference caused by current conduction can permanently disturb or even stop pacemaker functioning.
Risk assessment at workplaces

Individual risk assessments for workers with a pacemaker may use the results of general EMF risk assessments carried out earlier at the workplace. However, generally accepted occupational EMF exposure limits cannot be applied for workers with a pacemaker, because they may not guarantee undisturbed functioning of the pacemaker. The pacemakers should experience no interference when the EMFs are below the exposure limits for the general public given by the European Council Recommendation (1999/519/EC).

As for the risk assessment process, it is important that all relevant parties are involved: the employer, the occupational health care personnel and the employee with a pacemaker. The cardiologist attending to the employee should be consulted when appropriate. Even though risk assessments are individual, other existing evaluations can be exploited.
Examples of devices requiring individual risk assessment for a worker with a pacemaker

- Demagnetizers
- Welding equipment
- Induction heaters
- Microwave dryers
- MRI and other comparable medical devices
- Lawn mowers, leaf blowers, and other combustion engine driven tools
- High frequency heaters
- High power electric generators and motors
- Electrochemical process equipment
- Electronic equipment repair and maintenance
- Electric drills and other high power tools
- Powerful chain saws
- Powerful transmitter antennas
- Strong static magnets
- Powerful devices that use electric currents
Risk assessment for a worker with a pacemaker

1. Check the need for a risk assessment, i.e. identify workers with pacemakers.

2. Determine background information and any special instructions the employee has received from the cardiologist.

3. Evaluate the level of risk assessment needed. For instance, in office environments evaluations based on expert data without EMF measurements are sufficient.

4. When needed, carry out a special risk assessment, including measurements of the EMFs in the work environment.

5. Evaluate the results and decisions on the required measures. This may include restricted access areas or reorganisation of work practices.

6. Document the results for future use.

7. Maintain the assessment and update it whenever substantial changes occur at the workplace or in the settings of the pacemaker.
1. Identification of workers with a pacemaker
2. Determining background information
3. Need for special risk assessment
4. Conduction of special risk assessment
5. Evaluation of results and required measures
6. Documentation
7. Maintenance of risk assessment
Summary

An individual risk assessment shall be carried out for each worker after having a pacemaker implanted, to evaluate the possible EMF safety issues at the workplace. Generally, public spaces and work environments that do not contain high-power electric devices are safe for workers with a pacemaker. However, the use of electrical equipment in the immediate vicinity of a pacemaker is not recommended. In addition, electric equipment must be undamaged, and handled in accordance with manufacturers’ instructions.

In most cases, EMFs are not an obstacle to the continuation of work after pacemaker implantation. Technical measures in the work environment can help reduce a worker’s exposure to EMFs and the likelihood of pacemaker interference.
The recommendations in this leaflet are general guidelines for ensuring the undisturbed function of cardiac pacemakers in EMF work environments. These recommendations are not a substitute for a pacemaker patient’s individual risk assessment by the responsible physician or another healthcare or risk assessment professional.
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