Implantable cardioverter defibrillator and 50-Hz Magnetic Field exposure in the workplace

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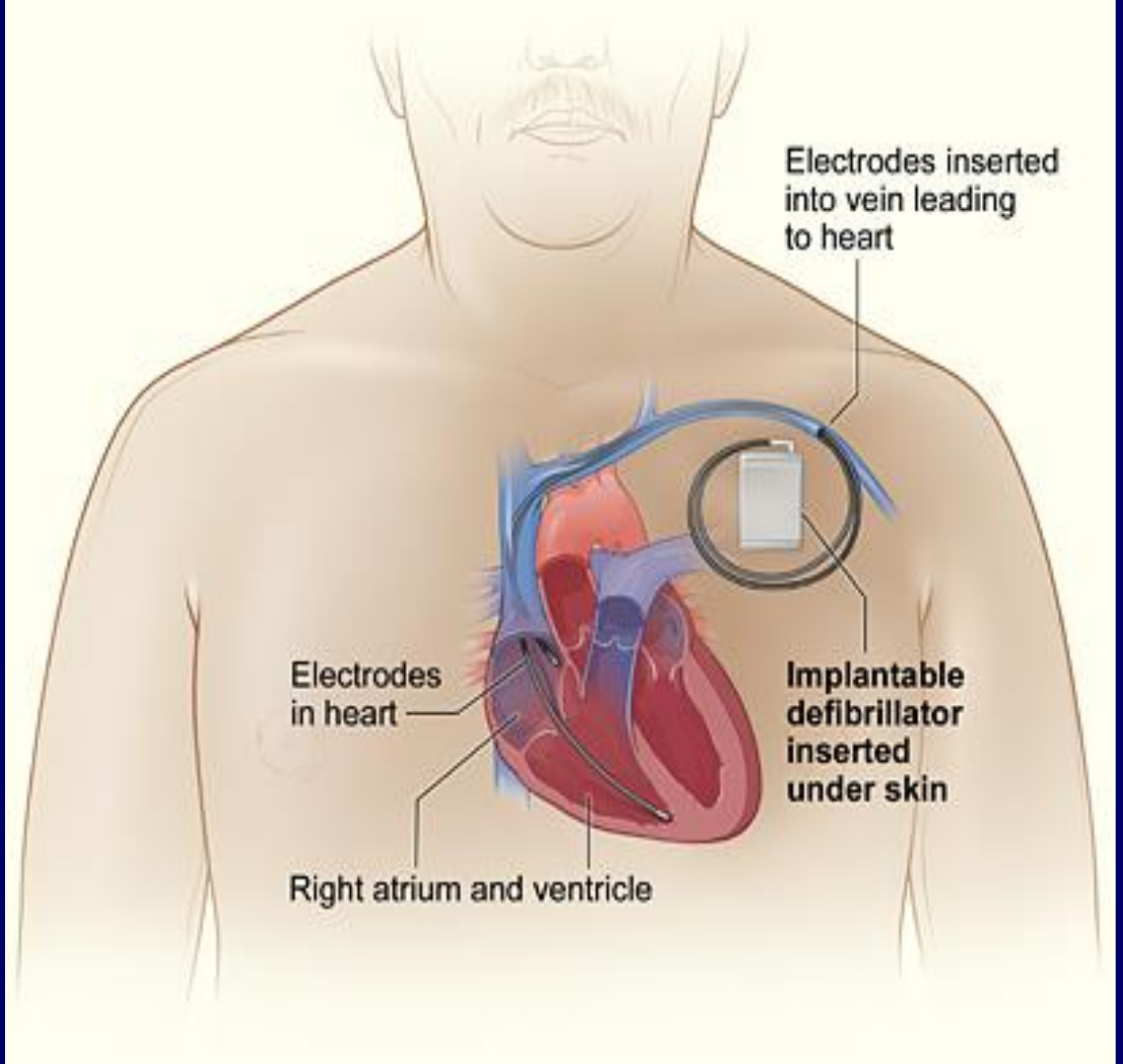
A question that makes sense

- The risk of electromagnetic interferences could concern everyone in everyday life at work and at home…since they are everywhere!






Electrodes inserted into vein leading to heart
Electrodes in heart
Implantable defibrillator inserted under skin
Right atrium and ventricle

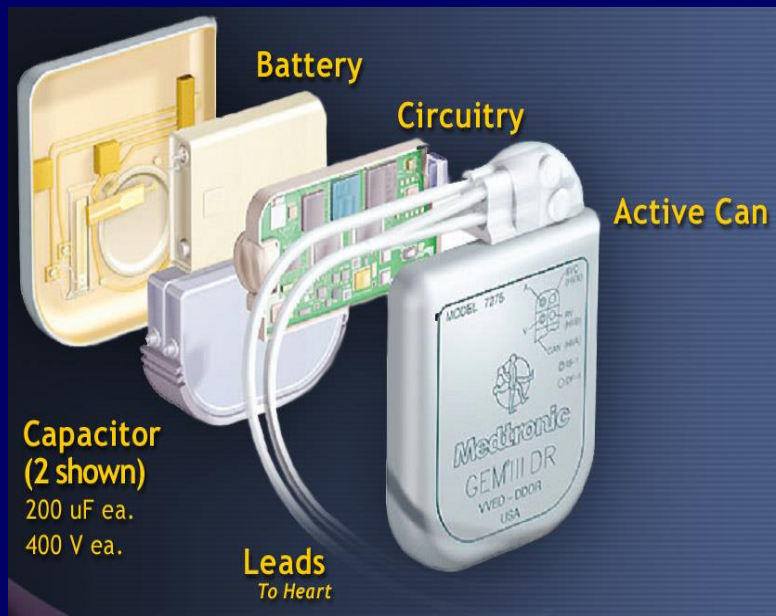
To whom ICDs are implanted?

- 10 000 ICDs are implanted every year
- In France: 140 ICDs/ million of inhabitants /year
- Most of the patients are young and active adults
- and ICDs have demonstrated clear life-saving benefits

ICD Components

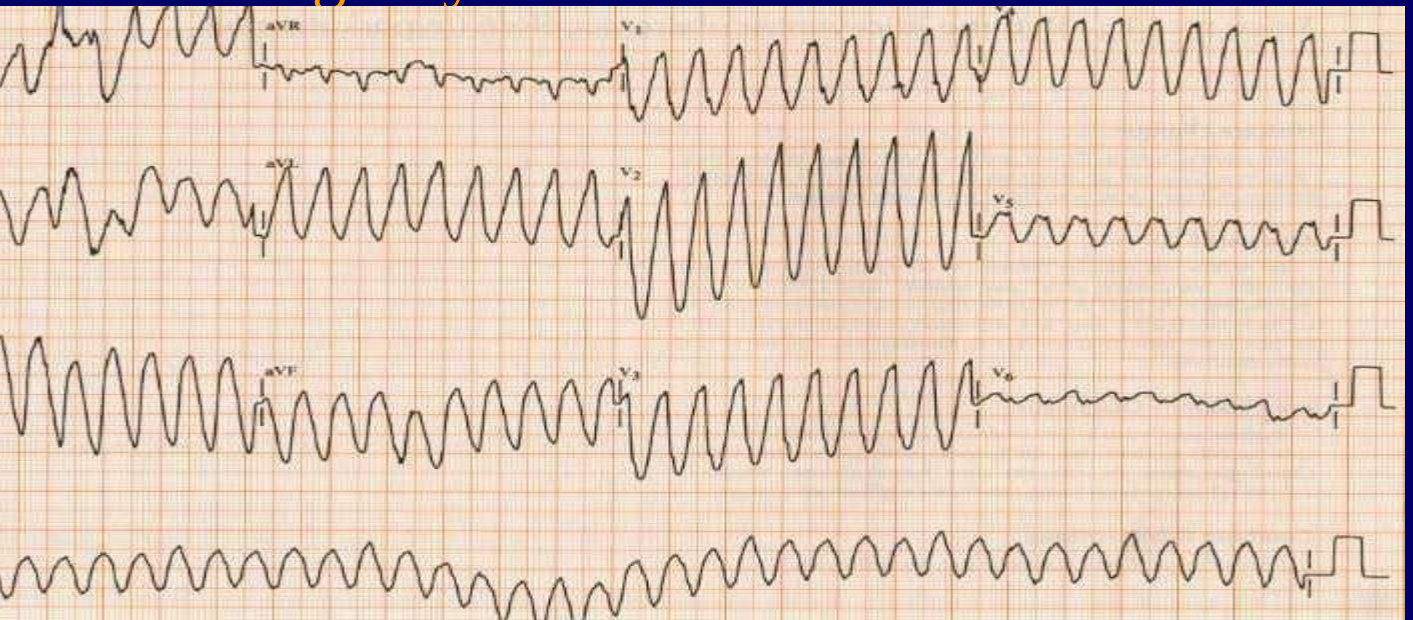
With all the functions of a PM and:

- a high voltage circuit with capacitors (500 to 800 volts)
- a special lead to record and pace low voltage, and send high voltage to defibrillate
- a reed magnetic switch to inhibit a new shock in case of recurring shocks



How does an ICD work?

- It constantly monitors the rate & the cardiac rythm to prevent sudden cardiac death due to:
  - ventricular tachycardia: the ventricles work to fast and it can result in no pulse (hemodynamic collapse),
  - ventricular fibrillation: the heart contractiosn of the ventricles are uncoordinated and unable to properly pump the blood: absolute emergency!



Interferences: the possible consequences ?

- Detection of extracardiac signals ⇒ untimely electric shock

- Damaging of the battery or of the circuit..

⇓

inhibition of the electric shock ⇒ Death?

In any case: interference is reversible after withdrawal of exposure

The experimental approach:

EFFECTS OF 50 Hz 100 µT MAGNETIC FIELD INTERFERENCE ON RECENT GENERATIONS OF IMPLANTED PACEMAKERS

M. SOUQUES[1], JA. TRIGANO[2], R. FRANK[3], I. MAGNE[4], O. BLANDEAU[2], JP. GERNEZ[4]

- 265 patients recently implanted from different manufacturers
- Monitored while passing through, and standing between a system of two coils generating a 50 Hz 100 µT magnetic field. (E field:0,10V/m)
- Tests performed with clinically relevant sensing parameters.
- Recordings made with the field on and off for each patient position.
- ECG analyzed in real time, with the physician blinded to the level of the patient's exposure.
- At the end of the tests, the pacemaker programming was controlled…. and reprogrammed….. if necessary.

The exposure system

- The exposure system was made up of a pair of rectangular Helmholtz coils distant from 80 cm, forming a gate.

The practical approach: testing in the real life

« The team »:

- the worker's cardiologist with ERE
- a manufacturer's representative with telemetry equipment
- a technician qualified to measure EMF
- the occupational physician (if any)
- the worker (informed &with a written informed consent)

The advantages:

- in the working place the E field is not vertically oriented due to the metallic structures (the field is tridimensional)
- the workers move and the orientation between the worker and field changes
- the configuration of the working place must insure maximum exposure, and the worker must move around to explore all foreseeable orientations between the field and the implant

One example:
50 years old, hydroproduction unit, 4 years of follow up

Office computer	Operating position	0,5µT at ICD operating position	ICD control : normal
63kV substation outside	At grid contact	11µT	normal
Bulbe control room	At control cabinet contact	90 µT	normal
Machinery room alternator	contact	150µT	normal
Cable gallery	At cables contact	650µT	normal

In the cable gallery: 650μT

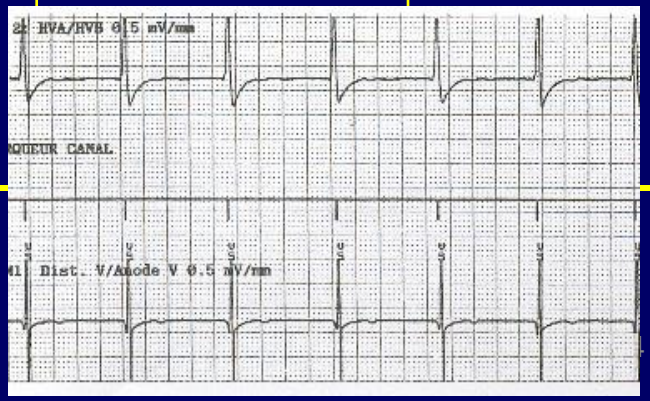
Another example: man 33 years old

Maintenance technician in a 225 et 400 kV substation (ICD Medtronic)

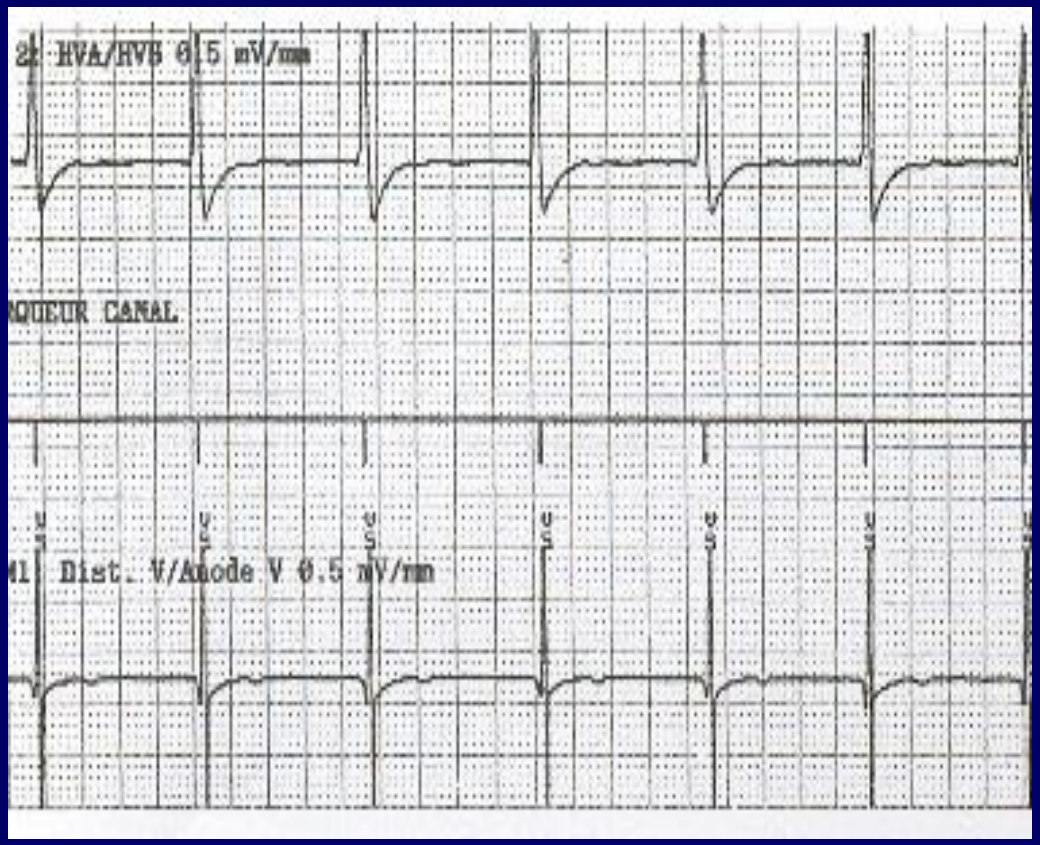
- MF max measured in contact with ICD :
- No dysfunction detected for this ICD
- Worker declared fit for the job occupied by the occupational physician ,in accordance with the cardiologist

Where the measurements have been implemented?

	B (µT)	E (kV/m)
Inside the substation relay building	20,4	0,011
Under the 400 kV lines (1700 A)	20,2	5,7
Under an out going lines 400 kV	65,4	12,2
In front of control cublicle 400kV	44,3	4,8
Close to a breaker of the substation 225kV	23	3
Under disconnectors crossing 400kV	76,8	12



Any interference in the 400 kV substation

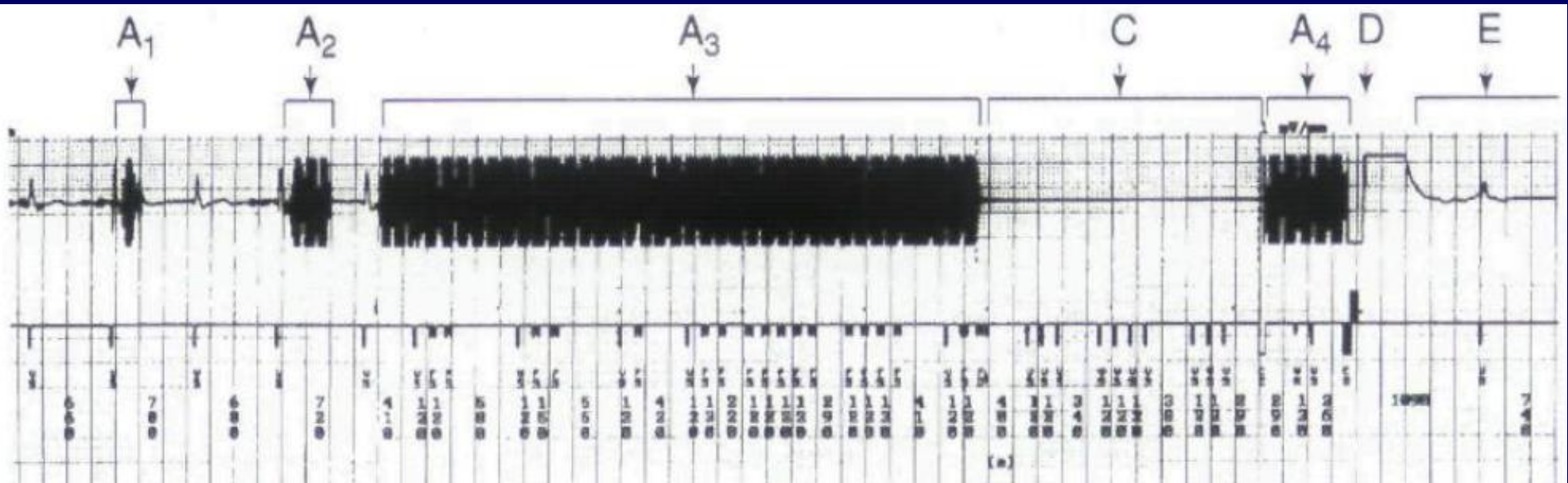


Alternating Current Electrocution Detection and Termination by an Implantable Cardioverter Defibrillator

ALI MEHDIRAD, CHARLES LOVE, STEVEN NELSON, STEPHEN SCHAAL, JANET COLLINS, and KATHY HUFFMAN

From the Cardiology Division, Department of Medicine, The Ohio State University Medical Center, Ohio State University, Columbus, Ohio

MEHDIRAD, A., ET AL.: Alternating Current Electrocution Detection and Termination by an Implantable Cardioverter Defibrillator. *A patient with an ICD accidentally grasped a power line and was electrocuted. He was unable to release the cable during electrocution though he remained conscious. After receiving a shock from his ICD, the powerline was released. ICD interrogation revealed inappropriate detection of alternating current and delivery of a shock. (PACE 1997; 20:1885–1886)*



Keep in mind!

When an interference is suspected, the first thing to do is to remove the worker from the source field .

Thank you for your attention!