RESEARCH REPORT

# Electromagnetic Fields from Shortwave Diathermy Equipment in Physiotherapy Departments

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**Key Words**

Specific absorption rate, diathermy, shortwave therapy, electromagnetic fields.

**Summary**

Shortwave diathermy results in thermal and possibly athermal effects in the tissues.

The international organisations concerned with the safe use of non-ionising radiation have derived reference field strengths to provide limiting exposure fields.

Electromagnetic field strengths from shortwave diathermy equipment were measured in six physiotherapy departments.

Values above the reference level were detected up to one metre from electrodes and cables when shortwave equipment was used in the continuous mode.

This confirms previous reports concerning significant field strengths from diathermy equipment and calls for proper use and handling of diathermy equipment by physiotherapists.

## Introduction

Shortwave electromagnetic radiations range in frequency from 10 to 100 MHz, commonly known as radiofrequency waves. Shortwave diathermy units used in physiotherapy departments have a frequency of 27.12 MHz.

Shortwave diathermy can be delivered in either a continuous mode, used primarily to heat tissues; or pulsed mode, waves of the same frequency delivered to a patient in the form of pulses. Pulsed shortwave diathermy is commonly used in clinical practice at levels that have minimal heating effects (Kitchen and Partridge, 1992).

Absorption of energy in the body from electromagnetic fields is expressed in terms of the rate of absorption per unit mass of tissue; this is called the specific absorption rate (SAR) and is measured in units of watts per kilogram (W/kg). The International Radiation Protection Association (IRPA), the International Non-ionising Radiation Committee (INIRC) (1988) have recommended that the whole body (SAR) from electromagnetic fields should be limited to 0.4 W/kg (Martin *et al*, 1991). This is defined as the mean exposure for all tissues in the body averaged over a period of six minutes. These levels apply to occupationally exposed workers such as physiotherapists but not to patients undergoing diathermy treatments, for whom the potential benefits should outweigh any possible hazard.

The values recommended by the NRPB (1989) for diathermy treatments (27 MHz) are:

| | Derived exposures levels | | |
|---|---|---|---|
| *Frequency* | *Magnetic field* | *Electric field* | *Power density* |
| 27 MHz | 0.18 A/m | 61.4 V/m | 10 W/m$^2$ |

Electric and magnetic fields have been recorded during treatment of patients and phantom treatments in physiotherapy departments in a number of hospitals and health clinics (Martin *et al*, 1991). According to their results, electric field strengths of $10^5$-$10^7$ (V/m$^2$) were measured close to three of the five diathermy units tested. Field strengths above the recommended whole-body levels for shortwave equipment extended 0.5 to 1.0 metres from the electrodes and cables when operated in the continuous mode. For the pulsed mode, field strengths above the recommended whole-body levels extended to 0.3-0.5 metres from the electrodes and to 0.8m on the highest pulse and power settings (Martin *et al*, 1991; McDowell *et al*, 1991).

The aim of this study was to measure the level of shortwave electromagnetic radiation during the operation of diathermy equipment in the continuous mode.

## Methods

*Field strengths* were measured with the following instruments:

1. Holaday Electromagnetic field meter, HI3002 Broadband Exposure Meter (Holaday Industries); probes used: LFH and CH.

2. Narda 8616 Electromagnetic Radiation monitor; probe used: 8613 (isotropic probe) 10-300 MHz.

3. Raham 484 (General Microwave) with probe 84B.

*Location:* strengths were recorded during treatment of patients in physiotherapy departments in six health clinics in the central area of Israel.

*The diathermy units* investigated in this study were of two types: five Curapuls 419 units and ten Ultratherm 608S units.

### Procedure

The machines were operated on power settings between 2 and 4, in the continuous mode (maximal power setting: 10 for Curapuls 419, and 8 for Ultratherm, peak power output 400 watts).

The measurements were made under normal operating conditions with the electrode placed on the back of the patient or on the shoulder.

Exposure was determined at distances of 20, 50, 70 and 100 cm from the electrodes.

## Results

Table 1 gives the data and figures 1 and 2 show contour maps of stray electric fields around a Curapuls 419 (power setting 3) during a back and shoulder treatment respectively.

**Table 1: Electric field strengths during back and shoulder treatment with a Curapuls 419**

| *Distance (cm)* | *Electric field (V/m$^2$)* |
|---|---|
| *Back treatment* | |
| 20 | $1*10^5$ |
| 50 | $3*10^4$ |
| 70 | $8*10^3$ |
| 100 | $3*10^3$ |
| *Shoulder treatment* | |
| 20 | $5*10^5$ |
| 50 | $2*10^5$ |
| 70 | $4*10^4$ |
| 100 | $2*10^3$ |

Table 2 gives the data and figure 3 shows the contour map around an Ultratherm 608S unit during a back treatment (power setting 3).

**Table 2: Electric field strengths during a back treatment with an Ultratherm 608S**

| *Distance (cm)* | *Electric field (V/m$^2$)* |
|---|---|
| 20 | $3*10^5$ |
| 50 | $5*10^4$ |
| 70 | $3*10^3$ |
| 100 | $1*10^3$ |

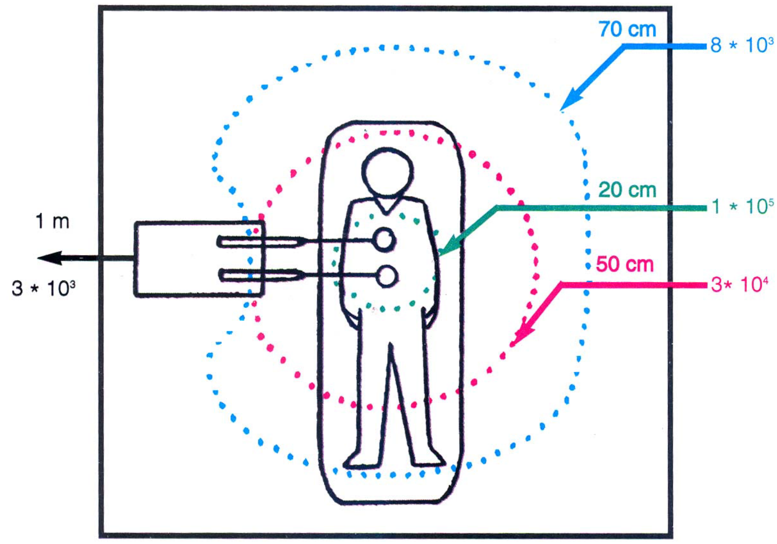


**Fig 1: Electric field strengths during a back treatment with a Curapuls 419 (V/m$^2$)**

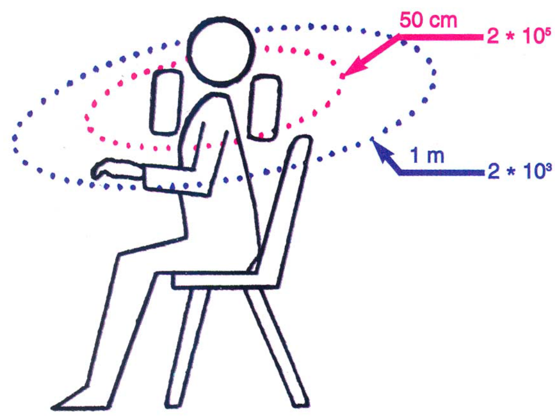


**Fig 2: Electric field strengths during a shoulder treatment with a Curapuls 419 (V/m$^2$)**

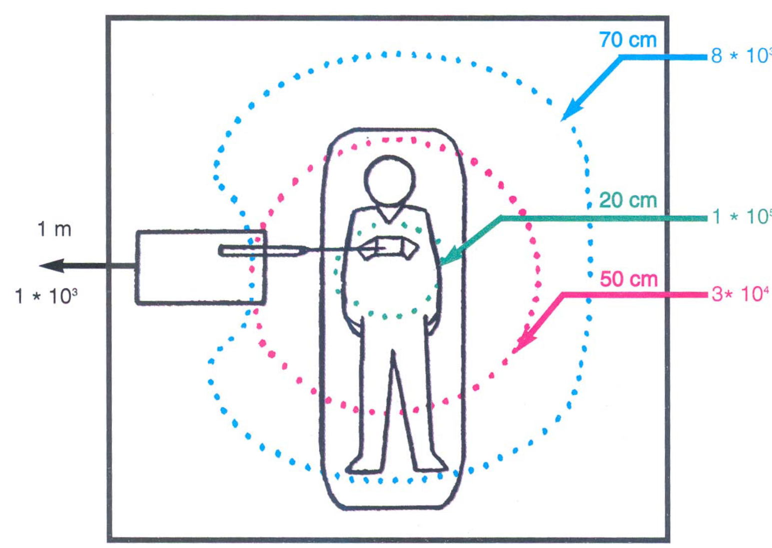


**Fig 3: Electric field strengths during a back treatment with an Ultratherm 608S (V/m$^2$)**

Magnetic field strength measurements fell below the recommended NRPB's whole-body exposure levels at a very short distance from the units, while the electric field strengths measurements fell at a distance between 70 centimetres to one metre from the electrodes and cables. These results apply both to Curapuls 419 and Ultratherm 608S.

## Discussion

Martin *et al* (1991) and McDowell *et al* (1991), measured the electromagnetic fields from therapeutic diathermy equipment. Field strengths above the recommended whole-body levels from shortwave equipment extended 50 cm to 1.0 m from the electrodes and cables using the continuous mode and 30 cm to 50 cm in the pulsed mode. The units were operated at low and medium levels. They conclude that there is little danger of the reference levels being exceeded if physiotherapists remain at least 1 m from the shortwave electrodes during the majority of treatments in the continuous mode, and do not approach within 50 cm from the electrodes and cables.

In recent years, a number of published articles have addressed possible adverse effects to physiotherapists working with shortwave diathermy. Kallen *et al* (1992) described a higher degree of shortwave use among those physiotherapists who gave birth to malformed or perinatally dead infants.

Following a report of a cluster of four cases of congenital malformations among 25 pregnancies of a physiotherapy staff exposed to shortwave diathermy during pregnancy, Larsen (1991) and Larsen *et al* (1991) looked for an association between shortwave and adverse pregnancy effects. A positive but weak and statistically insignificant trend was found for congenital malformations, greater for female infants than for male ones. An unexpectedly low ratio of male to female births was found for the physiotherapists exposed to shortwave diathermy, and there seems to be a negative impact on lengths of gestation and birthweight for male deliveries, although this is also not statistically significant.

Quellet-Hellstrom *et al* (1993) found no correlation between shortwave diathermy and spontaneous abortions, although Taskinen *et al* (1990) found a threefold odds ratio for spontaneous abortion occurring after the tenth week of gestation on those exposed to shortwave diathermy. Taskinen *et al* (1990) also found that shortwave diathermy was associated significantly with congenital malformations in the lower exposure category and not in the highest one.

## Conclusion and Recommendations

Our measurements confirm the findings described by Martin *et al* (1991) concerning electromagnetic field strengths from continuous mode shortwave diathermy. In the light of these findings and those of other studies, safe use and handling of diathermy equipment by physiotherapists and strict adherence to recommended safety guidelines cannot be overemphasised.


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