

How safe are microwaves?

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This unusual paper consists of a series of questions derived from discussion among a group of industrial physicians who in the course of their work have been asked to give advice about exposure to microwaves. Those who can answer any of these questions, both in a quantitative and qualitative way, are invited to send answers to the editor. Interesting and helpful replies will be considered for publication.

THE DIFFICULTY we have in answering questions about microwaves stems from the fact that we have been unable to keep up to date with the striking advances in physics since we were last exposed to the subject in our pre-clinical days. It is difficult enough to keep up to date with advances in biological knowledge.

The depth of our ignorance will be apparent from the nature of our questions. We make no excuses for this, having found it better—and safer—to confess ignorance rather than assume knowledge. We may derive some comfort from the possibility that our physicist colleagues are in the same position with regard to biology. Only in the effort to understand one another can progress be made.

So far as the electromagnetic spectrum is concerned we have some practical knowledge of the effect of infra-red (glass-blower's cataract), ultraviolet (welder's flash) and more particularly ionizing radiations (diagnosis and therapy, radiation sickness, etc). We find it difficult however to understand the mechanisms at cellular or tissue level which produce the effects that have been attributed to microwaves.

Effects attributed to microwaves

An enormous variety of biological phenomena have been attributed to microwaves. These include

heating effects

on the lens, genitalia, brain, metal implants and whole body (temperature regulation defects)

central nervous system effects

headaches, insomnia and restlessness during sleep, electroencephalographic changes, cranial nerve disorders, pyramidal tract lesions, conditioned reflex disorders

autonomic nervous system effects

neuro-vegetative disorders, fatigue

peripheral nervous system effects

effects on locomotor nerves

psychological disorders

neurosthenia, depression, impotence, anxiety, lack of concentration

blood disorders

increase in haemolysis rate, increased sedimentation rate, blood and bone marrow changes, decrease in erythrocytes, leucopaenia, changes in phagocytic and bactericidal function of blood, increased blood glucose, increased gamma globulin and total protein.

vascular disorders

thrombosis, hypertension

enzyme changes

reduced cholinesterase activity, reduced phosphatase activity, increased transaminase

metabolic disorders

increase in urinary phenol, glycosuria

gastro-intestinal disorders

anorexia, epigastric pain, constipation

histological changes
changes in spermatid epithelium

genetic changes
mutations, mongolism.

Question on effects

1 We should like to know what mechanism is responsible for such a wide spectrum of effects, if indeed the experiments and observations are valid.

Questions on the nature of microwaves

In particular we should like to know

2 How important is the wavelength?

- (a) are shorter wavelengths more penetrating or more likely to cause damage?
- (b) are polyfrequency radiations more or less dangerous than monofrequency?
- (c) is any sector of microwave energy more likely to be absorbed than another?

3 How important is the waveform?

- (a) are broad-beam sources more or less likely to cause trouble than narrow-beam sources?
- (b) are pulsed frequencies more dangerous than continuous?

4 How important is the intensity?

- (a) how does intensity vary from the source?
- (b) does the law of inverse squares apply?
- (c) is field intensity the same as power density?

5 How important is duration of exposure?

- (a) can persons be exposed to higher levels for shorter periods without danger?

6 Is there any magnetic component and does it produce any special effect?

7 Are X-rays likely to be produced by some apparatus and if so what kinds?

- (a) is there any protective effect against ionizing radiation?

8 Is there a unit for measuring dose-rate and total dose?

9 Is whole body exposure more or less likely to cause trouble than local exposure?

- (a) is the heating effect greatest at the surface or at some measurable point within tissue?
- (b) what level of exposure would cause local burns or underlying damage to tissue including bone?
- (c) can heatstroke occur from whole body exposure?
- (d) why do metal implants heat more quickly than tissues?
- (e) what is the effect on cardiac pacemakers?

10 What organs or tissues are at greatest risk?

11 What is the effect on electrical potentials of nerve fibres of the central or peripheral nervous systems?

12 What are the earliest signs of exposure?

13 How is the rate of recovery related to power density and duration of exposure?

Questions on tests

14 Biological

- (a) what sort of tests can we do to detect early effects (blood, eye, electroencephalography etc.)?
- (b) should there be any prohibitions on employment (eye or blood conditions, pregnancy)?
- (c) are periodic clinical examinations of any value?

15 Personal

- (a) are there any personal monitoring devices?

16 Environmental

- (a) what sort of environmental tests are possible?
- (b) what is the best type of measuring apparatus?

Questions on protection

17 What protective measures can be employed?

- (a) distance
- (b) screens
- (c) shielding
- (d) protective clothing