MOBILE MICROWAVE EFFECT ON BACTERIAL ANTIBIOTIC SENSITIVITY

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ABSTRACT

The effect of mobile microwave on antibiotic sensitivity of *Staphylococcus ureus* was estimated. One hundered samples of ear swab were collected from mobile phone users. They were subjected for *S. aureus* isolated and identification by Staph API- 20 enzymes. Forty three of *Staph.* strains were selected as identical biochemical test. They were ordered into eight groups according to calling times of mobile users , ranged from zero (used as control) to three hundred and six hours of calling time. Seventeen different antibiotic discs sensitivity were measured for *S. aureus*. Microwave of mobile phone showed significant effect ($P<0.01$) on strains sensitivity according period of calling time. All strains showed more antibiotic resistance development at long calling period group than those have less calling (control and firsts groups). The present study may be explanation of mobile microwave of mobile effect on DNA expression as far as antibiotic resistance encoded by plasmid DNA.

INTRODUCTION

In recent years many studies have investigated whether mobile phones and radio frequency (RF) fields in general could cause biological effect. Epidemiological studies on mobile phone users have focused on cancers originating in the head, especially brain tumors. Overall, research indicates that mobile phone use does not increase the risk of cancer, especially when used for less than ten years (1). Findings from published studies in the ongoing Interphone project, which pools data from 13 countries, supports that finding (1).

The principal studies focused on those wave bands which held promise for use in instruments and appliances for general utility or popular applicability. Today, those microwave bands called UHF (300 to 3,000 MHz) are used in many commercial

devices, including television, microwave communications, microwave, ovens, medical diathermy, radio navigation, long-range radar, and an abundance of special equipment designed for specific uses (2-5).

Many reports show that the bactericidal action of microwaves resides in the thermal effect, i.e., energy transfer from microwaves to the specimen material (5, 6).

Animal studies that investigated if RF fields could induce cancer, enhance the effects of cancer-causing substances, or accelerate the development of tumors found no or no consistent effects when the study was repeated. Recent studies have used higher field strengths than previous ones, without any further effect (1).

Some studies suggest effects on DNA at exposure levels close to guideline limits, but there is little agreement between studies, and the significance of the effects observed remains unclear (1).

Different biological effects have been investigated in cell cultures, but so far no mechanism that might lead to cancer could be found for radio frequency fields below the recommended safety limit for exposure from mobile phones(1).

When exposed to RF fields, the body absorbs energy from them. Evaluating how much RF energy an individual absorbs every day is not obvious as the level of exposure depends on many factors, especially distance from the various sources and duration of exposure. Field strength or the amount of energy the field transmits, falls rapidly with distance, meaning a person may absorb more energy from a device used at close quarters – a handheld mobile phone, for example – than from a more powerful source, like a radio transmission tower, that is farther away (1).

Various bacteria, fungi, actinomycetes, and bacteriophages were exposed to microwaves of 2,450 MHz in the presence and in the absence of water. It was found that microorganisms were inactivated only when in the presence of water and that dry or lyophilized organisms were not affected even by extended exposures. The data presented here prove that microorganisms are killed by "thermal effect" only and that, most likely, there is no "nonthermal effect"; cell constituents other than water do not absorb sufficient energy to kill microbial cells (7).

Most of the studies mentioned above concluded that the microwave effect, if it existed, was indistinguishable from the effects of external heating.

There is, in fact, plenty of evidence to indicate that there are alternate mechanisms for causing DNA covalent bond breakage without invoking the energy levels of ionizing radiation (Watanabe 1985(8), 1989(9), Ishibashi 1982(10), Kakita 1995(11), Kashige

1995, Kashige 1990, 1994(12,13,14)). Still, no theory currently exists to explain the phenomenon of DNA fragmentation by microwaves although research is ongoing which may elucidate the mechanism (Watanabe 1996)(15).

The results of microwave irradiation affected two bacteria, *S. aureus* and *E. coli*. The death curves exhibited classic exponential decay, as well as a possible second stage. These curves are based on data from Kakita *et al* (1999)(16).

There is evidence that microwave radiation may speed up rates of folding and unfolding for globular proteins in solution[17]. This should increase the chances of collision between partially unfolded molecules, leading to irreversible aggregation and hence increased light scattering [18],

Present day use of mobile phones is ubiquitous. This causes some concern for human health due to exposure to high-frequency electromagnetic fields (HFEMF) from mobile phones. Consequently, it has examined the effects of 2.45 GHz electromagnetic fields on bacterial mutations and the hypoxanthine-guanine phosphoribosyl transferase (HPRT) gene mutations. Bacteria were exposed to HFEMF for 30 min at specific absorption rates from 5 to 200 W/kg. In all strains, there was no significant difference in the frequency of revertant colonies between sham exposure and HFEMF-exposed groups(19).

There has been much debate over the possible health hazards of electromagnetic fields produced by mobile phones. The purpose of this project is to determine what effects such fields have on bacterial antibiotic sensitivity by exposed bacteria to varying calling time microwave. Furthermore, it's an explanation of microwave effect on bacterial DNA as far as bacterial antibiotic sensitivity is controlled by plasmid.

MATERIALS AND METHODS

Volunteers and Sampling: one hundred healthy volunteers who were usual costumers of mobile phones an ear sample was made from college of pharmacy employee dated November 2009. Inquiring about the periods of total time calling with phone was carried out. A healthy control group of non users was studied too.

Sampling:

Ear swab were collected from one hundred people. They were used mobile phone at various calling times. According to their calling time were classified into eight groups ranged from zero calling time (as control) to about 306 hours calling time.

Bacteriology:-

Different media were prepared as described by their manufacturer company (Difco and Bacto) as nutrient agar and Muller-Hinton agar.

Swab sample were cultured on nutrient agar and incubated at 37°C for overnight.

Out of different bacterial species, *Staphylococcus aureus* were selected for the present study. Further biochemical test were done by Staph API-20 Enzyme to select only those species of *Staphylococcus aureus* have identical enzymatic styles.

Antibiotic sensitivity:-

Seventeen antibiotic discs were selected to evaluate staph strains susceptibility at different calling time's intervals.

Inhibition zones for each antibiotic disc were measured.

Statistical analysis:-

Forty three isolates with identical strains of *S. aureus* at different calling time were distributed in eight groups. Analysis of variance (ANOVA) confirmed an efficacy effect by a mobile phone wave on *Staphylococcus aureus* resistance against about seventeen antibiotics(20).

RESULTS AND DISCUSSION

Many of Bacterial species were isolated from one hundred ear sample; *Staphylococcus aureus* were selected among different species. It was more frequent than others strains. Also further biochemical test were done by API 20-Enzyme to select strains of *S. aureus* those have identical biochemical test (table 1). This step was to be the variable factor only time of mobile calling on bacterial sensitivity as shown in table (2).

Table(1): API-20 enzyme results of *S. aureus* obtained from ear

Biochemical test	Glu	Fru	Mne	Mal	Lac	Tre	Man	Mel	Nit	Pai	Vp	Raf	Xyl	Sac	Mdg	Nag	Adh	Ure
Result	+*	+	+	+	+	-*	-	-	ND*	ND	ND	-	+	+	-	-	-	-

+* :positive
-* : negative
ND: not detected

Samples:

Fourty three ear sample at different calling time were distributed in eight groups. First group hav'nt mobile consider as control, while the eighth group have about three hundred and six hours of calling time.

Table(2):Rates of inhibition zones for each antibiotic of different samples.

Antibiotic disc	Rate of inhibition zones
AK*(30µg)	22.91±4
AX(25µg)	15.26±3
C(30µg)	19.60±5
CIP(5µg)	20.98±5
CTX(30µg)	9.33±2
DA(2µg)	18.74±3
E(15µg)	17.93±4
F(300µg)	22.91±3
KF(30µg)	10.63±2
L(2µg)	15.07±4
NA(30µg)	9.79±3
P(10µg)	13.93±3
S(10µg)	15.91±3
T(30µg)	15.98±4
TE(30µg)	14.95±5
TMP(5µg)	12.95±2
TOP(10µg)	20.16±5

AK*;Amikacin, AX;Amoxcillin, C;Chloromphenicol, CIP; Ciprofloxacin, CTX; Cefotaxime, DA; Clindomycin, E;Erythromycin, F;Nitrofurantion, KF;Cephalothin, L;Lincomycin, NA; Naldixic acid, P; Pencillin, S; Streptomycin, T; Oxytetracycline, TE; Tetracycline, TMP, Trimethoprim.

Majority of antibiotics showed antimicrobial activity against *S. aureus* with different diameter of inhibition zones varied from 26mm to zero with average 16.6mm as shown in table (3).

Antmicrobial activity means of different calling time groups were summarized in table (4). Amickacin (AK), ciproflacsxcin (CIP), Furantion (F) and Topromycin (TOP) have the major inhibition zones were recorded (mean 21.17mm±1.73).on the other hand the lowest inhibition zones were recorded in CTX, Naldixic acid NA and Cephalexin (KF) (9.91mm±0.71).

Table(3):Rates of inhibition zones for all antibiotics at each duration groups

Groups	**0hr*(C) N**=5**	**4-5hr N=5**	**6-10hr N=5**	**11-19hr N=5**	**20-25hr N=5**	**27-54hr N=6**	**77-94hr N=6**	**110-306hr N=6**
Rate of inhibition zones	**20.12 ±4**	**19.11 ±4**	**14.35 ±3**	**14.51 ±5**	**16.56 ±3**	**13.82 ±3**	**12.41 ±3**	**16.41 ±3**

Strong correlation between calling time and bacterial resistance were recorded ($p<0.01$). The resistance had been come into view significantly ($p<0.01$) at seventh group were calling time about 94hour(12.41mm) than control and those people with less calling time(20.12mm) (Figure 1).

Surprisingly that bacterial resistance developed significantly with period time of calling for most antibiotics with some exceptions (Table4 and Figure1-7). Mean antibiotic inhibition zones of group one was 20.12mm then reduced to be 19.11mm, 14.35mm, 14.51mm at groups 2nd, 3rd, and 4th while the exception was in 5th groups (16.56mm) then reduction return at groups 6th, and 7th (13.82mm and 12.41mm) while the exception recorded also at group 8th (16.41mm).

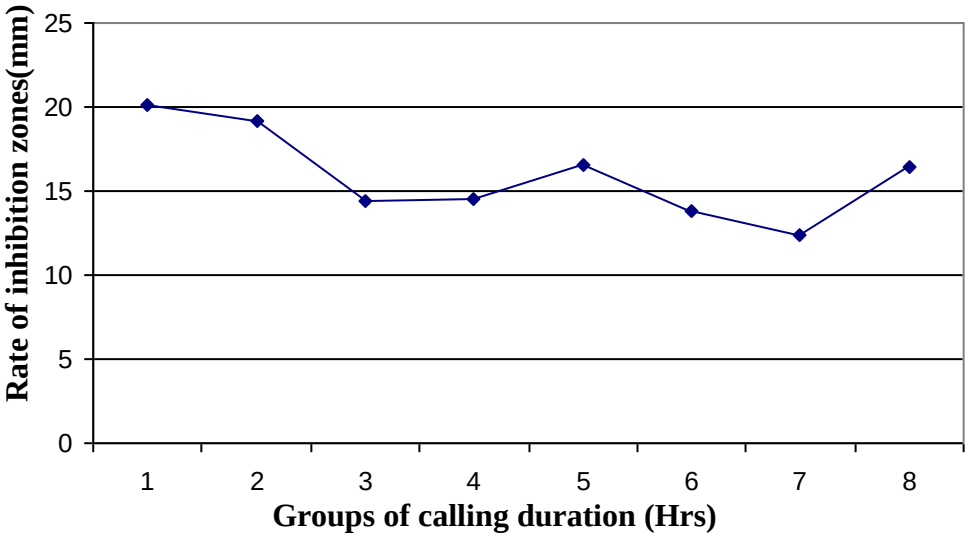


Figure (1): Resistance development of *S. aureus* with long calling duration.

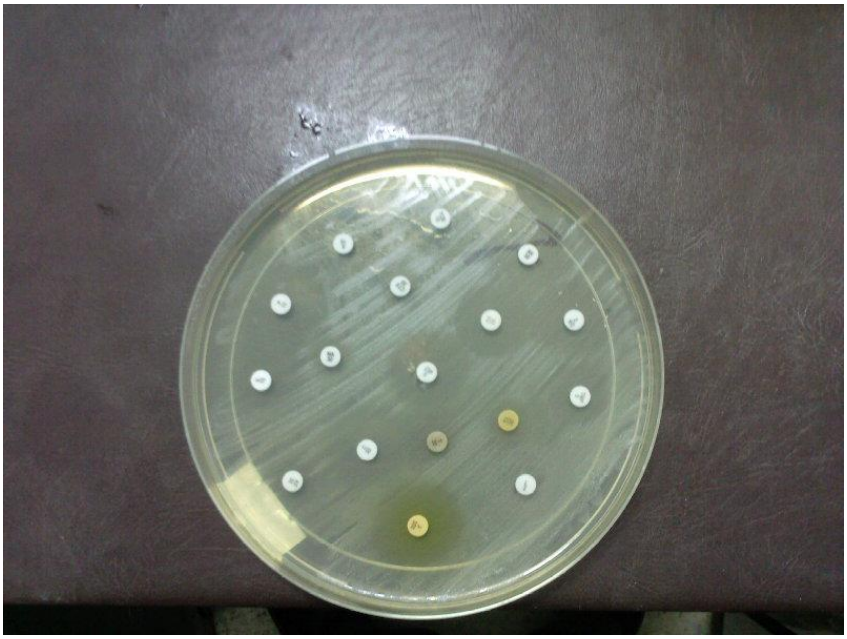
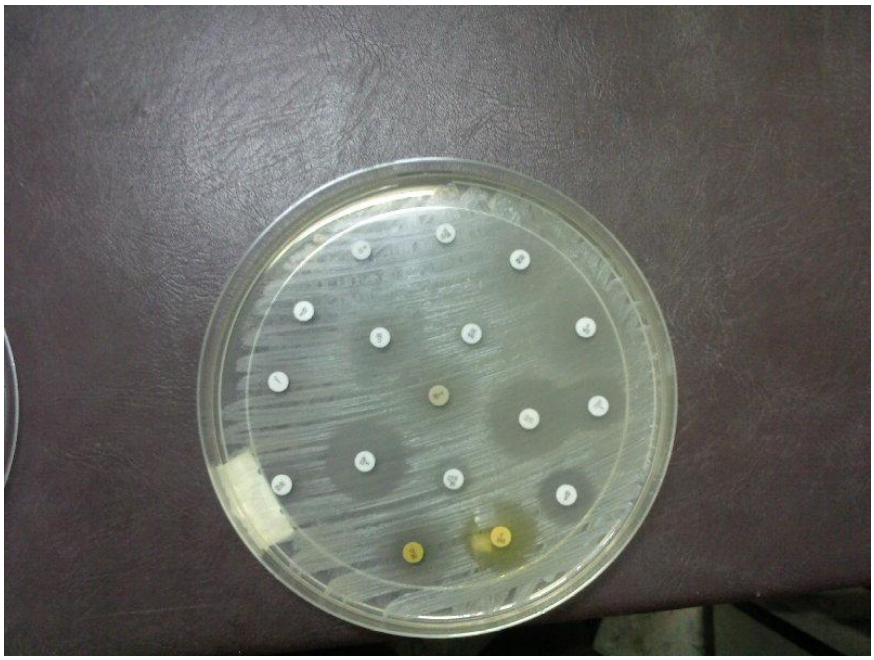
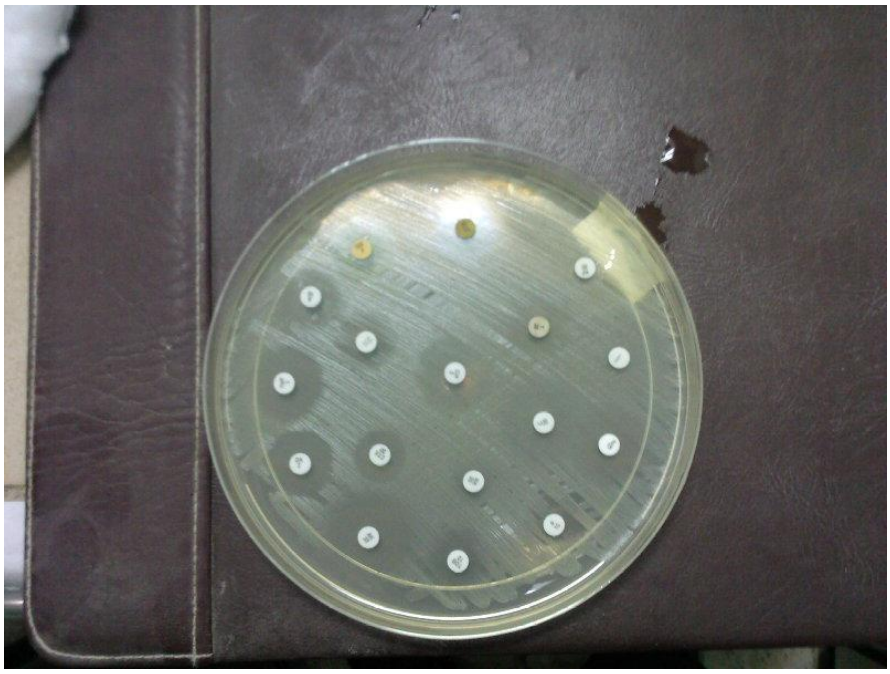


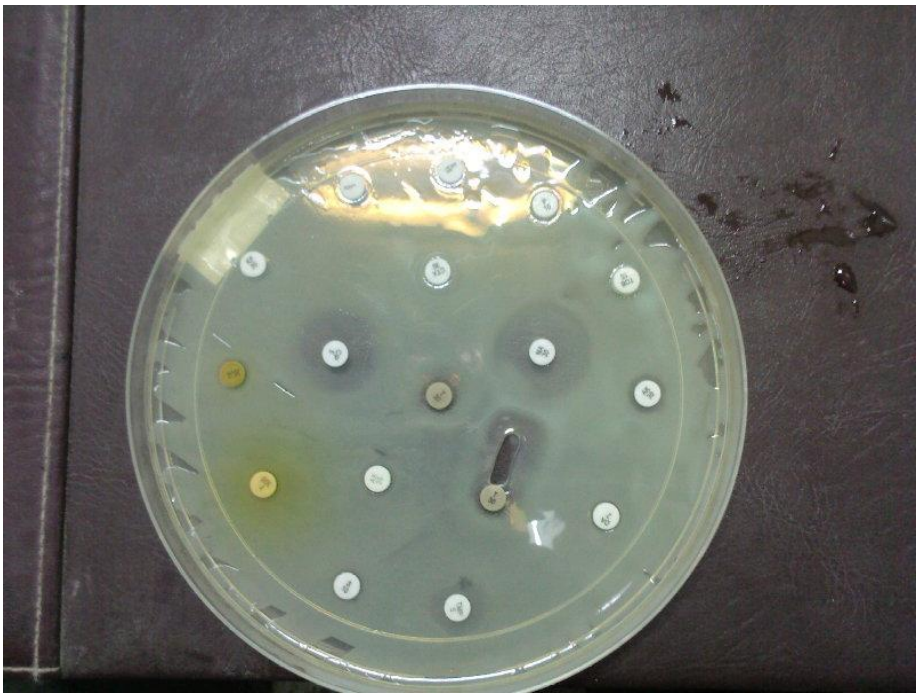
Figure (2): Group one of antibiotic sensitivity against *S. aureus* without mobile microwave calling time.



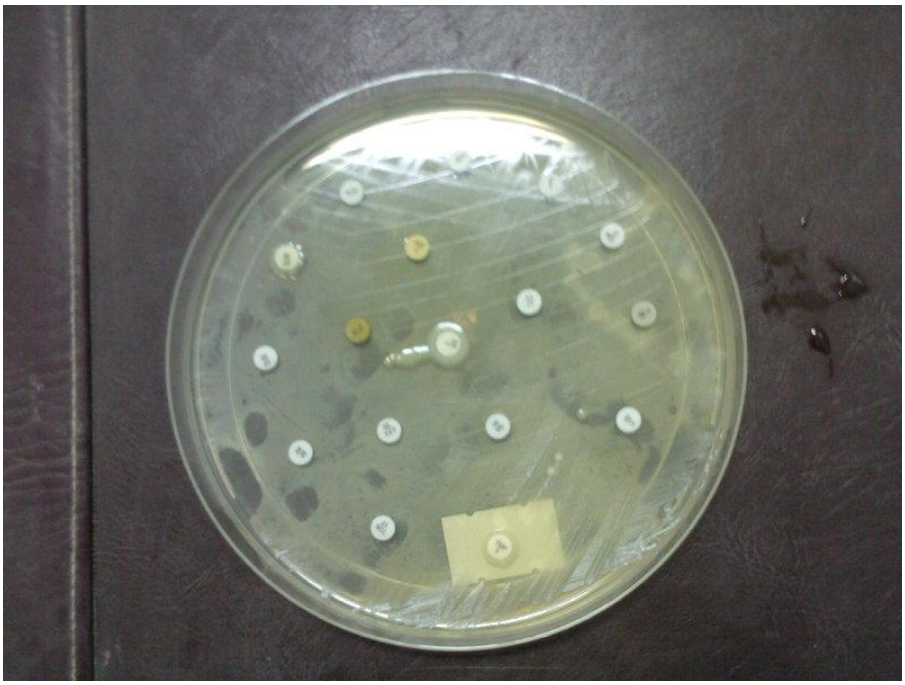
Figure(3): Group two of antibiotic sensitivity against *S. aureus* with mobile microwave calling time about five hours.



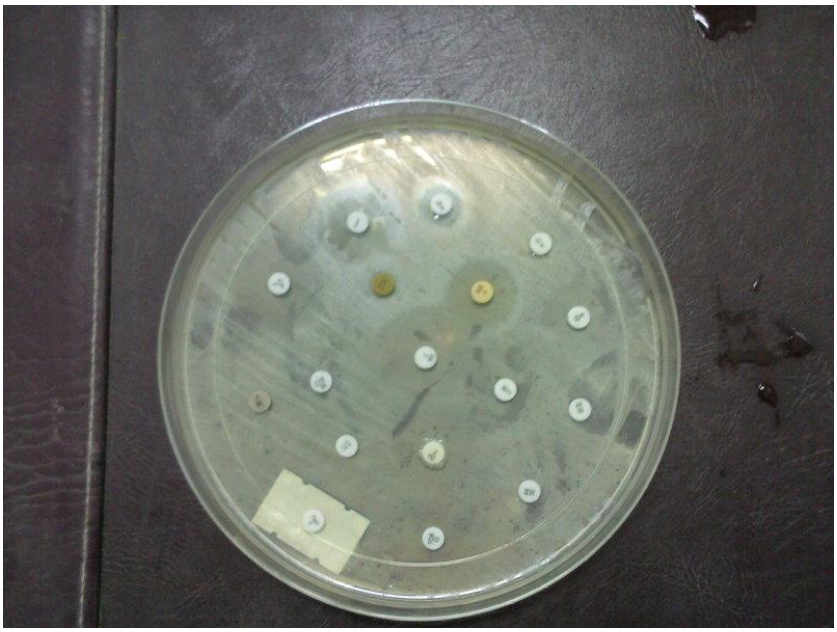
Figure(4): Group three of antibiotic sensitivity against *S. aureus* with mobile microwave calling time up to 10 hours.



Figure(5): Group four of antibiotic sensitivity against *S. aureus* with mobile microwave calling time up to 19 hours.



Figure(6): Group six of antibiotic sensitivity against *S. aureus* with mobile microwave calling time up to 54 hours.



Figure(7): Group eight of antibiotic sensitivity against *S. aureus* with mobile microwave calling time up to 306 hours.

Really, we didn't find any study correlate between mobile microwave effect and bacterial resistance. The present study gives details that may have effect on Bacteria plasmid to enhance bacterial resistance. So, long calling time may get adverse mutation lead to reverse bacterial sensitivity as shown at group eight (long call duration).

Some studies suggest effects on DNA at exposure levels close to guideline limits, but there is little agreement between studies, and the significance of the effects observed remains unclear (1-3).

Few users have had mobile phones for more than ten years, which makes it difficult to investigate the antibiotic resistance risk of longer term use.

Different biological effects have been investigated in cell cultures, but so far no mechanism that might lead to relationship could be found for radio frequency fields below the recommended safety limit for exposure from mobile phones(1).

Also, children who start using mobile phones will have a greater lifetime exposure than people who were adults when they began using mobile phones

Data for risk assessment of static magnetic fields are still inadequate, and the effects of mixed fields, where static fields interact with other electromagnetic fields, are still

largely unknown. A number of new technologies, such as MRI equipment, are using combinations of different fields, which makes this a priority for research.

Microwaves are part of the electromagnetic spectrum and are considered to be that radiation ranging in frequency from 300 million cycles per second (300 MHz) to 300 billion cycles per second (300 GHz), which correspond to a wavelength range of 1 m down to 1 mm. This nonionising electromagnetic radiation is absorbed at molecular level and manifests as changes in vibrational energy of the molecules or heat(20). Identifying and evaluating the biological effects of microwaves have been complex and controversial. Because of the paucity of information on the mechanism of interaction between microwave and biological systems, there has been a persistent view in physical and engineering sciences, that microwave fields are incapable of inducing bioeffects other than by heating (20).

The present article is an attempt to familiarise the reader with pertinent information regarding the effects, mainly athermal, of microwave irradiation on biologic systems, especially microorganisms.

The present study recommends reducing of calling duration to be only for necessary cases. Also recommends for more studies with others Bacterial strain to confirm exactly that microwave have altering effect to convert bacteria tobe more resist which inturn reflect that mobile microwave have DNA mutagen effect.

More research is needed to establish whether or not there is a risk associated with long term mobile phone usage well beyond ten years.

تقدير تاثير موجات جهاز الهاتف الجوال على حساسية المكورات العنقودية الذهبية للمضادات الحيوية

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الخلاصة

الدراسة الحالية هي تقدير تاثير موجات جهاز الهاتف الجوال على حساسية المكورات العنقودية الذهبية للمضادات الحيوية . اخذت مئة مسحة من الاذن لمستخدمي الهاتف الجوال. وجد ان المكورات العنقودية هي السائدة والتي تم .ثلاثة واربعون عزلة تم اختيارها. (Staph API- 20 enzymes)تشخيصها بواسطة اشرطة

وزعت العزلات الى ثمان مجاميع حسب فترة الاتصال الكلية لكل مستخدم (0-306) ساعة حيث استخدمت المجموعة الصفرية كمجموعة سيطرة. سبعة عشر قرص مضاد حيوي لقياس الحساسية الدوائية للمكورات العنقودية. اظهرت موجات جهاز الهاتف الجوال تأثير معنوي على حساسية المكورات العنقودية الذهبية للمضادات الحيوية عند مجاميع الأشخاص ذوي مدة الاتصال الأطول حيث لوحظ تطور مقاومة للمضادات الحيوية مقارنتا مع أشخاص المجموعة الضابطة والمجاميع الأولى ذوي الاتصال الأقل مدة. الدراسة الحالية تفسر ذلك بان لموجات جهاز الهاتف الجوال تأثير على تغيير الدنا لان المقاومة يشفر لها من قبل البلازميد.

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