Short Report

Electromagnetic Radiofrequency Radiation Emitted from GSM Mobile Phones Decreases the Accuracy of Home Blood Glucose Monitors

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ABSTRACT

Mobile phones are two-way radios that emit electromagnetic radiation in microwave range. As the number of mobile phone users has reached 6 billion, the bioeffects of exposure to mobile phone radiation and mobile phone electromagnetic interference with electronic equipment have received more attention, globally. As self-monitoring of blood glucose can be a beneficial part of diabetes control, home blood glucose testing kits are very popular. The main goal of this study was to investigate if radiofrequency radiation emitted from a common GSM mobile phone can alter the accuracy of home blood glucose monitors. Forty five female nondiabetic students aged 17-20 years old participated in this study. For Control-EMF group (30 students), blood glucose concentration for each individual was measured in presence and absence of radiofrequency radiation emitted by a common GSM mobile phone (HTC touch, Diamond 2) while the phone was ringing. For Control- Repeat group (15 students), two repeated measurements were performed for each participant in the absence of electromagnetic fields. The magnitude of the changes between glucose levels in two repeated measurements ($|\Delta C|$) in Control-Repeat group was 1.07 ± 0.88 mg/dl while this magnitude for Control-EMF group was 7.53 ± 4.76 mg/dl ($P < 0.001$, two-tailed test). To the best of our knowledge, this is the first study to assess the electromagnetic interference in home blood glucose monitors. It can be concluded that electromagnetic interference from mobile phones has an adverse effect on the accuracy of home blood glucose monitors. We suggest that mobile phones should be used at least 50 cm away from home blood glucose monitors.

Keywords

Electromagnetic Radiation, Radiofrequency, Interference, GSM, Mobile Phones, Home Blood Glucose Monitors

The use of mobile phones has increased rapidly over the past decades [1,2]. Mobile phones are very popular communication devices for doctors and nurses who are continuously moving around in clinics and hospitals. Mobile communication technology has been used in different fields of healthcare delivery [3]. Health care providers also use mobile phones as an input/output tool for hospital information systems (HIS). Mobile phones enable healthcare professionals to possess a portable platform from which to provide many healthcare-related applications and are a popular means to directly communicate with colleagues and patients. However, the electromagnetic radiofrequency (RF) radiation in microwave (MW)

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range emitted from mobile phones may interfere with medical electronic equipments [4]. Therefore, requirement for shielding medical equipments have long been part of the US FDA's requirement to market medical equipments. In contrast with the US FCC, which concentrates on the potential interference of RF emitting devices with medical equipments, the FDA focuses on the issue of safety and efficiency of medical equipments for patient use. FDA's range of the products which can be classified and regulated as "medical devices" is very broad and includes devices such as medical information networks, mobile phones programmed to remind patients to take prescribed medicines on time.

Home blood glucose monitors (HBGMs), measuring glucose levels by using a convenient glucose meter and test strips, efficiently help patients achieve optimal health through understanding the effects of medications, meal planning, and physical activity on their glucose levels. HBGMs also help patients make decisions about treatment modalities and allow them to recognize possible emergency situations. Over the past years, our laboratory has focused on studying the health effects of exposure of laboratory animals and humans to some common and/or occupational sources of electromagnetic fields such as mobile phones [5-12] and their base stations [13], mobile phone jammers [14], laptop computers [15], radars [6], dentistry cavitrons [16] and MRI [11]. The purpose of this study was to determine if electromagnetic radiofrequency radiation emitted from GSM mobile phones decreases the accuracy of home blood glucose monitors.

Materials and Methods

Forty five female nondiabetic students ranged in age from 17 to 20 year participated in this study. Blood samples were obtained from volunteer participants by venipuncture and analyzed for glucose level by using a new BIONIME (GM110, Taiwan) blood glucose monitoring system.

For Control-EMF group, within ten minutes after venipuncture, blood glucose concentration for each individual was measured in presence and absence of electromagnetic fields caused by a common GSM mobile phone (HTC touch, Diamond 2) during ringing. Position of the mobile phone and the BIONIME home blood glucose monitor during measurement is shown in figure 1. For Control- Repeat group, two repeated measurements in the same time interval were performed for eac participant in the absence of electromagnetic fields.

After performing both measurements in

Figure 1: Position of the mobile phone and the BIONIME home blood glucose monitor during measurement.

Control-EMF and Control-Repeat group, the magnitude of the changes between glucose levels in two repeated measurements or $|\Delta C|$

$$|\Delta C| = \textit{Glucose level in the 1st measurement - Glucose level in the 2nd measurement} \quad \text{(Eq. 1)}$$

was calculated as:

In this equation, glucose level in the 2nd measurement was either the measurement in the presence of EMF (in Control-EMF group) or the repeated measurement in Control-Repeat group.

Results

Blood glucose levels (mg/dl) in 30 participants of Control-EMF group are indicated in

Table 1: Blood glucose level (mg/dl) in 30 participants of Control-EMF group. Blood glucose concentration for each individual was measured in presence and absence of electromagnetic fields generated by a mobile phone during ringing.

		Glucose Level (mg/dl)		
	Age (y)	Control (1st Measurement)	EMF (2nd Measurement)	$\lvert\Delta C\rvert$ (mg/dl)
	18	82	94	12
	19	78	84	6
	19	89	69	20
	18	90	92	2
	20	82	95	13
	18	95	90	5
	19	92	82	10
	18	91	88	3
	18	73	93	20
	19	88	81	7
	18	89	91	2
	20	90	93	3
	19	90	86	4
	19	86	99	13
	18	75	81	6
	20	92	96	6
	20	95	99	4
	18	90	79	11
	18	96	103	9
	19	100	92	2
	19	90	95	5
	18	85	88	3
	18	86	95	9
	19	87	80	7
	18	85	97	12
	20	92	86	6
	20	96	93	3
	19	94	101	7
	17	87	80	7
	18	82	73	9
Mean	18.7	88.23	89.17	7.53
SD	0.83	6.20	8.30	4.76
Max	20	100	103	20
Min	17	73	69	2

table 1. The 45 participants in the study ranged in age from 17 to 20 year old with a mean of 18.70 ± 0.84 y for Control-EMF group and 18.73 ± 0.96 y for Control-Repeat group. Blood glucose levels (mg/dl) in 15 participants of Control-Repeat group are indicated in table 2. The range of blood glucose level for Control-EMF group was between 69 and 103 mg/dl while it was between 82 and 100 mg/dl for Control-Repeat group. The magnitude of the changes between glucose levels in two repeated measurements ($|\Delta C|$) in Control-Repeat group was 1.07 ± 0.88 mg/dl while this magnitude for Control-EMF group was 7.53 ± 4.76 mg/dl. After performing Mann-Whitney U-Test, the difference between $|\Delta C|$ of these two groups was statistically significant ($P < 0.001$, two-tailed test).

Discussion

Findings of this study showed that mobile phones can cause electromagnetic interference in home blood glucose monitors and stop these popular user-friendly devices from working properly. The magnitude of the changes between glucose levels in two repeated measurements ($|\Delta C|$) in Control-Repeat group was 1.07 ± 0.88 mg/dl while this magnitude for Control-EMF group was 7.53 ± 4.76 mg/dl ($P < 0.001$, two-tailed test). To the best of our knowledge, this is the first study to assess the electromagnetic interference in home blood glucose monitors. Electromagnetic interference of medical equipments has been known for some time in hospitals. In some countries authorities have published guidelines about interference from mobile phones in medical

Table 2: Blood glucose level (mg/dl) in 15 participants of Control-Repeat group. Blood glucose concentration for each individual was measured twice in absence of electromagnetic fields generated by a mobile phone during ringing.

		Glucose Level (mg/dl)		
	Age (y)	Control (1st Measurement)	Repeat (2nd Measurement)	$\|\Delta C\|$ (mg/dl)
	20	92	90	2
	20	95	94	1
	18	90	90	0
	18	96	95	1
	19	100	100	0
	19	90	91	1
	18	85	84	1
	18	86	84	2
	19	87	88	1
	18	85	86	1
	20	92	92	0
	20	96	96	0
	19	94	92	2
	17	87	84	3
	18	82	83	1
Mean	18.73	90.47	89.93	1.07
SD	0.96	5.11	5.09	0.88
Max	20	100	100	3
Min	17	82	83	0

equipments. In January 2009, the UK NHS announced that use of mobile phones in NHS hospitals is generally allowed, as long as their use does not affect the safety of patients or other people, patients' privacy and dignity or the operation of medical equipment. In this report UK NHS, confirmed that mobile phones–generated electromagnetic interference of medical equipments can stop medical equipment such as dialysis machines, defibrillators, ventilators, monitors and pumps from working properly [17]. Based on the results obtained in this study, it can be concluded that electromagnetic interference from mobile phones has an adverse effect on the accuracy of home blood glucose monitors. We suggest that mobile phones should be used at least 50 cm away from home blood glucose monitors.

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Conflict of interest

None declared.

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