INFORMATION BRIEF (RAPID REVIEW)

INTERFERENCE BY MOBILE PHONES ON MEDICAL DEVICES

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PURPOSE

To provide brief information on the interference by mobile phones on medical devices.

BACKGROUND

Mobile phone users and technologies have grown rapidly since they began. The first-generation (1G) technology which supports voice calls thru voice network radio waves transmission in an analogue signal was found sensitive to other radio devices stored/used nearby, causing background disturbance.[1] The following second-generation (2G) mobile phone was a step ahead with improvement in better bandwidth and using digital radio signals transmission. Better known as Global System for Mobile Communication (GSM), it utilised Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) technologies to eliminate the barriers of limited user base and background noise.[1]

Mobile technology later evolved to the third generation (3G). It is based on Universal Mobile Telecommunication Systems (UMTS) which are mainly centred around high-speed data applications.[2] It enables the network operators to use a broader range of more advanced services, therefore achieving greater network capacity and improved spectral efficiency.[3] Technological progress in mathematical and algorithmic improvements has resulted in the 3G mobile network transmitting signals with higher efficiency at lower power.[1] Current mobile phones are mostly in the fourth generation (4G). The 4G is riding on Long Term Evolution (LTE) technology used for devices constantly connected to the internet and improved bandwidth and speed.[2] Long Term Evolution and UMTS have different signal properties and lower maximum power emission which have a lower potential for electromagnetic interference (EMI).[5]

The newly implemented mobile technology known as the fifth generation (5G) combines analogue and digital formats so that analogue reflects sound and digital-only images and videos. The 5G wireless devices in a mobile cellular network communicate with a local antenna using radio waves, these antennas are typically millimetre-wave antennas, which are smaller than antennas used in previous generations. They have a low-power automatic transmitter and receiver in a cell that is often reused.[3]

New-generation mobile phones emit radio frequency energy needed for cellular communication, which is a potential cause of EMI. Electromagnetic interference is a phenomenon in which radiation emitted from a source of electromagnetic waves can adversely affect the functioning of nearby electrical devices. New-generation mobile phones can also induce magnet response from static magnet fields present in the mobile phone components,

as it has incorporated more magnets for optimisation of wireless inductive charging, attachment of accessories, and keeping flexible display flip phones folded.[4]

The abovementioned risk has led to the widely adopted U.S. Food and Drug Administration (FDA) recommendation that mobile phones should be maintained at a distance of six inches away from implanted medical devices, in particular cardiac defibrillators.[5]

Mobile phones are vastly becoming a source of communication in the healthcare setting. Based on previous evidence, LTE mobile phones' EMI could potentially interfere with the function of medical devices.[6] In most cases, it usually has a minor effect on medical devices and can be tuned out easily, However, it remained a potent source of interference and should be kept within acceptable limits.[7]

Due to many brands and generations of mobile phones, the EMI on medical devices depends on various factors including power emitted by the mobile phone, the frequency of operation, the distance between the mobile phone and the medical device, mode of operation of the mobile phone and the immunity of the medical device concerned. The malfunctioning of medical devices ranges from distortion in monitors, noise in electrocardiogram (ECG) recordings, switching off the devices, resetting of the devices and alteration in flow rates. All these changes in the functionality of medical devices are called EMI incidents. Depending on the type of EMI incident that occurred, it can be classified as light, significant or hazardous.[6]

As of now, many hospitals have established policies to prohibit the use of mobile phones in risky areas such as intensive care units (ICUs). This is because applied medical devices are not the same in all hospitals and thus have different sensitivities to interference.

EVIDENCE SUMMARY

A total of 63 titles were retrieved from scientific databases such as Medline, EBM Reviews, and EMBASE via OVID and PubMed. Google was used to search for additional web-based materials and information. The last search was conducted on 13 February 2023. One systematic review and two experimental studies were found to be relevant and included in this review.

Based on the systematic review, critical care devices are more sensitive to EMI from 2G than 3G mobile phones in three studies. The maximum distance at which the interference is observed for 2G and 3G mobile phones is 1.5 metres and the minimum distance at which interference is observed for 2G mobile phones, and 3G mobile phone is 0.5 and 0.35 metres, respectively. Medical devices were tested including an ECG monitor, intensive care monitor, ultrasound equipment, X-ray equipment and dialysis equipment. However, one study showed that all the monitoring devices having long leads such as ECG recorders, pulse oximeters, and treadmills are sensitive to EMI from both 2G and 3G mobile phones during their ringing and

conversation phase. At the same time, the other devices were insensitive to the EMI. Though the EMI incidents were observed, they occurred at closer distances with minimal effects on the devices. One study which investigated EMI between different types of critical care devices used in ICU and 3G mobile phones including LTE phones demonstrated two of the 32 medical devices exhibited EMI during the evaluation. The results pointed out that the emitted peak power from the mobile phone and the distance between the mobile phone are the significant factors to induce EMI in the medical device. Devices emitting higher nominal power produced a greater number of EMI incidents at a greater distance than the devices emitting a lower power. Also, it was found that the frequency of mobile phones did not influence the occurrence of EMI in medical devices.[6]

An experimental study was conducted to evaluate the effects and the magnitude of EMI from the current generation of smartphones with cardiac implantable electronic devices (CIEDs). The study showed no EMI detection, no pacing inhibition, and no false implantable cardioverter-defibrillator (ICD) shock was detected by real-time interrogation of CIEDs during standby mode, 30-second calling-in and 30-second calling out at any position and any brand of smartphones. There was no urgent emergency physician consultation, and no cardiac care unit admission was detected in the study. There were also no changes in any device parameter, including pacing function, sensing function, impedance and threshold, before and after the test protocol.[8]

Another experimental study analysed the incidence of magnetic interference across all CIED types and manufacturers when used with iPhone 12. The study showed magnetic interference was more frequent with the back of the iPhone 12 facing the CIED compared to the front of the iPhone facing the CIED (interference rate: 84.6% vs 46.2%, respectively). However, no magnetic interference was observed in the subcutaneous implantable cardioverter-defibrillator (Boston Scientific) and the cardiac contractility modulation system (Impulse Dynamics). In total, clinically significant magnetic interference between the iPhone 12 and CIEDs occurred in 30 patients (18.3 % of the study population). In all cases, magnetic interference with the iPhone 12 only occurred when the phone was placed close to the CIED pocket, with the back of the iPhone 12 facing the CIED. Among patients with magnetic interference, 60.0% were implanted with a transvenous pacemaker, 16.7% with an ICD, 13.3% with a cardiac resynchronisation therapy defibrillator and 10.0% with a cardiac resynchronisation therapy pacemaker.[9]

CONCLUSION

Limited evidence suggested that mobile phones may cause EMI when used nearby medical devices. It is difficult to generalise because each study compared different mobile phones with different brands and types of medical devices. Distance is a key factor that can decrease mobile phones' EMI on medical devices. FDA recommends that mobile phones should be maintained at six inches away from implanted medical devices, in particular cardiac defibrillators. UK National Health Service on the other hand does not recommend a ban on the use of mobile phones but suggests reducing the risks of interference to critical medical devices.

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