

Compatible Deployment, Use, and Management of Mobile Phones and Wireless Communication Equipment in Hospitals

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Introduction: There is a growing need in hospitals throughout the world to continue incorporating new technology to offer more efficient, cost effective, and higher quality healthcare for patients. In this regard, use of mobile phones and other mobile wireless equipment (PDAs, 802.11a,b / LAN, pagers, radios, mobile computers, etc) by doctors and hospital staff for improved communication as well as rapidly evolving "mobile" information access is becoming increasingly common. Visitors and patients are likewise finding mobile communication increasingly indispensable, especially in times of emergency and crisis. One immediate benefit that improved communication and direct information access might provide to hospital staff is decreasing the frequency of common mistakes, identified in a recent Institute of Medicine (IOM) report as contributing to between 44,000 and 98,000 deaths per year in the US, with a similar percentage in the UK and Australia¹. As the use of mobile wireless equipment among doctors and other individuals within hospitals continues to increase, however, concern regarding potential electromagnetic interference (EMI) with life-critical medical devices has also increased, prompting many hospitals to establish broad precautionary policies banning mobile phones and other wireless equipment from the entire facility. At the other extreme, several recent publications have advanced the relatively unmanaged use mobile phones and other wireless equipment in the hospital^{2,3,4}, possibly introducing significant and

unnecessary risk. Recent efforts by industry associations and international standard setting groups to develop effective and practical recommended guidelines for compatible deployment, use, and management of mobile wireless equipment throughout the hospital are ongoing, and should help establish more consistent policies regarding the use of mobile phones and wireless equipment inside hospitals.

Keywords: mobile phones, medical devices, electromagnetic interference (EMI), hospitals

Results: Medical device manufacturers generally comply with a recommended 10 V/m immunity level against interference from RF emissions in the design of new equipment⁵, although there may not be regulation in place in many countries to mandate this immunity level. In addition, older model medical devices (commonly found in hospitals) may not have been designed with these immunity considerations in mind. Figure 1 shows that measured field strengths from mobile phones often exceed 10 V/m level when transmitting at full power and in close proximity⁶. RF signals from many PDA and 2-way pager devices are transmitted at comparable power levels, although as short bursts spaced on the order of 4-10 seconds apart that may result in a slightly lower average, but similar peak, field

¹Kohn LT et al (1998) Institute of Medicine, Committee on Quality of Health Care in America report entitled "To Err Is Human: Building a Safer Health System"

² Aziz O, Aziz S, Paraskeve P, Darzi A (2003) Use of Mobile Phones in Hospital: Time to Lift The Ban? *Lancet* 361:788

³ Myerson S. G., Myerson A. R (2003) Mobile Phones in Hospitals. *British Medical Journal* 326:460-461

⁴ Klein A. A., Djaiani G. N. (2003) Mobile Phones in the Hospital. *Anaesthesia* 58:353 - 357

⁵ The International Electrotechnical Commission (IEC) standard **IEC 60601-1-2** (revised in 2001) entitled "Medical electrical equipment - Part 1-2: General requirements for safety - Collateral standard: Electromagnetic compatibility - Requirements and tests"

⁶ Morrissey et al., *Health Physics* (2002) 82:45-51

⁷ American National Standard's Institute (ANSI/IEEE) standard C63.18 "Recommended Practice for an On-site, Ad-Hoc Test Method for Estimating Radiated Electromagnetic Immunity of Medical Devices to Specific Radio Frequency Transmitters" 1999

strengths. Standard on-site, ad hoc protocols ⁷ for determining the susceptibility of medical devices from mobile phones and other RF emissions have been developed, and results from studies ⁸⁻¹⁶

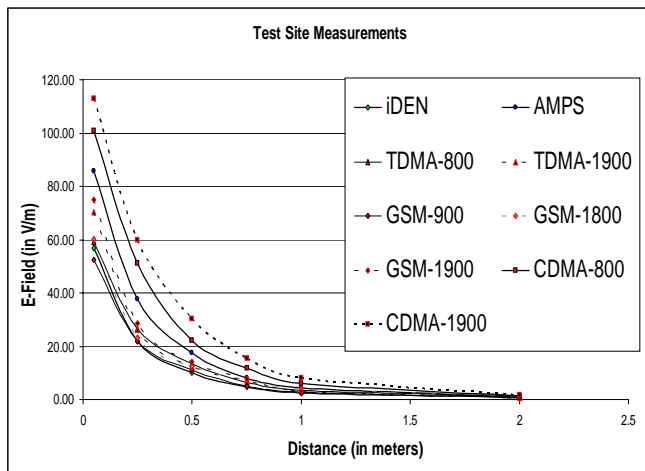
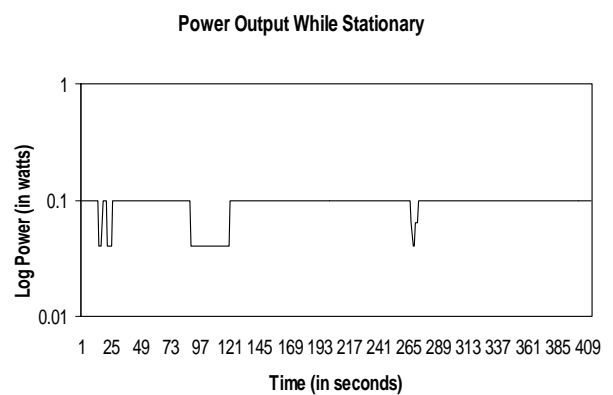
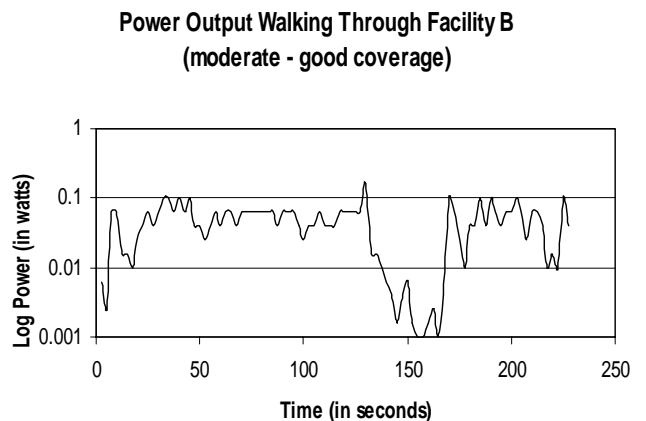
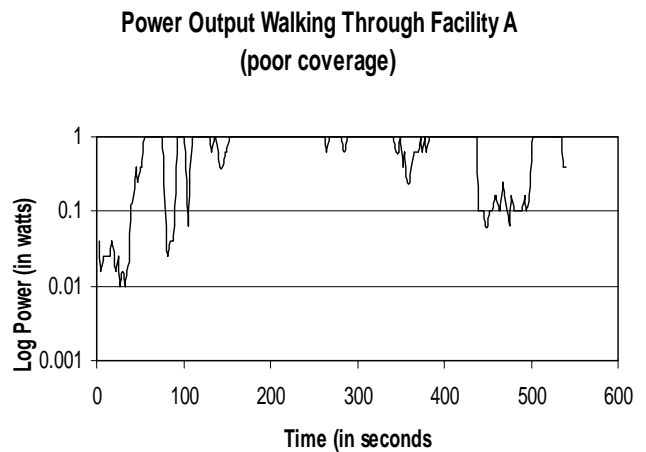


Figure 1. Field strength measurements (in V/m) taken inside an anechoic chamber using a standard field strength meter at incremental distances from mobile phones representing each of the common signal technologies set to full transmit power in test mode.

using the ANSI C63.18 or similar test protocols have shown that EMI with medical equipment is not a common event, although significant EMI events can occur in life-critical medical devices under test conditions, usually involving constant transmission at full power and in close proximity for extended periods of time. With proper management and engineering, however, mobile phones can be directed to transmit at power levels well below the threshold for medical device EMI (figure 2). Additional management procedures can further mitigate EMI issues.

The need to develop international guidelines for the compatible deployment, use, and management of mobile phones and other mobile wireless communication equipment in the

Figure 2. Data collected from 1900 MHz GSM phones that have been modified to allow collection of transmit power control data. Facility buildings A and B act as representative examples of different building structures showing dramatic differences in mobile phone power control dynamics and fluctuations. These differences are likely due to different levels of network coverage as well as internal structure, shielding, and reflecting objects. Neither facility A or B had supplementary in building network infrastructure that can reduce average transmit power control levels much further.



hospital has been driven by a number of sources. Increasingly, doctors are employing mobile phones for regular communication and managing patients. The American Medical Association

⁸ Morrissey et al., Health Physics (2002) 82:45-51
⁹ MDA Bulletin (MDA DB 9702), March 1997
¹⁰ Sibakov et al., VTT Technical Bulletin (ESPOO 1998)
¹¹ Tri et al., Mayo Clinic Proceedings (2001) 76:11-15
¹² Hietanen et al., Health Physics (2000) 79(suppl):S77-S84
¹³ Handa et al., IEEE Trans Electromagnetic Compatibility (2000) 42:470-475
¹⁴ Rice et al., J. Clin Engineering (Sep/Oct 2000) 260-264
¹⁵ Barbaro et al., Biomedical Instrumentation & Tech (2000) 34:361-369
¹⁶ Turcott, Witters. Biomed Instrum Technol (1998) 32:241-52

(AMA) has published recommendations that advocate the managed use of wireless devices throughout the hospital facility⁹. From the hospital's perspective, it is becoming increasingly apparent that proper application of wireless technology has the potential to increase productivity, decrease costs, and generally improve the quality of healthcare. Immediate access to patient data, test results, consulting physicians, charge capture, dictation, and alerts while the doctor or emergency medical technician is either on- or off-campus, or at the point-of-care, has the potential to revolutionize healthcare. The Health Informatics Industry is rapidly developing software applications for use on existing wireless equipment. Medical Device manufacturers are likewise rapidly developing wireless data transport and medical telemetry applications that allow their point-of-care devices to interface and transport data over existing wireless communication networks. The Communications Industry is eager to supply customers affiliated with the huge healthcare market with products. Finally, patients and visitors are finding mobile phones increasingly indispensable, especially in times of crisis.

As a result, mobile phones and other mobile wireless handsets are increasingly finding their way into the hospital. Examples of successful deployments in the U.S. include the University of Florida / Shands Hospital, Rhode Island General, Jacobi Trauma Center in the Bronx, and many others. However, uncertainty and concern with regard to EMI have acted as major obstacles to the full deployment of wireless technology in many other facilities. The Association for the Advancement of Medical Instrumentation (AAMI) has recognized the benefits wireless technology and the increasing application in healthcare, and offers a guideline as a Technical Information Report that is endorsed by the US FDA (CDRH)^{10,11}. Other guideline documents exist from IEEE / COMAR¹²,

the US Army¹³, and the Health Council of the Netherlands¹⁴, although these are not entirely consistent in their recommendations. In the U.S., hospital accreditation groups such as JCAHO (Joint Commission on the Accreditation of Healthcare Organizations) have requested guidance policies on this issue. The International Standards Organization (ISO) TC215 group on Health Informatics is currently developing an international recommendation to be provided as a Technical Report that will offer consistent guidelines for mobile phones in the hospital to fully support the potential benefit such technology can provide while mitigating EMI risk due to unmanaged use, and is expected to be completed in 2004.

General Guidance Recommendations:

- Dedicated mobile phones & wireless equipment used by doctors and hospital staff should be distinguished from non-dedicated equipment for personal use by patients, visitors, and staff.
- For dedicated equipment, appropriate testing (ANSI / IEEE C63.18), system engineering (supplementary infrastructure as necessary), medical device management, and user guidelines should be implemented.
- For non-dedicated mobile wireless equipment, separate management policies should be implemented, and may include selective restrictions in sensitive / critical care areas.
- Signs outlining the hospital policy should be clearly posted.
- Adequate access to areas where non-dedicated mobile phone use is encouraged will facilitate compliance with selective restrictions.
- EMI management should be ongoing, verifying and characterizing reported incidents and making necessary adjustments to policy.

¹⁷ Lyznicki et al. Council on Scientific Affairs and AMA Recommendations to Medical Professional Staff on the Use of Wireless Radio Frequency Equipment in Hospitals. *Biomedical Instrumentation and Technology* (2001) 35:189-195

¹⁸ AAMI Technical Information Report #18 Guidance on Electromagnetic Compatibility of Medical Devices for Clinical and Biomedical Engineers. Part 1: Radiated RF electromagnetic Energy

¹⁹ FDA CDRH website at <http://www.fda.gov/cdrh/emc/emc-in-hcf.html>

²⁰ Ziskin M (COMAR) (1998) Model Review of Medical Device EMI due to RF Transmitters (Radios, Cell Phones,

Etc) and Appropriate Recommendations. *IEEE Eng. Med. Biol.*, May/June 1998, pg 111-114

²¹ US Army Center for Health Promotion and Preventative Medicine: MEDCOM regulation 40-2 (20 Mar 2002), pg 18-19, 24

²² Health Council of the Netherlands in their report entitled "Mobile Telephones: An Evaluation of Health Effects" submitted to the Minister of Housing, Spatial Planning, and the Environment