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The Expected Human Risk of Disease Associated with Smart Meters

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Introduction

Advanced metering infrastructure (AMI) technology to regulate the usage of public utilities has been employed in an increasing number of communities across the United States. One component of this technology, the smart meter, has raised concerns from members of the public about possible adverse health effects derived from exposure to the radiofrequency (RF) emissions of the meters[1]. The City of Madison intends to introduce an AMI system to read water meter data electronically in order to improve the customer billing process and more readily monitor municipal water usage[2]. This system upgrade will undoubtedly lead to similar concerns among some residents of the City of Madison that have been voiced in other communities during the introduction of AMI. Therefore, in an attempt to address this concern, Public Health Madison and Dane County (PHMDC) conducted a review of the scientific literature and other available informational resources to provide a brief overview of the issue to the general public to increase awareness and understanding of the issue.

AMI technology and smart meter overview

Purpose of system

The purpose of AMI is to provide automatic electronic meter readings of public utilities such as water, natural gas, and electricity to measure consumer consumption and provide improved billing for provided services[1-3]. A critical component of this system is the Smart Meter; a wireless meter that contains miniature, low power, radio transceivers that are installed in the home of the individual consumer, typically in the basement of the structure[1, 2]. Each Smart Meter acts as a wireless communication module that, in addition to one or more cell relay meter(s), form a network of reliable communication that allows each meter to transmit data via RF to, and receive data from, the City of Madison Water Utility[1]. In the City of Madison, the AMI network will involve approximately 66,000 meters and is projected to be completed by December 2012 for collection of customer data[2].

Smart meter operation

The type of Smart Meter involved in the City of Madison network operates in the Industrial, Scientific, and Medical (ISM) band at frequencies ranging from 902 to 928 megahertz (ISM) with a power output of approximately 0.516 Watt; specifications similar to those of wireless routers for home computer systems commonly found in homes across Dane County[1, 5]. Also similar to wireless computer routing systems, the emission of RF from the Smart Meters occurs intermittently throughout the day during the transmission and/or receipt of data; otherwise, the meter remains in stand-by until the subsequent communication with the AMI network. Thus, the transmissions of the Smart Meter are normally infrequent and may only consist of a few milliseconds during the transmission phase of each communication; normally totaling from a few seconds of transmission during a 24-hour period to, at most, a few minutes during the day[1, 4, 5].

Exposure and expected risk to human health

RF overview

Radiofrequency (RF) is a form of electromagnetic radiation with wave frequencies ranging from approximately 3 kilohertz (KHz) to 300 GHz. This type of radiation is non-ionizing and lacks the strength to break chemical bonds due to low levels of frequency and longer wavelength; examples of this type of radiation include radio and sound waves, visible light, and microwaves[6, 7]. Non-ionizing radiation should not be confused with the higher frequency ionizing radiation; a type of radiation that is considerably higher in energy and has the ability to strip away electrons from atoms and, in the case of very high energy radiation, has the ability to destroy the nucleus of the atom that may lead to molecular changes, tissue damage, and an increased risk of adverse health outcomes that include, but not limited to, the initiation and/or promotion of carcinogenesis [6-8]. Examples of ionizing radiation include x-ray and gamma-ray radiation[6].

Research has repeatedly demonstrated that exposure to high levels of RF radiation can lead to thermal injury due to the ability of the radiation to heat biological tissue rapidly; a principle that provides the operational basis for microwave ovens. The eyes and the testes are particularly vulnerable to tissue damage derived from RF heating due to the lack of available blood flow to dissipate the excess heat load[7, 9]. In addition to thermal injury, other non-thermal biological effects have been proposed with RF exposure including genetic and cellular effects, changes in protein expression, hormonal effects, and an increased risk of certain types of cancers, most notably glioma and meningioma of the brain[4, 9, 10]. However, there is no consistent statistically significant evidence to definitively support a causal relationship between exposure to RF radiation and non-thermal adverse human health effects[9, 10-13].

Federal standards governing RF radiation exposure in the United States have been recognized and adopted by the Federal Communications Commission (FCC) since 1985; guidelines derived from the recommendations of the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE) and are supported by the National Institute of Occupational Safety and Health (NIOSH), the United States Environmental Protection Agency (US EPA), and the Occupational Safety and Health Administration (OSHA) [7]. The actual values of the standard are dependent upon electric and magnetic field strength, power density and environmental setting (i.e. occupational/controlled exposure and general population/uncontrolled exposure) of the RF emission source[12, 13]. Therefore, similar devices may have slightly different permissible exposure limits.

Expected risk to human health derived from Smart Meters

Adverse effects to human health are governed by the length, number, and level of exposure(s). In the case of smart meters, the meters are normally installed in the individual home; therefore, there is the potential to daily exposure to RF emissions. However, as previously discussed, the total transmission time of the meter ranges from a few seconds to a few minutes during a typical 24 hour period; thereby, limiting the human exposure to RF radiation derived from the smart meter[1, 3]. Specific considerations also influence the level of potential RF exposure; the most notable is distance from the meter during operation. Research has demonstrated that measured RF radiation generated from smart meters is greatest within close proximity of the meter and rapidly declines with increasing distance; each far below the FCC limit of 0.610 milliwatts per square centimeter (mW/cm^2), a spatially averaged and time averaged value, deemed most applicable for smart meter operations[1, 11-13]. In a recent investigation conducted by the Electric Power Research Institute, the time-averaged RF fields were estimated to be approximately 35% of the FCC maximum permissible exposure (MPE) level at 20 centimeters (cm), less than 1% at 1 foot from the smart meter, and falling to below 0.1% at a distance of 5 feet; at 10 feet the estimated maximum likely RF field was calculated to be below 0.01% of the MPE[1].

Research specifically evaluating the potential association between the use of smart meters and adverse effect to human health is lacking. However, a significant amount of research is available for other wireless devices that have similar signal frequencies during operation as the smart meter; one of the most researched example is the cellular phone. Similar to smart meters and other wireless devices, several non-thermal human health effects have been purportedly associated with cell phone use; including, but not limited to, sleep and memory disruption, headaches, genotoxicity, and the increased risk of brain cancers[, 14, 15]. Also similar to RF-related research, there is no consistent statistically significant evidence that conclusively links the exposure to RF radiation derived from the use of cellular phones to the development of non-thermal human health outcomes[10, 14-16].

Due to the lack of evidence supporting non-thermal effects associated with the use of cellular phones no adverse health impacts would be expected to result from the installation and operation of smart meters in customer households. This conclusion is based upon the fact that the level of usage of and the power generated from the cellular phone is higher than that of the smart meter, as well as, the significant difference in the proximity of the human exposure to RF radiation when comparing the two devices. In other words, the risk of adverse health conditions associated with RF radiation would be greater in cellular phones in comparison to smart meters due to the increased power, longer and more frequent exposure, and shorter distance of exposure reportedly derived from cellular phones. However, since no association with non-thermal effects have been demonstrated with cellular phone use, no non-thermal effects would be expected due to the operation of smart meters.

Conclusions

The use of AMI networks allow improved and more efficient monitoring and billing of public utilities. However, the emission of RF radiation from the smart meter component of this system has raised concern due to the purported link of this type of radiation to adverse human health impacts[1]. A thorough review of the relevant literature suggests that there is little evidence to support an association with any potential health effects that may result from the installation and/or normal operation of the smart meter. This conclusion was based upon the reported infrequent and low level of RF emissions from the device and the lack of data supporting an association between RF exposures at this level to the development of non-thermal effects in exposed individuals[1, 9-13]. Therefore, PHMDC supports the deployment of AMI network technology proposed by the City of Madison Water Utility and do not foresee any potential individual and/or community health danger due to the installation and operation of this technology[2].

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