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United States District Court

District of Oregon

Portland Division

AHM, by and through
her Guardian *ad litem* and father,
David Mark Morrison**,** and
David Mark Morrison, individually,

v.

Portland Public Schools,

Defendant.

Civil Action No. 3:11-cv-00739-MO

Declaration of
L. Lloyd Morgan
Addendum F – Poster –
Exposure Limits The underestimation of absorbed cellphone radiation, especially in children

Exposure Limits: The underestimation of absorbed cellphone radiation, especially in children

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Abstract

The Specific Absorption Rate (SAR) cellphone certification method is used to test all cellphones today and relies on a homogenous model of the head Standard Anthropomorphic Mannequin (SAM) that underestimates SAR. Because the anatomically based Finite Difference Time Domain (FDTD) computer simulation method differentiates specific tissues, is less expensive, and allows for inclusion of children and pregnant women, it provides a superior method. The SAM-based SAR method underestimates cellphone radiation absorption for the head for over 90% of the population and for commonly used pants or shirt pocket by 4 to 7-fold. When used by children, most cellphones exceed SAM-based SAR-based exposure limits. As commonly used against the body, all cellphones exceed the SAM-based SAR-based exposure limits.

Introduction

The Federal Communications Commission (FCC) adopted an exposure limit in **August 1997** [1]. In **December 1997** it published a Supplement on how to evaluate compliance to the exposure limit, though it was implicit that the existing compliance method was *not fully repeatable* between certification facilities [2]. In **June 2001**, a revised Supplement achieved compliance repeatability for a SAR [3] that was widely adopted by other national standard setting authorities.

In 1997 and in 2001, the FCC noted that "T]he finite-difference time-domain (FDTD) algorithm is the most widely accepted computational method for SAR modeling … [and] adapts very well to tissue model … such as those available from the visible man project" [2]. To date, all certification processes rely on SAM-based SAR. In 1998 the International Commission on Non-Ionizing Protection (ICNIRP) adopted exposure guidelines but did not describe compliance methods, referring to other organizations' methods [4]. Both the FCC and ICNRIP exposure limits use the SAM-based SAR metric.

Methods

To compare the FDTD and SAM-based SAR cellphone certification methods, we reviewed published reports of comparative models in the context of FCC and ICNIRP exposure limits.

Results

Since 2001, multiple studies have shown that the FDTD method results in up to 2-fold higher SAR value in children compared to the SAM-based SAR certification method [5-11], and a higher SAR value for >90% of population whose head size is smaller than the SAM head.[6,11]. Many people commonly keep cellphones in their trouser or shirt pockets, which results in up to a 7-fold higher SAR when the FDTD method is used compared to the existing method [12]. **Figure 1** shows the equipment use in the SAM certification method. **Figure 2** shows the SAM model.

Discussion

Comparison of Certification Methods

Use of the existing Virtual Family [13] with the FDTD method allows for determination of the SAR in each tissue type for a wide range of humans from the fetus of pregnant women, to children, to obese adults, compared to the existing method based only on SAM, a very large male head [14]. Further, the FDTD method allows for the inclusion of energy absorption characteristics of 40 tissue types in a human head, including differences in children.

The Virtual Family is based on MRI scans that indicate distinct dielectric constants, permittivity and conductivity of tissues at accurate 3-dimensional locations, compared to the existing certification method, which uses the average adult tissue absorption's characteristics. The FDTD method also indicates that the specific absorption characteristics of a child's tissues results in greater energy absorption than the average adult's head tissues [8-9]. **Figure 3** shows members of the "Virtual Family."

Unlike the existing SAM-based SAR method, the FDTD method, can determine the SAR for highly vulnerable tissues such as the eye and testes as well as for medical implants, and it has far better resolution (e.g., 1 mm^3 compared to ~1 cm^3). **Table 1** summarizes the differences between the 2 cellphone certification methods.

Health Effects

Controlled clinical and experimental studies have found that cellphone radiation significantly impairs sperm motility, morphology and count [15-17], with a near-significant ipsilateral risk of testicular cancer where cellphones were placed in trouser pockets (OR=1.8, CI:0.97–3.4, p=0.061) [18], and a risk of eye cancer (OR=4.2, CI: 1.2–14.5) from "probable/certain exposure to mobile phones" [19].

Studies have also shown for users with the highest cumulative hours of use, and/or for >10 years of cellphone use, risks for brain cancer (OR range: 1.60-2.6) [20-22], risks for acoustic neuroma (OR range: 1.8-5.0) [23-26], risks for meningioma from cordless or cell phones (OR range: 1.6-4.8) [20,24], and risks for leukemia (OR range: 2.1-3.0) [27-28].

Finally, studies have found a risk of parotid gland tumors (a salivary gland located in the cheek, below the ear) [29-31]. The Danish-Swedish Interphone study found for ≥10 years of ipsilateral use, OR=2.6, CI: 0.9-7.9, p=0.078 [29]. An Israeli Interphone study found for >1,035 cumulative hours of use, OR=1.96, CI: 1.11-3.44 [30]. Another Israeli study found a dramatic increased in parotid gland cancers (from 1970-2001, there were 37 cancers per year; from 2002-2006 it increased to 61 cancers per year [31]. Recently, a preliminary report from China found very high risk from heavy cellphone use, >10 years, OR=20.7, 95% CI: 9.4-45.8, >2.6 average hours/day, OR=31.3, 95% CI: 10.8-90.5 [32]. Based solely on the evidence on brain tumors, IARC has recently determined that radiofrequency energy and electromagnetic radiation is a "possible" brain carcinogen IARC's May 31, 2011.

The underestimation of SAR by the existing method is of great importance given that serious health effects from cellphone use have been found.

Conclusions

- The existing SAM-based method underestimates the SAR for the majority of the population.
- Children's brains absorb up to 2 times the SAR per the FDTD method compared to the existing method
- Adults absorb 4 to 7 times higher SAR when phones are used in their shirt or trouser pockets
- The FDTD method's accuracy is far superior to the existing method because:
    1) It accounts for each tissue type
    2) It allows for the determination of SAR in children, the fetus, and people of differing sizes
    3) It allows for determination of the SAR to the eye and testes
    4) It allows for determination of the SAR where medical implants are used

Since more than 5 billion mobile phones are used worldwide, the underestimation of radiation absorption is a significant public health issue.

Because the existing SAM-based cellphone certification method is inadequate, a new certification system needs to be implemented based on the FDTD method

Figure 1. Robotic arm with electric field probe for SAM (Source: Speag DASY 52 Info Sheet)

Figure 2. SAM Uniform Phantom Source: Speag Phantom Product Flyer
CTIA is Cellular Telecommunications Industry

Figure. 3. The Virtual Family http://www.itis.ethz.ch/services/population-and-animal-models/population-models/

Table 1. Summary of the results confirming that children absorb more radiated electromagnetic energy of the cellphones resulting in higher specific absorption rate (SAR) as compared to adults and results when a cellphone is place in a shirt pocket (adapted from Table 3, Han et al 2010)

Author, Year	Highlights of results
Gandhi et al., 1996 [6]	Deeper penetration of absorbed energy for models of 10- and 5-year old children; peak 1-g SAR for children up to 53% higher than adults. See Figure 7.
Wiart et al., 2008 [5]	1-g SAR of brain tissues of children is about two times higher than adults.
Kuster et al., 2009 [7]	Spatial peak SAR of the CNS of children is " significantly larger (~2x) because the RF source is closer and skin and bone layers are thinner"; " bone marrow exposure strongly varies with age and is significantly larger for children(~10x)."
DeSalles et al., 2006 [8]	The 1-g SAR for a 10-year old boy is about 60% higher than for the adults.
Peyman et al. 2001	Children's SAR is 50% to 100% higher than an adult's SAR.
Christ et al 2010 [10]	Hypocampus and hypothalamus receive 1.6 to 3.1 higher SAR in children compared to adults; children's bone marrow receive 10 times higher SAR than adults; children receive higher SAR to the eyes than adults; children's cerebellum receive >2.5 time higher SAR than adults.
Kang et al. 2002 [12]	Up to 7 times SAR when back of cellphone in a shirt pocket is closest to skin.
Gandhi et al 2002 [35]	10 mm spacer on SAM artificially lowers SAR. Deeper penetration of absorbed energy for smaller heads typical of women and children; peak 1-g SAR for smaller heads up to 56% higher than for larger heads. Plastic spacer used on SAM for ear (or pinna) decreases SAR by 15% per millimeter. ICNIRP's 2 W/kg, 10 g spatial peak SAR results in 2.3 to 3 times high SAR than FCC's 1.6 W/kg, 1 g spatial peak SAR
Wang et al 2003 [36]	Compared to peak local SAR in the adult head, we found "a considerable increase in the children's heads" when we fixed the output power of radiation.

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