

## Section 14

### Strategies for Radiofrequency Exposure Reduction

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## Summary

- Although there is no clear evidence of health effects related to public exposure to radiofrequency (RF) fields, strategies exist to reduce personal exposure to RF.
- The mitigation strategies can include substitution, engineering controls, and administrative controls.
- With substitution, one can replace certain wireless RF devices with hard-wired alternatives, e.g., substituting landline corded phones for mobile phones and cordless phones.
- Engineering controls include choosing devices that emit lower RF levels. Some devices have engineering modifications, like power-saving and non-idling functions.
- Administrative controls include limiting duration and frequency of use as well as turning off devices, where possible, when not in use. In general, distancing from RF-emitting devices will reduce personal exposure. For mobile phones, options are the use of headsets, the speaker phone and text-messaging.
- Attempts at shielding from RF are typically ineffective and may actually enhance exposure.

### 14.1 Introduction

The increasing use of RF devices for communication has provided benefits of convenience, practicality, and innovation to society as a whole. Use of mobile phones has promoted safety and saved countless lives by allowing remote communication. Furthermore, the scientific evidence to date offers no clear evidence of health effects associated with public exposure to RF.<sup>1-3</sup> However, mitigation strategies do provide an option for the concerned public to reduce personal exposures to RF. As there are multiple sources of RF, reducing or eliminating one source may have limited impact on total personal exposure to RF, and possibly very little impact on exposure to EMF in general.

In occupational hygiene, the hierarchy for exposure reduction includes substitution, engineering controls, administrative controls, and personal protective equipment. In the case of reducing RF exposure to the general public, similar strategies include non-use, technology and design changes for RF-emitting devices, distancing and limiting use, and exploration of shielding measures.

#### **14.1.1 Substitution**

The most effective way to reduce total exposure to RF is to avoid the use of RF-emitting devices, especially devices that result in the highest personal exposures such as mobile phones used at the head. Exposure to RF from mobile phones or cordless

phones can be eliminated by using landline corded phones but with loss of flexibility in communication. Direct cable connections can replace use of a wireless local area network (WLAN) or WiFi, but the effective reduction to total RF is minimal.<sup>4</sup> As well, improperly wired connections, which are not uncommon, can produce magnetic fields.<sup>5</sup>

#### ***14.1.2 Engineering controls***

The next most effective method of exposure reduction is to use devices that produce lower output power and specific absorption rates (SAR).

It is possible to choose mobile phones with a lower US Federal Communications Commission (FCC) rating of SAR (tested at maximum power). However, a lower SAR FCC rating does not necessarily translate into lower real-world SAR as contemporary mobile phones do not often reach or maintain maximum output power levels in the field.<sup>6</sup> The published literature indicates that, compared to Global System Mobile (GSM) second generation (2G) mobile phones, the technologies of Code Division Multiple Access (CDMA) (2G) and third-generation (3G) wide-band CDMA (wCDMA) and Universal Mobile Telephone System (UMTS) produce lower RF power measurements by not transmitting as often at maximum power.<sup>6</sup> More research is needed to assess the newer technologies associated with fourth generation mobile phones using Long Term Evolution (LTE) or Worldwide Interoperability for Microwave Access (WiMax) to determine what RF output power levels they produce in real-world situations.

Engineering features used to mitigate RF exposure from mobile phones include power control, discontinuous transmission, increased efficiency (requiring lower power output) and improved antenna placement. Good base station coverage will minimize RF exposure when using a mobile phone, as adaptive or power control reduces the output power to the minimum necessary for fidelity of the signal.<sup>7</sup> Living further away from base stations (e.g., in a rural area with poor base station coverage), does not necessarily decrease overall exposure for mobile phone users, as the mobile phone needs to increase output power levels to maintain a good connection. In general, choosing devices that operate at higher frequencies may reduce absorption of RF into tissues.<sup>1</sup> RF exposure from cordless phones can be reduced by choosing ones that have the following features: 1) a power-saving function (which allows for a decrease in output power when the connection is good, and 2) a system that does not intermittently signal (send a beacon) when the handset is off and placed in the cradle of the base station.<sup>8</sup>

Many RF-emitting devices have already incorporated engineered features that mitigate scatter and exposure. Smart meters have very low duty cycles, transmitting RF only for milliseconds, which limit active exposure to RF. As well, they have back plates that significantly reduce RF transmission into the house (as does the house wall to which they are attached). Because banks of smart meters need to communicate with a single controller, only one smart meter can communicate at a time, which eliminates the possibility of exposure to multiple signals simultaneously.<sup>9</sup>

### **14.1.3 Administrative controls**

Exposures are highest in the near field of RF-emitting devices (e.g., several centimetres for most mobile phones [depending upon the antenna size] and 16–33 cm for WLAN access points [wireless routers]).<sup>10,11</sup> In the far field, the power density decreases proportionally to the square of the distance between the emitter and receiver, therefore exposures become minimal in the far field.<sup>12</sup>

For mobile phones, distancing can be accomplished through use of headsets, use of the speaker phone, or text-messaging while keeping the phone away from the body/head. Studies show that SAR measurements at the head are 8–20 times lower when using a wired hands-free kit than when using the phone at the ear.<sup>13</sup> However, one study indicated although wired hands-free kits decreased overall SAR at the head, they could increase localized SAR in the region of the ear due to the increased magnetic field exposure from the wired ear phone.<sup>14</sup> Two Bluetooth headsets were tested for the Swiss Federal Office of Public Health (FOPH) and the SAR values were 12 and 34 times lower than the SAR for the lowest-emission mobile phone available.<sup>8</sup> For cordless phones, headsets and speaker functions can also be used.

Although not using the phone next to the head may reduce exposure, it can result in increased exposure to specific areas of the body and it can also reduce the efficiency of the phone if the body impedes the signal, causing increased output power and exposure to RF. As power output for data transfer, such as downloading files from the internet, can be up to four to 30 times higher than voice data transfer (depending on the technology), distancing the device from the body while transferring data can decrease exposure.<sup>6,8</sup>

Even when not in use but powered on, mobile phones continue to emit RF, albeit at low levels. To limit this type of exposure, mobile phones can be kept away from body areas when in use (i.e., not on belts or in pant pockets). Because the mobile phone is attempting to maintain connection even when not in active use, shutting off the phone will limit exposure to low levels of RF. For GSM phones, the first connection to the base station occurs at maximum power before dropping to a lower output power level; therefore, turning on and off the phone frequently could increase overall exposure.<sup>15</sup> Limiting duration of use, such as the length of a mobile phone call, and number of calls, will also reduce personal exposures.

Far-field WiFi emissions of RF are much lower than for near-field RF when using mobile phones at the head. Although WLAN access points can be placed far from WLAN terminal devices, this can result in a poor connection, thus increasing output power. While a laptop computer with WiFi capabilities directs RF across the screen and up away from the body,<sup>10</sup> which limits exposure to RF, using a laptop computer on a table at some distance from the body can further reduce other EMF exposures. Because WLAN continues to transmit intermittently (but at very low levels of RF) to continue establishing a connection even when not in active use, devices can be shut off when not in use.

For mobile phone base stations, distance does not necessarily translate into lower exposures to RF. The direction of the radiated power (main lobe) is also an important determinant of level of exposure that is better indicated by line-of-sight. For instance, in a Bavarian study, buildings or vegetation blocking direct sight to a base station reduced power density to 1/30<sup>th</sup> of the levels compared to points with sight to the base station, but at the same distance.<sup>7</sup>

#### ***14.1.4 Protective equipment***

Source shields or protective devices have limited effectiveness in reducing exposure at the cost of interfering with the signal. Shielding from base stations requires creation of a complete metallic cage, but even a small opening or a slit may reduce the shielding effect substantially. In addition, a shield to reduce ambient levels of RF may cause any RF-emitting sources indoors (e.g., mobile phones or cordless phones) to generate resonances producing higher local exposures when using that particular device than without shielding.<sup>7</sup>

Shields for mobile phones are available, but when tested, earpiece pads and shields did not affect SAR substantially, sometimes decreasing SAR marginally but sometimes increasing it.<sup>16</sup> Antenna caps did reduce SAR up to 99%, but they also deteriorated the signal quality. Some shielded cases reduced the SAR without impairing signal quality, whereas others reduced signal quality corresponding to the reduction in SAR. Another problem with using shielding of mobile phones is that it reduces the battery life.<sup>8</sup> For the most part, tests on mobile phone protectors demonstrate that these are either ineffective or increase the transmit power to compensate for the interference with the signal.<sup>7</sup> No evidence could be found that suggests metallic clothing or headgear reduces exposure to ambient RF.

Table I provides a summary of mitigation strategies as suggested by national and international public health organizations, grouped according to the hierarchy of occupational hygiene exposure reduction methods. The specific recommendations for exposure reduction to RF by the World Health Organization as well as Canadian, US, and other international organizations are given in Appendix A.

Table 1. Mitigation strategies for reducing personal exposure to RF

RF Source	Substitution	Engineering Controls <sup>8</sup>	Administrative Controls <sup>8</sup>	Protective Equipment
Mobile phone	Limit use Use landline phones	Use phones with low SAR ratings Use phones that emit at lower output power in the real-world scenarios	Keep phone at a distance from the head using handsets or speaker phone function Do not place in front of pocket or against body during use or when left on Limit duration of use Only use when connection with base station is good	Do not use shields
Cordless phones	Use landline phones	Use models with a power-saving function that decreases output power when the connection is good Use models that do not produce beacon signals when placed in the base-station cradle	For some models, store the handset in base station cradle For some models, ensure base station maintains good connection with phone Keep phone base station at least 50 cm from area of use	Do not use shields
WLAN	Limit use Use wired systems	Only use the antenna provided with the WLAN transmitter	Install access point at least 1 m away from work area Position access point in central location so all devices have a good connection Do not hold device against body when in use Turn off WiFi when not in use	Do not use shields

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## 14.3 Appendices

### ***Appendix A: Statements regarding reduction of exposures by International Organizations***

#### *World Health Organization (WHO)*

WHO established the International Electromagnetic Fields (EMF) Project<sup>17</sup> in 1996 to assess the scientific evidence of possible adverse health effects from electromagnetic fields. WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2012. In a factsheet on EMF and health effects, the WHO notes that “using “hands-free” devices, which keep mobile phones away from the head and body during phone calls, exposure is also reduced by limiting the number and length of calls. Using the phone in areas of good reception also decreases exposure as it allows the phone to transmit at reduced power. The use of commercial devices for reducing radiofrequency field exposure has not been shown to be effective.”<sup>2</sup>

#### *Canada*

The Health Canada website provides these strategies for reducing RF exposures from mobile phones: 1) limit the length of cell phone calls, 2) use “hands-free” devices, and 3) replace cell phone calls with text messages. Health Canada also encourages parents to take these measures to reduce their children's RF exposure from mobile phones since children are typically more sensitive to a variety of environmental agents. Health Canada also does not recommend any precautions to limit exposure to RF energy from mobile phone towers as exposure levels are typically well below those specified in health-based exposure standards.<sup>18</sup>

#### *United States*

The US Environmental Protection Agency (EPA) indicates on their website that “although there is not sufficient evidence to conclude that there is a definite risk associated with long-term mobile phone use, people who are concerned can take simple steps to reduce exposure: 1) Limit use – reducing the number/length of calls, 2) Use “hands-free” devices – Using “hands-free” devices can help to keep mobile phones away from the head.”<sup>19</sup>

#### *Europe*

UK's Health Protection Agency says, “Measures that could be taken to reduce exposures were described in the IEGMP report and in the subsequent Mobile Phones and Health 2004 report [6], but the technology continues to develop, which alters the options available. Moving the phone away from the body, as when texting, results in very much lower exposures than if a phone is held to the head. Also, the use of the more recent 3G mode of transmission instead of the older 2G mode will produce much

lower exposures. Other options to reduce exposure include using hands-free kits, keeping calls short, making calls where the network signals are strong, and choosing a phone with a low specific energy absorption rate (SAR) value quoted by the manufacturer. Exposures from devices held further away from the body such as wireless-enabled laptop computers, and transmitter masts in the community are very much lower than those from mobile phones and community or individual measures to reduce exposures are not necessary."

[http://www.hpa.org.uk/Publications/Radiation/HPAResponseStatementsOnRadiationTopics/radresp\\_AGNIR2012/](http://www.hpa.org.uk/Publications/Radiation/HPAResponseStatementsOnRadiationTopics/radresp_AGNIR2012/)<sup>20</sup>

The Norwegian Institute of Public Health mentions that 1) hands-free mobile phones reduce exposure significantly, 2) when a GSM mobile phone transmits at maximum power, exposure from some models may exceed ICNIRP's reference values, 3) greater density base station density leads to lower exposures, 4) technological advancements of mobile phones is decreasing exposure and that although mobile phone use may be increasing, the exposures may be decreasing due to the fact that newer UMTS phones produce much lower power than GSM.<sup>21</sup>

The Federal Office of Public Health (FOPH) in Switzerland offers the most detailed and prolific recommendations for minimizing exposure to RF<sup>8</sup>:

#### Mobile phones

- 1) For new phone purchases, ensure the phone has low SAR.
- 2) Keep calls short and use text-messaging.
- 3) Use hands-free system (headphone, headset) with low power Bluetooth emitter.
- 4) Whenever possible, ensure signal quality is good.

FOPH provides further advice such as warning against the use of shielding devices which may make connection quality worse, thereby increasing output power.<sup>8</sup> Also, FOPH recommends keeping mobile phones at least 30 cm from active medical implants.<sup>8</sup>

#### Cordless (DECT) phones

- 1) Ensure DECT base units are at least 50 cm from relaxation places or work stations occupied for long periods.
- 2) For longer calls, used corded phones or headset.
- 3) Low radiation DECT phones are available in some facilities. Models are available where the base station does not emit radiation when the handset is in place and where the headset reduces output power if the connection is good.

## Bluetooth

Some mobile phones that use Bluetooth to access the internet use Class 1 transmitters which transmit at similar levels to a mobile phone. FOPH recommends that for that the internet connection is switched off when making phone calls to reduce exposure to the head.

## WLAN

- 1) Only switch on WLAN when needed.
- 2) Don't hold your laptop close to the body while it is connected to WLAN.
- 3) Whenever possible, install the WLAN access point 1 m from places where you work, sit or rest for long periods of time.
- 4) Position access point centrally so that all the devices have good reception.
- 5) Choose WLAN g standard over b standard. Exposure is lower because it transmits data more efficiently.
- 6) WLAN transmitter must only be used with an antenna provided for this purpose by the manufacturer. If an unsuitable antenna is used, the maximum permitted transmission power may be exceeded.

## Microwave ovens

FOPH makes recommendations around safety and handling of foods in microwaves, but the only recommendation related to RF is to keep the door frame and seal clean and check that the door latch and seal is intact. However, based on testing of a microwave oven with the maximum permitted leakage radiation allowed (5 mW/cm<sup>2</sup> at 5 cm), FOPH reports that the recommended threshold was exceeded only with direct contact with the microwave oven; at 5 cm, levels were much lower than SAR limits.

## Baby monitors

- 1) Place baby monitor at least a metre away from crib.
- 2) Do not use systems that transmit continuously. Set the baby unit to voice activation mode.
- 3) Ensure that the adaptor is plugged in at least 50 cm away from the crib.

