

Hearing Aids and the Digital Mobile Phone – an Update



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1. So what is the problem?

When held up against a hearing aid, Digital Cellular Telephones, which we will call digital 'cellphones', create a buzz. With many hearing aids, especially the older ones, the buzz can be so loud that it makes speech coming over the telephone impossible to understand. In extreme cases the speech can't even be heard.

2. I thought everything digital was wonderful. Why does a digital cellphone cause so much trouble?

The digital phone appears to a hearing aid like a road with corrugations in the pavement appears to a car: Digital cellphones turn their rf (radio frequency) transmitter on and off at 50 or 220 times a second, creating the electrical equivalent of driving over a washboard road.

3. Does this problem occur with analog cellphones?

No. The analog cellphone transmitter goes on once at the beginning of the call and stays on until you finish the conversation. It is like driving over a single bump in the road; you may not even notice it.

4. Does the buzz occur when the hearing aid is on the microphone or telecoil setting?

Both, although the telecoil is usually worse because the digital pulses cause both rf and magnetic interference. As we'll see later, the hearing aid designer can solve the rf interference. The magnetic interference comes in just like a signal. To my knowledge, the cellphone manufacturers have not been able to solve their magnetic buzz problem.

5. Does the antenna design affect the interference problem?

Yes, antennae that stick out from the head seem to cause a little less interference, but the reduction is only about 5 dB in the level of the buzz. After all, the primary purpose of the cellphone transmitter is to send a powerful enough signal to reach several miles. It is almost impossible to make dramatic changes in the rf output picked up by the hearing aid without weakening the desired signal.

6. When did the problem first appear?

When cellphone manufacturers introduced the digital "GSM" system in Europe (GSM is an abbreviation for Global System for Mobile communication). I saw for myself how powerful the buzz could be in 1994 when I bought a European GSM digital cellphone and tried to use it in my hotel room. When I started the call, a loud buzz suddenly came from across the room where a TV had been playing quietly. The buzz got even louder as I approached the TV. I had to turn the TV off to hear the cellphone. No wonder holding such a powerful rf buzz source tightly against a hearing aid causes problems!

7. Didn't European cellphone manufacturers know that such a powerful buzz source would cause a problem with hearing aids?

Of course, several studies showed that it would be impossible to use the new GSM cellphones with most existing hearing aids. European cellphone manufacturers took the position that hearing aid wearers shouldn't buy cellphones!

8. What happened in the US?

Up until 1996, hearing aid wearers could use cellphones because US cellphones were all analog (the type which doesn't interfere with the operation of hearing aids). In 1996, however, Sprint introduced digital phones into the Washington DC area. Some members of the consumer organisation SHHH (Self Help for the Hard of Hearing) purchased the phones and reported that they couldn't use their hearing aids with the new digital phones. In some cases, even standing near someone else using a digital cellphone caused a loud buzz in their hearing aid. Led by Donna Sorkin, the director of SHHH at the time, they mounted a campaign to get things changed. The SHHH website provides information on this and other things.

9. Why didn't the cellphone manufacturers simply say buzz off, as they did in Europe?

Because in the U.S., a law called the "Americans with Disabilities Act" requires that disabled people have equal access to services. The members of Congress who passed the act put pressure on the Federal Communications Commission to fix the problem it had caused by allowing digital cellphones, well known to be incompatible with existing hearing aids, into the United States. Since all the cellphone ads claimed that digital cellphones were the best (which certainly isn't true for sound quality), Donna Sorkin and others argued that the digital cellphones had to be made compatible with hearing aids.



Hearing Aids and the Digital Mobile Phone *(contd)*



10. What happened?

Beginning in 1996, several meetings ensued, with over 100 engineers and lawyers from the U.S. and Europe in attendance at the initial meetings. Groups of 30-50 engineers, lawyers and consumer advocates discussed possible solutions to the various aspects of the problem: One of those groups specifically addressed the telecoil problem, for example. We started out assuming that cellphones would meet hearing aids halfway, each solving half the problem. And it didn't happen. Most cellphones don't produce much less of an rf buzz than they did in 1996. The one exception is the "CDMA" spread-spectrum phones, which seem to produce less buzz¹.

11. After all this work, has the problem been solved?

Yes, at least for microphone operation of the hearing aid. Our heroes, the hearing aid engineers, solved the problem by designing hearing aids that were highly resistant to rf interference. The problem was simplified when microphones were introduced that were themselves almost completely immune. Some hearing aid circuits were already immune and others were later designed to be immune. The combination of the microphones and circuits and careful wiring produced hearing aids that can be worn against a digital cellphone with little or no interference.

12. I'm sure our readers would like you to explain the engineering details.

Gladly. In the case of the microphone, a filter at the microphone terminals keeps the rf out of the microphone preamplifier where it is otherwise converted into a strong buzz. In the case of the circuit, a variety of design tricks can be used. (A well-balanced input circuit, for example, can reject the buzz by opposite-phase cancellation). The toughest problem in custom hearing aids is to wire all of all these components together without effectively creating an antenna that can deliver more rf to the microphone or amplifier circuit than even well-designed components can handle.

13. If digital cellphones cause buzz problems, how about digital hearing aids?

Both analog and digital hearing aids can be designed to have excellent immunity on the microphone setting. Neither can have good immunity on the telecoil setting until a digital cellphone is designed with drastically reduced magnetic buzz output. That may not be practical, because of the large current pulses required by the rf output stage.

14. Is buzz immunity better with BTE, ITE, ITC or CIC hearing aids?

All of them can be designed to be immune. The BTE is a real challenge, because the wires are longer and the circuit components larger, creating the potential for more rf pickup. As mentioned above, a custom ITE creates difficulties because each has a different wiring. At the time digital cellphones were introduced, most existing BTE and ITE aids showed a large interference problem, after all, no one told the hearing aid designers they would soon be facing a strong rf buzz source 1/2" away! Some CIC aids, however, were relatively buzz free. The CIC aid is the easiest to immunise because all components are small and the wires are short.

15. Is there a standard immunity rating that will guarantee their hearing aids will work with any digital cellphone?

Yes, there is. Although most of the 100 cellphone and hearing aid engineers and lawyers drifted away after attending the first few meetings (nearly all the cellphone engineers disappeared), a few hardy souls have been meeting regularly over the last four years to produce a standard method of testing hearing aids and cellphones. The resulting U.S. ANSI C63.19 standard will make it possible for hearing aid companies whose designs are usable with digital cellphones to make that claim. A similar standard, IEC in Europe uses a different measurement method but also ensures cellphone compatibility.

16. So when I fit my next pair of hearing aids, how will I know if they will work with digital cellphones?

The simplest check is to try the hearing aid with a digital cellphone! Even better is to have the patient bring their cellphone to your clinic on the day the hearing aids are fitted².

Notes

1. There are different types of modulation technology used with digital cellphones. The original is European GSM (PCS in the U.S.), which allows 8 talkers on a channel and has a nasty 220 Hz (217 to be exact) buzz. For a while, the most popular modulation scheme in the U.S. was TDMA (Time Division Multiple Access), which uses a slightly more civilised 50 Hz buzz, but allows only 3 talkers on a channel. The most sophisticated modulation scheme is CDMA (Code Division Multiple Access), which is a spread spectrum scheme that takes the equivalent of 136 Intel 386 processors between two talkers to keep it alive, according to one telephone engineer. As a reward for the complexity, it seems to produce less interference with hearing aids.

2. For a complete test, you need to drive around a bit while carrying on a conversation. When you drive between "cells" (those 50-100 foot tall poles with metal candles around the top), the nearest cell tells your digital cellphone to operate at nearly 600 mW (full power), which produces the most buzz.

