



**Jason Galster, PhD,**  
**CCC-A, FAAA,**  
 Manager of Clinical  
 Comparative Research,  
 Starkey Hearing  
 Technologies, 6600  
 Washington Avenue  
 South, Eden Prairie,  
 MN 55344, USA.

**Correspondence**  
 E: jason\_galster@  
 starkey.com



**Harvey Abrams, PhD,**  
 Director of Audiology  
 Research, Starkey  
 Hearing Technologies,  
 6600 Washington  
 Avenue South, Eden  
 Prairie, MN 55344, USA.

**Correspondence**  
 E: harvey\_abrams@  
 starkey.com

**Declaration of  
 Competing Interests**  
 JG and HA are both  
 employees of Starkey  
 Hearing Technologies.  
 They have been  
 reimbursed for attending  
 several conferences,  
 have been paid for  
 organising education  
 programmes, and hold  
 shares in the company's  
 employee stock option  
 programme.

# Connected Health: bridging the patient and professional

While you were sleeping, the world changed. Thomas Friedman opens the first chapter of his book *The World Is Flat* with a similar title. Friedman outlines many changes that occurred during the technological maturation of the early 2000s. Connectivity was largely the catalyst of these changes. Communities once distant and disparate were linked, seemingly overnight, by the internet. Services once local are today global. That 'phone call to your local restaurant no longer reaches the restaurant; rather, it is routed to a central location, likely in a distant locale, to a person that has never visited your neighbourhood or enjoyed the chicken curry that is assuredly the best in town. Health care has, understandably, made this same leap. For instance, some facilities use centralised call centres for scheduling outpatient appointments and fielding general questions.

In 2001 the American Medical Association issued a press release reminding patients "...the internet cannot replace a physician's expertise and training... if you have questions, trust your physician not a chat room".<sup>1</sup> Eleven years later, 59% of adults look online before any other resource for information regarding their health. Beyond that, 50% of those internet users seeking health care information online have done so in the process of caring for someone else.<sup>2</sup> These data points reflect a change in not only behaviour of the patient but also, more importantly, the caretaker. Often we regard the person in need of care as wholly a part of our oldest generations. Although this may be true, caretaking falls to the next generation, children, and family members. Today, this generation is the first of the connected.

Eighty-seven percent (5.9 billion people) of the global population has immediate access to a mobile telephone.<sup>3</sup> Remote access to information is no longer perceived as an abstract concept or a luxury. Soliciting information from an unseen, anonymous source is a routine process. This increased acceptability of remote anonymous information delivery corresponds well to changes that will be required in the future as the demand for health care services exceeds the availability of trained professionals.

The World Health Organization has reported a global shortage of 2.3 million health care professionals.<sup>4</sup> Similar trends appear on the horizon for hearing health care, although on a smaller scale. Freeman

(2009)<sup>5</sup> estimates that there are 12,800 licensed full-time audiologists practising in the United States. Over the next decade 6,000 of those will reach retirement age only to be replaced by a collective graduate body of 5,500 newly licensed professionals. With little change in the academic model for audiologic education the number of hearing care professionals will remain flat, and with the future bringing us an ever expanding aged population, steps must be taken to increase access to diagnosis and treatment of hearing loss.

Provision of health care from a distance has been defined in countless ways and undergone a number of evolutionary steps. A brief glance at related literature and marketing will identify remote health care as tele-medicine, tele-health, tele-audiology, online care, e-health, health 2.0, wireless health, and m-health, each with subtle, but intentional differences. A unifying term, Connected Health, encompasses these health care trends, ideas, and movements, articulating the inherent goal of leveraging remote services for care-related needs. Connected Health will empower consumers of health care and providers of health care services to affect change in existing models.

Aspects of Connected Health have been considered and validated with some rigour in audiology (that is, tele-audiology). The first validation initiatives occurred in the area of diagnostics and showed with some certainty that remote diagnostic testing could be completed with sensitivity and specificity similar to that observed in the

clinic. These findings were documented for behavioural audiometry<sup>6,8</sup> as well as testing of otoacoustic emissions and the auditory brainstem response.<sup>9</sup> The Connected Health movement has also introduced numerous options for screening hearing with little more than a pair of headphones and a computer or mobile device. At least three hearing aid companies – Starkey, Unitron, and Siemens – have introduced mobile screening applications for use with a smart phone or tablet device. If the screening is failed (a criteria determined by the application developer), referral options are provided using the GPS capabilities of the compatible mobile device. These referral locations are often local and familiar to the user.

Connected Health has also brought audiologic treatment options to the forefront of technology development. For several years, Starkey Hearing Technologies has offered an option to remotely program hearing aids using a telephone's touchtone signals – an approach that has also been leveraged for a variety of medical applications (for example, pacemakers and insulin pumps). The remote hearing aid adjustments are limited to those most commonly used for managing listening comfort or speech audibility. Recently, a means for robust remote programming of hearing aids was developed. Though not commercially available, this application simply requires that the patient or remote clinic install a program by plugging in a USB device. Once installed, the audiologist selects the patient from a list of remote programmers and automatically connects to the hearing aids. Once the remote

connection is active, the hearing aid programming session may proceed identically to one held in an office. The options for communication during the session are managed by the audiologist and patient. Utilities such as Skype allow for audio and video conferencing. In the case of a patient who may not have a robust internet connection, communication between the audiologist and patient can be conducted over the telephone. The process of remote programming requires only small amounts of data transmission making the quality of the internet connection of lesser concern during programming.

Our older generations want to lead a healthy, independent lifestyle in their habitual environment. Hearing loss is an obstacle that isolates a person from the world around them, in many ways working against this goal of independence. Hearing aids are readily available communication tools that facilitate independence and social involvement. By continuing hearing care into the home with Connected Health technologies, such as remote hearing aid programming, patients will maintain a closer connection to their audiologist, receiving incremental care and management that ensures success.

While a mismatch between the availability of trained audiologists and an expanding population of hearing impaired adults will likely influence the scope and growth of connected hearing health care services, other important social and demographic factors are at play. Consumers are more tech-savvy; they have an insatiable appetite for immediate information; there is an increased perception of health care as

a consumer product; and consumers expect to partner with their providers in health care decisions. Connected Health technologies are being well-leveraged by the health care community, but a gap remains within the field of audiology. We must look forward to new opportunities that allow patient needs' and expectations to be met efficiently and from a distance; Connected Health technologies will be the stonework that bridges the patient and professional.

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