The potential impact of new technologies

Summary and key findings

- Health and social networking technologies with the greatest near-future impact for older people will be those developed to use generic, freely available platforms including the internet and smartphones and tablets running Windows 8.1, Android or iOS.
- The near-future technological development with the greatest impact on telemedicine, telehealth, telecare and smarthome technology for older people will be the development of the 'internet of things', machine to machine (M2M) networks and associated standards for interoperability, that will provide improved resilience and communication between sensors and systems.
- In general, the technological developments with the greatest impact will be those that are 'needs and outcomes' rather than 'technology' led.
- Far-future technologies, that are currently under development, with the greatest potential impact for older people, include wearable exoskeletons and driverless cars. The use of care robots is currently showing less promise.
- Barriers to future impact
    - While the existing telecommunication networks are adequate for telehealth devices which monitor vital signs, more reliable transmission links will be required for telehealth services which use devices that are implanted into the body and/or that administer drugs.
    - Barriers to health technology innovation include the current lack of standards for inter-operability of equipment and systems.
    - For technology to be accepted by older people it has to be affordable, easy to use, and satisfy an identifiable need.

The potential impact of new technological developments

The key overarching technological developments of the past 50 years have been firstly the growth of digital technology, the exponential rise of computing power and the associated miniaturisation of components leading to the increased portability of devices; secondly the extended ability to communicate using networks including GSM cellular networks, satellite technology and the internet and particularly since the 1990s the development and growth of the World Wide Web; and thirdly the widespread availability of satellite based global positioning systems. These enabling and driving technologies have encouraged a number of developments. These include, recently, the widespread use of smartphones and touchscreen based tablet computers, the associated use of a wide variety of different 'apps' and the growth in the use of social networking. Most recently it has seen the development of the 'internet of things', allowing sensors and other devices to become more resilient and communicate over longer distances.

The potential impact of these technological developments for older people is huge and limited only by market development, costs, time and human ingenuity.

Technology today

Assistive technology, telehealth and telecare

Telecare helps people who need the help of Health Services or Social Care to continue to live at home. It uses technology that can monitor activities and safety, provide virtual home visiting, activate reminder systems, increase home security and convey information.
Telehealth is aimed at helping people manage their own long-term condition, including diabetes, heart failure and chronic obstructive pulmonary disease (COPD), in their own home.
Assistive technology is a wide-ranging concept covering 'any device or system that allows an individual to perform a task that they would otherwise be unable to do, or which increases the ease and safety with which the task can be performed'.[1]

Telecare devices include personal alarms, fall detectors, epilepsy sensors, enuresis sensors (detecting bed moisture), large button telephones, carbon monoxide, gas and flood detectors, all possibly linked to a central alerting system, key safes (securely holding house keys but with a code to allow access for carers and emergency services) and Buddi systems (personal tracking system using global positioning system [GPS] technology).

[1] Cowan and Turner-Smith (1999), The role of assistive technology in alternative models of care for older people.

Telehealth devices include blood pressure, blood oxygen and blood sugar level monitors, spirometers (measuring lung capacity) and simple weighing scales linked to a central monitoring unit that can itself be linked to a health centre or surgery.

Apple's new operating system iOS 8 will include the ability to monitor health and fitness through 'HealthKit' which brings together a number of healthcare and fitness apps including blood pressure and heart rate monitors and allows them to communicate with each other, and 'Homekit', bringing together the control of appliances and other connected devices in the home.

Although there have been many descriptions and evaluations of current and past telehealth and telecare projects, rigorous evaluations using randomised control trials or large scale observation are less common. A 2007 review of rigorous evaluations[2] concluded that the most effective telehealth/telecare interventions for reducing health service use were those monitoring vital signs but there was less evidence to support the interventions in terms of cost effectiveness or patient satisfaction. Interventions in which the user recorded their own information in various ways, and received feedback, seem to result in an improvement both in symptoms and in quality of life.

One of the most comprehensive evaluations of telehealth and telecare projects has been the Whole System Demonstrator Programme established by the Department of Health in 2008 involving 6,191 patients and 238 GPs in Newham, Kent and Cornwall. Headline results indicated that, if used correctly, telehealth can deliver, for the end user, a 45% reduction in mortality rate and, for the health service, a 15% reduction in A&E visits, a 20% reduction in emergency admissions, a 14% reduction in elective admissions, a 14% reduction in bed days and an 8% reduction in 'tariff' costs.[3]

Telecare as implemented in the Whole Systems Demonstrator trial did not lead to significant reductions in service use, at least in terms of results assessed over 12 months.[4]

Barriers to the adoption of telehealth and telecare associated with non-participation and withdrawal from the trial were identified. Respondents held concerns that special skills were needed to operate equipment but these were often based on misunderstandings. Respondents' views were often explained in terms of potential threats to identity associated with positive ageing and self-reliance, and views that interventions could undermine self-care and coping. Finally, participants were reluctant to risk potentially disruptive changes to existing services that were often highly valued.[5]

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[2] Barlow et al (2007), A systematic review of the benefits of home telecare for frail elderly people and those with long-term conditions
[3] Department of Health (2011), Whole System Demonstrator Programme: Headline findings - December 2011
[4] Steventon et al (2013), Effect of telecare on use of health and social care services: findings from the Whole Systems Demonstrator cluster randomised trial
[5] Sanders et at (2012), Exploring barriers to participation and adoption of telehealth and telecare within the Whole System Demonstrator trial: a qualitative study

Three themes emerged from the Whole System Demonstrator programme as particularly important areas for consideration when adopting telehealth and telecare: leadership; working practices, skills and development; and data management.[6]

Fears have been expressed that the use of telehealth and telecare may lead to the depersonalisation of services. Pols (2010) found that the contrary was the case with telecare leading to more frequent and more specialised contacts between nurses and patients[7].

Telecare is still a relatively recent development, so solutions are often single-purpose and specialized. In fact, many of the capabilities required for home care can be supported by general-purpose components. The tendency so far has been to focus on devices. In future, the emphasis will need to be on platforms as integrated and extensible frameworks that work with a wide variety of sensors, actuators, and services.[8] The setting of interconnectivity standards will facilitate the future development of telehealth and telecare platforms and services.[9]

Evaluations are inevitably of current and past technologies. As telehealth and telecare sensors of different types become pervasive, linked to commonly available technology 'platforms', the important issues for potential future impact will be to maintain reliability, acceptability, ease of use and value for money. Successful implementations are likely to be 'needs and outcomes', rather than 'technology', led.[8]

Seven predictors that play an important role in the perception of home telemedicine services (HTS) among older adults are: perceived usefulness, effort expectancy, social influence, perceived security, computer anxiety, facilitating conditions, and physicians' opinion.[10]

Future high impact areas of telemedicine are likely to be remote consultation and diagnosis; reminder systems for patient behaviour change; the expansion of clinical data integration into electronic health records; and the gradual integration of telehealth into standard healthcare delivery systems, requiring inter-operability of medical devices, health records and other technologies.[11]

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[6] Giordano et al (2011), *Perspectives on telehealth and telecare: Learning from the 12 Whole System Demonstrator Action Network (WSDAN) sites*,
[7] Pols (2010), The heart of the *matter*. About good nursing and telecare
[8] Turner and McGee-Lennon (2013), Advances in telecare over the past 10 years
[9] European Telecommunications Standards Institute (ESTI), Telecare In and Outside Intelligent Homes – Issues and Recommendations for End User Aspects, STF264
[10] Cimperman et al (2013), Older Adults' Perceptions of Home Telehealth Services
[11] Ackerman et al (2010), Developing Next-Generation Telehealth Tools and Technologies: Patients, Systems, and Data Perspectives

Technology in care homes

Barcode-based medication administration systems have the potential of reducing medication administration errors in care homes by confirming that the correct medication is being given to the correct resident at the right time. A UK evaluation of one such system[12] showed its effectiveness in avoiding a large number of care home medication administration errors which would otherwise have occurred, but did not evaluate the ease of use of the system. Hospital based bar-code systems linked to electronic medication administration records (eMAR) have been shown to completely eliminate transcription errors.[13]

Although technology based solutions have been shown to reduce medication administration errors, they will only be embraced by care home staff if they are reliable, easy to use and do not add significantly to staff workload for a particular task. Care home staff will find workarounds for workflow blockages perceived as unnecessary, even if these are intentional safety checks introduced by the system.[14]

In 2013, Anchor launched an initiative to make ipad technology available to residents in all its care homes in England. The tablet computers allow Anchor's activity co-ordinators to access a range of resources enabling activities "to be tailored to customer's own interests and life experiences". Anchor are using the iPads to help capture residents' "living stories", keep them in touch with long distance family members and improve communication with those whose first language is not English. A similar programme was adopted by the Care Homes and New Technology (CHANT) project in Leicester, a part of the Transformation Fund (2009/10) programme administered by NIACE.

Sensor systems already available to care homes include bed and chair occupancy sensors, enuresis sensors (detecting moisture) and sensors to detect epileptic events and falls. In common with other sensor technology use, it is likely that, in future, such sensors will move away from being separate stand-alone systems to sensors that use standard protocols to communicate with systems running on widely available general purpose platforms, providing greater flexibility and choice.

Care home residents are commonly unable to visit their GP and require the GP to visit the care home. GPs, on the other hand, make very few home visits and are geared up to receive patients at the surgery, consulting patient notes on the surgery IT system. Where a care home has a small number of 'preferred' GPs it would be possible to establish a secure IT link from the care home to the surgery IT system so that the GP can consult patient notes and

[12] Szczepura, Wild and Nelson (2010), Preventing medication administration errors using pharmacy-managed barcode medication management systems in long-term residential care

[13] Poon et al (2010), Effect of bar-code technology on the safety of medication administration

[14] Vogelsmeier, Halbesleben and Scott-Cawiezell (2008), Technology implementation and workarounds in the nursing home

update them when visiting the care home. The IT link also means that computer based prescriptions may be generated in the home and signed by the GP during a visit. Such a link is likely to bring about a reduction in GP prescribing and monitoring errors.[15]

Smart homes

Smart-home technologies included different types of active and passive sensors, monitoring devices, robotics and environmental control systems. They incorporate technologically advanced systems to enable domestic task automation, easier communication and higher security.[16] A 2013 review of smart home initiatives[17] reported that older adults would readily accept smart-home technologies, especially if they benefited physical activity, independence and function and if privacy concerns were addressed.

Smart homes monitor the behaviour of the occupant and provide support in an autonomous fashion by activating support devices. To ensure it is suitable for older people, there is a need for purpose-designed equipment based on an understanding of user needs. Even people with dementia can be assisted if the new technology does not require complex interactions with the user. The house can provide support with automatic lighting, support in the kitchen and bathroom, provide memory support and help reduce wandering with people with dementia, with the aim of improving the occupants' independence and quality of life. Key elements of the technology are prompting and reminding devices, mainly using recorded voice messages. To be effective, the technology requires an external infrastructure to provide assessment, technical backup and monitoring.[18]

Tracking devices

The use of Global Positioning Systems and wearable sensors or hand-held devices allows the development of easy to use way-finding applications giving some older people greater freedom to roam, but also offers opportunities for the protection of vulnerable older people who may prone to ‘wandering’. This raises ethical issues depending on whether such measures are viewed as surveillance or protection and the degree of understanding and involvement of the person being monitored.[19]

[15] Centre for Policy on Ageing (2012), Managing and administering medication in care homes for older people
[16] Lê et al (2012), Smart Homes for Older People: Positive Aging in a Digital World
[17] Morris et al (2013), Smart technologies to enhance social connectedness in older people who live at home
[18] Orpwood (2012), Smart Homes
[19] Landau and Werner (2012), Ethical aspects of using GPS for tracking people with dementia: recommendations for practice

mHealth

In 2013 6.8 billion mobile phone subscriptions were held by people world-wide.[20] mHealth refers to the promotion of health using these mobile and smart-phone technologies. A number of reviews of mHealth interventions[21],[22] have concluded that text messaging can be effective in promoting behaviour change while there is also weak evidence that medication reminders and support messages may also help in the management of long term conditions.[23]

Smartphones are increasingly viewed as handheld computers rather than as phones, due to their powerful on-board computing capability, capacious memories, large screens and open operating systems that encourage application development. The eCAALYX Android smartphone app receives input from a BAN (a patient-wearable smart garment with wireless health sensors) and the GPS (Global Positioning System) location sensor in the smartphone, and communicates over the Internet with a remote server accessible by healthcare professionals who are in charge of the remote monitoring and management of the older patient with multiple chronic conditions.[24]

Social networks

Social networking and the use of Skype may, potentially, be very effective in improving social-connectedness. There is emerging evidence that such applications can help to prevent social isolation and loneliness among older people[25,26] and, in the short term, this use of pc, tablet and network technologies may prove to be the most beneficial.

Usability

If technology is to be of value to older people it has to be obviously beneficial, easy to use, cheap and accessible. Typical of an attempt to seamlessly merge technology into existing life experiences and

[20] Kwan (2013), mHealth Opportunities For Non-Communicable Diseases among the Elderly
[21] Free et al (2013), The Effectiveness of Mobile-Health Technology-Based Health Behaviour Change or Disease Management Interventions for Health Care Consumers: A Systematic Review
[22] Cole-Lewis and Kershaw (2010), Text messaging as a tool for behavior change in disease prevention and management
[23] De Jongh et al (2012), Mobile phone messaging for facilitating self-management of long-term illnesses
[24] Kamel Boulos et al (2011), How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX
[25] Morris et al (2014), Smart technologies to enhance social connectedness in older people who live at home
[26] Independent Age (2010), Older people, technology and community: the potential of technology to help older people renew or develop social contacts and to actively engage in their communities

requirements is the digital walking stick created by Fujitsu. The walking stick is designed to help older people find their way, as well as monitor things such as heart rate and temperature. Its location can also be followed online - and can be set up to send email alerts if it thinks the user may have fallen over.

Current and near-future developments in technology

Care robots

The development of robots, to provide practical help and care for older people in need, is still in its infancy but the development of socially assistive robots is a little more advanced and has been met with a generally positive reception.[27]

Service robots include self-navigating vacuum cleaners and mops but, for the most part, developed robots still provide only monitoring and social interaction functions.[28]

The internet of things

The internet of things provides interconnectedness for devices and equipment, for example sensors and displays. Typically M2M (machine to machine) communication requires much less bandwidth than traditional internet connections so it encourages the development of ‘ultra-narrowband’ technology which allows communication over much longer distances and through buildings, and requires much less power enabling a battery life of perhaps 15-20 years. The M2M network uses gaps in existing frequency bands called ‘white spaces’. BT, in collaboration with Neul, is currently testing a version of the ‘internet of things’ called NeulNet while, in 2015, Arqiva plans to launch a UK version initially covering 10 cities and linked to the international Sigfox network.

Because sensors can be attached to just about anything, the potential of the internet of things is limitless, but it is particularly promising for the development of smarthome and telehealth and telecare applications for older people.[29]

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[27] Louie et al (2014), Acceptance and Attitudes Toward a Human-like Socially Assistive Robot by Older Adults
[28] Pearce et al (2012), Robotics to Enable Older Adults to Remain Living at Home
[29] McCullagh and Augusto (2011), The internet of things: the potential to facilitate health and wellness

Drivers for technological change

A 2010 report to Ofcom[30] identified three main technology drivers for the development of assisted living services (ALSs) for older people, but which also have wider relevance. These are:

(1) Moore's law, the heuristic observation that the number of transistors in a dense integrated circuit doubles approximately every two years , will lead to cheaper equipment which offers greater processing speed and memory while consuming less power

(2) Broadband communication will be available to all

(3) The current move to mass-market devices with software application programming interfaces (APIs), on which independent companies can then design specialist applications, will continue.

The report concluded that, in combination, these drivers have significant implications for the development of ALSs and, together, they will reduce the cost of equipping a home for telecare or telehealth substantially - perhaps from £2,000 to £200

The report states that "*Today telehealth services use a combination of sensors, hubs and remote servers to provide better and more cost efficient management of chronic conditions such as diabetes, COPD, heart failure and asthma. As the decade advances new ALT developments could improve the management of chronic conditions, extend the range of conditions which are managed at home, and allow management while outside the home.*

We expect to see a shift over the next few years, from alarm-based telecare systems to systems which use more continuous life style monitoring. We also expect to see the development of augmented reality services for those with cognitive disabilities and telecare services for older people when they are outside the home - through SMS reminder systems, navigation services, and services to locate dementia sufferers who wander and become lost.

As well as telecare and telehealth services to ensure physical well-being, we expect to see take-up of a range of digital participation services which will connect, engage, stimulate and entertain older and disabled people in their homes. Already digital participation services offer older and disabled people access to a wide range of Internet services which allow them to save money and to participate more fully in society.."

The belief is that, in future, providers of telehealth, telecare, and other technology to help older people, will move away from equipment combining specialist hardware and software to the development of sensors and software that will work with widely available technology such as tablets and

[30] Lewin et al (2010), Assisted living technologies for older and disabled people in 2030: A final report to Ofcom

smartphones. Illustrative of this is the Scanadu Eco-System, a suite of consumer medical device products allowing an individual to monitor their own health at anytime, anywhere. Each product is designed to wirelessly connect to a smartphone and provide analytics and intelligence to live a healthier life.

The Scanadu Scout™ (illustrated) monitors temperature, blood pressure and heart rate while the Scanaflo™ is a urine test kit that is designed to give early information about liver, kidneys, urinary tract, or metabolism. The Scanaflo will test for levels of glucose, protein, leukocytes, nitrates, blood, bilirubin, urobilinogen, specific gravity, and pH in urine. A smartphone app guides the user through the test procedure, automatically processes the test results, stores them, and explains them.

For the medical profession, scanning technology such as ultra-sound, that has traditionally been static and hospital based will become available in surgeries and to visiting nurses, operated through tablets and smartphones.

The 2010 report to Ofcom[30] notes that over the next 20 years the main public network platforms - both fixed and mobile - will move from circuit switched to IP networks and the reliability of these networks will need to improve significantly if they are to be acceptable for telecommunications applications generally. *"During this transition it is unlikely that the functionality of the public IP network platforms will be influenced significantly by the networking requirements of ALT based applications. It is more reasonable to assume that the functionality of ALT-based services will be constrained by the network functionality of the public IP network platforms."* The report concludes that while the existing spectrum allocation should be adequate for almost all assisted living services including telehealth devices which simply monitor vital signs, medical regulations will, almost certainly, demand more reliable transmission links for telehealth services which use devices that are implanted into the body and/or that administer drugs.

High impact longer-term technological developments

Technological developments, which are already here in nascent form but which may have dramatic long-term impacts for older people when fully developed, include wearable exoskeletons and driverless cars. In both cases the technology may offer help to older people who have lost mobility.

A flexible 'wearable' exoskeleton that will be invisible to observers and support the ability to walk

The Release project[31], which took place between September 2011 and March 2013, with funding from the EPSRC, undertook a feasibility study aimed at developing concepts for a wearable exoskeleton. The challenge was to design an exoskeleton that would be invisible to observers and liberating for the end user beyond the 'basic' issue of supporting someone to be able to walk. The project involved researchers from University College London with a variety of backgrounds; orthopaedics, physics, mechanical engineering, nano-technology and accessibility.

Researchers used biomechanical knowledge of walking to develop the exoskeleton concept. The project also looked at options for materials that could alter from being flexible to stiff, so that it could be used to support movement, and investigated a suitable energy source to drive the exoskeleton system. Researchers found potential materials to use for the basis of the exoskeleton, such as magnetic gels used with chemical actuators, which can change size and stiffness when exposed to different magnetic field strengths or low electrical voltage. The researchers propose that these materials may provide the basis for a motor-less exoskeleton. This allowed the project team to concentrate on identifying a means of generating the required magnetic field without it being obvious to view in an exoskeleton design.

[31] http://www.ucl.ac.uk/arg/research/projects/current/release

The research findings from this project are being taken forward into the WAM - Wearable Assistive Materials project, which has been funded by the EPSRC and started in March 2013. The WAM team now aim to use the knowledge gained from Release to produce the composite material which will have the appropriate properties for the basis for a wearable exoskeleton.

Meanwhile, in June 2014 exoskeleton developer ReWalk Robotics announced that the U.S. Food and Drug Administration had cleared the company's ReWalk Personal System for use at home and in the community. ReWalk is a wearable robotic exoskeleton that provides powered hip and knee motion to enable individuals with Spinal Cord Injury (SCI) to stand upright and walk. ReWalk, is now available throughout the United States. Also in the USA, military technology developer Lockheed Martin has created a titanium exoskeleton the Human Universal Load Carrier (HULC) for use by soldiers.



3D printing is an emerging technology and is already being used to develop well-fitting prosthetics. In February 2014, at an event in Budapest, Ekso Bionics demonstrated a complete personalised hybrid robotic exoskeleton created using 3D printer technology.

Driverless cars

One of the major issues for older people, particularly in rural areas, when they are no longer able to drive, is the lack of availability of timely, inexpensive and convenient public transport services. Taxi services, while more flexible, are expensive and may not be available when needed.

Driverless cars were once the stuff of science fiction but, in 2014, in California, on ordinary suburban streets, Google demonstrated the use of a driverless vehicle with only start, stop and pull-over buttons.


Meanwhile, in Europe, BMW, Volvo and Bosch have all recently tested driverless cars on public roads[32], and regard autonomous technology as being a key area of their future business. Driverless car technology will be licensed for testing on public roads in the UK from January 2015. The development of driverless technology will be an evolutionary process with a mixed environment of driven and autonomous vehicles for many years[33]. Bearing this in mind, a team from Oxford University, in collaboration with Nissan is developing a autonomous navigation system, based on low-cost lasers and cameras, with less reliance on external infrastructure, such as GPS, or communication with other intelligent vehicles.

[32] Excell (2013), *Autos on autopilot: the evolution of the driverless car*
[33] Department for Transport (2013), *Action for Roads: A network for the 21st century*

It would not be feasible, even if it were economically sustainable, in an urban environment for every older person in need to have their own driverless vehicle, but driverless shared vehicles such as taxis could make flexible and convenient transport more widely, cheaply and readily available for those in need.

Outside cities, driver assisting technology is currently most developed for driving on motorways and in heavy traffic. It is envisaged that, in future, groups of autonomous or semi-autonomous vehicles will form 'trains', 'cohorts' or 'platoons' to make the most efficient use of motorway space.

Digital inclusion

Overall over 80% of households in Britain now have internet access but the extent of digital inclusion is closely related to income and age.[34] Older people and poorer people are both less likely than other groups to use digital technology and the internet, so older poorer people are particularly disadvantaged. The principle barriers to the digital inclusion of older and disabled people are they do not see the relevance and value of internet use; they do not have the skills and confidence necessary to use a PC and browser to access the internet; and many cannot afford the equipment and broadband connection required.[35]

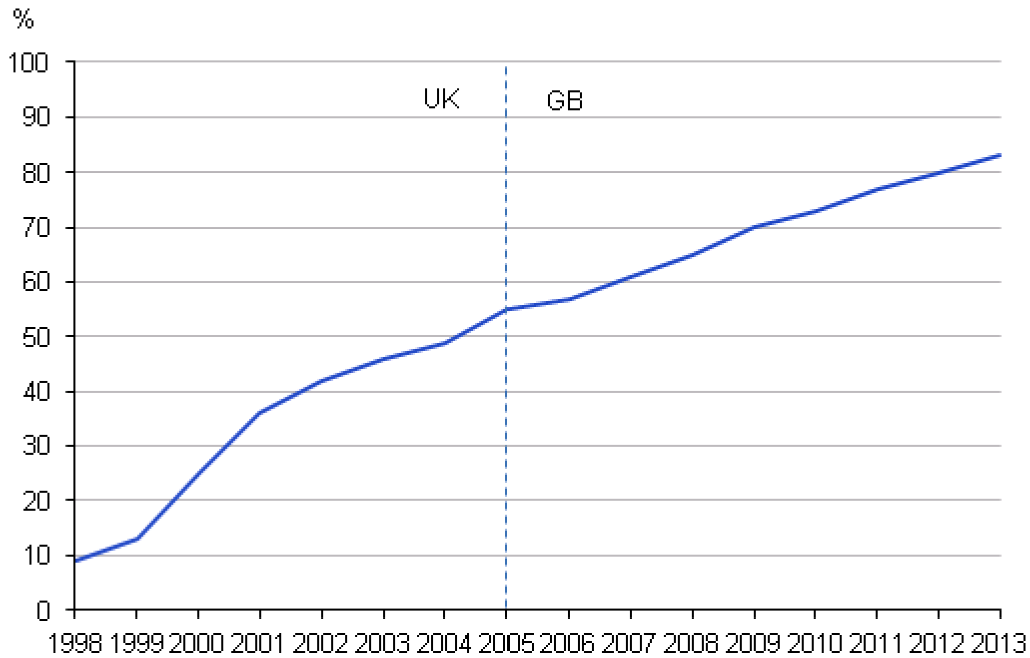
It is claimed that the growth of smartphone and tablet (touchscreen) technologies, held to be more intuitive and therefore easier to use, will reduce this digital divide. According to Ofcom[36], the proportion of people aged over 65 that are accessing the web reached 42% in 2013, up nine percentage points from 33% in 2012, which is a 27% increase over the year. One reason for this is an increase in the use of tablet computers by older people aged 65-74 to go online, up from 5% in 2012 to 17% in 2013. By comparison, nearly all adults under 35 years old now go online (98%).

The increase in internet use between 2012 and 2013 was driven by three different age-groups: 25-34s (98%, up from 92% in 2012), 45-54s (91%, up from 84%), but, most notably, those aged over 65. People aged 65-74 were also two thirds more likely to use a smartphone in 2013 compared to 2012 (20% vs. 12%).

[34] Green and Rossall (2013), Digital inclusion evidence review
[35] Lewin et al (2010), *Assisted living technologies for older and disabled people in 2030: A final report to Ofcom*
[36] Ofcom (2014), Adults' Media Use and Attitudes Report 2014

Although older people continue to be digitally disadvantaged, and may always be so – with the implication that some provision has to be made in any 'digital by default' strategy, there is clear evidence that the gap is narrowing.

Households with Internet access, 1998 to 2013



Source: Office for National Statistics

Notes:

1. UK estimates from 1998 to 2004, Great Britain estimates from 2005 to 2013.

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