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 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.

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.

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.

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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 al (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\(^\text{12}\) 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.\(^\text{13}\)

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.\(^\text{14}\)

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

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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 initiatives17 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

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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.\textsuperscript{20} mHealth refers to the promotion of health using these mobile and smartphone technologies. A number of reviews of mHealth interventions\textsuperscript{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.\textsuperscript{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.\textsuperscript{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\textsuperscript{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

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\textsuperscript{20} Kwan (2013), mHealth Opportunities For Non-Communicable Diseases among the Elderly
\textsuperscript{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
\textsuperscript{22} Cole-Lewis and Kershaw (2010), Text messaging as a tool for behavior change in disease prevention and management
\textsuperscript{23} De Jongh et al (2012), Mobile phone messaging for facilitating self-management of long-term illnesses
\textsuperscript{24} Kamel Boulos et al (2011), How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX
\textsuperscript{25} Morris et al (2014), Smart technologies to enhance social connectedness in older people who live at home
\textsuperscript{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

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\(^\text{30}\) 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\(^\text{30}\) 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\(^\text{31}\), 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.

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\(^{30}\) http://www.ucl.ac.uk/arg/research/projects/current/release

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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 roads32, 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 years33. 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. 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. 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, 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%).

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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**

![Graph showing percentage of households with internet access from 1998 to 2013 with a steady increase.]

Source: Office for National Statistics

**Notes:**

Review of the literature

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Within each section, the reviewed literature is listed in reverse chronological order with the most recent publication first.
## a) Reviews and overviews

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<th>Findings</th>
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<tr>
<td>Lynch J and Draper H (2014) <em>Ageing well with technology</em>, Birmingham Policy Commission</td>
<td>While telecare and telehealth are not new concepts, the technology-based provision has seen a global rise in prominence in recent years. This can be explained in terms of the challenges presented by ageing populations and increased demand on health and social care services, as well as in economic terms as public institutions search for a panacea to shrinking budgets and uncertain futures. The UK Government has consistently advocated, over the past decade, widespread adoption of these services. It has backed this position with large-scale funds and encouragement of prominent industry players. Telecare and telehealth have developed in the context of tackling health and illness issues and of efforts to ensure older people who may be at risk of losing their independence are helped to avoid entering long term hospital placements or residential care for as long as possible. The type of equipment in use ranges from low-tech standalone pieces, such as vibrating pagers or movement sensor lights, to sophisticated monitoring equipment, such as GPS trackers or even ingestible sensors in pills to promote medication compliance. Research money is also being heavily invested in robotic technology. A rough distinction can be drawn between single purpose robotic devices and more ambitious care robots, multi-functioning single units that, linked into smart home technology and telecare technology, could potentially become carer-companions for users. The broadening in scope of ideas about telehealth has complemented advancements in smart home technology aimed at improving people’s quality of life through the management of their home environment, usually through non-obtrusive monitoring of the inhabitant and/or encouraging their independence. Smart home technology is beginning to incorporate ways of facilitating social interaction, for example enabling video-mediated contact between friends and family and virtual participation in group activities. One key consideration is how these technologies are designed to be user-friendly, with particular reference to older people. Internet access is also vital for developments in social networking to reach their potential in tackling social isolation. Where telecare and telehealth are concerned, there is a paucity of research on the experiences of people of BME origin.</td>
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<td>Petrie H, Gallagher B and Darzentas J (2014)</td>
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<td>Rodeschini G (2011)</td>
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The Think Piece suggests that there is a need for current thinking about technology for older people, and the understanding of older people’s experiences of ageing to catch up with each other. Understanding how older people engage with technology is key to shaping our attitude and approach. However, the report highlights that there is conflicting and mixed evidence about the usage of new technology by older people which leads to confusion:

Figures from the Office of National Statistics shows increased use of the internet by over 65s in the last five years, but a recent Oxford Internet Survey suggests that while use of the internet has continued to grow for those in the 25-54 age range, no such growth is evident in the over 55s.

2009 Ofcom research suggests that only one in ten internet users aged 55 and over have a social networking site profile. Yet other usage figures from a popular social networking site suggests a huge increase in users aged 64 and over. In UK alone, the number of people 64 years or older using this networking site increased by a staggering 390 per cent between November 2008 - October 2009.

An approach to designing consumer and assistive technologies that is focused on ‘us as we age’, not ‘them that are already old’ would lead to the design and development of technology better suited to a diverse population.

This chapter provides an overview of the use of technology in older age including the use of telehealth, telecare and the use of assistive technologies, mobility technologies, sensory augmentation and cognitive support.

It considers the potential value of use of the internet and social media and the risk of digital exclusion.

The author concludes that although disabling conditions such as sight loss and reduced manual dexterity are commonly associated with older age it is the condition rather than age itself that inhibits the use of technology.
While the ageing of the population around the world raises serious concerns about social security, pensions, long-term care, health care and family systems, digital-age tools have been proposed as possible resources to improve outcomes. Considerable literature has appeared suggesting that Assistive Technologies (ATs) and Information and Communication Technologies (ICTs) may improve quality of life, extend length of community residence, improve physical and mental health status, delay the onset of serious health problems and reduce family and care-giver burden. The goal of this review is to separate the evidence base for these claims from simple optimism about the ultimate value of technology-based tools. This is accomplished through an extensive examination of the empirical research literature in the field of ATs and ICTs as they relate to older adults and ageing populations. This review describes how these technologies are being utilized by older adults and barriers to their use, and identifies what is known—based on scientific studies—about the utility and effectiveness of the technologies. Appropriate social work practice in the digital age requires knowing what tools are available and their documented effectiveness and limitations.

The review considers the implications of current research knowledge for social work practice, education and research.
<table>
<thead>
<tr>
<th>Key messages from this evidence review are:</th>
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<tr>
<td>• Most studies of older people’s involvement with technology focus on the internet.</td>
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<td>• Fewer people aged 65+ have access to the internet than younger age groups, but numbers are increasing rapidly.</td>
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<td>• Despite barriers, such as cost, the user-friendliness (or the lack of it) of equipment and unfamiliarity/resistance to change, many older people already benefit from new technologies.</td>
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<td>• The main functions used are those enabling them to keep in touch regularly and relatively cheaply with family and friends.</td>
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<td>• Older people who do have home access use the internet more than other age groups.</td>
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<tr>
<td>• The use of technology for enabling social contact and participation can be very successful, but many older people need help at the start and some need ongoing support or reassurance.</td>
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<td>• Many websites are poorly designed and are not fully accessible to older users.</td>
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<td>• Older people (65+) are increasingly accessing information and advice, goods and services via the internet.</td>
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<td>• There are reasons other than cost-saving for technological solutions to help older people remain independent in their own homes, including assistance with everyday tasks compensating for lost physical and cognitive function.</td>
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<td>• Technology can also be successfully used for monitoring older people remotely, but this works best with the older (potential) beneficiaries’ informed consent and active participation.</td>
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<td>• Older people’s involvement with telecare and remote health monitoring are best achieved when the technology is simple and designed for the beneficiary to understand and to use.</td>
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b) The use of assistive technology

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<tr>
<th>Study</th>
<th>Findings</th>
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<td>Parr A and Down K; FAST – The Foundation for Assistive Technology (2013) <em>Research and development work relating to assistive technology 2012-13</em>, Department of Health</td>
<td>In the year from April 2012-March 2013 FAST recorded 218 projects carrying out research and development activity in assistive technology over the year, of which 88 concluded during the year, a similar level of activity to that recorded the previous year’s report. All the research into assistive technology included in the report is being carried out in the UK during the period April 2012-March 2013 and is being funded by the UK government or is funded by the European Union (EU) with participation from a UK organisation. The report includes a useful overview of the policy context. The feature section of the report highlights some of the projects that have concluded during the past year, including: Innovation in supporting people at risk of falling; Biomechanical and sensory constraints of step and stair negotiation in older age; Recovering and regaining abilities - WiiStar; Recent developments in lower-limb prostheses - Customisation of cosmetic covers for artificial limbs; SSHOES - to develop assessment, design and rapid manufacturing techniques to produce affordable bespoke shoes; Tomorrow's technology including SRS: The SRS project, funded by the EU FP7 programme, created prototypes of remotely controlled, semi-independent robotic devices designed to support older people at home; RELEASE - a feasibility study aimed at developing concepts for 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 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.</td>
</tr>
<tr>
<td>Reference</td>
<td>Summary</td>
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A total of 1877 “smart home” publications were identified by the initial search of peer reviewed journals.
Of these, 21 met the inclusion criteria for the review and were subject to data extraction and quality assessment.
Smart-home technologies included different types of active and passive sensors, monitoring devices, robotics and environmental control systems. One study assessed effectiveness of a smart home technology. Sixteen reported on the feasibility of smart-home technology and four were observational studies.
Conclusion: Older adults were reported to readily accept smart-home technologies, especially if they benefited physical activity, independence and function and if privacy concerns were addressed. Given the modest number of objective analyses, there is a need for further scientific analysis of a range of smart home technologies to promote community living. |
| Davenport R D, Mann W and Lutz B (2012) How Older Adults Make Decisions Regarding Smart Technology: An Ethnographic Approach, *Assistive Technology* 24 (3) : 168-181 | Comparatively little research has been conducted regarding the smart technology needs of the older adult population despite the proliferation of smart technology prototypes. The purpose of this study was to explore the perceived smart technology needs of older adults with mobility impairments while using an ethnographic research approach to construct a preliminary decision tree model of how these smart technology decisions are made.
In-depth individual interviews with 11 older adults aged 65 and older with mobility impairments provided insight into how older adults perceived smart technology. Audio-taped interviews were transcribed verbatim, then analyzed for key phrases that represented participant decision criteria. Decision criteria concepts were combined to construct an older adult smart technology decision tree model. The model consisted of a preliminary decision stage that participants engaged in to make the decision of whether a change was needed in their current pattern of behaviour; followed by an evaluation stage that included five potential barriers (i.e., not easy to use/learn) and seven potential facilitators (i.e., decreasing imposition on family/friends) to the smart technology need decision process. Future designers could use this decision model to create appropriately matched technological devices to promote independence of aging baby boomers with mobility impairments. |
How might assisted living technologies (ALTs) help older and disabled people live longer and richer lives at home over the next 20 years?

This report identified five main possibilities. ALTs might enable service providers to:

1. Deliver better and more cost-effective social and health care into the homes of older and disabled people enabling them to live at home longer. The report refers to these as telecare and telehealth services respectively;
2. Deliver services which entertain, educate and stimulate social interaction so as to enrich the lives of older and disabled people who live at home (digital participation services);
3. Provide services which encourage users to get fitter and to adopt healthier lifestyles (wellness services) and
4. Enable older and disabled people to work from home so as to participate more in the economy and in society (teleworking services). The report refers to this collection of services as assisted living services (ALSs).

There are three main technology drivers for the development of ALSs:

1. Moore’s law 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 APIs, on which independent companies can then design specialist applications, will continue.

In combination these drivers have significant implications for the development of ALSs:

- They will reduce the cost of equipping a home for telecare or telehealth substantially - perhaps from £2,000 to £200.
- They will expand the range of ALSs which older and disabled people can use. For example use of broadband communications opens up the possibility for digital participation and teleworking services.
- They could change the nature of the industry which supplies ALT equipment from one in which specialist companies deliver stand-alone systems in which software and hardware is combined, to one in which specialist companies develop applications software specifically for older and disabled people to run on mass-market platforms such as mobile devices.

Continued below...
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.

The authors expect to see a shift over the next few years, from alarm-based telecare systems to systems which use more continuous lifestyle monitoring. They 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, the authors 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.

Teleworking services are important to the future well-being of older and disabled people who wish to live independently at home, allowing older and disabled people to continue to contribute their skills to the economy and to society. They also enable greater job flexibility for potential informal carers who might otherwise struggle to combine a part-time job with responsibilities as a carer.

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<tr>
<td>Assisted living technologies for older and disabled people in 2030: A final report to Ofcom,</td>
<td>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. The authors expect to see a shift over the next few years, from alarm-based telecare systems to systems which use more continuous lifestyle monitoring. They 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, the authors 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. Teleworking services are important to the future well-being of older and disabled people who wish to live independently at home, allowing older and disabled people to continue to contribute their skills to the economy and to society. They also enable greater job flexibility for potential informal carers who might otherwise struggle to combine a part-time job with responsibilities as a carer.</td>
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Nearly 14% of people over age 71 have some form of dementia, with prevalence increasing to nearly 40% of those over age 90. As dementia progresses, it impacts a person’s independent functions and can increase the burden on caregivers. The use of assistive devices can help individuals with dementia live more independently. However, older individuals with cognitive impairment have difficulties using assistive technology devices because the devices are not designed to address their needs. The development of “smart devices” has potential in assisting older adults with cognitive impairment. Eleven community-dwelling seniors with moderate cognitive impairment (Mini-Mental State Examination scores ranging from 12–20) participated in this study. The Functional Independence Measure scores of participants were also collected to determine participants' current level of independence on selected tasks. Three tasks were selected to represent three levels of complexity: drinking water, brushing teeth, and upper body dressing. Participants were prompted through these tasks with simulated smart machine–based prompting. The need for prompts was highly individual, but given appropriate machine-delivered messages, participants completed the tasks an average of 86% of the time across the three self-care tasks. Machine-based prompting devices could aid caregivers as well as increase independence in some tasks.


Key messages from the review

- The term ‘assistive technology’ incorporates a wide variety of devices.
- Assistive technology can be supportive, preventive or responsive.
- The increasing proportion of older people in the population makes the use of assistive technology an attractive option in social services.
- Perceptions vary as to whether or not assistive technology has sufficient benefits.
- Existing research supports the greater use of assistive technology but further evaluation and ‘local learning’ is needed.
- The views and needs of people using assistive technology need to be taken into account.
This research is about people over the age of 70, the houses they live in and the role of assistive technology in enabling them to live as independently as possible in their own homes. It builds on earlier work for the Royal Commission on Long Term Care and has considered how far, and at what cost, existing housing stock can be modified with Assistive Technology to enable older people to remain in their own homes.

**Buildings**
- The extent of adaptation required of buildings in order to accommodate a user’s needs varies greatly. However the main factors that influence the extent of adaptation are related to mobility.
- As user needs become more extensive and complex, so the costs of adaptation rise and more properties are encountered which cannot be adapted to meet user needs.
- The degree of adaptability of buildings is largely dependent on their design and configuration.
- The most adaptable property types are ground floor flats and bungalows. The least adaptable are flats in converted houses and maisonettes in high-rise blocks.
- The single most important factor affecting adaptability is the number of storeys within a property, particularly where users need to use a wheelchair inside the home.
- The cost of adaptations varies considerably, between different types of adaptation, between property types, and within property types.
- Some of the Partner housing providers had properties that were impossible to adapt, others had properties that were easily adapted to meet quite extensive and complex needs, whilst others could achieve a high level of adaptability only through incurring very significant costs.
- The development of user profiles has enabled quantitative analysis of combinations of AT and buildings.
- The methodology has generated data that has both face validity and is capable of analysis and interpretation.

**Assistive technology**
- There is confusion about terminology of AT.
- Users need information about opportunities for AT. Information is in the wrong place, described using the wrong terminology, and with wrong or unhelpful associations (“disability”). It is not clear who pays or how to obtain AT.
- Information is needed for both housing providers and staff. AT advisers require interdisciplinary skills. Continued...

...continued.

- There are not enough builders in some areas to install and maintain AT.
- Providers and assessors need to take a holistic view of the older person’s needs. AT appeared to be installed as a response to particular health problems while little thought was given to other disabilities.
- Thinking through the full needs of the person will lead to more effective AT provision.
- It is no use installing AT unless people feel they need it. On the other hand, if they do not know about it, they will not even be able to consider whether they feel they need it!
- A number of positive developments are occurring at national level. All agencies need to think about AT as integral to community care packages and not just a response to a particular personal need.
- There is a danger of the latest AT being seen as different instead widening existing opportunities. The idea of the “smart house” and of alarm technology needs to be demystified.
- There are inadequate national statistics on AT.

**Older people**

- There were considerable variations in AT provision between respondents
- There is need to listen to older people. They are quite clear about their needs, but very much less clear about what AT is there to help them, how they can access it and what they have to pay.
- Older people want to be able to control as many day-to-day routine activities as possible and AT can help them in this.
- Older people welcome AT when it addresses a FELT need
- Older people have variable access to AT and therefore variable help from AT. They often have unmet needs.
- Installation of AT is not usually a problem, but the on-going reliable operation of the AT is essential.

**Costs**

For most profiles the total costs over the lifetime and reduced lifetime of the hypothetical users were lower for the realistic scenario of Augmented AT plus Reduced care services than for Basic AT plus Full care services. Even when Maximum AT plus Reduced care services was considered this was the case for normal life expectancy although when reduced life expectancy was considered the number of profiles for which there was a saving and those for which there was not was balanced, such that on average the costs were no greater. That is to say taking the most conservative of assumptions, the savings on costs of care services made possible by AT were no greater than the cost of the AT when the costs of installation and the supply of portable AT were taken into account. However, more realistic assumptions show substantial savings; even more so if related to the cost of institutional care. Account has not been taken of the other benefits which would accrue from the provision of AT, in terms of the prevention of falls and improved quality of life.
c) Attitudes to technology

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<th>Study</th>
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<tr>
<td>Louie W-Y G, McColl D and Nejat G (2014) Acceptance and Attitudes Toward a Human-like Socially Assistive Robot by Older Adults, Assistive Technology 26 (3)</td>
<td>Recent studies have shown that cognitive and social interventions are crucial to the overall health of older adults including their psychological, cognitive, and physical well-being. However, due to the rapidly growing elderly population of the world, the resources and people to provide these interventions is lacking. This work focuses on the use of social robotic technologies to provide person-centred cognitive interventions. This article investigates the acceptance and attitudes of older adults toward the human-like expressive socially assistive robot Brian 2.1 in order to determine if the robot's human-like assistive and social characteristics would promote the use of the robot as a cognitive and social interaction tool to aid with activities of daily living. The results of a robot acceptance questionnaire administered during a robot demonstration session with a group of 46 elderly adults showed that the majority of the individuals had positive attitudes toward the socially assistive robot and its intended applications.</td>
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<td>Mitzner T L, Boron J B, Fausset C B, Adams A E, Charness N, Czaja S J, Dijkstra K, Fisk A D, Rogers W A and Sharit J (2010) Older adults talk technology: Technology usage and attitudes, Computers in Human Behavior 26 (6) : 1710-1721</td>
<td>Older adults (n = 113) participated in focus groups discussing their use of and attitudes about technology in the context of their home, work, and healthcare. Participants reported using a wide variety of technology items, particularly in their homes. Positive attitudes (i.e., likes) outnumbered negative attitudes (i.e., dislikes), suggesting that older adults perceive the benefits of technology use to outweigh the costs of such use. Positive attitudes were most frequently related to how the technology supported activities, enhanced convenience, and contained useful features. Negative attitudes were most frequently associated with technology creating inconveniences, unhelpful features, as well as security and reliability concerns. Given that older adults reported more positive than negative attitudes about the technologies they use, these results contradict stereotypes that older adults are afraid or unwilling to use technology. These findings also highlight the importance of perceived benefits of use and ease of use for models of technology acceptance. Emphasizing the benefits of technology in education and training programs may increase future technology adoption.</td>
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The reported study was conducted in 2005/2006 as part of a European Union Northern Periphery Programme (EU NPP) project called Our Life as Elderly. Its aims were to explore the views of those aged 55 years and over and living in remote communities about current and future health and social care service provision for older people. Participants did not consider themselves ‘old’ and expressed the need for independence in older age to be supported by services. Several aspects of services that were undergoing change or restructuring were identified, including arrangements for home care services, meals provision and technological support. Participants valued elements of the traditional model of care they had been receiving: these were local, personal emphasis and continuity. They were suspicious of new arrangements perceived to emphasise technical efficiency. Health and care services were described as inter-linked with other aspects of rural living, including transport and housing (which might have to be relinquished to pay for care). Proximity to family was desired for social and domestic support only; health and related support should be from generic service providers. Community members were involved in reciprocal help-giving of many types. Technology was perceived to be ‘coming’ and the researchers wanted to gauge opinions. To do this a vignette was used that discussed home monitoring devices as well as the use of telemedicine at GPs’ surgeries. The vignette was used because, in early interviews, participants found it difficult to comment on the abstract idea of technology. Perhaps surprisingly, most participants were supportive of, or accepted the inevitability of, technological support of various types if it would help maintain people at home. Their reservation was that it would remove the personal aspects of care and, as with ‘meals on wheels’, they emphasised that the social dimension of interaction with health and care professionals was as important as the ‘technical’ intervention provided.
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<th>Reference</th>
<th>Summary</th>
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<tr>
<td>Mihailidis A, Cockburn A, Longley C and Boger J (2008) The Acceptability of Home Monitoring Technology Among Community-Dwelling Older Adults and Baby Boomers, Assistive Technology 20 (1) : 1-12</td>
<td>This pilot study investigated the willingness of two generational cohorts (current baby boomers and older adults) to accept home monitoring technology. Thirty individuals (15 baby boomers and 15 older adults) of both genders and living in the community participated in structured, mixed methods interviews. The participants' opinions and views on various technologies (e.g., personal emergency response systems, fall detection systems) and sensor types (e.g., switches, motion sensors, computer vision) were determined, including locations within the home where they would be willing to install and use such technologies. Overall, it was found that these technologies would be acceptable if they allowed the participants to remain in their own homes and to age in place. Furthermore, a between-group analysis indicated that there were not many statistically significant differences between the opinions of the two cohorts with respect to preferences about types and locations of these technologies.</td>
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<tr>
<td>OFCOM Consumer panel (2006) Older people and communications technology: An attitudinal study into older people and their engagement with communications technology</td>
<td>Digital Television (DTV) is considered mainstream and accessible by this age group and those that do not have this technology do so out of choice, rather than due to technical or economic reasons. Reasons for non-take up of the internet were significantly more complex and varied. Aside from those that had experience of PCs at work, attitude and character appeared to be the key determinants of whether this age group would become users. Good examples of this were the ‘Self Starters’ who were sufficiently self motivated to take up learning about PCs without any prior exposure. Notably, age, economic and health reasons were not significant barriers to take-up, rather non-users talked about issues relating to motivation and ability, as well as social and environmental reasons. Importantly, non-users divided into two distinct groups. Once groups rejected the idea outright. The other voiced concerns but after some discussion showed interest in having a go. The evidence suggests that there are a significant number of non-users who currently feel ‘disengaged’ from the modern world but given the appropriate support and assistance would overcome their concerns and fears and benefit from PC / internet usage. To engage with this audience, the environment for learning has to be specifically tailored towards older people – in essence, courses (free if possible) run by older people for older people and designed for genuine beginners. In addition, the idea of a mentor, based locally that could assist face-to-face or at least over the telephone, was considered similarly important. Ideally suited to assisting with this tailored approach would be the ‘Self Starters’ group – their learning experiences have meant they have a unique insight into the difficulties faced by older people when learning PC / internet skills.</td>
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### d) Digital inclusion and exclusion - Statistical information

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<th>Study</th>
<th>Findings</th>
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| Green M and Rossall P (2013) Digital inclusion evidence review, Age UK | This review covers only the aspects of digital inclusion connected with internet use, and the term “digital exclusion” refers throughout only to those not using the internet. The research quoted has been selected from a wide-ranging review of the evidence sources, but only those results which the authors consider generally reliable and timely enough to use. Some findings which were interesting have been excluded due to low statistical significance.  
It is possible that a “tipping point” has now been reached. For the first time, the number of people aged 65+ who have used the internet has overtaken those who have never used it. The quarterly Labour Force Statistics survey shows that 5,489,000 are in the “ever used” category and 5,030,000 have never used the internet. In addition, web enabled TV and web access devices designed specifically for older people may soon be available and affordable.  
In the last reported year (2012), ONS estimate that 36% of single 65+ households and 69% of older couples (where at least one person is aged 65+) have internet access.  
There is a decreasing likelihood of using the internet as age increases. Those at older ages (75+) are over five times more likely not to be using the internet than individuals aged 55 to 64.  
- Older individuals with a lower monthly income are less likely to use the internet than those with a higher monthly income with a very apparent gradient.  
- People with the lowest monthly income (£0-249) were over five times less likely to be using the internet than those with a monthly income of £3,000 or more |
| Office for National Statistics (ONS) (2013) Internet Access - Households and Individuals, 2013 | On 15 May 2013, as part of the Internet Access Quarterly Update, ONS reported that 42.4 million people in Great Britain had used the Internet, representing approximately 86% of the adult population. Use of a computer is inextricably linked to the ability of an individual to use the Internet. In 2013, 70% of adults in Great Britain used a computer every day, up from 45% in 2006.  
A sizable increase in daily computer use, by age, in the past seven years has been for adults aged 65 and over. In 2006, just 9% reported that they used a computer every day, this compares to 37% in 2013 |
### e) Ethical issues

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<th>Study</th>
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| Landau R and Werner S (2012) Ethical aspects of using GPS for tracking people with dementia: recommendations for practice, *International Psychogeriatrics* 24 (03) : 358-366 | Problems with out-of-home mobility are among the more common behavioural disturbances in dementia. Today people with dementia can be aided by easily accessible assistive technologies, such as tracking devices using Global Positioning Systems (GPS). Attitudes toward these technologies are still inconclusive and their use with people with dementia raises ethical concerns. The lack of ethical consensus on the use of GPS for people with dementia underlines the need for clearer policies and practical guidelines.  
  
  Methods: The article summarizes qualitative and quantitative findings from a larger research project on the ethical aspects of using GPS for tracking people with dementia.  
  
  Results: The findings are formulated in a list of recommendations for policy-makers as well as for professional and family caregivers. Among other points, the recommendations indicate that the preferences and best interests of the people with dementia should be central to the difficult decisions required in dementia care. Further, no-one should be coerced into using tracking technology and, where possible, people with dementia must be involved in the decision-making and their consent sought.  
  
  Conclusions: The decision whether, when and how to use GPS for tracking people with dementia should be made at the time of diagnosis jointly by the person with dementia, his/her family and professional caregivers. This decision should be made in formal structured meetings facilitated by a professional team. |
In Europe, telecare is the use of remote monitoring technology to enable vulnerable people to live independently in their own homes. The technology includes electronic tags and sensors that transmit information about the user's location and patterns of behaviour in the user's home to an external hub, where it can trigger an intervention in an emergency. Telecare users in the United Kingdom sometimes report their unease about being monitored by a “Big Brother,” and the same kind of electronic tags that alert telecare hubs to the movements of someone with dementia who is “wandering” are worn by terrorist suspects who have been placed under house arrest. For these and other reasons, such as ordinary privacy concerns, telecare is sometimes regarded as an objectionable extension of a “surveillance state.” This article defends the use of telecare against the charge that it is Orwellian. In the United States, the conception of telecare primarily as telemedicine, and the fact that it is not typically a government responsibility, make a supposed connection with a surveillance state even more doubtful than in Europe. The main objection, it is argued, to telecare is not its intrusiveness, but the danger of its deepening the isolation of those who use it. There are ways of organizing telecare so that the independence and privacy of users are enhanced, but personal isolation may be harder to address. As telecare is a means of reducing the cost of publicly provided social and health care, and the need to reduce public spending is growing, the correlative problem of isolation must be addressed alongside the goal of promoting independence.

This article provides an overview of the international literature on the most important ethical considerations in the field of assistive technology (AT) in the care for community-dwelling elderly people, focused on dementia following a systematic literature review. Three main themes were found. The first theme, personal living environment, involves the subthemes privacy, autonomy and obtrusiveness. The second theme, the outside world, involves the subthemes stigma and human contact. The third theme, the design of AT devices, involves the subthemes individual approach, affordability and safety. The often referred to umbrella term of ‘obtrusiveness’ is frequently used by many authors in the discussion, while a clear description of the concept is mostly absent.

Continued...

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| When it comes to AT use in the care for elderly people living at home, ethical debate appears not to be a priority. The little discussion there relies heavily on thick concepts such as autonomy and obtrusiveness which seem to complicate the debate rather than clarify it, because they contain many underlying ambiguous concepts and assumptions. Most encountered ethical objections originate from the view that people are, or should be, independent and self-determinant. The authors question whether the view is correct and helpful in the debate on AT use in the care for (frail) elderly people. Other ethical approaches that view people as social and reciprocal might be more applicable and shed a different light on the ethical aspects of AT use. |


| This article considers the ethical implications of providing assistive technology to people with intellectual disabilities within a framework of Autonomy, including information provision, response bias, coercion and the right to privacy; Beneficence; non-maleficence, including issues of stigma, risk and social contact; and Justice. The authors conclude that it is important to recognise that the introduction of AT&T is not like any of the decisions that are made in the normal course of providing support. The introduction of AT&T involves a transfer of control from staff, or the person themselves, to a technological system. This involves a change in the normal decision making processes for the person, and potentially a change in the normal safeguards that having staff directly involved brings. |
f) Future developments in technology

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<tr>
<td>Ransley M (2014) Developing Wearable Assistive Materials for Orthopaedic Applications - 3 Month Report, University College, London</td>
<td>The development of WAM, a smart material capable of changing between rigid and flexible configurations to provide a thin, light exoskeleton for a range of mobility disorders, is an ambitious interdisciplinary effort, and one to which modelling and simulation have not currently been employed. The exact nature and underlying structure of the material have yet to be fully elucidated, though the need for such a product and the potential actuators worth investigating have been made clear in a previous report. Several new conceptual contributions relating to the structure and mechanisms of WAM are presented here. The aim of this report is to consolidate what has been learned, worked on and read about as part of the WAM research group, to demonstrate how modelling and simulation could prove important in the project, and to state what the group intends to produce, in terms of theory, software and physical prototypes, in the coming months.</td>
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<tr>
<td>Excell J (2013) Autos on autopilot: the evolution of the driverless car, The Engineer 5th August 2013</td>
<td>Car-makers, technology suppliers and transport authorities around the world are increasingly viewing the autonomous car as the key to a safer, less congested and more energy efficient road system. Across Europe, automobile companies including BMW, Volvo and Bosch have all recently tested driverless cars on public roads, and regard autonomous technology as being a key area of their future business. In the US, search engine giant Google, which has a test fleet of around 10 autonomous cars, has successfully lobbied for changes to legislation in Nevada, Florida and California that enable it to test its technology on the road. And here in the UK the government last month confirmed that road trials of a driverless car developed by Oxford University and Nissan will begin later this year. There are a number of key functions an autonomous car has be able to perform. ‘It must know what is happening around itself; it must know where it is and where it wants to go; it must have the reasoning and decision-making capability to plan a safe trajectory; and finally, it needs the “muscles” or actuators that can take control of the vehicle’s steering and control systems. Continued..</td>
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Car-makers seem to be taking a broadly similar approach to solving these problems: using advanced imaging systems to gather information about a vehicle’s surroundings that is then cross-checked against detailed GPS and map data.

In recent months, both Bosch and BMW have announced successful trials on sections of the German autobahn — a significant move away from the test track and into the more dynamic and unpredictable environment of a real-life road.

A team of robotics specialists from Oxford University is taking a different approach and working on the development of a low-cost autonomous navigation system that doesn’t rely on existing infrastructure or communication with other intelligent vehicles.

The vision is shared by the UK government’s Department for Transport (DfT), which, in its recently published ‘Action for Roads’ report, predicts a world where by 2040, semi-autonomous vehicles are commonplace on our roads.

The fully autonomous car will not appear overnight. Despite some hugely impressive prototype vehicles, the car industry and the road regulators are rightly conservative. But a number of technologies slated to appear soon on production vehicles — including traffic-jam-assist technology that will take control of the vehicle on congested highways — will bring the autonomous dream a step closer to reality.

This paper investigates the potential of The ‘Internet of Things’ to monitor health and wellness. It reports on two categories of system: home telehealth monitoring normally used by people with an illness or chronic condition, and mobile, unfettered systems for classifying movement activity; specifically designed to motivate active people, currently used by sports enthusiasts. For each application sensor technology is readily available at reasonable cost, but integration and usability are major issues. Enhanced connectivity and feedback can leverage this technology’ to promote wellness and it is believed that intelligent and autonomous ‘things’ (sensors, processing and communication devices, and displays) can be usefully employed for this purpose. This technology may be appropriate to managing chronic disease and empowering the ageing population, if the systems can be tuned to their requirements, with particular reference to usability.
g) mHealth and the use of smartphone technology

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<th>Study</th>
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| Kwan A (2013) *mHealth Opportunities For Non-Communicable Diseases among the Elderly*, mHealth Alliance; Pfizer | The imminent global threat of non-communicable diseases (NCDs), combined with an expanding older population, calls for urgent solutions that have wide reach, strong potential for scale-up and the ability to extend existing health systems into the community. In early 2013, the number of mobile phone subscriptions around the world reached 6.8 billion, and this figure is expected to grow and surpass the world population in the year 2014. This recent explosion and near ubiquity of mobile phone uptake around the world may offer opportunities for NCD prevention, health promotion, treatment and disease management. mHealth efforts focused on NCDs are already being implemented, and new evidence based on rigorous trials have begun reporting the benefits of text messaging, automated telephone monitoring, treatment reminders and self-care support for improving health outcomes related to chronic disease management. This paper describes the ways mHealth can help avert risk factors associated with NCDs in the context of aging. These include:  
  • Enabling and creating new resources in the community such as in-community or home monitoring systems with access to providers  
  • Strengthening the health system response to NCDs by offering flexible ways for health professionals to reach patients remotely, which can also help alleviate the human resource crisis in health  
  • Allowing the elderly and their caregivers to take more control of managing their health conditions by sending informational messages and encouraging self-management with telecare options  
  • Improving decision support by offering guidelines and protocols on the mobile phones of health providers or community-based health workers  
  • Formalizing linkages between patients and primary health centers through patient networks, helplines, appointment reminders, or simple phone calls from providers to their patients  
  • Digitizing monitoring systems for treatment, health records, and disease surveillance information that can assist decision making on the policy, patient-provider relationship, or individual levels. |


|---|
| A systematic review to assess the effectiveness of mobile technology interventions delivered to health care consumers. 

The researchers identified 75 controlled trials (studies that compare the outcomes of people who do and do not receive an intervention) of mobile technology-based health interventions delivered to health-care consumers that met their predefined criteria. Twenty-six trials investigated the use of mobile technologies to change health behaviours, 59 investigated their use in disease management, most were of low quality, and nearly all were undertaken in high-income countries. In one high-quality trial that used text messages to improve adherence to antiretroviral therapy among HIV-positive patients in Kenya, the intervention significantly reduced the patients’ viral load but did not significantly reduce mortality (the observed reduction in deaths may have happened by chance). In two high-quality UK trials, a smoking intervention based on text messaging (txt2stop) more than doubled biochemically verified smoking cessation. Other lower-quality trials indicated that using text messages to encourage physical activity improved diabetes control but had no effect on body weight. Combined diet and physical activity text messaging interventions also had no effect on weight, whereas interventions for other conditions showed suggestive benefits in some but not all cases.

Conclusions: Text messaging interventions increased adherence to ART and smoking cessation and should be considered for inclusion in services. Although there is suggestive evidence of benefit in some other areas, high quality adequately powered trials of optimised interventions are required to evaluate effects on objective outcomes. 

These findings provide mixed evidence for the effectiveness of health intervention delivery to health-care consumers using mobile technologies. Moreover, they highlight the need for additional high-quality controlled trials of this mHealth application, particularly in low- and middle-income countries. 

Specifically, the demonstration that text messaging interventions increased adherence to antiretroviral therapy in a low-income setting and increased smoking cessation in a high-income setting provides some support for the inclusion of these two interventions in health-care services in similar settings. However, the effects of these two interventions need to be established in other settings and their cost-effectiveness needs to be measured before they are widely implemented. Finally, for other mobile technology–based interventions designed to change health behaviours or to improve self-management of chronic diseases, the results of this systematic review suggest that the interventions need to be optimized before further trials are undertaken to establish their clinical benefits. |
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<td>de Jongh T, Gurol-Urganci I, Vodopivec-Jamsek V, Car J and Atun R (2012) <em>Mobile phone messaging for facilitating self-management of long-term illnesses</em>, The Cochrane Collaboration</td>
<td>This review studied whether mobile phone applications such as Short Message Service (SMS) (also known as text messaging) and Multimedia Message Service (MMS) can support people to better manage their long-term illnesses by sending medication reminders or supportive messages, or by offering a way for people to communicate important information to their healthcare providers and receive feedback. It found moderate quality evidence that under some conditions these types of applications may indeed have some positive impacts on the health status of patients with diabetes, hypertension and asthma, and on their ability to manage their own condition, although for some outcomes no significant effect was observed. In two studies, there was very low quality evidence that participants evaluated the mobile phone messaging support positively. Also, in two studies, there was very low quality evidence that: there was no difference in health service utilisation by diabetes patients receiving text messaging support and those who did not (one study); and that asthma patients receiving text messages visited the doctor more often but were admitted to hospital less often than those not receiving the messages (one study). Conclusion: The study found some, albeit very limited, indications that in certain cases mobile phone messaging interventions may provide benefit in supporting the self-management of long-term illnesses. However, there are significant information gaps regarding the long-term effects, acceptability, costs, and risks of such interventions. Given the enthusiasm with which so-called mHealth interventions are currently being implemented, further research into these issues is needed.</td>
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<td>Kamel Boulos M N, Wheeler S, Tavares C and Jones R (2011) <em>How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX</em>, <em>BioMedical Engineering OnLine</em> 10 (24)</td>
<td>The latest generation of 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. This paper provides a brief state-of-the-art overview of health and healthcare smartphone apps (applications) on the market today, including emerging trends and market uptake. The paper covers apps targeting both laypersons/patients and healthcare professionals in various scenarios, e.g., health, fitness and lifestyle education and management apps; ambient assisted living apps; continuing professional education tools; and apps for public health surveillance. Among the surveyed apps are those assisting in chronic disease management, whether as standalone apps or part of a BAN (Body Area Network) and remote server configuration. The study describes in detail the development of a smartphone app within eCAALYX (Enhanced Complete Ambient Assisted Living Experiment, 2009-2012), an EU-funded project for older people with multiple chronic conditions. Continued...</td>
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</table>
Kamel Boulos M N, Wheeler S, Tavares C and Jones R (2011) How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX, *BioMedical Engineering OnLine* 10 (24)  

...continued.

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. Finally, the study briefly discusses barriers to adoption of health and healthcare smartphone apps (e.g., cost, network bandwidth and battery power efficiency, usability, privacy issues, etc.), as well as some workarounds to mitigate those barriers.


Mobile phones provide a low cost method of addressing certain health system needs in developing countries. This review examines SMS-supported interventions for prevention, surveillance, management and treatment compliance of communicable and non-communicable diseases in developing countries. It searched both peer-reviewed and grey literature reporting the use of SMS messages for disease prevention, surveillance, self-management and compliance in developing countries. A total of 98 applications fulfilled the inclusion criteria (33 prevention, 19 surveillance, 29 disease management and 17 patient compliance applications). In 31 projects, the SMS applications were evaluated. The majority of applications focused on HIV/AIDS and were located in India, South Africa and Kenya. Most used bulk (push) messaging. In general, they were well accepted by the population. The review provides further evidence that mobile phones are an appropriate and promising tool for disease control interventions in developing countries.


== see *Future developments in technology* section above ==

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Mobile health tools that enable clinicians and researchers to monitor the type, quantity, and quality of everyday activities of patients and trial participants have long been needed to improve daily care, design more clinically meaningful randomized trials of interventions, and establish cost-effective, evidence-based practices. Inexpensive, unobtrusive wireless sensors, including accelerometers, gyroscopes, and pressure-sensitive textiles, combined with Internet-based communications and machine-learning algorithms trained to recognize upper- and lower-extremity movements, have begun to fulfill this need. Continuous data from ankle triaxial accelerometers, for example, can be transmitted from the home and community via WiFi or a smartphone to a remote data analysis server. Reports can include the walking speed and duration of every bout of ambulation, spatiotemporal symmetries between the legs, and the type, duration, and energy used during exercise. For daily care, this readily accessible flow of real-world information allows clinicians to monitor the amount and quality of exercise for risk factor management and compliance in the practice of skills. Feedback may motivate better self-management as well as serve home-based rehabilitation efforts. Monitoring patients with chronic diseases and after hospitalization or the start of new medications for a decline in daily activity may help detect medical complications before rehospitalization becomes necessary. For clinical trials, repeated laboratory-quality assessments of key activities in the community, rather than by clinic testing, self-report, and ordinal scales, may reduce the cost and burden of travel, improve recruitment and retention, and capture more reliable, valid, and responsive ratio-scaled outcome measures that are not mere surrogates for changes in daily impairment, disability, and functioning.

Diabetes has emerged as a major public health concern in developing nations. Given the inadequate human resources and under-functioning health systems, we need novel and innovative approaches to combat diabetes in developing-country settings. In this regard, the tremendous advances in telecommunication technology, particularly cell phones, can be harnessed to improve diabetes care. Cell phones could serve as a tool for collecting information on surveillance, service delivery, evidence-based care, management, and supply systems pertaining to diabetes from primary care settings in addition to providing health messages as part of diabetes education. As a screening/diagnostic tool for diabetes, cell phones can aid the health workers in undertaking screening and diagnostic and follow-up care for diabetes in the community. Cell phones are also capable of acting as a vehicle for continuing medical education; a decision support system for evidence-based management; and a tool for patient education, self-management, and compliance. However, for widespread use, we need robust evaluations of cell phone applications in existing practices and appropriate interventions in diabetes.
| Abroms L C, Padmanabhan N, Thaweethai L and Phillips T (2010) iPhone Apps for Smoking Cessation: A Content Analysis, *American Journal of Preventative Medicine* 40 (279) | With the proliferation of smartphones such as the iPhone, mobile phones are being used in novel ways to promote smoking cessation.

This study set out to examine the content of the 47 iPhone applications (apps) for smoking cessation that were distributed through the online iTunes store, as of June 24, 2009.

Each app was independently coded by two reviewers for their (1) approach to smoking cessation and their (2) adherence to the U.S. Public Health Service’s 2008 Clinical Practice Guidelines for Treating Tobacco Use and Dependence. Apps were also coded for their (3) frequency of downloads.

Apps identified for smoking cessation were found to have low levels of adherence to key guidelines in the index. Few, if any, apps recommended or linked the user to proven treatments such as pharmacotherapy, counselling, and/or a quitline.

Conclusions: iPhone apps for smoking cessation rarely adhere to established guidelines for smoking cessation. It is recommended that current apps be revised and future apps be developed around evidence-based practices for smoking cessation. |
| Cole-Lewis H and Kershaw T (2010) Text messaging as a tool for behavior change in disease prevention and management, *Epidemiologic Reviews* 32 (56) | Mobile phone text messaging is a potentially powerful tool for behaviour change because it is widely available, inexpensive, and instant. This systematic review provides an overview of behaviour change interventions for disease management and prevention delivered through text messaging. Evidence on behaviour change and clinical outcomes was compiled from randomized or quasi-experimental controlled trials of text message interventions published in peer-reviewed journals up to June 2009. Only those interventions using text message as the primary mode of communication were included. Study quality was assessed by using a standardized measure. Seventeen articles representing 12 studies (5 disease prevention and 7 disease management) were included. Intervention length ranged from 3 months to 12 months, none had long-term follow-up, and message frequency varied.

Of 9 sufficiently powered studies, 8 found evidence to support text messaging as a tool for behaviour change. Effects exist across age, minority status, and nationality. Nine countries are represented in this review, but it is problematic that only one is a developing country, given potential benefits of such a widely accessible, relatively inexpensive tool for health behaviour change. |
h) Robotics

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<th>Study</th>
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<tr>
<td>Louie W-Y G, McColl D and Nejat G (2014) Acceptance and Attitudes Toward a Human-like Socially Assistive Robot by Older Adults, Assistive Technology 26 (3)</td>
<td>== see Attitudes to technology section above ==</td>
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<tr>
<td>Robinson H, MacDonald B and Broadbent E (2014) The Role of Healthcare Robots for Older People at Home: A Review, International Journal of Social Robotics – July 2014</td>
<td>This review aimed to identify the areas of need that older people have, and the available solutions. In particular, robotic solutions are explored and critiqued and areas for future development identified. The literature was reviewed for factors that influence admission to nursing home care, and for technological solutions to these factors. The main issues facing older people are physical decline, cognitive decline, health management, and psychosocial issues. Robots exist that may meet some of the identified issues but gaps where robots could be developed include delivering interventions to prevent physical decline occurring and robots with multiple functions, including a range of cognitive stimuli and health education. To reduce barriers to acceptance, robots designed to provide physical and healthcare assistance should have a serious appearance. On the other hand animal-like robots can address psychosocial issues and function like pets. While smart phones and computers can offer some solutions, robots may promote adherence due to a social presence. Robots are being developed to address areas of need in older people, including physical, cognitive, medical and psychosocial issues. However more focus could be placed on developing preventative interventions, multifunctional robots, greater educational content and motivational aspects of appearance and interaction style.</td>
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Interest is growing in robots to enable older people to remain living at home. This study conducted a systematic review and critical evaluation of the scientific literature, from 1990 to the present, on the use of robots in aged care.

The key research questions were as follows: (1) what is the range of robotic devices available to enable older people to remain mobile, independent, and safe? and, (2) what is the evidence demonstrating that robotic devices are effective in enabling independent living in community dwelling older people?

Results showed that robotics is currently available to assist older healthy people and people with disabilities to remain independent and to monitor their safety and social connectedness. Most studies were conducted in laboratories and hospital clinics. Currently limited evidence demonstrates that robots can be used to enable people to remain living at home, although this is an emerging smart technology that is rapidly evolving.

Service robots currently include commercialised domestic robots, such as self-navigating vacuum cleaners and mops, known as Roomba and Scooba respectively. Service robots also include “pet” or sociable robots, such as the Aibo robotic pet dog, Paro the robotic pet seal, and similar robotic animals that use “pet therapy” to assist older people to maintain mobility, and to keep active. Service robots have also been developed for hospital settings. One example of this is the iWARD project in Germany where modular designed robots have been adapted for different roles for independent living, health, and safety. They can also act in a team to service the needs of medical and other health professional staff such as for remote consultations and communication between staff in different wards.

The literature reveals some misconceptions about the potential for robotic interaction with humans. For example, popular opinion holds that robotic technologies are only applied to individuals when they are disabled. However, there is a small yet increasing awareness that robotic technologies can also complement current health care service provision by monitoring older people within their home environment and assisting them to mobilise safely and prevent falls. Narrative literature reviews on the role of robotics in health care or social assistance robots have previously been completed mainly speculating about the future of robotics in health.

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Only a very small number of controlled clinical trials evaluated the effects of implementing robotic technology in the home for the purposes of potentially assisting with daily living activities, home care, home maintenance and housework, security, safety, falls detection, or social interaction. Moreover, none of the studies on robotics presented costing of the devices, discussed safety concerns to the user, whether the devices could be mass produced, or social issues such as acceptance by older people in their home environment. It was also notable that the studies in this paper focussed on application of robotic technologies for purposes of movement rehabilitation in people who had impairments and disabilities arising from conditions such as arthritis, back pain, balance impairment, stroke, or spinal cord injury. To date no studies have objectively measured the potential application of robotic technologies as monitoring devices in the home setting. Potentially artificial intelligence could be used to measure the health status of their “owner,” provide reminders for specific medications to be taken; or provide contingency procedures in the case of an adverse event such as a slip, trip, or fall.

One study in this paper demonstrated an increased exercise capacity when healthy older participants utilised a robotic exoskeleton for walking training in a “home” setting; however as the study was limited to only one group, with no direct comparison to an age-matched control group who participated in the walking program without the exoskeleton, it is difficult to rigorously evaluate the effectiveness of the use of the robotic exoskeleton in this study. Moreover, follow-up data measures were not taken, therefore it is not possible to ascertain the long-term effectiveness of the technology in assisting in maintaining independence.

However, this paper has demonstrated that applications of robotic technologies have progressed much further than what the general public perceive robots are capable of undertaking. Robotic technology studies, despite being methodologically weak, have demonstrated capability of functional improvements following loss of function in upper and lower limbs, or to assist with mobility in indoor environments. The range of the robotic technologies presented shows that the technology is now progressing to the point that that home trials of these different robotic technologies will be undertaken in the near future.
### i) Smart homes

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<td>Nawaz A, Helbostad J L, Skjærret N, Vereijken B, Bourke A, Dahl Y and Mellone S (2014) Designing Smart Home Technology for Fall Prevention in Older People, HCI International 2014 - Posters' Extended Abstracts Communications in Computer and Information Science 435 : 485-490</td>
<td>Falls in older people constitute one of the major challenges in healthcare. It is important to design technologies that can help prevent falls and improve falls management. Smart home technology could be of importance in this context, but the technology has to be user-centred or adapted to be useful in this particular context. This study assessed usability of paper and interactive prototypes of a smart home touch screen panel. The study implemented five scenarios related to fall risk, fall assessment and exercise guidance, designing a smart home interface for independent living in general and fall management in particular. A usability evaluation showed that older people had positive experiences when using the touch screen interface. The study demonstrated the need for user-centred interfaces for older people in the context of falls prevention.</td>
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<td>Lê Q, Nguyen H B and Barnett T (2012) Smart Homes for Older People: Positive Aging in a Digital World, Future Internet 4 (2) : 607-617</td>
<td>Smart homes are homes with technologically advanced systems to enable domestic task automation, easier communication, and higher security. As an enabler of health and well-being enhancement, smart homes have been geared to accommodate people with special needs, especially older people. This paper examines the concept of “smart home” in a technologically driven society and its multi-functional contribution to the enhancement of older people’s lives. Discussion then focuses on the challenges in the use of smart homes among older people such as accessibility and ethical issues. Finally, some implications and recommendations are provided</td>
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The authors summarise a 1-year evaluation of an autonomous smart home for people with dementia installed in one of Housing 21’s ExtraCare housing flats in Deptford, London. They describe the background to the work, and the structure of the evaluation programme. They discuss the impact of the technology on the tenant, which was assessed using three outcome measures: a questionnaire-based measure; recorded interviews with the tenant and his family carer; and behaviour data logged by the installed technology.

Enabling smart technology uses a system of pre-recorded prompts or messages to support people with dementia to live independently. The aim is to use an integrated messaging system to support an individual’s independence. Bath Institute of Medical Engineering evaluated this technology over a 12-month period. This practice experience has highlighted the importance of a therapeutic approach to ensure that the use of technology is optimised for the benefit of vulnerable adults and their families.

Smart homes are equipped with sensors, actuators, and/or biomedical monitors. The devices operate in a network connected to a remote centre for data collection and processing. The remote centre diagnoses the ongoing situation and initiates assistance procedures as required. The technology can be extended to wearable and in vivo implantable devices to monitor people 24h a day both inside and outside the house. This review describes a selection of projects in developed countries on smart homes examining the various technologies available. For example: In Osaka, Matsuoka has developed a smart house that automatically detects unusual events caused by disease or accident through its 167 sensors. Seventeen electrical appliances are also fitted with sensors. Mathematical models translate the raw data into behavioural data and allow the detection of unusual situations. Wearable, implantable, and microsystems that can be swallowed such as microcapsule devices are now available. LifeShirt is a miniaturized, ambulatory version of respiratory inductance plethysmography. The garment is a machine-washable, lightweight, form-fitting shirt with embedded sensors to measure respiration.

A “smart home” is a residence wired with technology features that monitor the well-being and activities of their residents to improve overall quality of life, increase independence and prevent emergencies. This type of informatics applications targeting older adults, people with disabilities or the general population is increasingly becoming the focus of research worldwide. The aim of this study was to provide a comprehensive review of health related smart home projects and discuss human factors and other challenges.

Methods: To cover not only the medical but also the social sciences and electronics literature, the study conducted extensive searches across disciplines (e.g., Medline, Embase, CINAHL, PsycINFO, Electronics and Communications Abstracts, Web of Science etc.). In order to be inclusive of all new initiatives and efforts in this area given the innovativeness of the concept, we manually searched for relevant references in the retrieved articles as well as published books on smart homes and gerontechnology.

Results: A total of 114 publications (including papers, abstracts and web pages) were identified and reviewed to identify the overarching projects. Twenty one smart home projects were identified (71% of the projects include technologies for functional monitoring, 67% for safety monitoring, 47% for physiological monitoring, 43% for cognitive support or sensory aids, 19% for monitoring security and 19% to increase social interaction).

Evidence for their impact on clinical outcomes is lacking.

Conclusions: The field of smart homes is a growing informatics domain. Several challenges including not only technical but also ethical ones need to be addressed. In spite of the growing number of initiatives in this area, the field is in relatively early stages and is currently lacking an extensive body of evidence. Most of the identified studies demonstrate the feasibility of the technological solution or preliminary evaluation approaches with a limited number of subjects either in a laboratory setting or limited community based settings. Technical, ethical, legal, clinical, economical and organizational implications and challenges need to be studied in-depth for the field to grow further.
### Technology and social interaction

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| Morris M E, Adair B, Ozanne E, Kurowski W, Miller K J, Pearce A J, Santamaria N, Long M, Ventura C and Said C M (2014) Smart technologies to enhance social connectedness in older people who live at home, *Australasian Journal on Ageing* | This study aimed to examine the effectiveness of smart technologies in improving or maintaining the social connectedness of older people living at home. A systematic review and critical evaluation of research articles published between 2000 and 2013 was carried out. 

Eighteen publications were identified that evaluated the effect of smart technologies on dimensions of social connectedness. Fourteen studies reported positive outcomes in aspects such as social support, isolation and loneliness. There was emerging evidence that some technologies augmented the beneficial effects of more traditional aged-care services. 

Conclusion: Smart technologies, such as tailored internet programs, may help older people better manage and understand various health conditions, resulting in subsequent improvements in aspects of social connectedness. Further research is required regarding how technological innovations could be promoted, marketed and implemented to benefit older people. |
| 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*, Independent Age and Calouste Gulbenkian Foundation | At the time research for this report commenced, little attention was being paid to the issue of older people and access to technology. Today, things are different. The Digital Britain report in 2008 highlighted the issue and spurred the Government to devote significant funding to digital participation initiatives, many with an emphasis on older people. Yet among a panoply of new initiatives, there has been little attempt to connect the use of technology by older people with potential social benefits such as reduced isolation and increased social participation – until now. This report demonstrates that technology is not merely an end in itself, but can be a means to enable older people to renew and develop social contacts and engage actively in their communities. It can provide opportunities to:

- participate in meaningful work and other activities (whether paid or on a volunteer basis);
- interact in new ways with family and friends;
- learn, develop skills and gather experience;
- share learning, skills and experience with others. |
k) Telecare

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<td>Turner K and McGee-Lennon M (2013) Advances in telecare over the past 10 years, <em>Smart Homecare Technology and TeleHealth</em> 21</td>
<td>This article reviews advances during the past decade or so in telecare (i.e., computer-supported social care at home). The need for telecare is discussed along with how it relates to social and health care. The expected benefits of telecare are also discussed. The evolution of telecare technology is reviewed, covering various system generations. The capabilities of present day telecare are covered, along with its advantages, limitations, and barriers to uptake. Recent evaluations and exemplars of telecare are discussed. The user requirements for telecare are presented, complemented by a discussion of the issues in user and professional acceptance. The article concludes with a summary of past developments in telecare and the prospects for the future. 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. Care providers will need to embody home care technologies into their overall service provision. Ideally, care should be provided holistically, irrespective of whether the issues are social or medical.</td>
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<td>To assess the impact of telecare on the use of social and health care. Part of the evaluation of the Whole Systems Demonstrator trial. Participants and setting: a total of 2,600 people with social care needs were recruited from 217 general practices in three areas in England. Design: a cluster randomised trial comparing telecare with usual care, general practice being the unit of randomisation. Participants were followed up for 12 months and analyses were conducted as intention-to-treat. Data sources: trial data were linked at the person level to administrative data sets on care funded at least in part by local authorities or the National Health Service. Main outcome measures: the proportion of people admitted to hospital within 12 months. Secondary endpoints included mortality, rates of secondary care use (seven different metrics), contacts with general practitioners and practice nurses, proportion of people admitted to permanent residential or nursing care, weeks in domiciliary social care and notional costs. Results: 46.8% of intervention participants were admitted to hospital, compared with 49.2% of controls. Unadjusted differences were not statistically significant (odds ratio: 0.90, 95% CI: 0.75–1.07, P = 0.211). They reached statistical significance after adjusting for baseline covariates, but this was not replicated when adjusting for the predictive risk score. Secondary metrics including impacts on social care use were not statistically significant. Conclusions: 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.</td>
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<td>Greenhalgh T, Wherton J, Sugarhood P, Hinder S, Procter R and Stones R</td>
<td>Telehealth and telecare research has been dominated by efficacy trials. The field lacks a sophisticated theorisation of [a] what matters to older people with assisted living needs; [b] how illness affects people's capacity to use technologies; and [c] the materiality of assistive technologies. We sought to develop a phenomenologically and socio-materially informed theoretical model of assistive technology use. Forty people aged 60–98 (recruited via NHS, social care and third sector) were visited at home several times in 2011–13. Using ethnographic methods, we built a detailed picture of participants' lives, illness experiences and use (or non-use) of technologies. Data were analysed phenomenologically, drawing on the work of Heidegger, and contextualised using a structuration approach with reference to Bourdieu's notions of habitus and field. We found that participants' needs were diverse and unique. Each had multiple, mutually reinforcing impairments (e.g. tremor and visual loss and stiff hands) that were steadily worsening, culturally framed and bound up with the prospect of decline and death. They managed these conditions subjectively and experientially, appropriating or adapting technologies so as to enhance their capacity to sense and act on their world. Installed assistive technologies met few participants' needs; some devices had been abandoned and a few deliberately disabled. Successful technology arrangements were often characterised by 'bricolage' (pragmatic customisation, combining new with legacy devices) by the participant or someone who knew and cared about them. With few exceptions, the current generation of so-called 'assisted living technologies' does not assist people to live with illness. To overcome this irony, technology providers need to move beyond the goal of representing technology users informationally (e.g. as biometric data) to providing flexible components from which individuals and their carers can 'think with things' to improve the situated, lived experience of multi-morbidity. A radical revision of assistive technology design policy may be needed.</td>
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Table 1: Barriers to adoption of TH and TC associated with non-participation and withdrawal from the trial

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<td>Telehealth (TH) and telecare (TC) interventions are increasingly valued for supporting self-care in ageing populations; however, evaluation studies often report high rates of non-participation that are not well understood. This paper reports from a qualitative study nested within a large randomised controlled trial in the UK: the Whole System Demonstrator (WSD) project. It explores barriers to participation and adoption of TH and TC from the perspective of people who declined to participate or withdrew from the trial. Qualitative semi-structured interviews were conducted with 22 people who declined to participate in the trial following explanations of the intervention (n = 19), or who withdrew from the intervention arm (n = 3). Participants were recruited from the four trial groups (with diabetes, chronic obstructive pulmonary disease, heart failure, or social care needs); and all came from the three trial areas (Cornwall, Kent, east London). Observations of home visits where the trial and interventions were first explained were also conducted by shadowing 8 members of health and social care staff visiting 23 people at home. Field notes were made of observational visits and explored alongside interview transcripts to elicit key themes. Barriers to adoption of TH and TC associated with non-participation and withdrawal from the trial were identified within the following themes: requirements for technical competence and operation of equipment; threats to identity, independence and self-care; expectations and experiences of disruption to services. 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. These findings regarding perceptions of potential disruption of interventions to identity and services go beyond more common expectations that concerns about privacy and dislike of technology deter uptake. These insights have implications for health and social care staff indicating that more detailed information and time for discussion could be valuable especially on introduction. It seems especially important for potential recipients to have the opportunity to discuss their expectations and such views might usefully feed back into design and implementation.</td>
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== see Ethical issues section above ==
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<td>This briefing has given an overview of the most important issues to consider when developing a good-quality evaluation of telecare or telehealth interventions. Careful planning is the key to carrying out a good-quality evaluation. Allow sufficient time for the planning and design stages.</td>
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<td>• The evaluation should be adequately funded and resourced, using staff with the appropriate skills to carry out the necessary tasks.</td>
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<td>• Set clear questions to be answered from the outset, to guide your planning. These can be identified from a review of the literature so as to address gaps in current knowledge, and by considering important local issues.</td>
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<td>• Select a design that is appropriate to, and can therefore accurately answer, the evaluation questions.</td>
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<td>• Clearly define the population for which the intervention will be evaluated. Set out clear criteria for inclusion and exclusion and ensure that these are adhered to. Make sure you identify an appropriate number of participants for the planned analyses.</td>
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<td>• Use valid and reliable measures of the outcomes of interest, and consider the time points at which they will be administered.</td>
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<td>• Factor in time to allow for completion of ethics or research and development applications, where the evaluation constitutes research.</td>
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<td>• Use evidence-based recruitment and retention strategies to ensure high levels of participation and to minimise attrition.</td>
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<td>• Ensure that data collection agreements between the sites involved are put into place prior to the start of data collection. Data management strategies, including frequent validation checks, should be factored into the planning.</td>
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- One of WSDAN’s key aims was to examine the progress and impact of telecare and telehealth interventions across these sites, to provide evidence and learning to feed into the larger Whole System Demonstrator evaluation.
- Three themes emerged as particularly important areas for consideration when adopting telehealth and telecare: leadership; working practices, skills and development; and data management.
- Key characteristics for growth and sustainability exhibited across the 12 sites included: collaboration within and across organisations; leadership; developing alliances and partnerships; identifying critical services; developing a shared vision; cultivating participation; building capacity; exploiting funding opportunities; and working across professional boundaries.
- While these factors appear necessary to sustain and expand telecare and telehealth services, they are insufficient on their own. Other areas that need to be addressed include: fostering fundamental service redesign; supporting professional development and staff training; analysing and designing the infrastructure prior to equipment being deployed; applying recognised standards; making decisions based on good interpretation of available data and evidence; and developing governance arrangements at national level to avoid regional variations in services.
- The changing political environment, including NHS reforms and reductions in local government funding, have also had a significant, negative impact on the adoption of telehealth and telecare services. As resources for investment have become squeezed, the continuity of focus provided by local leaders and champions has been eroded. For new technologies to be taken forward, it has been paramount to present robust business cases and sustainability plans that are structured around improved health and social care outcomes as well as efficiency deliverables (Quality, Innovation, Productivity and Prevention, or QIPP).


- Nurses and ethicists worry that the implementation of care at a distance or telecare will impoverish patient care by taking out ‘the heart’ of the clinical work. This means that telecare is feared to induce the neglect of patients, and to possibly hinder the development of a personal relation between nurse and patient. This study aims to analyse whether these worries are warranted by analysing Dutch care practices using telemonitoring in care for chronic patients in the Netherlands. How do clinical practices of nursing change when telecare devices are introduced and what this means for notions and norms of good nursing? The paper concludes that at this point the practices studied do not warrant the fear of negligence and compromised relations. Quite the contrary; in the practices studied, telecare lead to more frequent and more specialised contacts between nurses and patients. The paper concludes by reflecting on the ethical implications of these changes.
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<td>Telecare, the provision of care through remote interaction enabled by information and communication technology, is quickly developing. Integration with other technological developments is to be expected and will create systems that enable more intense, continuous and unobtrusive monitoring of health, and more personalised feedback and instructions. One of the goals of telecare is enhancing the independence and self-management of patients. In this article three degrees of self-management are described and a distinction is made between compliant and concordant forms of self-management. It is argued that telecare merely promotes forms of self-management in which compliance to medical instructions is central. Technological developments and normative policy considerations may enforce this trend to implement an interpretation of self-management in which compliance to a strict medical regime is prominent. Against this, a plea is made for developing telecare systems that incorporate concordant and collaborative forms of self-management, in which the patient’s own perspective is empowered.</td>
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<td>This article describes a systematic review of home telecare for frail elderly people and for patients with chronic conditions. The authors searched 17 electronic databases, the reference lists of identified studies, conference proceedings and Websites for studies available in January 2006. It identified summaries of 8666 studies, which were assessed independently for relevance by two reviewers. Randomized controlled trials of any size and observational studies with 80 or more participants were eligible for inclusion if they examined the effects of using telecommunications technology to (a) monitor vital signs or safety and security in the home, or (b) provide information and support. The review included 68 randomized controlled trials (69%) and 30 observational studies with 80 or more participants (31%). Most studies focused on people with diabetes (31%) or heart failure (29%). Almost two-thirds (64%) of the studies originated in the US; more than half (55%) had been published within the previous three years. Based on the evidence reviewed, the most effective telecare interventions appear to be automated vital signs monitoring (for reducing health service use) and telephone follow-up by nurses (for improving clinical indicators and reducing health service use). The cost-effectiveness of these interventions was less certain. There is insufficient evidence about the effects of home safety and security alert systems. It is important to note that just because there is insufficient evidence about some interventions, this does not mean that those interventions have no effect.</td>
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Telecare is advocated as a means of effectively and economically delivering health and social care services in people's homes, using technology that can monitor activities and safety, provide virtual home visiting, activate reminder systems, increase home security and convey information. Significant planned investment by central government will be rewarded if telecare results in fewer older people requiring institutional care, and more remaining independent in their own homes longer than would otherwise be the case. This paper, which reports on focus group work with older people, carers and professional stakeholders, considers key issues rarely addressed in provider-led studies. Emerging social policy implications centre on the potential impact of telecare on service users’ autonomy and privacy and, controversially, as a replacement for human support. It is argued that the development of relevant policy and practice in respect of telecare has to pay close and careful attention to concerns held by all stakeholders, particularly in regard to individual choice, surveillance, risk-taking and quality of service.
It is difficult to get a clear picture from the monitoring centre data on exactly how the service is being used, however user perceptions were very positive about Telecare. The majority of users felt that the equipment gave them a sense of security, increased independence and had worked well in emergencies. However - The overwhelming majority of users did not feel that they were actively engaged in the decision to install Telecare but, despite this, they generally found most of the equipment acceptable with the possible exception of the falls detectors which were felt to be bulky, uncomfortable and oversensitive to movement. Users did not think the equipment was stigmatising with the possible exception of the pullcord in bathrooms. However, even though users found equipment such as pendants acceptable, only a minority of users reported wearing the equipment all of the time.

In all of the pilots there were initial problems with referrals. This related to lack of engagement from mainstream services.

Frontline staff clearly showed that they recognised the importance and value of Telecare. Generally frontline staff were positive about Telecare and recognised the benefits that Telecare could provide for users, carers and the Directorate. Frontline staff stressed the importance of getting the human components of the system right.

Key lessons included: Service integration: A successful Telecare service should serve as a catalyst for improved service integration. Focused around the needs of the person in their own home, with a range of response and support services available depending on their changing needs, Telecare should include a process of signposting to community services that are already available and which may then be used in a preventive mode.

Human elements of the system: There is a danger that efforts will focus on the technological aspects of the service, but it is important to recognise and assess the human elements of the system. The implementation of Telecare requires appropriately qualified and experienced staff to recruit service users into the service; identification of monitoring centres that have the appropriate facilities to receive and take actions on calls and maintain necessary records; and the development of an appropriate response mechanism by agreements with named contacts, informal carers or with an appropriate service.

For carers who are supporting people with dementia, but also potentially the case for all carers, there is scope for more formal back-up mobile response services to provide more respite for informal carers, otherwise Telecare may increase the pressure on them.

Continued...

In developing Telecare a number of factors will need to be taken into account: *Local ownership especially in mainstream services; Importance of quality of call history data; A priority of long-term planning;*

It is important to ensure the development of Telecare is linked to broader developments. Telecare developed out of and is still grounded in the community alarms infrastructure.

Woodhouse P and Waddington E (2005) *A Virtual Care Village Model: A practical guide to assist developers of Telecare services - Housing LIN case study 17*, Housing Learning & Improvement Network

The Virtual Care Village Model, which Cumbria is developing, represents a dynamic whole systems approach applicable across a large rural county that is also able to accommodate local needs and variations. The common core of the model comprises of the following replicable elements:

- A geographical area within which mobile care and support services will be more responsive to peoples needs. This may be based on ‘response times’ or journey times, which vary according to the nature of the locality rather than, by a defined size or particular radius.
- The use of Telecare services (managed by the Integrated Community equipment Stores – ICES) including a range of sensors that enables the management of risk and the targeting of services in the event of an emergency.
- The use of mobile handsets (and the Telecare database) to enable care workers to be contacted by the alarm provider and enable secure access to information (such as current health needs and care services provided to the client) as required.
- The use of telemedicine services, purchased by the local Primary Care Trust (and managed by ICES) to enable the monitoring of a person’s vital signs from home as part of the strategy for managing Long Term Conditions.
- Continued development of Extra Care housing schemes for people who choose, or need to move into a more enabling type of dwelling.
- Continued development of homecare services dedicated to meeting the care needs of all those living in the area, including Extra Care schemes and responding to Telecare calls.
- Continued development of a responsive night time care service available across the area defined, (with possible retention of on site waking night service within Extra Care schemes and use of the scheme as a base for the night time care team).

Continued...
| Woodhouse P and Waddington E (2005) *A Virtual Care Village Model: A practical guide to assist developers of Telecare services - Housing LIN case study 17*, Housing Learning & Improvement Network | ...continued  
- Developing the potential for integration and modernisation of Housing Visitor, Housing Warden and Floating Support Services.  
- Reinforce partnership with Health, supported by extended use of Health Act Flexibility agreements. These developments significantly contribute to the implementation of new arrangements for meeting ‘Long Term Conditions’ targets, the agenda for integrating community and social work teams; developing community provider services such as generic home care services, and ICES. Potential for the development of shared information systems, including a client information database.  
- Development of a co-ordinated handyperson service.  
- Integration of voluntary sector community support services such as, the Alzheimer’s Society Family Support Service, Carers Associations, and services offered by Age Concern to provide the support required to maintain the quality of life for people who choose to be cared for at home. |
## I) Telehealth

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<th>Study</th>
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<td>Bryant Howren M, Van Liew J R, and Christensen A J (2013) Advances in Patient Adherence to Medical Treatment Regimens: The Emerging Role of Technology in Adherence Monitoring and Management, <em>Social and Personality Psychology Compass</em> 7 (7) : 427-443</td>
<td>Adherence is a term used to describe the extent to which an individual's behaviour coincides with health-related instructions or recommendations given by a healthcare provider in the context of a specific disease or disorder. Despite significant advances in biomedical science related to the treatment of disease, the problem of non-adherence remains pervasive and may be aptly described as a global public health concern. The recent proliferation of telemedicine coupled with the ubiquity of personal computers, mobile phones, and other wireless communication devices have, in part, led to the development and implementation of a variety of technology-based methods used to assess, monitor, and manage adherence. As the chronic illness burden continues to grow, these methods may offer solutions to some of the limitations of traditional means particularly for conditions requiring complex self-management and lifestyle adjustment. In this article, we briefly review recent advances in adherence monitoring and management including m-health, home telemonitoring systems, web-based support (i.e., self-management websites and virtual support groups), and patient portals and personal health records before concluding with a brief account of some exciting new technologies under development in the context of patient adherence.</td>
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<td>Cimperman M, Makovec Brencic M, Trkman P and de Leonni Stanonik M (2013) Older Adults' Perceptions of Home Telehealth Services, <em>Telemedicine and e-Health</em> 19 (10) : 786-790</td>
<td>The success of home telemedicine depends on end-user adoption, which has been slow despite rapid advances in technological development. This study focuses on an examination of significant factors that may predict the successful adoption of home telemedicine services (HTS) among older adults. Based on previous studies in the fields of remote patient monitoring, assisted living technologies, and consumer health information technology acceptance, eight factors were identified as a framework for qualitative testing. Twelve focus groups were conducted with an older population living in both urban and rural environments. The results reveal seven predictors that play an important role in perceptions of HTS: perceived usefulness, effort expectancy, social influence, perceived security, computer anxiety, facilitating conditions, and physicians' opinion. The results provide important insights in the field of older adults' acceptance of HTS, with guidelines for the strategic planning, developing, and marketing of HTS for the graying market.</td>
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As telehealth takes advantage of improved networks, there is a growing need to understand the infrastructure needs of future telehealth developments. This work aims to predict such needs based on current trends and research. The authors conducted a literature review of telehealth with a focus on advanced network infrastructure. They drew inferences from previous demonstrator projects in advanced telehealth, but the most important findings emerged from interviews with a panel of thought leaders. The results show that there will be simultaneous and coupled evolution of telehealth through the space spanned by three axes: care models, clinical applications, and technology. The authors also consider a two-dimensional model of reach and complexity to describe future applications. Universal access to advanced networks will drive fundamental changes in healthcare delivery. The biggest change will be seen in home and mobile health care delivery, forming part of a trend toward patient-centric models. Other aspects of decentralization in healthcare systems will include networks of caregivers. Besides this reach trend, the complexity trend will include integrating multiple-channel applications and seamlessly moving large datasets in real time among hospitals, other medical facilities, and homes. There is a need to provide infrastructure that does not have an upper limit on quality of service and allows telehealth to address mobility, usability, interoperability, intelligence, and adaptability in a systematic way.


== see Telecare section above ==
<p>| Patel S, Park H, Bonato P, Chan L and Rodgers M (2012) A review of wearable sensors and systems with application in rehabilitation, <em>Journal of NeuroEngineering and Rehabilitation</em> 9 (21) | The aim of this review paper is to summarize recent developments in the field of wearable sensors and systems that are relevant to the field of rehabilitation. The growing body of work focused on the application of wearable technology to monitor older adults and subjects with chronic conditions in the home and community settings justifies the emphasis of this review paper on summarizing clinical applications of wearable technology currently undergoing assessment rather than describing the development of new wearable sensors and systems. A short description of key enabling technologies (i.e. sensor technology, communication technology, and data analysis techniques) that have allowed researchers to implement wearable systems is followed by a detailed description of major areas of application of wearable technology. Applications described in this review paper include those that focus on health and wellness, safety, home rehabilitation, assessment of treatment efficacy, and early detection of disorders. The integration of wearable and ambient sensors is discussed in the context of achieving home monitoring of older adults and subjects with chronic conditions. Future work required to advance the field toward clinical deployment of wearable sensors and systems is discussed. |
| Barrett D (2012) The role of telemonitoring in caring for older people with long-term conditions, <em>Nursing Older People</em> 24 (7) : 21-25 | Long-term conditions have a negative effect on the lives of older people and those who care for them. This article examines how telemonitoring could help to meet some of these challenges. Telemonitoring involves patients at home recording vital signs, for example, blood pressure and pulse, and transmitting this information electronically to nurses based elsewhere. Nurses can then use these data to identify signs of deterioration, intervene promptly and prevent admission to hospital. There is some evidence that this form of care is popular with patients and can improve clinical outcomes. However, nurses should ensure that they understand the opportunities and difficulties presented by telemonitoring, develop the skills necessary to use it effectively and put themselves at the forefront of this innovative method of supporting care provision. |</p>
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<td>Department of Health (2011)</td>
<td>Whole System Demonstrator Programme: Headline findings - December 2011, Department of Health</td>
<td>The early indications from the Whole System Demonstrator Programme show that if used correctly telehealth can deliver a 15% reduction in A&amp;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. More strikingly they also demonstrate a 45% reduction in mortality rates.</td>
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The major goals of telemedicine today are to develop next-generation telehealth tools and technologies to enhance healthcare delivery to medically underserved populations using telecommunication technology, to increase access to medical specialty services while decreasing healthcare costs, and to provide training of healthcare providers, clinical trainees, and students in health-related fields. Key drivers for these tools and technologies are the need and interest to collaborate among telehealth stakeholders, including patients, patient communities, research funders, researchers, healthcare services providers, professional societies, industry, healthcare management economists, and healthcare policy makers. In the development, marketing, adoption, and implementation of these tools and technologies, communication, training, cultural sensitivity, and end-user customization are critical pieces to the process. Next-generation tools and technologies are vehicles toward personalized medicine, extending the telemedicine model to include cell phones and Internet-based telecommunications tools for remote and home health management with video assessment, remote bedside monitoring, and patient-specific care tools with event logs, patient electronic profile, and physician note-writing capability. Telehealth is ultimately a system of systems in scale and complexity. To cover the full spectrum of dynamic and evolving needs of end-users, we must appreciate system complexity as telehealth moves toward increasing functionality, integration, interoperability, outreach, and quality of service. Toward that end, our group addressed three overarching questions: (1) What are the high impact topics? (2) What are the barriers to progress? and (3) What roles can the National Institutes of Health and its various institutes and centres play in fostering the future development of telehealth?
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