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The Role of Technology in Addressing Health and Social Care Needs and Opportunities in a Rural Environment*

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People who live in rural areas do not have access to the health and personal care services that are available to the rest of the population. Some of their needs can be addressed using technology enabled services. The purpose of this paper is to describe the infrastructure requirements for successful implementation of technology enabled health and support services, and to consider the opportunities for using technology to satisfy the needs of people at each level of the Maslow Hierarchy. This involves the development of a more technology-related pyramid and a consideration of the requirements for a range of application examples for each level. It was found that applications relevant to physical and safety domains are mature, available and easy to implement. However, higher levels of need require people to have broadband or fast mobile access, as well as their own mobile computing devices such as a tablet or smartphone. These allow the use of apps that provide powerful ways of addressing needs. It is suggested that few existing technology services providers can offer a spectrum of applications that would be required by most end-users but that innovators will develop service delivery partnerships and utilize more generic support workers. Some pump priming may be necessary to ensure that service providers offer the required level of investment in training and equipment.

- Self-care
- Telecare
- Telecommunications
- Maslow
- Broadband
- Training

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Ageing populations and the higher healthcare expectations of the public in developed countries are combining to increase pressure on services with respect to cost and capacity (Care Quality Commission, 2016). Services can be transformed by bringing care closer to home, and often into the home (Monitor, NHS Improvement Agency, 2015). Efficiency may be improved through a greater use of information and assistive technologies (Kudyba, 2106). These may lead to significant cost reduction and quality improvement through, for example:

- Better scheduling of care visits by professionals
- Supporting self-care through easy access to advice and information
- Enabling people to live well through the efforts of empathetic carers
- Promoting independent living through long-term health and activity monitoring
- Understanding goals and ambitions and providing equipment that can help people to improve their quality of life
- Managing people's changing needs by greater use of data to support prediction and prevention strategies

However, it may be argued that the benefits of technology are most apparent when applied to people living in urban environments where there is a high population density, a well-developed communications infrastructure, and access to a large pool of well-trained care staff (Schur *et al.*, 2002). The opportunities for using technology in more rural areas are often perceived to be more limited, resulting in a need for both communities and local businesses to innovate to offer cost-effective solutions to the needs of people who may be geographically isolated. These might include the creation of alliances of a range of businesses and third sector organizations, and the development of more generic operational roles that can offer more efficient operation, thus reducing the need for visits by multiple agencies.

Rurality is considered by some to be a subjective term, even though it is well-defined in some countries using a specific index such as the Rural Urban Classification (Australian Bureau of Statistics, 2001), which defines areas as rural if they are outside settlements with more than a 10,000-resident population. The size of a community, distance from population centres and access to services are also relevant. Similarly, the Cloke index (Cloke, 1977) uses 16 different ways of drawing such conclusions that result in areas of England and Wales being categorized using four criteria: extreme rural, intermediate rural, intermediate non-rural and extreme non-rural (in addition to urban). This suggests that rurality is not simply about geography but implies positive lifestyle choices (Chigbu, 2013) which might, in turn, be relevant to aspects of mental health (Philo *et al.*, 2003).

In countries such as Canada, Brazil and the USA, the scale is significantly different, and population density and factors such as temperature, rainfall and the terrain are relevant to rural categorization in the way that they support

opportunities for farming and how rural an area might then be considered. The significance is that they can be used to determine the level of economic support available across a spectrum of activities such as building a house or setting up a business. In the USA, remoteness is considered differently for healthcare than for other government organizations and applications (Egede and Bosworth, 2008) which acknowledges the significance of rurality on the healthcare agenda and its importance in maintaining the well-being of citizens.

This paper considers some of the health and social care needs of rural communities, focusing on the support required by older and disabled people. It considers some technology enabled care solutions and the services that can become sustainable business elements while yielding meaningful benefits to the populations that they serve.

Enablers of technology support

Telecommunications

The analogue Public Switched Telephone Network (PSTN) is being slowly replaced by digital services that carry far more information reliably, enabling many new applications, especially those using video (Bughin, 2015). However, the speed of broadband based on fixed telephone lines depends both on the regional fibre infrastructure and on the distance between the home and the nearest exchange. The result is that highly populated areas have access to fast broadband while rural areas receive a much slower service (Greenemeier, 2017). The penetration of 3G and 4G services is equally dependent on population, with the result that there are many "not-spots" in rural areas of the UK, including the Lake District, Snowdonia and large areas of the Highlands (Rathbone, 2016). Here, it may be impossible to receive a reliable signal on a voice network inside some homes irrespective of mobile provider. Many villagers are therefore compelled to develop local projects to fund innovative schemes. In Wales, where some rural villages are cut off through lack of broadband and mobile signal, the Welsh Government offers funding to small companies (Access Broadband Cymru, 2016) for:

- A broadband satellite connection installation for the home or business
- A larger scale satellite connection for a village
- A wireless network delivered by a service provider
- A next generation broadband service

In Australia, the rollout of the National Broadband Network was originally designed to enable super-fast services to all properties irrespective of location, using a range of innovative communication technologies. This project is no longer going ahead (Sorensen and Medina, 2016) with the result that fast-broadband services are limited to larger towns and cities, often along coastal belts, but that gaps in provision are being rapidly made up by fixed mobile provision.

Equipment in the home

Computers and laptops were the only devices capable of accessing the internet until the appearance of smartphones and of tablet devices; these new devices have had a major impact since 2007 and 2010, respectively. Their touchscreen user interfaces, their simplicity of use, and the introduction of "apps" has offered generations of older people the opportunity to join the digital revolution without needing to learn code, word processing or other software applications (Adams and Lee, 2017).

Smart televisions can also be used to access the internet via a dongle or plug-in stick device, enabling the visual benefits of large screens to be realized by people with visual impairment. Vehicles including mobile libraries can be equipped with satellite-based communication systems that allow people in remote communities to try internet access using a range of different portable devices and computer systems in order that they can be shown some of the applications that are likely to be beneficial. When training is also offered to users this can improve take-up.

Service applications

Ultimately, the health, well-being and social care needs of individuals vary so much that it is impossible to provide a standard offering. Everyone is different, and each individual and family has different support networks and deficits that need to be filled in order that they can enjoy independence and a good quality of life. Assessment is therefore the key, and this is recognized in many processes developed worldwide (Banahan, 2004). However, simply recognizing a gap in provision doesn't directly link to a solution unless service providers are able to offer the relevant service element through monitoring centres that also provide coordination. As technology solutions mature, the potential for community care providers to extend their offerings to include new technology enabled solutions alongside more traditional human interventions, such as domiciliary care, also increases.

It follows that community businesses can work with technology specialists to provide a suite of applications. This may require the development of new generic roles for front-line staff who may be required to fulfil tasks such as:

- Identify needs and discuss possible solutions with service users
- Support the service users in using the technology more effectively
- Solve practical problems in the field to avoid the need for technical specialists to be called out unnecessarily

Forward looking businesses have an opportunity to work more closely with domiciliary and other community care providers to provide more holistic services that can benefit their service users.

The availability of physical or virtual (technology enabled) support

The Maslow Hierarchy of Needs (Maslow, *1943)* was originally proposed in 1943 to explain human development and motivation but has been extended *(Maslow, 1954)* into a popular framework for psychologists to use to understand the needs of individuals. It might then be a short step to identifying deficits and opportunities to improve quality of life. It is often drawn as five tiers of the Maslow Pyramid shown on the left in Figure 1, though this number is sometimes extended to seven or eight levels so that cognitive needs, aesthetic needs and transcendence can be included separately.

Figure 1 Maslow's Hierarchy of Needs pyramid extended to technology service opportunities

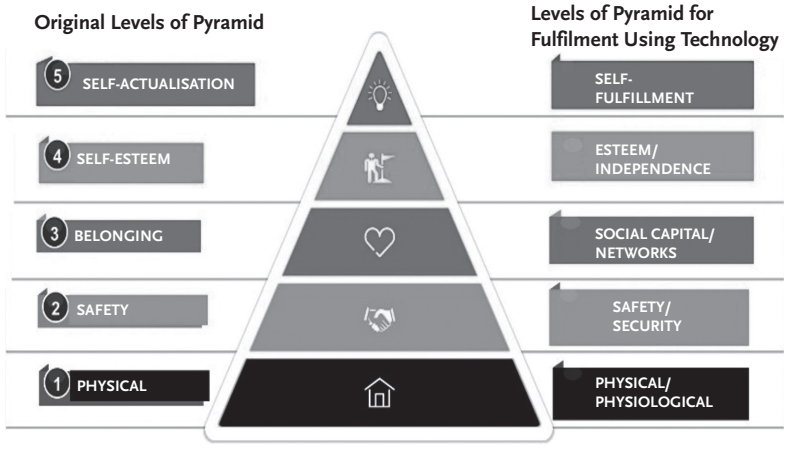

Table 1 identifies ways in which conventional health, social care, housing and other community services have developed to satisfy the needs associated with the five levels of Maslow's Hierarchy. It may be apparent that the basic physical needs of air, water and food are metabolic requirements for all animals (Taylor, 2015). Similarly, clothing and shelter from the elements should form part of human rights, as would a requirement for people to feel safe in their own homes and in the wider community. Higher levels of need are more associated with well-being, occupation, mental health and happiness (Tay and Diener, 2011), and may be supported by non-formal and non-profit care organizations including those that are faith-based and associated with or inspired by religion or religious beliefs (Levin, 2014).

Basic human needs and many more complex needs are interrelated and may require interventions at more than one level at a given time, and by more than one service or agency. But alternative approaches may be possible by addressing the five levels of need in a technology-specific manner that can be enabled by adopting a slightly modified definition of the needs and dimensions as shown on the right of Figure 1.

Table 1 Maslow and support responsibilities

	Dimension	Needs	Examples	Responsibility
1	Physical	Physiological	Breathing, circulation, nutrition, hydration, medication, treatment	Health service Homecare
2	Environmental	Safety and security	Housing, community, climate	Landlord Police
3	Sociocultural	Love and belonging	Relationships and communication with others, support systems, community activities, feeling loved	All stakeholders (including family/friends)
4	Emotional	Self-esteem	Sense of fear, sadness, loneliness, happiness, contentment	Society; third sector organizations
5	Intellectual and spiritual	Self-actualization	Thinking, learning, values, beliefs, decision making, fulfilment, helping others	Society; faith-based organizations

Technologies to support physical/physiological needs

It is not surprising that technology has been introduced to help people maintain their health status and to perform more self-care. The costs relate to both the time taken for health professionals to visit remote properties, but also to the transport difficulties faced by many older people who don't drive and who must rely on infrequent buses and trains. Table 2 provides a non-exhaustive list of applications for technology, and the infrastructure requirements for such applications to become practical and remote support mechanisms. In all cases, there are logistical needs to support installation and technical triage to provide reassurance and ongoing support.

Table 2 Technology to help with level 1 needs

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Comfortable home	Smart thermostat and ventilation	Internet	System hub	General advice and support
Environmental controller	Curtain/window controls; Automatic lights	None	Individual devices and interface	Maintenance and support

Continued

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Support for medication	Reminder and administration system	Internet and/ or telephone	Dispensing device with links	Delivery of medication; response
Hydration/ nutrition	Fridge and cooker monitors	Internet and/ or telephone	Interfaces and hub	Feedback support
Respiratory rate	Analyser and linked system	Internet and/ or telephone	Devices and hub	Data analytics; clinical support
Body temperature	Thermometer and linked system	Internet and/ or telephone	Devices and hub	Data analytics; clinical support

The systems that support such arrangements range from simple approaches, such as Florence (Cottrell *et al.*, 2015) that rely on texting, through to more complex systems with bespoke home interface units as were used in Whole System Demonstrator projects that included patients in the largely rural county of Cornwall (Henderson *et al.*, 2013).

Technologies to support safety and security concerns

One of the reasons that people need to move into residential care is to provide constant supervision in case they have an accident, or if they do not have the insight or cognitive ability to recognize a risk or an emergency (McCreadie, 2009). This is an expensive approach which, in rural areas, often means people being located some distance away from their own communities, resulting in them receiving few visitors. However, there is considerable evidence to show that many can continue to live safely in their own homes if the risks are managed through technology and is the basis of practical telecare systems that have become popular in developed countries during the past decade (Doughty and Williams, 2001).

Table 3 Technology to help with level 2 needs

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Raising alarms	Pendants; fall detectors and panic strips	Internet	System hub	General advice and support

Continued

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Intruder monitoring	Movement detectors and cameras	Telephone or Internet	Individual devices and interface	Maintenance and support
Video doorbells	Sensor and voice and image transmitter	Internet and/or 3G or4G	Bell unit and video display	Cloud processing
Automatic fall detection	Bed occupancy monitor	Telephone or internet	Bed sensor and hub	Emergency response
Location and alerts	GPS tracker	GSM	Wearable device	Management and retrieval
Environmental alarms	Heat and gas, and flood water detectors	Telephone or internet	Devices and hub	Emergency response
Property entry management	Teleconcierge systems	Internet or 3G or 4G	Devices and hub	Cloud processing
Memory support	Prompting aids and timers	Telephone or internet	Devices and hub	Cloud processing

Supporting social inclusion

Many older people are socially isolated and lonely through a lack of social belonging, little public contact and relationships that are unfulfilling (Hadi and Hadi, 2017). It is well established that social isolation can lead to mental health problems and, ultimately, to physical illness too, unless there are effective intervention strategies (Findlay, 2003). Virtual meetings might offer some benefits to people who live in rural locations but only if they can be arranged appropriately. The challenge may be to convince service providers to include such applications within their inventories.

It may be observed from Table 4 that the communication needs for this level are almost entirely dependent on internet access through broadband and Wi-Fi or through appropriate mobile services. Similarly, service is provided generally through an app and an appropriate web interface.

Table 4 Technology to help with level 3 needs

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Voice communication	Telephone and robotic assistants	PSTN and Wi-Fi/ broadband	Handset, hub and device	None

Continued

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Specialist disability interfaces	Special handsets or software	Telephone or Wi-Fi/broadband	Individual devices and interface	Maintenance and support
Advice and information	Telephone, smartphone or tablet	PSTN, Wi-Fi/ broadband or 3G or 4G	Handset of interface	24/7 call monitoring centre
Video consultation	Smart TV, tablet or smartphone	Wi-Fi/broadband or 3G or 4G	Only device and hub	Support video centre
Access to online services	Tablet, smartphone or laptop	Wi-Fi/broadband or 3G or 4G	Devices and hub	Internet service provider
Social networks	Tablet, smartphone or laptop	Wi-Fi/broadband or 3G or 4G	Devices and hub	App
Virtual events and services	Tablet, smartphone or laptop	Wi-Fi/broadband	Devices and hub	App

Technologies to make independence a reality

An individual's sense of self-esteem may be increased when they are able to perform tasks on their own and without the help of others, which is a key purpose for assistive technologies (Rainers *et al.*, 2005). The impact of devices and systems has been studied widely for a wide range of disabilities and deficits including dementia (Sum and Fleming, 2014). Table 5 describes some of the applications for technology that use telecommunications and information technology to support greater independence.

Table 5 Technology to support independence and self-esteem

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Activity planners and schedulers	Software	None	Laptop, tablet or smartphone	None
Internet shopping or electronic banking	Software	Wi-Fi/ broadband or 3G or 4G	Laptop, tablet or smartphone	App

Continued

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Public transport timetables	Software	Wi-Fi/ broadband or 3G or 4G	Laptop, tablet or smartphone	App
Meal planners	Software	GSM, 3G or 4G; Wi-Fi/ broadband	Laptop, tablet or smartphone	App
Prompts/ reminders and location alerts	Software	Wi-Fi/ broadband or 3G or 4G	Laptop, tablet or smartphone	App
Queries, jokes and fun items	Smart speakers	Wi-Fi/ broadband	Laptop, tablet or smartphone	App

Supporting self-fulfilment through technology

Many people have ambitions and desires that they may try to achieve through their own efforts; these may be personal goals or "bucket lists" of activities that they want to perform or places that they want to visit (Stathers, 2017). Physical and cost limitations can be obstacles to achieving these ambitions, but others may be overcome using technology of the type listed in Table 6.

Table 6 Technologies to support self-fulfilment

Application	Type of device	Communication needs (outside the home)	Hardware needs	Service requirements
Simple radio/ music finder and player	Hardware	Wi-Fi/ broadband	Bespoke	Subscription
Video reminiscence tools and services	Software	Wi-Fi/ broadband or 3G or 4G	Laptop, tablet or smartphone	App
New augmented and virtual reality techniques/ applications	Software and hardware	Wi-Fi/ broadband	Headset and computer	App
Virtual volunteering and meetings	Software	Wi-Fi/ broadband or 3G or 4G	Laptop, tablet or smartphone	App
Learning and using new languages	Software	Wi-Fi/ broadband	Laptop, tablet or smartphone	App

All the applications described in Table 6 are possible if individuals are clear in their ambition and are prepared to use apps and smartphones or tablets with their home Wi-Fi system and broadband. Thus, they are again dependent on the availability of the telecommunications infrastructure.

Discussion

It may be apparent from Tables 2 to 6 that there are many opportunities available to support the unmet needs of vulnerable people with technology. However, few of these are currently available within integrated services. It may be argued that there are at least eight areas in which actions may be needed in order that the benefits described above might be achieved:

- **Improved assessment processes**. This means moving away from older "disability models" of care and towards the person-centric attitudes and opportunities to improve people's lives as described in the 2014 Care Act in England.
- **Application inventories**. Both telecare services and community equipment services are currently restricted to a relatively small number of technologies. Many of the telecare devices that are employed were introduced over a decade ago following the awarding of the Preventative Technology Grant in England (Department of Health, 2004) and similar schemes in other countries. An extended inventory would need new investment.
- **Training**. Workforce development is likely to be an important factor to ensure that the carers who spend most time with older people are made aware of new developments. There are no clear responsibilities at this time; staff need to be trained to provide more appropriate assessments and to be able to prescribe the new items as described above.
- **Partnerships**. Care and support can be complex functions involving multiple agencies each with different concerns and areas of focus. Coordination can be delivered by a new model of monitoring or by direct partnership working between private and public sectors.
- **Communications infrastructure**. Free Wi-Fi is available in many town centres as well as in public places such as railway stations, hospitals, libraries and public transport. Successful utilization depends on having an infrastructure which is robust and secure and on having support staff that can maintain and restore the communications hubs following a failure.
- **Evidence of success**. Most implementations of technology used to support independent living fail to provide an evaluation that may be used to validate their claims of financial and outcomes benefits. Case studies offer limited

information without offering a full context that allows alternative interventions and outcomes to be compared. New products may need independent evaluation to convince commissioners of their efficacy, and the public of their value for money.

- **Business case**. The cost benefit analysis can be flawed if the comparison packages of care used in trials are either unrealistic or simply unavailable due to a lack of capacity within the social care sector. High cost residential care is often cited as the only alternative to technology when there are rarely beds available when needed nor in the desired locations. Supply chains have yet to mature, so it becomes difficult to introduce sustainable solutions.
- **Return on investment for organizations**. Providers of technology enabled care at home services need to receive guaranteed funding for a specified number of service users before they can be expected to offer the wide range of options described in this paper. A level of pump priming may be necessary to ensure that providers are able to justify their investment in training and in technology over both the short term and the longer term.

Conclusions

The potential applications of technology enabled care at home are numerous, as are the likely benefits to an ageing population. In practice, however, it is likely that only a small number of service providers in each country are capable of assessing the needs of an individual, knowing what applications might be relevant, and identifying whether they have the digital confidence and maturity necessary to successfully use them. The challenge might then become one of identifying all organizations that are demonstrating good practice and of encouraging and supporting them to expand their reach to include more rural areas. This may require them to partner with existing community care providers and to train their staff to better understand the aspirations and deficits of their clients. This could lay the foundations of system-wide transformation and improvement of care systems so that technology options become more routine and acceptable. The need for further evidence of success may be apparent both to ensure appropriate investment in communications infrastructure, and to persuade potential self-funding service users to invest in broadband for their homes and in the computing devices necessary to match technology applications with their needs.

Without a rapid acceptance of technology solutions, older and disabled people living in rural communities may have to accept a lower quality of life and access to a reduced level of intervention by care staff.

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