Digital health and its application in rural areas: a review of international experience

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1. Introduction

In recent years, there has been growing interest in research on the application of digital technologies in the delivery of health and social care. These debates have ranged widely, focusing in particular on the development of the technologies and their impacts on the quality and efficiency of health service delivery. As part of this debate, research has considered the extent to which digital technologies can be used to address spatial health inequalities that persist at various scales. While there are important health divides *within* major cities, there are also persistent differences between urban and rural areas. It is widely recognised, for instance, that rural communities are commonly disadvantaged due to remoteness and low population density that limits the range of specialist healthcare facilities that are made available. In this context, the purpose of this article is to review recent research that examines the application of digital health and the extent to which it can be used to overcome rural disadvantage. It is intended that this review will form a basis of consideration of the potential for digital solutions to health inequalities within the County of Cumbria, in the north-west of England, UK.

A systematic search of relevant literature was undertaken in order to identify and collate relevant articles. This was achieved using combinations of search terms including appropriate medical terminology (such as "telemedicine", "telehealth", "ehealth" "telecare") in combination with locational descriptions (primarily "rural areas" or "rural community"). During the process, a decision was taken to include examples from both developed and developing countries. While recognising that there are very significant differences between rural areas in these two contexts, there are some parallels in terms of the barriers created by remoteness and low population density. Also, inclusion of a wide range of socio-economic settings provides opportunities to comment on the role of digital technology in delivering health care at different stages in economic development (Rygh & Hjortdahl, 2007). The impact of rurality varies from developing to developed countries and rurality is often used as a metaphor for remote areas populated by indigenous peoples in developed countries.

2. Definitions of Rurality in relation to healthcare issues

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Available studies suggest that in developing economies rurality is generally associated with extreme poverty, lack of mobility, low levels of education and extreme weakness in, or even absence of, healthcare infrastructure. In this environment, the issue for digital health concerns the extent to which new technologies can compensate for a basic lack of functional health infrastructure (Krüger & Niemi, 2012; Agrawal et al, 2013 and Jaroslawski, 2014). Developing countries therefore face a much bigger challenge than in developed economies where digital health is usually seen as an addition to existing infrastructure (Jaroslawski, 2014).

Within developed economies however, there are significant differences between rural areas in different countries. For some, rurality is associated with extreme remoteness and peripherality as in the cases of Australia, Canada and parts of Scandinavia. In this context, a key question concerns the extent to which digital health can provide a means to access even basic healthcare by overcoming barriers created by the effects of time of travel and physical access to services (Liaw & Humphreys, 2006 and Wielandt & Taylor, 2010). Several of these studies also focus on communities where extreme peripherality intensifies significant social-cultural divides associated with ethnic minorities located in enclaves within remote areas as in the case of aboriginal communities in Australia (Mooi, 2012) and native North American communities in the USA and Canada ((Dick, 2007; Doorenbos, 2011 and Gibson, 2011).

In contrast, many smaller and medium-sized countries (as in much of Western Europe) have national systems of health care providing services across all regions. In such economies, rurality is associated more with low population density rather than extreme remoteness. Health issues are concerned with balancing efficiency and cost with the quality of delivery of services rather than compensating for a total absence of healthcare provision (Veitch, 1996; Brebner et al, 2004; Richards, 2005; Peddle, 2007; Atkinson, 2009; Sevean, 2009; Moffatt & Eley, 2010, Miyamoto et al., 2013 and Graves et al, 2013). The issue for digital health in this context concerns the extent to which new technologies can provide a cost-effective way of delivering specialised healthcare services to regions characterised by low population density (Smith et al., 2004; Ostrow, 2005; Roberts, 2012; Stenlund, 2012; Benavides-Vaello, 2013; Seibert, 2013 and Waranabe, 2013) as well as improving access to maternity and emergency health services (Brebner et al, 2004 and Wesson, 2013).

3. Types of intervention

Available research suggests that success in application of 'digital health' varies depending on the type of intervention and the needs and characteristics of the region in which the 'digital health' solution is applied. Types of 'digital health" can be grouped into four broad categories as shown below.

- Telemedicine – involves in particular the remote examination of a patient by a health professional. This has self-evident benefits for rural and remote areas where physical access to health professionals is restricted. Such remote examinations, however, depend on the existence of an appropriate digital infrastructure and removal of social and technical barriers that might deter users from accessing such services.

- Telehealth - the remote monitoring of patients and self-managing of health conditions at home and the sharing of data electronically between health providers. This has been identified as a way of transferring medical and social care knowledge over sparsely populated areas. To be successful this requires a higher level of digital expertise from the end user whether they are medical practitioners or patients.

- Telecare & assistive technologies - community alarms to enable patients to call for help in an emergency; equipment to enable people to manage independent living in and outside home). These technologies allow a degree of independence for patients but again, successful application depends on appropriate infrastructure and in many cases, personal income to fund such equipment in the home.

- Ehealth - the sharing of patient records, e-referrals, patient controlled records, social media and related products. Sharing such information in digital form may allow the medical and social care sector to provide services to a dispersed population more efficiently but this requires the correct legal, social and physical infrastructure to be in place and appropriate measures to reassure health professionals and patients regarding data security.

4. Digital health in rural areas

The literature provides a range of examples of studies of the application of digitial health technologies designed to meet the needs of rural communities. Telemedicine for instance has potential to improve the reach of medical expertise located in urban areas to support health and medical services in its more remote and rural areas without incurring significant additional cost of locating large numbers of health professionals in smaller scattered settlements. There are examples of success in the United States. Neufeld et al (2012) for example report a rapid pace of adoption of telemedicine to deliver mental health services in rural areas of Indiana while Wesson et al (2013) highlighted the potential for telemedicine in trauma treatment in rural USA. Other recent example are provided from Australia. Mooi et al (2012), for instance, report positive results from the use of telemedicine to support remote examinations and treatment for cancer patients (teleoncology) in a study focused on the needs of aboriginal communities in New South Wales. Their result confirm the need for clarity concerning patient consent to the approach, staff training for all involved in using new technologies, effective coordination between clinics and

individuals in the field as well as accurate documentation that is shared by practitioners.

Other studies comment on the institutional context for delivery of telemedicine. In this context, Martin et al (2012) argue that hospitals rather than smaller medical practices are best placed to handle the technical and legal implications of telemedicine in rural areas of the United States due to their institutional capacity. In the UK context, Brebner et al (2004) have demonstrated that extending the reach of casualty services in Aberdeen using teleconsultation (transmission of radiographs) networking through 14 community hospitals across the north-east of Scotland proved highly successful and achieved a high degree of satisfaction from patients.

In developing countries, attempts to provide healthcare through telemedicine have met with limited success mainly due to the lack of infrastructure upon which to build solutions. Success in telemedicine depends, therefore on finding innovative ways to create basic infrastructure and then make use of telemedicine to increase the reach of healthcare initiatives in rural areas. One example concerns the use of rapid-deployable infrastructure (cargo containers containing basic medical equipment) that is digitally-enabled (audio and video connectivity to cloud-based systems to facilitate access to diagnostics, decision-support and data sharing). This approach commonly applied to meet disaster situations could be applied more routinely, for instance, to deliver healthcare in remote areas in India (Agrawal et al, 2013). Where possible of course, the use of this approach is best integrated into the health care system available on the ground. At very least, there needs to be some understanding of local health issues and institutional limitations. A recent study in Tanzania, for instance, suggest that paediatric care advice can be offered to remote rural areas using telemedicine that links specialists to local areas via digital devices. This system appeared to work because the specialists involved had had some previous experience within the Tanzanian health system and therefore understood local situations (Krüger & Niemi, 2012).

As regards telehealth (which allows patients living in remote areas to lead relatively normal lives whilst being supported by medical professionals remotely through self-monitoring and self-management, the literature review suggests this is mainly restricted to developed countries. In a recent review of the use of telehealth to support mental health and substance abuse treatment in rural communities in the United States, Benavides-Vaello et al (2013) noted that self-management enabled by technology can be used to *"enhance a variety of clinical services and educational initiatives in rural communities, and [serve] as a viable mode to increase access to specialty professional services in remote areas in a convenient and economical way"* (p. 117).

The conclusion that telehealth can lower cost and increase patient convenience is supported by a wide range of recent studies. In Australia for instance, Moffatt & Eley (2010) note that *"patients are reported to have benefited from: lower costs and*

reduced inconvenience while accessing specialist health services; improved access to services and improved quality of clinical services" (p.276). In addition, they report benefits for health professionals who can use telehealth to gain *"access to continuing education and professional development; provision of enhanced local services; experiential learning, networking and collaboration"* (p. 276). Similarly, in a study of heart failure disease patients in the US, Graves et al (2013) found that telehealth showed five broad themes of effectiveness: improved knowledge, improved self-care behaviours, improved health outcomes, cost reduction and patient satisfaction and concluded that *"Sufficient evidence is available to support the use telehealth technologies as an effective and efficient approach to improving healthcare access, improving both health outcomes and health status, and reducing overall cost"* (Graves et al, 2013).

Similar support for the use of telehealth was found in specialist rheumatologist services in Australia (Roberts et al, 2012), in remote communities in Northern Canada (Sevean et al, 2009) and in the treatment of post-acute burns care to children in remote areas of Queensland Australia (Smith et al, 2004). Telehealth is also seen as a useful training tool for healthcare practitioners (Ostrow & DiMaria-Ghalili, 2005; Seibert et al, 2013). Telehealth and the use of video technology has also been seen as a way of delivering cancer educational programme to native people living in remote rural Alaska (Kundu et al, 2011).

In addition to matching telehealth delivery to community needs there were some other requirements identified for the successful implementation of telehealth services. These include effective advice and training for patients in the use of technologies. Edwards et al (2014), for example, demonstrate that success in developing telehealth for cardiovascular disease patients in England is only effective if end users are confident in using the appropriate technology. Previously studies in Labrador in Canada (Peddle, 2007) and England (Richards et al, 2005) have also shown that telehealth can only be adopted if the health professionals are fully confident with the technology.

Other studies suggest that while some delivery costs may be reduced by telehealth (staff time in particular), others may actually increase (requirement for patient training and staff development). This implies that telehealth solutions need to be effectively modelled to incorporate technological requirements, organizational readiness, legal and ethical concerns alongside cost modelling. As noted by Stenlund, (2012) in a study of dietician services in rural Ontario, there appears to be no consensus about the cost effectiveness of videoconferencing for consultations in relation to the costs of technology as well as possible hidden costs that arise from the need to address legal and ethical considerations associated with use of the technology (e.g. overcoming concerns about privacy and data security).

The literature review identified very few studies of telecare and assistive technologies applied to rural areas. This possibly reflects the fact that studies of

telecare tend to focus on immediate home environments and there is less relevance to regional context. E-health, however, which enables the sharing of data more quickly and accurately, does have regional relevance. Much of this research seeks to evaluate attempts to enable health and care workers to maintain access to records held at a central point and to update them in the field. Also, the digitalisation of patient records also opens up opportunities to give greater access to patients in general and not just in rural or remote areas.

In developed countries e-health is used as a medium to transmit health knowledge to remote communities. The use of the internet to educate low income families in Maryland on the dangers of obesity was seen as a solution but the case study indicated that content had to be regularly changed to keep the attention of the users (Atkinson, 2009). To achieve impact, Liaw & Humphreys (2006) argue that for health to work in rural Australia, the supporting IT infrastructure including the correct technology and trained operatives has to be in place. It has also been argued that the increasing availability of up to date data in the internet is helping to address long-standing problems associated with the belief that health care workers in rural areas lack access to the most recent and relevant advice and training (see, for example, Wielandt & Taylor (2010) on training provision for occupational therapists in rural Canada).

5. Success of digital health interventions in rural areas

From the range of studies referenced in this short article, it appears that there are many examples of successful applications of digital health in rural areas within developed economies worldwide. Where digital health has been applied successfully, patient surveys reveal high levels of satisfaction in different rural contexts. Prime examples of this include teleconsultation and radiograph transmission for fracture patients in accident and emergency in Scotland (Brebner et al 2004); treatment and monitoring of chronic disease utilising self-monitor in the USA (Graves et al 2013); access to specialist health services (Moffatt & Eley 2010); telepaediatric burns service provided in Queensland Australia (Smith et al 2004) and delivery of specialist cancer care in Australia (Mooi 2012). It is important to stress that digital health care can also be suited to delivering professional development efficiently to all levels of health and social care workers whether this is via specifically designed online courses or face to face mentoring via an internet connection.

However, where digital health has not been sympathetically introduced to a rural area it can produce a poor uptake of services or "mixed" responses. For example in Labrador Canada there was limited uptake of new consultation technologies due to issues of privacy, culture and trust (Peddle 2007) and in Ontario Canada telehealth introduced to support mental health consultations received a "mixed" response from participants (Gibson et al 2011). As with the general findings on digital health where possible practitioners and patients would prefer face to face contact with the

professionals they are dealing with BUT in the case of rural health there appears to be an acceptance that digital health has at least allowed a virtual access to these professionals that would be too expensive to deliver in person.

6. Some implication for delivery of healthcare in rural areas

This brief article confirms that there are numerous studies in the literature that report on attempts to make use of digital devices to improve the range, reliability and efficiency of healthcare in rural areas. The benefits that are associated with these initiatives can be related to cost, but this is not the only driver for such changes. Case studies reveal other factors at work including improvements in the speed, accuracy and appropriateness of response to need as well as patient and practitioner convenience. The literature suggests it is important to be clear about the precise benefits that are intended and who experiences these benefits.

The case studies in the review suggested that rural communities can benefit from digital health interventions but the precise benefits vary depending on the scale and characteristics of the intervention. Table 1 seeks to summarise some of these differences. As regards telemedicine, there are numerous reported cases of successful delivery of schemes designed to improve healthcare through remote examination of patients in rural areas. This seems particularly prevalent in situations where patients have urgent or emergency needs or they are in life-threatening situations. It is evident from these experiences however that new technology and basic health infrastructure is required for such interventions to succeed. In that sense, these are not necessarily alternatives to conventional delivery but work most effectively to cover weaknesses in existing services specific to rural areas. There are also social and cultural barriers to adoption of new technologies in healthcare that need to be considered and overcome in consultation with local communities.

On telehealth and telecare, the review indicates that there are clear benefits for patients living in rural areas in managing chronic health conditions and patient recovery by investing in digital technologies that enable remote monitoring and self-management of health conditions. This approach has clear benefits for patients in reducing the time spent travelling and possibly offsetting the need to move out of rural areas in order to be closer to appropriate medical services. While there are clear benefits for the patient in terms of cost and convenience, it is by no means clear that this approach will be more cost-effective for health service organisations. Cost comparisons with conventional delivery are complex. There is a possibility that such digital devices could reduce length of stays in hospital and reduce demands on practitioner time (cost reductions) but on the other hand there needs to be greater investment in the technologies and also funding for staff development and user training for effective use of equipment. It is likely that face-to-face contacts will be required to overcome possible social and cultural barriers that might exist and increasing patient confidence in the technology.

Equally, ehealth (sharing of data and e-referrals) could be a significant aid to rural healthcare workers by facilitating faster diagnosis and improving decisionmaking in rural communities. Such practices and technologies could potentially reduce the need for referrals to hospitals involving lengthy journeys with concomitant delays in diagnosis and treatment. However, case studies suggest there are concerns expressed about the legal and ethical basis of such data-sharing and data security.

Summary of lesson for rural application of digital health

Type	Examples	Application in rural areas	Barriers to overcome
Telemedicine	Remote examination of a patient by a health professional	Used to overcome barriers of geographic isolation Many examples of success and good patient feedback particularly for life-threatening conditions (e.g. cancer) and emergencies (accidents, burns). Possibly less so for routine consultation.	Need to invest in technology and re-think basic health infrastructure to provide the basis for rural delivery Need to understand social and cultural barriers – not just geographical issues Concerns about patient confidentiality to overcome
Telehealth and telecare	Remote monitoring, self-management, independent living, medical education	Transfers of knowledge and know-how over distance. Useful for chronic conditions– cardiovascular, rheumatics, post-acute treatments and long-term recovery.	Need to invest in training for practitioners and also users/patients Debates about cost – may reduce some costs but increase training and staff development at least in short term
Ehealth	Sharing of patient records, e-referrals, patient controlled records	Increased data-efficiency for practitioners - early diagnosis and improved decision-making and accuracy/appropriateness of treatments in rural situations	Needs attention to legal and ethical issues as well as data security

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