Rapid Review of Virtual Care

REIMAGINING HEALTHCARE IN AUSTRALIA

The journey from telehealth to 21st century design

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March 2021

Deloitte.
CHF Consumers Health Forum OF Australia
Curtin University
digital health CRC

Acknowledgement to Country

The Digital Health CRC and its partners acknowledges the Indigenous people of the many traditional lands and language groups of Australia. It acknowledges the wisdom of Aboriginal Elders both past and present and pays respect to Aboriginal and Torres Strait Islander communities of today.

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Background

This rapid review of virtual care was commissioned by Curtin University as part of a broader project, *Reimagining healthcare in Australia: the journey from telehealth to 21st century design*, developed by the Digital Health Collaborative Research Centre (DHCRC) in partnership with the Consumers Health Forum and industry partners Deloitte. The project has several components including this rapid review which will inform a white paper, webinars with key stakeholders, surveys of consumer views and preferences for virtual care and a roadmap of future research project proposals and potential policy change in virtual care.

Virtual care, in this report, refers to the use of digital technologies in the delivery of a broad range of health and community-based services to consumers. The intent of this review is to identify virtual care models that enhance or transform current care delivery. Technologies that are valuable in providing digital substitutes for existing work practices, such as electronic health records and telehealth, are not the focus of this review. The adoption of virtual care is influenced by complex social and technological factors as well as the broader political, cultural and economic environment. These factors are presented in this review in order that they are considered and planned for in realising new models of virtual care.

Methods

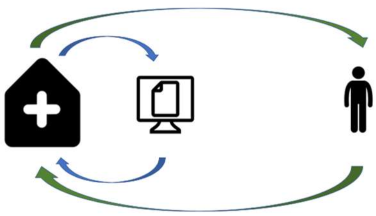
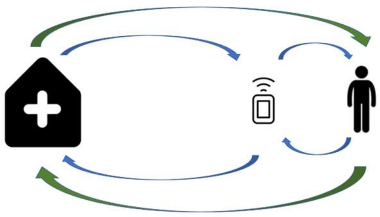
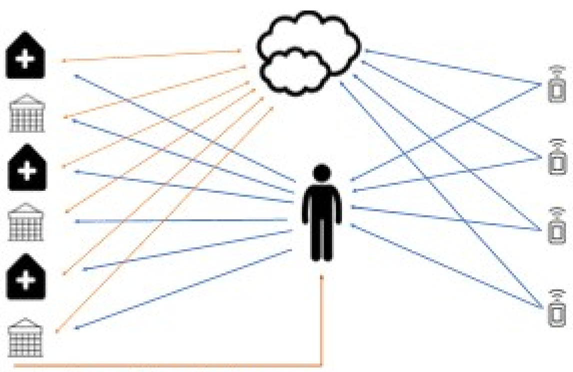
This rapid review involves a critical appraisal of 81 peer reviewed articles and 51 grey literature reports from Australia and internationally. The intention of the rapid review is to provide an overview of the literature and key themes rather than a comprehensive review of the literature and evidence. The review approach includes a search of the MEDLINE OVID electronic database and a search of relevant government and organisational websites to identify relevant reports. A snowballing strategy was also used to identify relevant documents in the retrieved articles and reports reference lists.

Findings: Models of Care

This rapid review finds promising evidence of a range of virtual care models that augment existing approaches and indications of a future that will be transformed by new models of virtual care. The evidence base is nascent and at times contradictory reflecting the challenges of evaluating and comparing virtual care models, the lack of evidence of at scale implementation and the context specific nature of successful implementation. Virtual care models are described in this report and evidence, where available, is provided to give an indication of their potential. However, the evidence does not fully inform the question of what works for whom and in what circumstances.

This review categorises virtual care developments into three horizons. The first horizon encompasses digital technologies that largely substitute for existing work practices enabling efficient data sharing to provide the building blocks for new models of virtual care. While there is a vast literature on implementation and evidence in Horizon 1, this area is not explored in detail in this review as it represents digital change within traditional models of care rather than enhanced or new models of care. The second horizon addresses virtual care models that build on Horizon 1 technologies to expand or augment existing care models through changed work practices. The third horizon highlights emerging and future models of care transformed by digital technologies. These horizons are summarised in Figure A.

Figure A: Three Horizons of Virtual Care

HORIZON 1		Building and consolidating a digital foundation within traditional models of care through digital data sharing between providers (e.g. eReferrals) and between providers and consumer (e.g. telehealth) enabling: • Improved efficiency of data sharing • Improved accuracy of information • improved decision making • Improved access to services • Reduced consumer risk
HORIZON 2		Enhanced models of care involving new work practices underpinned by remote monitoring and intervention, improved data accuracy, real time recording and increasing consumer access and control of data, which support self-care within an area of the care continuum through: • Data directly available from Device → Consumer + Provider • Data sharing mainly occurring via one or a limited number of devices
HORIZON 3		Maturing and evolving interoperable technologies will allow new models of care, yet to be fully defined. This horizon is characterised by the use of a broad range of consumer, care provider and non-care provider generated data stored in the cloud and analysed with AI to deliver a comprehensive range of services and information across the continuum to the consumer with a focus on personalised, primary, predictive, preventive and participatory care through data sharing via: • Device → Consumer • Device → Cloud + AI • Consumer → Provider/ Organisation • Provider/ Organisation ↔ Cloud + AI

Most literature identified and reviewed has a focus on Horizon 2, augmenting existing care and supporting task redesign, rather than new models of care in Horizon 3. Virtual care models in Horizon 2 are categorised according to a continuum from prevention, acute to maintenance care. A model of remote monitoring and management or intervention, with or without provider input, using a range of technologies from mHealth (use of mobile devices) to robots to Smart homes, dominates Horizon 2 across the care continuum. The adoption of this type of virtual care model is seen to occur within the context of well-developed and trusted provider-consumer relationships. Virtual care then allows more time for the provider-consumer relationship and better information to plan care.

The ubiquity of the Smart phone means that virtual care models involving mHealth have a larger and stronger evidence base. However, even here the challenges of virtual care evaluation are evident where the development of mobile applications (apps) is less expensive than developing evidence of quality and efficacy which can then be a barrier to informed decision making by users. Evidence of the benefits of Horizon 2 virtual care models is stronger in chronic disease prevention and management, areas such as diabetes. Evidence is also beginning to emerge in other areas such as virtual hospitals, virtually assisted aged care living and automated risk factor and screening programs. There are, however, some key gaps in the Horizon 2 literature in evidence around virtual care that promotes independent self-care in older people (such as Smart homes) and people with disabilities, particularly intellectual disability.

The evidence presented, while demonstrating the promise of virtual care, is at times weak and contradictory. This reflects the developing nature of many virtual care models in Horizon 2 and the challenges of evaluating and comparing virtual care models that vary in design and the context in which they are applied.

Much of literature regarding emerging Horizon 3 models is drawn from governmental and consulting firm reports rather than peer reviewed literature. Horizon 3 models are yet to be fully realised with limited research evidence around efficacy, effectiveness and cost effectiveness. Reports describe a future where it is envisaged that Horizon 3 will be characterised by connected digital technologies that will enable care to be delivered to the consumer in or near their home with less visits to hospital for routine and emergency care. Consumers will undertake self-care through a range of prevention activities delivered via a combination of technologies that allow remote monitoring and communication with providers. When a consumer does require specialised care that care will be personalised based on individual data to maximise outcomes (World Economic Forum, 2016). Virtual care ecosystems will be created through artificial intelligence assimilating and analysing data from a range of sources to create personalised, primary, predictive, preventive and participatory models of care.

Future transformations of care lie in the ability to address social and environmental determinants of health and wellbeing. Bringing together and analsying data from a range of different data sources will inform an understanding of environmental and social factors that influence health related behaviours. This will foster new models of virtual care that focus on personalised and preventive interventions to prevent the development of chronic conditions. The future will see significant disruption through the introduction of non-traditional agents entering health markets and using data and technology to improve health outcomes. However, progress in the health and community care sectors has been slow to date. Realising this future requires carefully addressing implementation factors that support virtual care development and adoption.

Findings: Implementation Factors

The review identifies implementation factors important in realising virtual care, at the user level, both consumers and workforce, as well as system level factors. User related virtual care implementation factors include co-design processes that, from the beginning, incorporate a range of potential consumers, along with other key stakeholders, to ensure consumer needs, preferences and equity of access issues are addressed. Developing consumer skills and providing support to engage in virtual care is also essential. Virtual care implementation needs to be accompanied by an understanding of digital health determinants, such as access to digital resources and digital literacy, and an assessment of equity. New virtual care developments must ensure people have equal access, an equal quality of care and equal health outcomes.

The workforce are key users of virtual care. Government reports in Australia and internationally identify the need for and challenge of developing workforce digital literacy. Worker readiness must be supported by leaders implementing strategic adaptive change management approaches that address workforce culture, specialist training and role creation in order that the workforce can use and promote virtual care models with consumers.

System level factors influencing successful virtual care implementation were found to be well documented in the literature and include collaborative governance and leadership structures, regulatory pathways responsive to the pace of new innovations, funding models, such as value-based care, that incentivise or foster virtual care, responsive information governance systems. A key tension in implementing virtual care exists between data security and data sharing. This tension must be addressed through technological development and regulation to ensure data is secure and used appropriately and that consumers have confidence in sharing data. System level infrastructure requirements underpinning virtual care models include secure connectivity and interoperability of devices to allow information to cross organisation, sector and geographic borders.

Conclusion

This rapid review of virtual care highlights a vision of the future with consumer-centric virtual care provided at a time, place and in a format of choice that will enable individuals to have greater control in improving their health and wellbeing. Realising this future requires strategic leadership guiding further work in co design, user readiness, regulatory and information governance controls and investment in infrastructure. Scale up and widespread adoption of virtual care models will be underpinned by stronger evidence obtained through effectiveness evaluations in real life settings informing what works for whom and in what context.

Rapid Review Summary

Aim of Rapid Review

- To identify Australian and international virtual care models that enhance or transform current care delivery across the care continuum.

Findings: Models of Virtual Care

- Most literature identified and reviewed has a focus on digital technologies augmenting existing models of care (Horizon 2) rather than new models of virtual care (Horizon 3).
- Augmented care models across the care continuum centre on a model of remote monitoring and management or intervention, with or without provider and /or consumer input, using a range of technologies.
- Stronger evidence of augmented care models in Horizon 2 exists around mHealth preventive care, virtual care in chronic disease prevention and management, with developing evidence in acute care.
- Descriptions of new transformational models of virtual care, Horizon 3, are found mainly in governmental and consulting firm reports and describe personalised and predictive care ecosystems developed from a broad range of data sources controlled by consumers and analysed with cloud based artificial intelligence to deliver information and services to meet consumer needs and preferences.

Findings: Implementation Factors

- Digital health determinants, such as access to digital resources and digital literacy, need to be addressed to promote equitable outcomes through virtual care models.
- Virtual care development must accommodate the needs and preferences of consumers early in collaborative co design processes to ensure appropriate development and equity of access.
- Workforce readiness strategies need to develop skills, new roles and workforce culture through technical and adaptive change to enable the workforce to utilise and promote virtual care models.
- System level factors that create an authorising environment for virtual care such as funding and procurement processes, standards and regulations need to responsive to rapid developments in technology.
- Future virtual care models are dependent on infrastructure investment and development in stable connectivity and interoperability of devices.

Areas for Future Focus

- Developing stronger evidence base through evaluating implementation, scalability, cost and adaptation to technology of virtual care models in real life settings rather than pilot development of technology (effectiveness vs efficacy).
- Providing evidence of improvements in quality of care and health outcomes, in addition to cost effectiveness data.
- Greater understanding and evidence on the quality of datasets and the effectiveness of AI and machine learning in screening and triaging.
- Addressing key implementation factors that currently inhibit the further development and widespread dissemination and uptake of virtual care models.

Section 1: Introduction

1. Overview

Transformation comes from new ways of working, not the technology itself
(Imison, Castle-Clarke, Watson, & Edwards, 2016 p.8)

This rapid review draws on peer reviewed and grey literature from Australia and internationally to identify virtual care models that will enhance or transform current care delivery. Virtual care, in this report, refers to the use of digital technologies in the delivery of a broad range of health and community-based services to consumers. Virtual care has the potential to change the way care is delivered to benefit consumers through improving consumer experience and outcomes (World Health Organisation, 2016). Virtual care is primarily a means to improve the quality and flow of information to enable high quality care and decision making via a range of models (Taylor, Hall, & Siegel, 2019). Delivering quality care, while overcoming constraints such as distance, time, cost and resources by deploying technology, is central to virtual care.

The anticipated benefits of virtual care in addressing an ageing population, rising prevalence of chronic disease and the costs associated with these are widely cited internationally (see for example Devlin et al., 2016; Hans, Gray, Gill, & Tiessen, 2018; M. Jones, DeRuyter, & Morris, 2020). Addressing these challenges requires moving beyond discipline specific approaches towards models of team based and integrated care across the health and community care sectors. Virtual care enables a shift away from provider centric models of care toward an integrated, preventive and personalised consumer led or self-care approach (Singhal & Carlton, 2019).

The transformation to new models of virtual care is in its early stages. Technologies such as electronic health records, telehealth, eReferrals, eDischarge and ePrescribing have been the focus of digital change over the past decades and are not yet fully mature. These technologies are important digital substitutes for existing work practices that can assist in delivering contemporary care. They enable efficient data sharing and provide the foundations for new models of virtual care. The global COVID-19 pandemic has seen a rapid shift to these forms of virtual care. For example, in Australia in March 2020 there was a broadening of access to Medicare Benefits Scheme funded telehealth from approximately 0.1% of the population in mainly rural areas to a more universal telehealth model to enable health care access through tele or video consultations from home (Fisk, Livingstone, & Pit, 2020). Additional funds were also made available for a digital mental health portal, online support for health workers and to support online and phone support by aged care community visitors to older people (Fisk, Livingstone, & Pit, 2020). These technologies, providing substitutes for existing work practices, have been discussed in depth in the literature. The intent of this rapid review is to focus on where virtual care can augment existing models of care or allow the creation of new models of care.

Virtual care adoption is influenced by complex social and technological factors as well as the broader political, cultural and economic environment. The focus is therefore about understanding what might work for whom and in which circumstances.

In reviewing digital innovations and opportunities there are no simple dichotomies of successful or unsuccessful approaches as different parameters and contexts influence effectiveness. Virtual care adoption is influenced by complex social and technological factors as well as the broader political, cultural and economic environment (Devlin et al., 2016). The focus is therefore about understanding what might work for whom and in which circumstances.

A dramatic increase in the number and type of digital technologies has created an increasingly complex environment for consumers, care providers and funders to understand and navigate. The health sector has been slow to respond to this complexity in implementing digital technologies and has had some notable failures along the way (Imison et al., 2016). This review addresses factors that influence implementation and must be considered and planned for to realise new models of virtual care.

This report is structured to first present key definitions and concepts used. This is followed by an explanation of the aim of the rapid review and review questions. The methods used to collect information for the review are then outlined along with the results of the literature search. Findings on augmented care, referred to as Horizon 2, are presented according to categories of prevention, acute care and maintenance which reflect key categories across a care continuum. Emerging virtual care models which cross the continuum to transform health and care, referred to as Horizon 3, are then described. This is followed by an overview of factors influencing the implementation of virtual care. The report concludes with a synthesis of key findings for future directions in virtual care.

2. Key definitions, concepts and scope

Virtual care in the health and community sector is described by a variety of overlapping and sometimes interchangeable terms including digital health, digital information and communication technologies, technology enabled care and eHealth. The rapid rate of development of technology means that terms and definitions continue to change as new technologies emerge (Australian Digital Health Agency, 2020). This presents a challenge in creating a clear and consistent understanding.

The term 'virtual care' used, in this report, refers to a diverse range of technologies that consumers, service providers and organisations may use to support care provided across a continuum from preventive, acute, to maintenance care. The term 'virtual health' is also used in this report, reflecting its usage in some of the literature reviewed, to describe virtual technologies and models of care that focus on health and health care delivery rather than maintenance care provided through independent or supported living.

Virtual care refers to a diverse range of technologies that consumers, service providers and organisations may use to support care provided across a continuum from prevention, acute, to maintenance care.

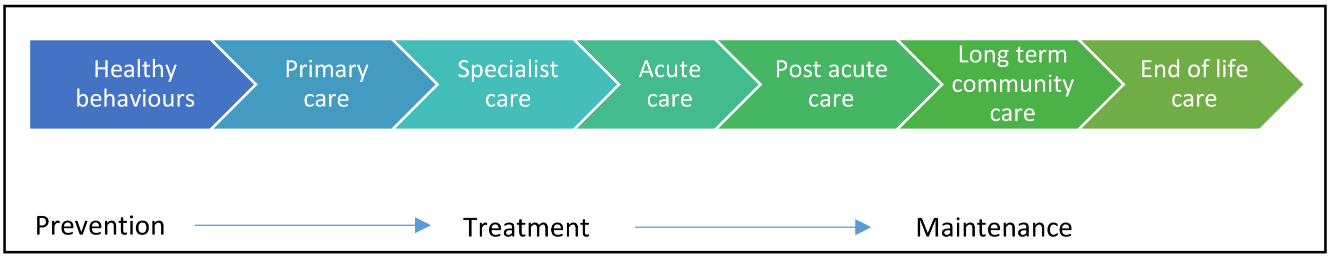
Key concepts

This rapid review presents models of virtual care across a continuum, considers models of care in terms of the level of innovation, or horizons, they represent; and examines how these models support consumer self-care. These conceptual frames are explained in this section.

Continuum of Care

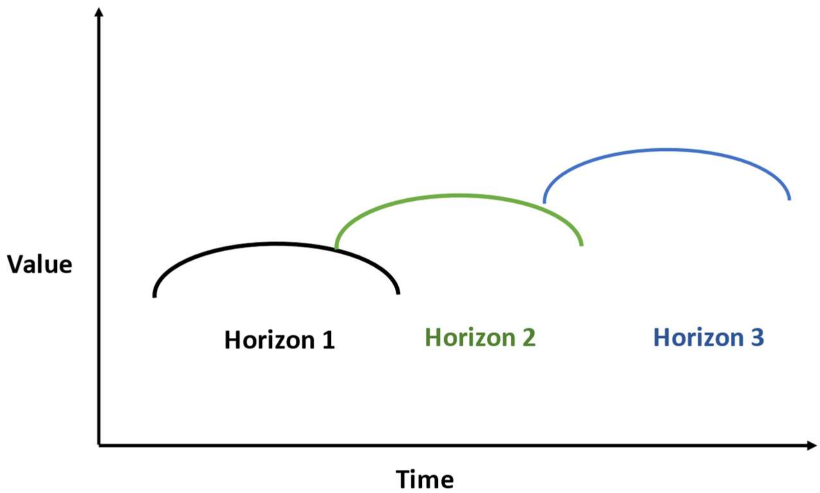
The continuum of care refers to a comprehensive range of health and community services spanning all levels of intensity of care that guides a consumer over their lifetime (Evashwick, 1989). The continuum of care ranges from preventive interventions to address the determinants of health and wellbeing, treatment aimed at addressing acute or managing chronic conditions; and maintenance interventions supporting assisted community living, such as aged care or disability care, and end of life care as shown in Figure 1.

Figure 1: Continuum of care



<u>Horizons</u>
Virtual care can either provide digital substitutes to existing tools, augment or expand existing models of care, or represent new models of care (Australian Healthcare and Hospitals Association, 2020). These three levels of development or growth in virtual care can be represented by three horizons as shown in Figure 2 and 3, a concept originally proposed by Baghia et al (1999).

Figure 2: Three horizons of virtual care



Horizon 1 can be seen as building and consolidating a digital foundation through data sharing through a range of digital technologies that equip care providers with greater decision making power (Australian Digital Health Agency, 2020). This horizon represents improved efficiency and quality of existing models of service provision achieved primarily through technological substitution for existing processes and work practices. Horizon 1 includes traditional and familiar technologies such as:

- Telehealth – the delivery of services, where consumer and providers are separated by distance. This may be by phone, text, email or video link,
- Digital information systems – technologies that support sharing and transmission of personal health and other information, such as eReferrals, eDischarge, ePrescribing and electronic health records (EHR)

Many of the Horizon 1 technologies have existed for years with, for example, the development of early telehealth occurring in the mid twentieth century and becoming more commonplace in the last two decades in specific

Three levels of development in virtual care can be represented by three horizons.

areas such as radiology with transmission of radiological images and in cardiology with paramedics transmitting cardiac rhythms to hospital emergency departments (Baumann & Scales, 2016) . While Horizon 1 technologies can improve consumer experience and outcomes and provide consumers access to some healthcare data, overall they retain a provider control and focus (Rowlands, 2019). The challenge with Horizon 1 technologies is one of implementation and integration with organisational processes and culture, as seen with EHR and telehealth. Horizon 1 technologies are covered extensively in the literature and are not the primary focus of this review. They are, however, important foundational technologies and integral to enabling augmented and new models of virtual care in Horizons 2 and 3.

Horizon 2 describes augmented or expanded models of care that lead to new work practices and approaches. Horizon 2 relies on technologies that can collect and analyse consumer data remotely and include:

Horizon 2 describes augmented or expanded models of care that involve new work practices

- Digital diagnostics and therapeutic technologies used to identify, prevent, manage or treat a condition or improve adherence with interventions. This includes remote monitoring and use of health data to inform prevention and/or interventions across the continuum of care from self-care to acute health care.
- Care navigation technologies that enable consumer access to health information, booking systems, triage systems and assessment and selection of providers.

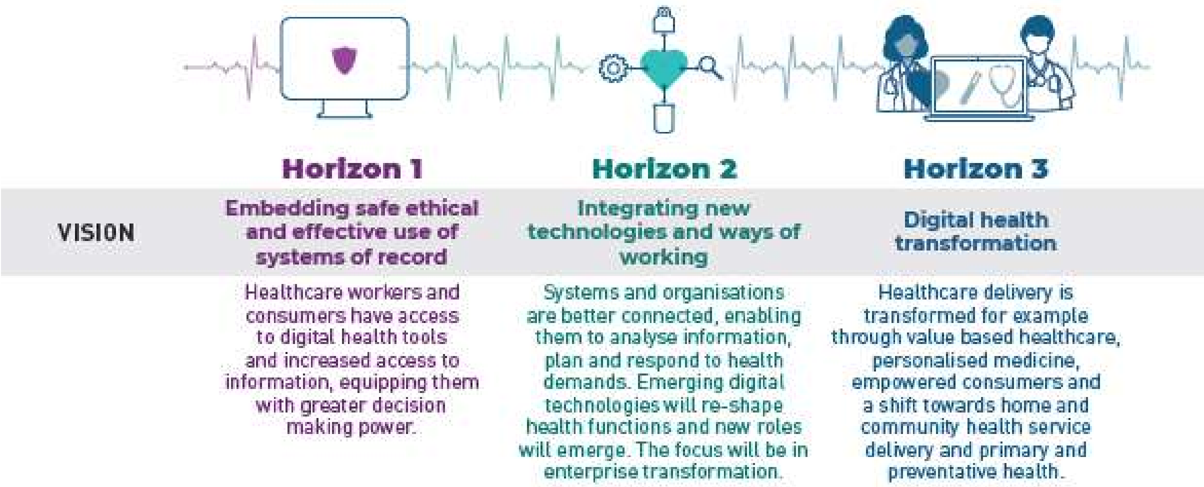
Horizon 2 technologies bring increasing consumer control of healthcare data and access to information, however, the focus remains on the delivery of healthcare services, rather than a broader goal of optimising health and wellbeing.

Horizon 3 depicts a future where the maturing of technologies such as Artificial Intelligence (AI), robotics and cloud-based services is opening up possibilities for new models of virtual care. The rapid evolution of digital technologies means this future cannot be fully described. However, this horizon is likely to be characterised by virtual care models supported by non-traditional or cross sector interoperable technological developments. These will enable the analysis of a comprehensive range of health and other data to create knowledge and provide services across the care continuum, with a particular focus on addressing the social determinants of health. Horizon 3 will facilitate empowered consumers to access preventive and personalised care and services in or near their home (Australian Digital Health Agency, 2020). The focus will be on consumers choosing who can access and analyse their data to provide information and services to promote their health and wellbeing (Rowlands, 2019). Horizon 3 is consumer centric with the preference, needs and choices of consumers being prominent. This transformation in Horizon 3 reflects a policy shift towards person centred care and away from provider controlled care (Productivity Commission, 2017).

Horizon 3 depicts a future where the maturing of technologies such as AI, robotics and cloud-based services is opening up possibilities for new models of virtual care.

The time frames indicate that developing and implementing efficiencies and improvements in existing models of care in Horizon 1 provides the building blocks for augmented and future models of care in Horizon 2 and 3. An example of this is EHR being a basic building block on which many future models of virtual healthcare rest. This horizon model is inevitably a simplification, with the possibility of technologies in all three horizons developing simultaneously (Australian Digital Health Agency, 2020).

Figure 3: Virtual care horizons (Australian Digital Health Agency, 2020 p. 48)



Horizon 2 and 3, emerging expanded or new virtual models of care will use a range of technologies as shown in Box 1

Box 1: Technologies used in virtual care

Technologies used in virtual care include:

- *mHealth* – the use of mobile device (such as Smartphones and tablets) functionality including voice and messaging service, applications, GPS, Bluetooth, internet technology and sensors (Albahri, Zaidan, Albahri, Zaidan, & Alsalem, 2018).
- *Smart wearables* – wearable technologies measuring multiple physiologic and physical parameters in a continuous fashion such as electrocardiogram (ECG), blood pressure (BP), sleep, location and motion monitoring. (Australian Digital Health Agency, 2020; Carreiro, Chai, Carey, Chapman, & Boyer, 2017). These may either be consumer wearables or clinical grade medical wearables that are prescribed (Mirmomeni et al., 2014).
- *Speech recognition and natural language processing*- technologies that can capture and interpret key elements of human speech (Robinson, Cottier, & Kavanagh, 2019).
- *Artificial intelligence (AI)* – the ability to perform tasks using algorithms governed by pattern recognition and self-correction on large amounts of data that provide machines the ability to solve problems that traditionally required human intelligence. AI include fields such as machine learning and deep learning.
- *Interventional and rehabilitative robotics* – the use of robots to assist people with health, social and emotional support, and assistance with activities (Barnett, Livingstone, Margelis, Tomlin, & Young, 2019).
- *Big data* - the integration and analysis of large volumes of digital data from multiple sources that is supported by computing technology.

Self-Care

Virtual technologies can assist individuals to develop relevant knowledge and skills and engage in activities that promote health and wellbeing. The degree to which virtual care models enable consumers to undertake self-care is of particular interest in this review. Self-care refers to the ability of individuals, families and communities to promote their own health, prevent disease and to cope with illness and disability with or without provider support (Nichols et al., 2020).

3. Review aim and questions

This rapid review aims to explore how virtual care can effectively augment or modify existing models of care or contribute to new models of care. The key questions posed in this review are:

1. What new virtual models of care are emerging in Australia and internationally that will improve the health and wellbeing outcomes of consumers and enable consumers to manage their health and wellbeing along the continuum of care?

2. What are the critical implementation factors that must be addressed, at the level of:
   a) Users, which includes both:
   - Consumers in achieving self-care and optimal outcomes, including equity issues for vulnerable populations, including First Nations, CALD, rural and remote populations, and
   - Health and professional workforces in delivering and promoting virtual care models.

   b) Systems supporting the use of virtual care through either creating an authorising environment via governance, policy, funding, regulation or through developing enabling systemwide infrastructure.

4. Method

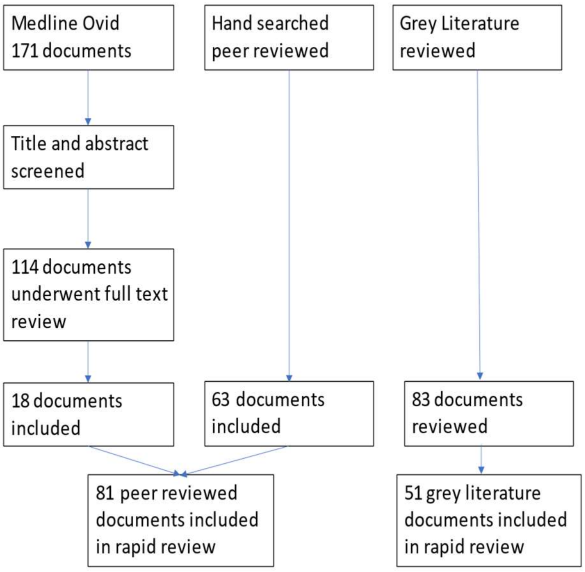
A rapid review of the literature was undertaken in which elements of the systematic review process were simplified to produce information in a short period of time (Tricco et al 2015). In this rapid review a search of MEDLINE OVID electronic database and Google Scholar was undertaken for peer reviewed articles using the terms Telemonitor* or Teleconsultat* or Telecare or eHealth or mHealth or "virtual care" or "virtual health" and innovation or new model. Terms such as "telehealth'' and "web-based'' were excluded in the search terms, as these technologies, which dominate Horizon 1, are captured as foundational elements in literature describing models of virtual care in Horizon 2 and 3. Given the prevalence of non-academic literature in this area, relevant government and organisational websites were also searched for key words (such as digital and virtual) to identify relevant reports, along with Google searches for relevant grey literature (see Figure 4). A snowballing strategy was used to identify other relevant articles in the retrieved articles and reports reference lists. Articles were included if they met the criteria defined in Table 1.

Table 1: Search Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion criteria
Time Period	Peer reviewed and grey literature from 2016 to 2020	
Language	English language	
Place	International	
Aspect of Care	The continuum of care from preventive, community care, primary care, acute care, subacute, mental health aged care and disability sector	End of life care
Type of technology	Telecare - new models of care that include telehealth as part of the combination of technologies used were included Digital diagnostics and therapeutics Virtual care navigation technologies	Digital information systems Articles and reports that have a singular focus on Horizon 1 technologies such as telehealth or web-based models of care.

The rapid review resulted in the inclusion of 81 peer reviewed articles and 51 grey literature documents. The document search and result process is summarised in Figure 3. 18 Peer reviewed documents from the Medline Ovid and 63 from the hand search underwent a full text review and were found to be relevant to the rapid review. 51 grey literature documents were reviewed and found to be relevant from hand searches.

Figure 4: Diagram of included studies



In Summary

This rapid review of Australian and international peer reviewed and grey literature is important in highlighting evolving and new virtual care models that enhance or transform current care delivery. Virtual care, as defined in this report, refers to a diverse range of technologies that consumers, service providers and organisations may use to support care provided across a continuum. Three levels of development in virtual care are described by three horizons representing either digital substitutes to existing tools and practices, augmentation of existing models or new models of care. The review has a focus on the latter two categories.

In order to realise Horizon 2 and 3 virtual care models barriers to development and the spread of innovations must be addressed. The review therefore also seeks to identify critical implementation factors that must be addressed.

The rapid review involved the critical appraisal of 81 peer review and 51 grey literature documents that were obtained through either a search of MEDLINE OVID electronic database or via a snowballing strategy to identify relevant articles and reports referenced in the retrieved literature.

Section 2: Results: Models of Care

5. Models of Care

The findings on augmented (Horizon 2) or new virtual care models (Horizon 3) are presented in this section. Literature identified and reviewed on Horizon 2 describe enhanced models of care found in every area of the care continuum which share key features of involving consumers in self-monitoring, and staff or interactive virtual technologies reviewing data and providing feedback or intervention advice. While the evidence base is strengthening in Horizon 2 and demonstrates the value of augmented models of care, the challenges for users and researchers in comparing and evaluating rapidly evolving technologies and models are evident. New and transformational models of virtual care in Horizon 3 are described in a smaller range of literature found mainly in government and consulting firm reports. Literature reviewed describes new transformational models of care that will emerge as virtual technologies further mature. These models although not fully defined will be characterised by consumer centric virtual care supported by non-traditional or cross sector interoperable technological developments.

This section begins with a discussion of the nature of evidence in this area. Horizon 2 models of virtual care are then presented under each category of the continuum of care, concluding with an exploration of Horizon 3 models.

Cost, location and difficulty accessing appointments are barriers frequently experienced by consumers (Australian Digital Health Agency, 2017). Virtual care provides opportunities to improve the delivery of a wide range of health and community services to consumers. Frequently cited benefits of virtual care for the consumer address common barriers and enhance patient experience and outcomes (Singhal & Carlton, 2019; Taylor et al., 2019) as summarised in Figure 5.

Conclusive evidence of the effectiveness of virtual care models is hard to find, as implementation may be imperfect, technologies may change during implementation and evaluations are often underfunded.

Figure 5: Commonly cited benefits of virtual care

However, conclusive evidence of the effectiveness of digital technologies or virtual care models is hard to find, as implementation may be imperfect, technologies may change during implementation and evaluations are often underfunded (Anglada-Martinez et al., 2015; De Rosis & Nuti, 2018). Many technological options for a given area may exist making comparison difficult (Anglada-Martinez et al., 2015). In addressing challenges of undertaking randomised control trials to demonstrate efficacy of new virtual care approaches, Pletcher et al (2020), describe a platform developed in the US that enables national surveillance of blood pressure from data combined from EHR, self-reported consumer outcomes, mHealth and wearables. This approach, under trial, allows real-world randomised controlled trials to demonstrate and compare the effectiveness of various interventions and could assist in overcoming some of the difficulties in collecting virtual care evidence.

Strong evidence currently exists in Horizon 1 areas such as telehealth and telemedicine, but less in other areas (Maguire et al., 2018). Evidence is at time contradictory or mixed reflecting different contexts and populations (Saner & van der Velde, 2016). Evidence that addresses implementation, scalability and adaptation to technology rather than pilot development of technology is seen as valuable (De Rosis & Nuti, 2018). Yet, evaluations of virtual care often focus on efficacy in controlled trial conditions rather than effectiveness in real life conditions (Bardosh, Murray, Khaemba, Smillie, & Lester, 2017). In addition to evidence of efficacy and effectiveness, information on the economic impact of virtual care models are needed (Taylor et al., 2019).

Virtual models are described in this section and evidence, where available, is provided to give an indication of their potential. However, the evidence does not fully inform the question of what works for whom and in what circumstances. Virtual care models that augment existing models of care are discussed in the following sections under Horizon 2 according to key categories within the continuum of care, prevention, acute care and maintenance.

5.1 Horizon 2: Prevention

Preventive care can involve addressing risk factors (primary prevention), screening for early detection (secondary prevention) and chronic disease or condition management (tertiary prevention) (Froom & Benbassat, 2000). Some virtual care prevention models will cross these categories and, for example, contribute to both screening and disease management. Effective prevention requires consumers to be actively engaged in their care. Virtual care models can provide bottom-up approaches that are person centred and empower consumers to make choices that sustain health and wellbeing (Spanakis et al., 2016). Prominent across the spectrum of the prevention space is mHealth, along with AI supported diagnostic technologies and the rapidly expanding area of virtual chronic disease prevention and management. These three areas are explored in the following sections followed by a discussion of future directions in virtual prevention.

5.1.1 mHealth and Risk Management

Virtual care provides an opportunity to reach populations at a scale not previously possible through past public health campaigns.

Addressing risk factors through primary prevention provides the greatest potential to reduce the burden of disease (Saner & van der Velde, 2016). Virtual care provides an opportunity to reach populations at a scale not previously possible through past public health campaigns. mHealth provides an attractive model for providing prevention due to the widespread adoption of smartphones. This is particularly so for low and middle income countries where public health infrastructure, healthcare funding and systems are under pressure (Beratarrechea et al., 2016).

mHealth preventive care involves using Smartphones and tablets to monitor risk factors such as weight, food, sleep, mood and physical activity; to screen for symptoms such as hypertension, arrhythmias or mental ill-health; and in disease specific apps for management of asthma or diabetes. mHealth preventive models uses a range of health data and embedded or external sensor devices, text and/or app format, with or without provider support. Use can be self-initiated by a consumer or prescribed by a provider. mHealth risk factor management models that incorporate recommendations to promote engagement in preventive community services and activities, such as physical activity, are consistent with calls for incorporating greater social prescribing in healthcare (RACGP and CHF, 2020).

Where apps are well designed they support consumer engagement in effectively self-managing risks or symptoms

The sheer number of health related apps available and rapidly increasing revenue generated from them indicates the demand for this form of virtual care (Hansen & Scheier, 2019). A US survey of healthcare consumers by Deloitte saw a jump in using apps and technology to monitor health and fitness from 17% in 2013 to 42% in 2020 (Betts, Korenda, & Giuliani, 2020). However, their ubiquity, lack of regulation and clarity in relation to their evidence base and the lack of effectiveness evidence provides consumers with overwhelming choice and barriers to making informed decisions, also making it difficult for front line providers to recommend one app above another. For example, few smoking apps have been found to adhere to key guidelines or include recommendation for proven interventions such as medications and counselling, with similar findings for physical activity apps (Spanakis et al., 2016). However, there is good evidence that where apps are well designed they support consumer engagement in effectively self-managing risks or symptoms. The benefits have been demonstrated in a range of mHealth initiatives across the prevention spectrum, including weight loss, physical activity, blood pressure maintenance, medication adherence and management of diabetes, although some reviews have found studies with small samples, and small or variable effect sizes (Chow, Ariyarathna, Islam, Thiagalingam, & Redfern, 2016; Dugas, Gao, & Agarwal, 2020; Gal, May, van Overmeeren, Simons, & Monninkhof, 2018).

Trials of smoking cessation through mHealth have found those receiving texts more likely to quit at 6 months compared to usual care and have led to global adoption of national mHealth smoking prevention programs (Chow et al., 2016; Whittaker, McRobbie, Bullen, Rodgers, & Gu, 2016). A systematic review of mHealth weight management, focusing on diet and physical activity, found a moderate decrease in weight and higher adherence to weight management interventions with mHealth self-monitoring compared to other interventions (Cavero-Redondo et al., 2020). A systematic review of mHealth apps for sedentary time, physical activity and fitness for older adults showed promising but non-statistically significant results, possibly due to small sample sizes (Yerrakalva, Yerrakalva, Hajna, & Griffin, 2019). Two other systematic reviews in this area demonstrate reduced sedentary behaviour and increased physical activity in the short term (Yerrakalva et al., 2019). There are some concerns that the evidence provided by some studies may not adequately include low income or minority groups (Chow et al., 2016). An additional concern is that the length of follow up in studies is often 6 to 12 months whereas engagement with apps may wane after this time (Chow et al., 2016).

Future developments in risk factor management include monitoring technology that can infer data, such as mood changes, through unobtrusive tracking of activity and social interaction (Spanakis et al., 2016). Innovations could include the development of context sensing abilities in tracking applications which would allow the sending of 'right mood, right time, right place feedback' (Spanakis et al., 2016 p. 7), that could be more effective than real time feedback. A review of grants funded for smartphone development in the US between 2014 and 2018 identified proposed innovations in mHealth in: developing AI supported prevention or treatment apps; bionic apps that control wearable or injected devices to compensate for biological limitations, such as vision, speech hearing, limbs; and the most common grant was for gamification apps that employ play to foster learning and skill development (Hansen & Scheier, 2019). These innovations were alongside a range of other apps that address behavioural therapies, education and provider and peer communication platforms (Hansen & Scheier, 2019).

5.1.2 AI and Prevention

Screening is an invaluable secondary prevention measure that leads to early diagnosis and prompt treatment of a disease, illness or injury to prevent more severe problems developing. There are several well-known non-traditional healthcare providers entering the screening space. One of the watch apps that Apple has developed can take electrocardiograms and monitor pulses for irregular heart rhythms with notifications enabling timely intervention. However, there are a number of areas for further research in terms of who might access this technology and the impact of intervention arising from low thresholds of detection or false positives (Wyatt, Poole, Mullan, Kopecky, & Heaton, 2020).

AI can provide powerful screening tools … more research and evidence is needed on the quality of datasets needed and the effectiveness of AI and machine learning in identifying conditions and disease.

AI is showing promise in enabling powerful screening tools. Automated image interpretation is being used, for example, in breast cancer screening and tools that can detect and grade cancer in breast biopsies (Koh, 2019). In a review of AI's potential to be used for early detection of breast cancer, Houssami et al (2019) examined 23 studies using mammograph or ultrasound imaging and found promising diagnostic performance. However, AI systems reviewed were not, in the view of the authors, ready for real world application due to a number of limitations with the data sets used to train the AI algorithms, meaning evidence gaps limited the ability to translate to clinical settings. A similar conclusion was reached in a comparable study regarding the need for bigger datasets to inform AI digital breast pathology assessment (Chang & Mrkonjic, 2020). Comprehensive screening of radiological images requires a multitude of strategies to detect various radiological features and at this stage AI systems are focused on single detection tasks, such as the presence of haemorrhage (Davenport & Kalakota, 2019).

In the future, AI algorithms will be used to process large and complex genomic datasets to develop a risk score, which can be used to predict and respond to people with high future risk of diseases, such as coronary vascular disease calculated after genomic testing of blood (Dias & Torkamani, 2019). Similarly, AI could be used to interrogate large data sets in primary care to identify people at risk of conditions such as arrhythmias (Kornej, Borschel, Benjamin, & Schnabel, 2020). However, more research and evidence is needed on the quality of datasets and the effectiveness of AI and machine learning in identifying risks, conditions and disease.

Box 2: mHealth Cough Diagnosis

mHealth Cough Diagnosis

A mobile application developed by Australian researchers uses artificial intelligence to accurately diagnose common respiratory disorders in children. The mobile app can listen to coughs and, when combined with patient entered symptom information, make diagnoses.

The platform was able to accurately diagnose pneumonia 87 percent and asthma 97 percent of the time which surpasses the diagnosing standards of the World Health Organization. The authors note the algorithm's diagnostic accuracy could be further improved with the additional input of clinical signs, for example respiratory rate or chest recessions.

(Porter et al., 2019)

AI screening tools are being used to detect complications of chronic disease. Devices can autonomously detect mild and early cases of diabetic retinopathy, which can cause vision loss for many people with diabetes. Patients have retinal images uploaded to servers with enough power to run a diagnostic software. When signs of diabetic retinopathy are present, the system recommends a follow-up with an ophthalmologist. If it detects no signs of the condition, the system recommends a follow-up screening in one year (U.S. Food and Drug Administration, 2018). Current iterations are getting better at matching specialist skills and reducing the number of false positives (King, 2019). Predictive models of prognosis have begun to be developed to assist in clinical diagnosis and treatment decisions. Machine learning has been used to predict the progression of diabetic kidney disease in patients with type 2 diabetes with 71% accuracy, and may be helpful in reducing the need for dialysis (Makino et al., 2019).

Several studies found chatbots significantly reduced depressive symptoms in those with major depressive disorders and were able to identify patients with depressive symptoms

AI enabled chatbots are being explored for both early detection and treatment of conditions. Chatbots are automated computer programs that can mimic human-like behaviour and hold conversations with people (Abd-Alrazaq, Rababeh, Alajlani, Bewick, & Househ, 2020; Vaidyam, Wisniewski, Halamka, Kashavan, & Torous, 2019). In the mental health field, AI-enabled chatbot technologies, designed to help consumers deal with anxiety and depression through engaging in intelligent conversations, augment the therapist role. In a review of the diagnosis and treatment of psychiatric disorders, several studies found chatbots significantly reduced depressive symptoms in those with major depressive disorders and were also able to identify patients with depressive symptoms (Vaidyam et al., 2019). While the evidence base needs to be strengthened, chatbots have the potential to improve mental health and be an adjunct to mental health interventions used by professionals (Abd-Alrazaq et al., 2020).

Box 3: Edna the chatbot

> **Edna the chatbot**
>
> Edna (electronic DNA) is a genomics chatbot developed by CSIRO that can help consumers make informed decision about seeking additional testing of a sample for potential gene variants responsible for preventable or treatable conditions. Edna can emulate the flow of a patient counsellor session to provide information, answer questions, collect a history and refer to a genetic counsellor if needed.
>
> (Ireland, Gaff, & Bradford, 2020)

Whilst AI assisted innovations demonstrate great promise across the prevention continuum, there is limited evidence around AI's ability to screen accurately and perform more complex diagnostics, which has limited its uptake by clinicians.

5.1.3 Virtual Care Models for Chronic Disease Management

Virtual delivery of tertiary preventive care to people living with chronic conditions is seen as an area for improved consumer outcomes and significant cost saving. Around 60% of Australians aged 65 plus have more than one chronic condition. Treatment for chronic disease accounts for the majority of expenditure of health, 90% of overall health care costs in the US (Szwartz & Godby, 2020). People with chronic diseases have frequent contact with providers, require care coordination and need to engage in self-management. Due to the focus on self-management in chronic disease, many decisions consumers make about their care occurs outside of the healthcare setting (Greenwood, Gee, Fatkin, & Peeples, 2017). Virtual care can increase access to data, education, advice and intervention in between provider visits.

At its simplest, virtual care can augment existing chronic care models through allowing people with complex and chronic conditions, such as diabetes or cardiovascular disease, to self-monitor or be monitored remotely. This type of monitoring can be combined with active follow up by clinicians, with advice, prescriptions or referrals, and can enhance communication between provider and consumer.

In a common augmented virtual care model, consumers self-monitor and tablet record, while staff review data and follow up, as in the case of a Danish Chronic Obstructive Pulmonary Disease (COPD) program (Collins, 2020). These models involve ongoing feedback loops with data collected being analysed using the evidence base, and then feedback is provided (Gee, Greenwood, Paterniti, Ward, & Miller, 2015). These types of virtual care models see consumers take responsibility for data collection roles previously undertaken by providers, while providers become health coaches. Variations of this model either remove the need for manual data entry for the consumer and/or clinician interpretation, as in the case of the artificial pancreas that monitors glucose and then provides the appropriate dose of insulin, all controlled by a smartphone (Singhal & Carlton, 2019). Another variation involves intelligent assistants that use natural spoken dialogue over the phone or device to conduct check-ups to collect relevant information (Spanakis et al., 2016).

virtual care chronic disease models see consumers take responsibility for data collection roles previously undertaken by providers, while providers (or virtual assistants) become health coaches.

Box 4: Sugarpod for diabetes management

Sugarpod for diabetes management
The company Wellpepper have developed a voice-enabled Type 2 diabetes support platform. Comprising a scale, foot scanner, and mobile interface working with Amazon Alexa voice functionality. The user steps on the scale in the morning which takes their weight and also pictures of their feet. The images are then analysed through machine-learning to identify any problems. Sugarpod asks the user questions about their habits and provides diabetes management tips, relevant educational material, and messages from their healthcare professional.
(Kataria & Ravindran, 2018; White, 2020)

A systematic review of the effectiveness of mHealth in the management of chronic diseases, such as diabetes and cardiovascular disease, found 6 of 9 studies reported a statistically significant difference in the primary clinical outcome of interest using apps, with or without clinician input and feedback (2016). While this review was unable to separate out the effect of the app alone, the evidence indicates the potential for mHealth in improving symptom management. In a review of the literature on mHealth efficacy in chronic disease, Scott et al (2020), found convincing evidence for diabetes apps, but conflicting evidence for other disease apps. Greenwood et al (2017), in a systematic review of reviews evaluating diabetes self-management through technology, found a significant reduction in HbA1C compared to interventions without technology. The most effective interventions where characterised by communication between provider and consumer, transmission of consumer healthcare data, tailoring of education and individualised feedback occurring regularly over time.

A qualitative analysis of an mHealth app for medication adherence and engagement was found to empower consumers through the ability to receive immediate feedback on questions and problems, and facilitate greater access to care (Bardosh et al., 2017). The authors also found a secondary effect in staff reporting improved motivation and satisfaction through the positive patient engagement with technology. A systematic review of the efficacy in mHealth, via SMS, in improving adherence to medication found 65% of the 20 studies reviewed had positive outcomes, although the study was not able to make comparison as the studies differed in methods used (Anglada-Martinez et al., 2015).

Virtual technologies can also enable improved communication and health record sharing between a consumer with a chronic disease and their providers, as in the case of the UK Patient Knows Best app (Collins, 2020). With this app, controlled by the consumers, individuals can access their clinical notes, send messages to their healthcare team, track symptoms and edit care plans. Programs such as these facilitate team working between consumers and providers and can be extended to a large range of providers and carers.

Virtual chronic disease care models enable a shift towards consumer focussed and controlled self-care approaches. The evidence supporting these virtual care models is stronger in some areas of chronic disease, such as diabetes, and in aspects of care, such as medication management. Evidence of the benefits of virtual care in managing a broader range of diseases is needed.

5.1.4 The future of virtual prevention

Future developments in virtual care in augmenting existing preventive chronic disease models are emerging. Games and virtual reality are being used in tertiary prevention, for example in chronic pain management, as they have motivational qualities that encourage repetitive cognitive or physical training and learning (Vugts, Zedlitz, Joosen, & Vrijhoef, 2020). Games are not only fun but have features that inform, instruct and modify behaviour (Vugts et al., 2020). The effectiveness of games have been shown to vary with their design and duration, and consumer gender, age, intelligence and gaming experience (Vugts et al., 2020). Kollins et al (2020) report on a digital therapeutic in the form of a tablet-based game software to reduce the severity of Attention Deficit Hyperactivity Disorder symptoms. The software, which can tailor the gaming tasks to consumer performance, was found to significantly improve the attention of users and provides a possible alternative to those unable to access non-pharmaceutical interventions. While gamification has the potential to better facilitate patient self-management, further evidence of effectiveness is needed (Miller, Cafazzo, & Seto, 2016).

Devices are beginning to emerge in areas of dementia, autism, schizophrenia and alcoholism. These can capture brain signals and decode thoughts and emotions, such as movement intentions and excitement or frustration, which can be used in disease prognosis, condition monitoring and even neurofeedback (Spanakis et al., 2016). Technologies are also being researched which would deliver personalised brain stimulation to treat Parkinson disease or mood disorders (Kataria & Ravindran, 2018).

In summary Horizon 2: Prevention

- mHealth, particularly Apps, currently dominate the prevention space. However, the ubiquity of Apps, lack of regulation and clarity in relation to their evidence base, and lack of evidence of effectiveness, provides consumers and providers with overwhelming choice and barriers to making informed decisions about which App to use or recommend.
- Good evidence exists that well designed apps and text messaging interventions support consumer engagement in effectively self-managing risks or symptoms. However, the length of follow up in studies is often 6 to 12 months, whereas engagement with apps may wane after this time.
- Sophisticated mobile virtual screening technologies exist (e.g. Apple watch) but little is known about who accesses these technologies and the impact of low thresholds of detection or false positives.
- AI shows promise in providing powerful screening tools to assist clinicians, however more research and evidence is needed on the quality of datasets and the effectiveness of AI and machine learning in identifying conditions and disease.
- A common augmented virtual care model involves consumer self-monitoring, and staff or interactive virtual technologies reviewing data and following up. Evidence is stronger in areas such as diabetes and in aspects of care such as medication management.

5.2 Horizon 2: Acute Care

In this section models of acute care that are enhanced through virtual care are presented in three categories: virtual hospitals, triage and rehabilitation.

5.2.1 Virtual Hospitals

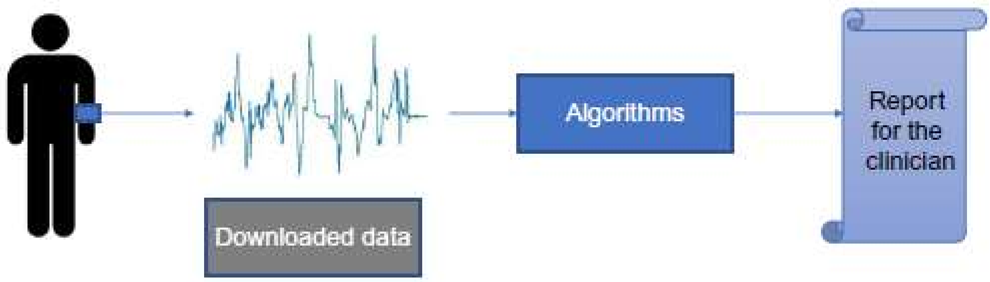
Virtual hospitals can reduce demand for bed based services and increase access for those in rural and remote locations … as well as reducing risk of infection and costs for inpatient care

Virtual care can enable many hospital-based interventions to move closer to the home either in ambulatory care settings or home based care, with a narrower scope of specialised care being provided in hospital settings. Trauma centres and intensive care units, along with complex surgery, may still occur in conventional settings, although new virtual care models are emerging (see discussion of eICU in Horizon 3). Care that mainly involves the exchange of information will become more distributed (Dentzer, 2019). In this way, virtual hospitals can reduce demand for bed based services and increase access for those in rural and remote locations (Moore et al., 2020). This approach delivers clear benefits for the consumer in terms of accessibility and convenience, as well as reducing risk of infection and costs for inpatient care.

Virtual hospitals can provide hospital level care in the community to those at risk of admission or readmission, including frail elderly and people with chronic and complex conditions, such as heart failure, stroke, diabetes, chronic obstructive pulmonary disorder and cancer (Moore et al., 2020). Genomics-based treatments, such as those for cancers, which primarily involve infusion and observation, could also move into or close to home (Singhal & Carlton, 2019).

Virtual hospital care can be delivered with or without a face-to-face component and models involve telehealth and/or telemonitoring via a range of modalities. The Kaiser Permanente system in the US provides care to 1 in every 30 Americans and conducts 50% of its patient encounters virtually by phone, email or video (Dentzer, 2019). A virtual care centre in the New England area of New South Wales continuously tracks an individual's heart rate, temperature, oxygen saturation and blood pressure through a band worn by patients and feeds the information back to doctors and nurses (see Figure 6). If a patient deteriorates, a health professional, supported by artificial intelligence, can decide to either continue treatment at home or move the person to hospital (Department of Health, 2020).

Figure 6: Wearable sensor data analysed by algorithms (Mirmomeni et al., 2014a p. 340; 2014b)



A recent evidence scan of virtual hospital literature found these interventions were similar or significantly better in reducing hospitalisations, readmissions, emergency department visits and length of stay (Moore et al., 2020). The review also found remote telemonitoring appears to have had a significant impact on all-cause related mortality and heart failure related mortality, suggesting it should be routinely included in all virtual hospital interventions. The authors point out the review findings should be interpreted with caution as the studies varied in key aspects such as population, samples size, interventions, and outcomes measures, however the review indicates the promise of digital technologies in supporting this new model of care.

Box 5: Virtual hospital characteristics

Virtual hospital characteristics:

- Risk identification and stratification of patients
- Need assessment and care planning
- Transition to community-based services on discharge
- Care provided through a combination of face to face, telephone, remote monitoring and other technologies
- In home diagnostic test, treatments, medication and equipment
- Integrated team care including a range of staff and social services
- Active monitoring of patient progress provided during and after hours
- Use of post discharge self-monitoring and devices.

(Moore, Du Toit, Jameson, Liu, & Harris, 2020)

5.2.2 Triage

Emergency patients can be at risk under conventional approaches due to delayed triage. As part of reducing the burden on hospitals, technologies have been developed to triage patients according to severity and prioritise access to services. This can occur in the form of triage advice provided directly to a patient to inform decisions about whether to attend a health service in person. A recent example of this type of consumer triage advice is a UK website hosted AI chatbot that undertakes symptom and risk factor scoring for COVID-19, then directs patients to the appropriate services or identifies where human intervention and expertise are needed (Lai et al., 2020). A systematic review of general and condition specific symptom checkers and online triaging tools found evidence to support these tools are weak, with low levels of accuracy in relation to the diagnosis of specific conditions (Chambers et al., 2019). In applying this type of model to urgent care triaging, the authors suggest the technology could result in increasing advice to access emergency care.

Triage occurring within health services comes in the form of clinical support tools enabling clinicians to determine clinical priority. In a review of emergency clinical decision support systems powered by machine learning, clinicians were provided with a triage category and prediction of need for critical care. They found improved clinician decision making, which lead to better patient outcomes, including reduced length of hospitalisation and mortality (Fernandes et al., 2020). There is increasing interest in AI powered triage tools that could interpret data from patient files or referrals to triage patients for surgery. For example, predictive analytics using big data sets and AI can be used to identify risk and prognosis for renal transplants based on consumer profiles. A review of literature on AI in augmenting the management of renal failure with dialysis and renal transplants found AI supported clinical decision making has an impact on the quality of life and survival of end stage renal disease, and predicted dialysis adverse events better than nephrologists (Burlacu et al., 2020). Myers et al (2020) outline a future in orthopaedics where AI could be used in knee replacement surgery to interpret radiological images, pain, loss of function and clinical decision making. Virtual assistants could be used to respond to voice commands to graph a trend in a pathology tests or book an appointment.

While these developments are encouraging, further research needs to be undertaken to improve the accuracy and build the evidence base for both online and clinical support digital triage technologies.

5.2.3 Rehabilitation

Virtual care has the capacity to minimise costs, maximise access and the amount of time spent in rehabilitation activities (Jones et al., 2020). A range of technologies can be used to combine data from sensors to support home based rehabilitation in between face-to-face provider visits through:

Virtual care has the capacity to minimise costs, maximise access and the amount of time spent in rehabilitation activities.

- Prescribing interventions/instructions to the patient and caregiver
- Gathering timely data on patient status instead of relying on imprecise recall during clinic visits
- Presenting data to the patient and clinician in a timely manner
- Updating prescribed in-home therapy and recommendations (Jones et al., 2020)

AI combined with sensors or remote monitoring transmitted via a smart phone have been used, for example, in rehabilitation after knee replacement to measure mobility, pain killer useage, range of motion, home exercise compliance and experience of pain (Ramkumar et al., 2019).

Virtual reality has shown promise in stroke rehabilitation. Virtual reality platforms can improve movement patterns above and beyond conventional physical therapy by providing feedback that can improve a person's sense of position in space, reinforce movement and reduce unnecessary movements (Aminov, Rogers, Middleton, Caeyenberghs, & Wilson, 2018). A key challenge in virtual rehabilitation care models is the level of impairment experienced by some rehabilitation consumers which can restrict their use of digital technology (Brouns et al., 2018).

In summary Horizon 2: Acute care

- Virtual hospitals can reduce demand for bed based services, increase access for those in rural and remote locations, reduce risk of infection and costs for inpatient care.
- Evidence of virtual hospital interventions reducing hospitalisations, readmissions, emergency department visits and length of stay or making no significant difference compared to usual care.
- Remote telemonitoring appears to have had a significant impact on all-cause related mortality and heart failure related mortality, suggesting it should be routinely included in all virtual hospital interventions.
- Evidence indicates promise of virtual triage, however, further research needs to be undertaken to improve the accuracy of digital triage technologies.
- Growing evidence of the application of virtual care in rehabilitation, however individual impairments can prove a barrier to use.

5.3 Horizon 2: Maintenance

Maintenance involves a range of services to assist people to live independently in the community. This may be for older adults who require services to enable them to age in place in their home or, if they require assisted living, in residential aged care settings. People with disabilities can similarly be supported to live at home or in assisted living settings.

5.3.1 Aged care

A number of pressures exist in the aged care sector, including increasing demand due to the ageing population, sector reform, workforce shortages, reduced informal carer support, increased rates of chronic disease and increasing consumer expectations for autonomy (Doyle & Mabbott, 2019; Liu et al., 2019). There is a growing focus on providing support for older adults to live independently in their home as they grow older. These pressures mean opportunities to innovate and adopt new technologies are increasingly being explored.

Wearables connected to AI can analyse activities of daily living such as eating, walking, sleeping and toileting to predict declines in health or functional status.

A range of technologies exist that can assist older people including voice activated technologies, wearable sensor devices for remote monitoring and implantable or injectable sensors that can deliver personalised treatment.

These technologies can:

- Improve assessment, monitoring and diagnosis
- Promote independent living
- Improve medication management
- Increase social connection
- Prevent falls
- Manage chronic disease
- Support those with cognitive issues
- Support family and carers (Barnett, Livingstone, Margelis, Tomlins, & Young, 2019).

Technology enabled assessment of older people has the potential to more accurately record the status of individuals in areas such as strength and mobility. For example, a variety of technologies have been applied to enable a digital version of the timed up and go test, a test of mobility in older people traditionally undertaken by a clinician with a stopwatch (Barnett, Livingstone, Margelis, Tomlins, & Young, 2019). Technology, such as Smart phones, can monitor and log a person's daily activities with data on mobility, travel and sedentary activity, providing opportunities for diagnosis, education and promotion of self- management (Canally, Doherty, Doran, & Goubran, 2015). The application of AI at the point of sensing turns wearables into thinkables that can analyse real time data (Mirmomeni et al., 2014). Thinkables can analyse activities of daily living, such as eating, walking, sleeping and toileting, to predict declines in health or functional status (Kataria & Ravindran, 2018). Preventive sensors, using information on activity levels and movement patterns, can predict and alert the user to an increased risk of falls, or even correct detected imbalance (Barnett, et al., 2019). Digital sensors can be used to detect falls via non-intrusive technology (motion sensors, smart floor, carpet or bed) or wearable detectors (in shoes or walking sticks) and automatically trigger assistance (Barnett, et al., 2019). This information, along with consumer history, preferences and goals, can be used by a provider to design personalised interventions or identify those in need of intervention (Canally et al., 2015).

Smart homes use a range of digital sensors to acquire information from the home and residents, linked to devices that can react to make everyday living easier and safer for people (Barnett et al., 2020; Marikyan, Papagiannidis, & Alamanos, 2019). Many review papers have been published examining different aspects of smart homes. The spectrum of smart home technology sophistication used in these reviews varies and includes those designed to deliver health benefits, environmental benefits, comfort through automation, social connection and various types of support for daily living (Marikyan et al., 2019). Smart home technologies, such as monitoring, security and energy efficiency, can be combined with machine learning and artificial intelligence to increase the sophistication and personalisation of services provided. A systematic review of the effect of smart homes, using telemonitoring on older adults with chronic conditions found an effect on physical functioning and depression, but no impact on reduced hospitalisations (Liu et al., 2019). The authors conclude that the evidence base is low in this area and Smart home technologies need further development to be useful for virtual care.

Figure 7: Smart home (Source; https://olayshowerdiscount.blogspot.com/2007/06/iot-diy-smart-home-automation-security.html)

Voice activated technology reduces the requirement for high levels of digital literacy, vision, dexterity or memory (Barnett, et al., 2019). Voice activated virtual assistants can assist people with early stage dementia and set reminders for daily tasks, such as meal preparation and medicine reminders (Barnett, et al., 2019). Robots with visual sensors and natural language programming can respond to simple request to find objects (Allaban, Wang, & Padır, 2020). The next frontier with these robots is to link to other devices in a smart home environment in order to undertake more complex tasks (Allaban et al., 2020).

Technologies to increase social connectedness include telecare, general information communication technologies (ICT), such as the internet and mobile related online programs, and robotics. While ICT appear to be effective, they require a degree of digital literacy. An alternative is social robots which are artificial agents embodied with the features of a human or an animal (Pu, Moyle, Jones, & Todorovic, 2019). Robots have been developed in the UK to interact, patrol homes, decipher voices and expressions to determine how aged care residents are feeling (Kataria & Ravindran, 2018). A systematic review of randomized controlled trials examining the effect of social robots, mainly in long term care facilities, found non-statistically significant improvements in agitation and anxiety, and concluded they have the potential to improve older adults wellbeing, but better quality evidence is required (Pu et al., 2019). With additional development and sensors to monitor vital signs, robots will be able to detect signs of illness and alert staff. Similar virtual models that do not require digital literacy can be found in chatbots which are being developed and may increase social connectedness for older people, as well as those with chronic conditions (see Box 6).

Box 6: Harlie the chatbot

Harlie the chatbot [1]
CSIRO have developed a smartphone chatbot app for at-home social and communication therapy for those with neurological diseases, autism and other conditions affecting speech, language and communication. The 'Harlie' app, like Apple's Siri or the Google Assistant, uses AI technology and natural language processing algorithms to chat with humans. In addition, the app can provide therapy, education and virtual companionship for those who have special needs, are afflicted with a health condition or just lonely. Harlie can ask insightful questions of the user, and can interpret and appropriately respond to declarative and exclamatory statements.

The literature also touches on technologies that can assist a carer to support an older person, either through remote monitoring or communication technologies that reduce the time and energy required to provide support. Technologies include medication reminders, safety and security related technologies, devices supporting memory and orientation, and those for social interaction. A review of these technologies in dementia care found that carers would generally recommend their use and found the security and safety devices the most useful, but little evidence was found of a reduction in the burden of care or improved wellbeing of carers (Sriram, Jenkinson, & Peters, 2019). This may be that assistive technologies are not currently targeting the areas of greatest need, for example, in dementia care this is repetitive questions, getting lost, aggression, incontinence and assistance with activities of daily living (Sriram et al., 2019). The burden of caregiving has been identified as being a barrier to adopting new technologies along with fears that these technologies may, in fact, increase their workload (Barnett, et al., 2019).

Despite the potential benefits, the adoption of smart home technology and virtual care in the aged care sector is low and there is a need for greater understanding of the needs of users, plus a stronger evidence base (Doyle & Mabbott, 2019; Marikyan et al., 2019).

5.3.2 Disability care

Technology has the ability to make possible activities that people with disabilities are normally unable to undertake and remove traditional barriers to accessing care, services and engaging in social and work activities that improve quality of life (Manzoor & Vimarlund, 2018). Simple technology has been used for decades in the disability field to augment care, for example mobility and communication devices. Many virtual care models discussed in previous sections, such as models using mHealth, chatbots and smart homes, will be useful to people with disabilities in building virtual disability care models.

One of the main challenges in using virtual care, for people with communication disabilities, is interacting with digital interfaces. People with disabilities still encounter access issues with basic digital technologies, such as information on websites (Raja, 2016). Simple activities that were once easy can be harder when made virtual for disabled people. For example, turning up a thermostat may require interaction with a digital interface. There is a need to provide a range of access options to ensure people with disabilities can communicate and receive information in a format of their choice, for example, speech to text and vice versa for those with vision impairment, text for those with hearing impairment and voice recognition for those with mobility impairment (Raja, 2016). While technologies are available to assist communication, the cultural, legal, regulatory and policy environment is particularly important in ensuring that people with disabilities have access to adaptions such as these to benefit from virtual care models made available to the general population (Manzoor & Vimarlund, 2018).

Latest advancements in assistive devices include a smart glove that can translate sign language to digital text, an eye mask system that allows people to communicate with only eye movement, and robotic limbs (Disability Experts of Florida, 2020). The development of smart appliances that can be controlled remotely via, for example, a smartphone, will assist people to use everyday items (The future of things). The future also includes devices such as cars for the blind and driverless cars, which would allow people with a range of physical and mental disabilities to access safe, independent transport (Disability Experts of Florida, 2020). The key point is that effective use of virtual care by people with disabilities is reliant upon a person centred approach, tailored to individual abilities, needs and level of language comprehension, and taking into account the context within which they will be used (Oudshoorn, Frielink, Nijs, & Embregts, 2020).

Existing literature on technology use by disabled people has a focus on those with physical disabilities or health conditions, with much less research on those with intellectual disabilities (Werner & Shpigelman, 2019). Evidence needs to be generated on accessible models of virtual care that are inclusive of a range of disabilities.

In summary Horizon 2: Maintenance

- A range of remote sensor technologies combined with AI locally or in the cloud, exist to predict declines in health or functional status in older people, and identify those in need of intervention by combining with consumer history, preferences and goals, to be used by a provider to design personalised interventions.
- Smart homes show promise in providing predictive and responsive living environments, however, despite growing interest in this area the evidence base is low reflecting the vast range of Smart home applications examined in the literature.
- Devices with low/no digital literacy requirements, such as social robots, have the potential to improve older adult wellbeing, but better quality evidence is required.
- Technologies to assist carers with medication, security and orientation, have been shown to be well received by carers in the dementia area, however, little evidence was found to reduce the burden of care or increase the wellbeing of carers, possibly reflecting the need to target areas of greatest need, such as assistance with activities of daily living.
- Effective use of virtual care by people with disabilities is reliant upon a person-centred approach tailored to individual abilities, needs and level of language comprehension.
- Evidence needs to be generated on accessible models of virtual care that are inclusive of a range of disabilities, including intellectual disabilities.

5.4 Horizon 3

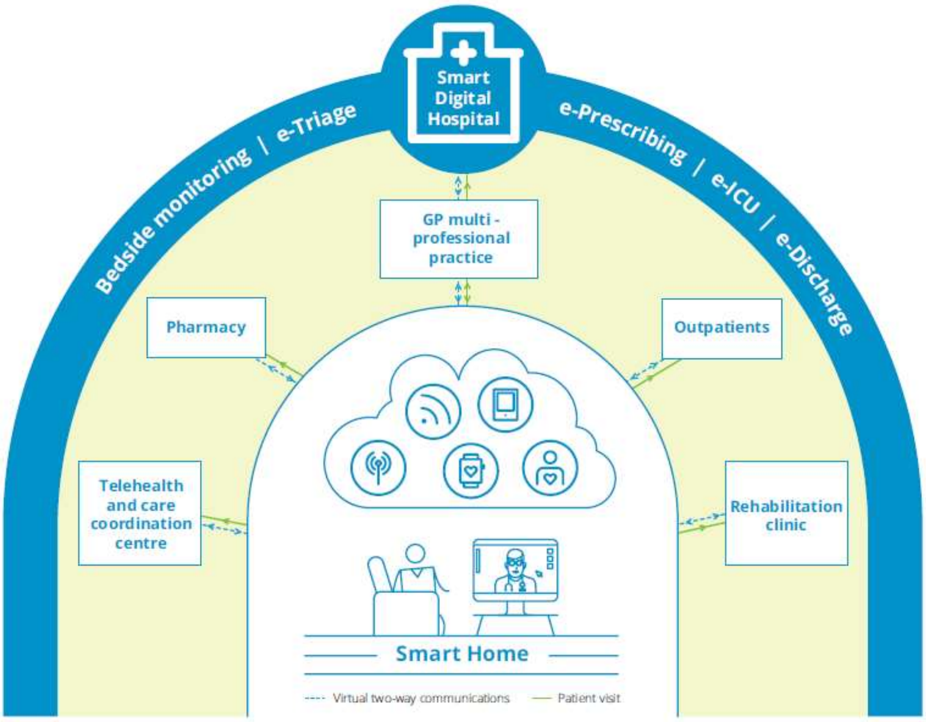
The maturing and further development of technologies such as AI, robotics and cloud-based services is opening up possibilities for new models of virtual care. Although these models cannot be fully described, due to the evolving nature of the digital technologies upon which they will be based, a vision for and key features of Horizon 3 virtual care models are presented in this section.

A combination of new technologies will enable care to be delivered closer to the consumer at a time, in a format and location of their choice.

The future is seen as one in which a combination of new technologies will enable care to be delivered closer to the consumer at a time, in a format and location of their choice (Alam et al., 2019; Dentzer, 2019). When a consumer has a health problem the interaction is likely to be digitally led through the primary care sector (Taylor et al., 2019). At the primary care level consumers will provide information via sensors to providers prior to the virtual appointment. This data, incorporated with medical history gained from virtual assistants, will be analysed to suggest a diagnosis and management to the providers (Accenture Consulting, 2015). Ongoing care will be provided via personalised virtual self-management programs.

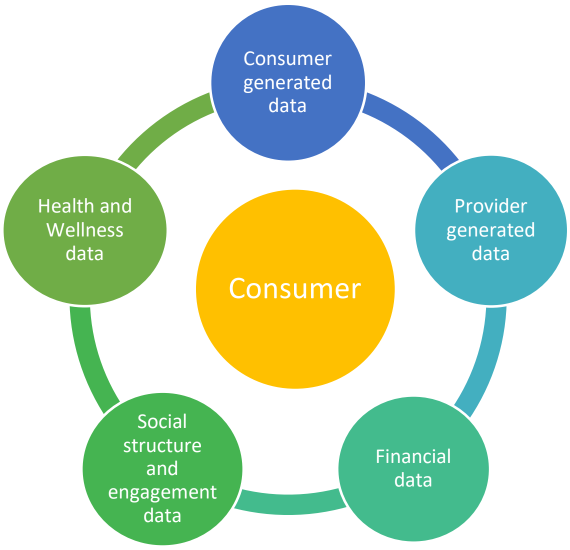
Consumers will visit GPs, specialists and hospitals less often, as shown in Figure 8 (Moore et al., 2020). There will be a transition from emergency hospital care to local urgent care centres, and hospital based procedures being performed in ambulatory care settings (Singhal & Carlton, 2019). Consumers will be empowered to take more control of their own wellbeing, with a greater focus on prevention and self-care through a range of technologies that allow remote monitoring and communication with providers (Barnett, et al., 2019; Imison et al., 2016). When a consumer does require specialised care that care will be personalised based on individual data to maximise outcomes (World Economic Forum, 2016).

Figure 8: Future healthcare experience (Taylor et al., 2019 p. 41)



The realisation of this virtual care future involves analysing large datasets to enable intuitive and personalised virtual care ecosystems. These ecosystems will be created through artificial intelligence assimilating and analysing data from a range of sources (see Figure 9) to create personalised, primary and participatory models of care (Singhal & Carlton, 2019). Knowledge derived from analysing various data sources will be used to recruit personalised preventive, diagnostic and therapeutic interventions drawing from a broad range of medical and social providers, and caregivers (Singhal & Carlton, 2019).

Figure 9: Future digital ecosystem (modified from Singhal & Carlton, 2019)



The Internet of things (IoT) refers to everyday devices and tools that connect to the internet, from an automated light switch to a driverless car, and are commonly referred to as smart devices (Dash, 2020). AI and IoT have been compared to the brain and the human body. The body's sensory nerves collect sensory data for brain interpretation just as the IoT collects data that AI systems interpret to understand clinical or care scenarios (Myers et al., 2020). Companies such as Apple and Google are converging devices such as watches, glasses, cars and homes through IoT platforms, which remove physical boundaries and enables, for example, the control of the home environment from a car (Marikyan et al., 2019). These connected devices are 'able to generate, collect, analyse or transmit data or images, and can connect to health care provider networks and transmit data to either a cloud repository or internal servers" (Ronte et, al, 2018 p.47). In the medical realm the IoT is already seeing application in connecting and analysing complex data to inform patient management (see Box 7).

Box 7: eICU

eICU
The Philips eICU program is an example where a hub and spoke model puts an intensive care team in a central monitoring facility where they can be responsible for monitoring real time data with the assistance of predictive analytics from 50–500 remote ICU beds and advising local staff on appropriate care.
(Dash, 2020; Philips, 2019).

A McKinsey review of digital transformation anticipates a combination of technologies such as remote monitoring, robotics, AI and drone deliveries independently addressing diagnostic and treatment needs without clinician input (Singhal & Carlton, 2019). Within this vision lies potential disruption of wholesale and retail distribution of medical devices and pharmaceuticals.

Box 8: Imagining the future

Imagining the future
The future may involve a consumer with a health condition who will be remotely monitored, alerted in the event of an issue with their heart, a driverless medical vehicle will be dispatched fitted out with a range of devices and sensors to further assess the heart.
(Dentzer, 2019)

As clinical care is responsible for a minority of overall health outcomes with the rest being explained by social determinants, virtual care will move beyond health and community care services (Singhal & Carlton, 2019). The future is in enabling agents to act on social and environmental determinants. Bringing together and analsying data from a range of different data sources allows the inference of new knowledge (Spanakis et al., 2016). This data can be linked at an individual level to inform an understanding of environmental and social factors that influence health related behaviours such as physical activity, smoking, alcohol consumption, weight and sleep (De Lecuona & Villalobos-Quesada, 2018; Saner & van der Velde, 2016; Szwartz & Godby, 2020). This information can be used to target upstream interventions to prevent the development of chronic conditions.

Box 9: Air Louisville Project

The AIR Louisville Project

The AIR Louisville project in the US is an example of a cross sector initiative aimed at primary and secondary prevention that relied on simple technology underpinned by cross sectoral data sharing and analysis. The project recruited asthma sufferers and gave them an electronic inhaler sensor that fitted onto their inhaler and passively monitored the use of inhaled medications along with time and location and sent this via a smartphone to a central server. The use of the smartphone application promoted self-management through providing information about asthma control and adherence, potential environmental triggers and education. This data led to a 78 percent reduction in rescue inhaler use and a 48 percent improvement in symptom-free days for participants. This asthma data was linked to weather and air quality data. This combined data was able to identify environmental factors leading to asthma hotspots and inform air quality initiatives such as tree planting and emission reduction.

(Barrett, Combs, Su, Henderson, & Tuffli, 2018).

Horizon 3 could see significant disruption of the healthcare sector through new models of care emerging from new stakeholders, such as telecommunications, insurers, finance, technology and retail industries (Singhal & Carlton, 2019). As healthcare spending represents a large slice of most national economies, this provides a compelling reason for non-traditional players to enter virtual care particularly at a time when traditional retail opportunities face increasing competition from online stores (Deloitte, 2018). Virtual care requires an in-depth knowledge of technology combined with quality service delivery for which the retail and commercial service sector is well suited. Healthcare has already seen the emergence of new players from outside the traditional health sector with Samsung, Google and Apple as just a few examples (World Economic Forum, 2016) and this trend is likely to continue as highlighted in Box 10 and 11.

Horizon 3 could see significant disruption of the healthcare sector through new models of care emerging from new stakeholders.

Box 10: Ping An Good Doctor

Ping An Good Doctor

Ping An is China’s biggest insurer and is investing large resources in developing health related technology to develop a comprehensive health ecosystem. Ping An Good Doctor is the largest telemedicine platform in the world with over 300 million users. The platform has an automated triage system which gives an initial diagnosis and indicates if a person should seek consultation with a specialist. The platform can link to a specialist and dispense and organise the delivery of medication. Health sensors monitoring, for example, pulse, blood pressure and blood glucose are linked to the Good doctor app which can then through AI assisted analysis provide personalised health management.

(Ping An Insurance (Group) Company of China, 2020)

Box 11: Best Buy Healthcare

Best Buy Healthcare

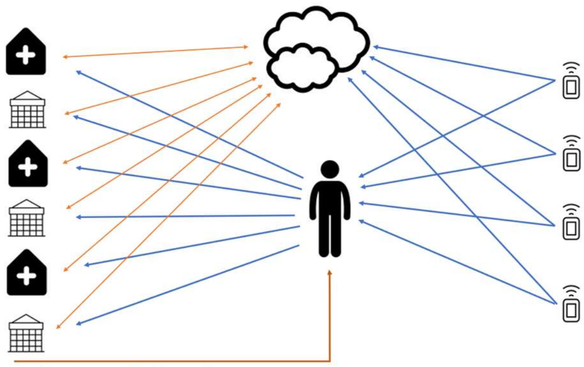
Best Buy., Inc. is an American multinational consumer electronics retailer that has identified virtual care as a key part of its growth strategy. The company has shifted its focus to technology enabled senior care and smart homes through the acquisition of a number of digital health related businesses as it recognises the revenue that can be generated from care for older people.

The company want to be seen as the ‘’chief technology officer for your home" for everything from fixing faulty WiFi systems to sending alerts if an older person hasn't opened their refrigerator recently and is therefore not eating sufficiently.

(Wahba,2020)

Horizon 3 virtual care models are characterised by the use of a broad range of consumer, care provider and non-care provider generated data stored in the cloud and analysed with AI to deliver a comprehensive range of personalised and preventive consumer centric services and information (see Figure 10).

Figure 10: Horizon 3 Virtual Care



However, innovations in virtual care have often been slow to be adopted. The future of personalised and connected care in Horizon 3 is dependent upon innovation and adoption of connected devices at scale (Ronte, Taylor, & Haughey, 2018). The factors that contribute to virtual care implementation and dissemination at scale are discussed in the next section.

In summary: Horizon 3

- Horizon 3 will see a combination of new technologies enabling care to be delivered closer to the consumer at a time, in a format and location of their choice.
- Virtual care ecosystems that use a broad range of consumer, care provider and non-care provider generated data from connected devices stored in the cloud and analysed with AI will deliver a comprehensive range of personalised and preventive consumer centric services and information.
- Virtual care will move beyond health and community care to see a broad range of agents acting on social and environmental determinants.
- Significant disruption will occur through the emergence of new stakeholders in health markets who will increasingly engage and invest in virtual models of care.
- Realising this future is dependent upon innovation and adoption of connected devices at scale.

Section 3: Results: Implementation Factors

6 Implementation factors

Health does not lack innovation, the issue always is in scalability, and execution in a fragmented system (Australian Digital Health Agency, 2017 p. 38)

The potential for exponential growth in virtual care exists, replicating similar growth in other industries, such as online retail platforms and home and ride sharing services (Singhal & Carlton, 2019). Despite a rapid increase in the number of new technologies available, the scope of digital change in health and care services has been limited (Brown, Jones, & Bond, 2019). The focus for many health systems globally has been on Horizon 1 with, for example, the development of electronic health records (EHR). Despite this focus, EHR are still not a standard part of routine care across the health sector (Australian Digital Health Agency, 2020). With the exception of primary healthcare which has seen a mass adoption of electronic records and more recently during the pandemic a rapid transition to telehealth, significant advancements in the adoption of emerging technologies in health services have not been seen (Australian Digital Health Agency, 2020). The review findings highlight that evidence supporting Horizon 2 virtual care model is strengthening in some areas however broad scale adoption is not apparent. The findings also made clear Horizon 3 virtual care models, yet to be realised, are dependent upon further development and maturation of interconnected digital technologies. This section presents key factors, identified in the review, that will contribute to the implementation and dissemination at scale of the models identified to enable a virtual care future to be realised.

The key challenge in scale up is not finding the technological fix but navigating diverse stakeholder interests and structural barriers

Technologies that have evidence of benefits to consumers are not necessarily implemented or are very slow to be implemented due to a range of implementation challenges. Implementation is a lengthy process requiring time for knowledge translation and overcoming obstacles related to the specific context in which the technology is applied (Herrmann et al., 2020; Hollmark, Lefevre Skjöldebrand, Andersson, & Lindblad, 2015). Many of these factors are non-technological and work together to create a complex situation. Addressing issues as complicated without recognising their complexity can lead to problems. Complicated issues are difficult but predictable, whereas complex issues are 'dynamic and emergent' (Maguire, Evans, Honeyman, & Omojomolo, 2018 p.12).

Many virtual care solutions are proposed in the literature but not many have gone to scale. Evaluations generally focus on efficacy in controlled trial conditions rather than effectiveness and cost effectiveness in real life conditions, which can inform scale up processes (Bardosh et al., 2017). Key learnings from effectiveness trials, or implementation science, can inform how interventions are diffused in the real world and how various social, cultural and political factors influence the use of technology (Bardosh et al., 2017).

In a comparative qualitative case study, Bardosh et al (2017) examined the potential for scale up of a mHealth app in Kenya and Canada to approve adherence to medication and engagement in care. The authors found the process of refining, tailoring and co-designing the platform to meet specific user expectations in different contexts took time and resources that was not initially anticipated. The authors found evidence of efficacy and cost benefit data was powerful in attracting funds to research effectiveness, and instrumental in generating provider buy in for the scale up. However, even with efficacy evidence, scale up was challenging due to different political, financing and health system structures in the two countries. The authors conclude the key challenge in scale up is not finding the technological fix, but navigating diverse stakeholder interests and structural barriers that mediate individual access to virtual care services. This effectiveness study demonstrates the complexity of scale up. Technology implementation frameworks, such as that developed by Greenhalgh et al (2017), reinforce this point through highlighting the intersecting range of domains that contribute to the complexity of scale up and spread of virtual care approaches in real life settings.

An international review of digital health maturity found that most of 22 countries examined were at an average level of maturity (level 3 of 5), with major challenges in workforce, interoperability, privacy and cross border data policies (Mechael & Edelman, 2019). Devlin et al (2016), in an UK evaluation, identified five key challenges associated with rolling out a broad portfolio of digital tools and services nationally at scale and at pace:

- Challenges of maintaining effective collaborative partnerships;
- Need for agility and adaptive learning in the face of external changes in the environment such as organisation restructure and economic pressure;
- Tension between co design and delivering at pace and scale;
- The challenge of marketability and commercialisation in a public healthcare environment; and
- Interoperability challenges.

To embrace new virtual care horizons these implementation challenges need to be understood and addressed. Factors that contribute to the complexity of implementing virtual care, most commonly cited in the literature, are categorised in this section under two main headings: user level factors, including equity, acceptance and readiness issues; and system level factors, encompassing governance and leadership, funding, policy and procurement, regulatory issues, data security, and safety and infrastructure.

6.1 User level requirements

Equity of access along with user acceptance of and readiness for virtual care are key factors influencing dissemination and implementation, and are addressed in this section. Users include both consumers and the workforce who use and promote virtual models of care.

6.1.1 Equity

High quality digital access is … a right not a luxury and an investment not a cost
(Consumers Health Forum of Australia, 2020 p. 20)

Virtual care has the potential to increase access to services and reduce existing disparities. However, uptake of digital technologies currently mirrors existing social inequality, meaning that vulnerable populations that already experience difficulty accessing health services can be marginalised further through requirements to access services through digital technology (Baum, Newman, & Biedrzycki, 2014; Choy, Jackson, & Jones, 2020). Transitioning to telehealth during the COVID-19 pandemic provides a clear example of this. While increasing access for many, access to telehealth via videolink was excluded for those Australians either not online or not fully able to use this technology.

Access to digital technologies is increasingly seen as an important determinant of health and wellbeing (Baum et al., 2014; Crawford & Serhal, 2020). Digital access, as a determinant, has several components, as shown in Box 12.

Box 12: Digital Health Determinants:

Digital Health Determinants

- Access to digital resources
- Use of digital resources for health seeking or health avoidance
- Digital health literacy
- Beliefs about potential for digital health to be helpful or harmful
- Values and cultural norms/preferences for use of digital resources
- Integration of digital resources into community and health infrastructure

(Crawford & Serhal, 2020)

The Australian Digital Inclusion Index explores digital health determinants through calculating a level of digital engagement of the Australian population over time via measuring access, affordability and digital ability via a survey of 15,000 Australians. The 2020 index report, capturing data up to March 2020, shows a slowing of the rate of increase in digital inclusion in Australia (Thomas et al., 2020). A clear digital gap exists for those with lower levels of education, employment and income, those in rural and remote areas, adults over 65 and Aboriginal and Torres Strait Islander people. More than 2.5 million Australian remain offline. ABS data paints a similar picture with 88% of metropolitan households and 77% of remote households having internet access (Australian Bureau of Statistics, 2018). Aboriginal Australians in remote regions have had even lower rates of access than non-Indigenous remote populations (McCallum and Papandrea, 2009).

Equitable virtual care requires addressing overlapping issues of access to technology with literacy, health literacy and digital literacy requirements.

Equitable virtual care requires addressing overlapping issues of access to technology with literacy, health literacy and digital literacy requirements. Literacy and language barriers need addressing through allowing consumer to have access to plain English and where possible information in multiple languages (Choy et al., 2020). People with disability need access to communication devices and information provided in a format that is appropriate to the type and level of disability in order to access virtual care. Financial considerations influencing consumer access to technology include costs related to purchase, installation, repair and maintenance, and internet connection (Barnett et al., 2020).

In addition to access to devices and literacy skills, consumers need access to support in using technology when needed. Limited access to educational, employment and social supports that provide opportunities to develop digital literacy are experienced by some groups of the general population, such as the unemployed, and compound digital inequities (Baum et al., 2014; Brown, Jones, & Bond, 2019). Findings from a survey of 404 participants, conducted by a technology firm specialising in aged care in Australia, concluded older people are open to new ways of communicating but lack confidence because of limited access to knowledge they need to use devices (Scenna & Nixon, 2019). The research found the majority of older people rely on family and friends for technology support, but had challenges accessing this support when needed due to time, distance or knowledge barriers. 7% of survey participants reported having no one to turn to and only 2% reported receiving assistance from care providers.

Equity must also be considered in selecting and using data to inform virtual care models. For example, algorithms used in AI for screening can be subject to bias. Myers et al (2020), argue that much medical data and evidence in the U.S. is based on information obtained from white men. An algorithm derived from this data may be less accurate in predictions about women, cultural minorities, or any other underrepresented group in the data set. Biases in AI can also occur latently from the way in which algorithms learn over time and are used in practice (DeCamp & Lindvall, 2020). These issues need to be addressed to promote public trust and adoption of AI based virtual care models.

6.1.2 Consumer Acceptance

> *"…young, healthy, highly educated, mostly male entrepreneurs are developing marginally useful apps and gadgets for people just like themselves" (Herz, 2014)*

While virtual care solutions abound, there is evidence that consumer dissemination and acceptance rates are sometimes low (Herrmann et al., 2020). A tension exists between technology led and user centred virtual care development. The former is characterised by decisions to develop technological solutions to long standing issues, such as the development of EHR. The latter responds to a need of a group of users.

A study of the uptake of digital technology to improve medication adherence found tailoring the design of the technology to meet the needs of a group of users was essential (Herrmann et al., 2020). Collins (2020), in a review of technological initiatives in chronic disease management, described four successful case studies where collaborative design processes were integral to understanding firstly issues with care delivery and then how technology could meet unmet needs. Issues such as poor eyesight, forgetting passwords and how to use devices, reduced fine motor skills interfering with the ability to enter data on a touch screen, all required design changes. Access to timely 24-hour support for both providers and consumers was found to be critical in maintaining engagement with new technology. Numerous studies and reports like this identify that successful implementation is dependent upon a well-developed understanding of consumer needs and preferences (Consumers Health Forum of Australia, 2020; Hollmark et al., 2015).

Collaborative design experience is not common, with top-down design and late-stage engagement with service users to check ease of use being the usual approach (Collins, 2020). While ease of use is a frequently cited enabler that is facilitated by user engagement in the design stage (Maguire et al., 2018; Wachter, 2016), it is only one of several enablers. A qualitative study by Cook et al (2016), exploring underlying factors that impact on consumers' decisions to initially adopt and continually engage with technology, found consumer acceptance of their need for assistance, an understanding and/or experience of the usefulness of the technology, ease of use, the presence of a referrer in aiding decisions about adoption and its reliability, all promoted technology adoption. Older people's engagement with Smart home technology was found to be related to four enablers in co-design: participating in decision about monitoring and sharing of data; device suitability (reliable low cost and non-intrusive); support; and training in how to use devices (Barnett et al., 2020).

Poor uptake can be related to misalignment of initiatives with user requirements, such as access, ease of navigation, complexity, appropriateness, capacity, privacy and confidentiality concerns (Brown et al., 2019). Stigmatisation, a negative attitude to technology generally, a lack of support in set up, addressing issues, and sending data are other barriers identified (Cook et al., 2016). Individual user preferences also influence consumers' reaction to technology. For example, daily sending of recordings was preferable to a GP visit for some and an inconvenience to others. Understanding these preferences and responding flexibly through technology is important (Cook et al., 2016).

Virtual care development needs to accommodate the preferences of consumers, the variability in the conditions they manage and the settings in which they live. Understanding consumer needs and preferences comes from close collaboration with, and leadership by, consumers. The Consumers Health Forum in their Consumer Commission Report (2020) outlines the need for partnerships between consumers, researchers, policy consultants and technology starts ups in the co-design process to highlight lived experience. This collaboration also requires involving consumers in virtual care co-design who are at particular risk of digital exclusion in order to promote equitable access.

Virtual care development needs to accommodate the preferences of consumers, the variability in the conditions they manage and the settings in which they live.

One of the key tensions in embracing user focused co-design process is the time and resource required to undertake development, and the challenge this presents to delivering to timelines and at scale, especially when this approach is less familiar to technology companies (Devlin et al., 2016). Findings from an Australian 2020 roundtable of stakeholders and experts suggest that virtual care innovations can be drawn from what communities are already doing to share information and build ties to strengthen health and wellbeing (Choy et al., 2020).

6.1.3 Workforce readiness and change management

Frontline workers and support staff are key users of virtual care technologies. A workforce who are skilled and supported in the use of digital technologies is a key enabler of virtual care. The workforce needs support to adjust work routines and accept, use and promote virtual care (Hans et al., 2018). Resistance to innovations that interfere with existing work practices, or scope of practice, or are not incentivised through funding, have been noted (Australian Digital Health Agency, 2020; Barnett et al., 2020; Chen, 2018). The small business nature of many community-based and primary practices also present a barrier. The Australian Digital Health Agency (2020) reports that specialist care, often small to medium businesses, still rely on largely paper records although this is beginning to change with next generation specialists who are digital natives.

The National Health Service (NHS) Topol review of workforce requirements for a digital transformation in the UK estimates that 90% of all healthcare jobs will require digital skills in 20 years (Topol, 2019). This may be an underestimate as it is likely that all care providers will need some level of basic digital literacy (Australian Digital Health Agency, 2020). The English National Audit Office (Davies, 2020) identified skill shortages as a significant risk for digital transformation. The Australian Digital Health Agency (2020) recently released a digital health workforce and education roadmap that outlines the anticipated transformation required of the Australian workforce over the next decade. Digital literacy of the entire health workforce, specialised training for specific adoption of new technologies, using data for planning and prevention, and changing the workforce culture to enable uptake of virtual care models are seen as key elements in achieving a ready and capable workforce. Variation in digital maturity within the sector along with the lack of a digital competency framework are seen as key barriers.

Front line workers need virtual data to be presented in a way that they can interpret quickly and easily and link to existing consumer records (Hans et al., 2018). These workers also need to be able to identify an appropriate technological solution for a particular consumer issue. A Deloitte paper on digital transformation in healthcare in the UK found, from a survey of 1500 clinicians, that finding the right technologies and the complexity of technologies were significant challenges to implementation (Taylor et al., 2019).

Digital health literacy needs to be embedded in initial training for a range of health professional as well as cultivating lifelong learning approaches to enable adaption to ongoing technological advancements. A review of digital health maturity internationally found 20 of 22 countries examined either provide no digital health training to health professionals as part of their training or only do so for less than 25% of health professionals (Mechael & Edelman, 2019). Barriers to workforce development at the student level include curriculum crowding, digital health access for student learning, limited demand and lag time in development of digital health subjects (Edirippulige et al., 2018).

Digital health navigator' roles are needed to support not only consumers but the workforce in their use of digital interventions.

As well as the current and future workforce requiring new skills and knowledge, the transformation to virtual care is expected to create new roles. These are anticipated in the areas of supporting consumers, care delivery and digital technology (Australian Digital Health Agency, 2020). Consumers will benefit from health coaches to assist their adoption of new technologies (Australian Digital Health Agency, 2020). A recent roundtable of Australian experts and stakeholders have expanded on this to identify the need for 'digital health navigator' roles to support not only consumers but the workforce in their use of digital interventions (Choy et al., 2020). To support care delivery, managers with skills in extracting meaning from data will assist in driving better operational decisions. Behavioural scientists will develop digital behavioural interventions that support healthy behaviours (Australian Digital Health Agency, 2020; Szwartz & Godby, 2020).

Bridge professionals who can assist translating the technical into the clinical world are particularly important in successful implementation in health

Digital technology roles are needed to implement virtual care and provide training, education and support to the workforce (Hans et al., 2018). Distinct cultures of information technology (IT) and health have led to a lack of clinical involvement in IT projects (Maguire et al., 2018). Bridge professionals who can assist translating the technical in to the clinical world are particularly important in successful implementation in health (Australian Digital Health Agency, 2020). These clinician and non-clinician informatics professionals not only need to understand technology but also need a deep understanding of the work undertaken by front line workers and be responsive to their feedback as part of an effective and adaptive change management process (National Advisory Group on Health Information Technology in England, 2016). Countries are beginning to invest in specialist digital health and informatics degree courses that will address some of the needs which are currently not being met (Mechael & Edelman, 2019).

The Topol review (Topol, 2019) has highlighted the need for organisations to support workforce capability through crafting an open inclusive culture of innovation, and ongoing education and learning, and a focus on consumer centred design. A 2018 King's Fund report on digital change in health and social care highlights the approach to digital change management varies but has largely been seen as technical with predictable changes anticipated and planned for (Maguire et al., 2018).

The authors argue that, in fact, implementing virtual care involves both technical change and adaptive change, the later relying on human behaviour for its successful adoption. This adaptive change must include the broad array of users from consumers to clinicians, to data entry and analytical staff. A key element of adaptive change is engaging users and addressing their concerns. User engagement helps identify risks and, in the case of the workforce, engages staff prior to the inevitable disruption associated with technological implementation.

Changing workforce culture is an important adaptive change in implementing virtual care. Culture and attitudes to technology are considered by some to be the biggest barriers to digital transformation in healthcare (Hans et al., 2018; Jones, Zinaida, Rutter, & Somauroo, 2019). Frontline clinicians have fears of virtual care models weakening the therapeutic relationship (Ayre et al., 2019). There is evidence that technology can inhibit clinicians 'engaging with the psychological, social and existential dimensions of illness' (Collins, 2020). Workers may also fear increased workloads required to learn and use technology (Ayre et al., 2019). Medico-legal concerns are also evident. In a study examining virtual diabetes management, primary care providers expressed a preference for technology features that placed the onus on patients to take action, rather than real time monitoring, which gave the impression that their data was being actively monitored by clinicians (Ayre et al., 2019). Additional fears may relate to perceiving the introduction of virtual care as cost cutting measures and threats to job security (Devlin et al., 2016).

Virtual care will require the workforce to be more agile with changing roles and blurred professional boundaries. Leaders need vision, planning and management skills to support the workforce in accepting and adapting to virtual care through workforce planning (Chen, 2018). Organisations will need to plan investment in education and communication programs to encourage a shift toward digital technology (Jones et al., 2019). Leaders will need to be able work through both how to understand opportunities and evaluate risks with unfamiliar technologies and how to manage the organisational aspects of integrating technology with the workforce while managing impacts of employees and maintaining their engagement (Australian Digital Health Agency, 2020). In response to this, the NHS, recognising the need for local leadership, recommended a chief information officer on every health service board to support leaders in making this transition (National Advisory Group on Health Information Technology in England, 2016). Preparing the workforce for virtual care models is a key strategic responsibility of leaders.

In summary: User level implementation factors

Equity

- A digital gap currently exists for those with lower levels of education, employment and income, those in rural and remote areas, adults over 65 and Aboriginal and Torres Strait Islander people.
- Equitable virtual care requires addressing digital health determinants of access to technology, literacy, health literacy, digital literacy requirements along with educational, employment and social supports in using digital technology.
- Algorithms used in AI for screening can be subject to bias if data sets are unrepresentative of the population.

Consumers as users

- Virtual care development must accommodate the needs and preferences of consumers, the variability in the conditions they manage and the settings in which they live.
- Early stage partnerships between consumers, researchers, policy consultants and technology starts ups in co design process are needed to highlight lived experience.

Workforce as users

- Skill shortages are a significant risk for digital transformation.
- Virtual care transformation requires new roles in areas of supporting consumers, care delivery, digital technology and bridge professionals who can assist translating the technical into the clinical world.
- Implementing virtual care involves both technical change and adaptive change, the later relying on engaging and addressing the needs of a broad range of users for its successful adoption.
- Leaders have a key strategic responsibility to prepare the workforce for virtual care models.

6.2 System level requirements

Virtual care implementation occurs in the context of strategy, policy, funding, procurement decisions and infrastructure constraints at national, regional and local levels. These various system level factors influencing implementation are discussed in this section.

6.2.1 Clear goals

Business cases need to be developed around better care processes and better safety and quality outcomes, rather than purely cost savings or the extent of digitisation.

Clarifying the aim of virtual care transformation is important in highlighting that digital technology is a means to improve care and outcomes for consumers rather than an end in itself. A focus on these aims is especially important where there is increasing evidence that cost savings related to digital investment may be unrealised in the short and perhaps the long term. This is made more complex in the context of public health systems where governments are required to make large investments in technology at a time when there is a focus on cost containment due to rising healthcare costs (De Rosis & Nuti, 2018). In a set of recommendations for NHS digital transformation drawing on previous learning, the Wachter review (Wachter, 2016) suggests financial return on investment may take up to 10 years. Business cases need to be developed around better care processes, including improved information, care coordination, efficiencies that enable more direct provider time with consumers, and better safety and quality outcomes, rather than purely cost savings or the extent of digitisation (Maguire et al., 2018).

However, developing a business case for investment costs can be difficult as there is a lack of not only evidence of cost effectiveness but also the quality, safety, and efficacy of digital technologies (Australian Digital Health Agency, 2020; Barnett et al., 2020a). Digital change and implementation literature identifies the length of time to realise and demonstrate virtual care benefits (Maguire et al., 2018). If a clear case for implementing virtual care cannot be made, this can be a barrier to uptake and may make innovation and the development of cost-effective models slower. This points to the importance of investing in research to develop evidence of effectiveness of virtual care models to support investment.

6.2.2 Governance, leadership and collaboration

Governance, leadership and collaboration are important factors noted in the literature in ensuring virtual care strategies and goals are implemented. Governing bodies have a role in developing a supportive policy context to enable innovation in virtual care (De Rosis & Nuti, 2018). This involves developing policies related to funding, standards, regulations, knowledge sharing, data security, education and training. Policies also need to address the potential for new technologies to exacerbate health inequities and must actively promote equity, as seen in the Australian National Digital Health Strategy (Australian Digital Health Agency, 2017, Baum et al., 2014).

Governance and leadership requirements for successful virtual care implementation are varied and at times contradictory in the literature. Countries internationally have moved from more centralised to regional approaches to implementing digital transformation and vice versa without clear evidence of the advantages of each (National E-Health Transition Authority, 2016). Centralised control is seen to enable large budgets, tight controls over expenditure, standardisation and accountability, but this can come at the cost of local innovation, agility, collaboration and tailoring solutions to local needs (National E-Health Transition Authority, 2016). The NHS experience over the last two decades demonstrates that central leadership is important in avoiding locally led approaches that do not necessarily adhere to recognised standards (Maguire et al., 2018). Governments have played a key role internationally on health care digital transformations via large scale investment in strategies, national bodies and funding incentives to support the sector. In Australia, we have seen government fund the My Health Record and expand telehealth during COVID-19, in the US financial incentives have been used to support physicians and hospitals to adopt electronic records (Jones et al., 2019).

An additional challenge, for countries such as Australia and the UK, is the complexity of the health system with centralisation of some aspect of funding and regulation, with the organisation and delivery of care being a regional government responsibility. This presents challenges in scaling innovations across the nation (Asthana, Jones, & Sheaff, 2019). Middle out approaches are emerging that allow bottom up engagement to ensure local variations and ownership to occur within a top down national framework and standards (Maguire et al., 2018). The UK Wachter review (National Advisory Group on Health Information Technology in England, 2016) suggests local/regional learning networks are an important part of supporting organisations in purchasing, implementation and ongoing improvement in digital technology. This view is reflected by the AHHA who see a possible joint role for health service and primary health networks to undertake local planning and funding (Australian Healthcare and Hospitals Association, 2020).

New collaborative forms of governance are seen as important in innovation and implementation of virtual care models. Collaboration across government, providers, academia, private industry, consumer advocacy groups, clinicians and consumers are needed to address the needs, goals and issues of all stakeholders and co-design solutions (Consumers Health Forum of Australia, 2020; De Rosis & Nuti, 2018). An example of this is the Delivering Assisted Living Lifestyles at Scale (dallas) program, which is a UK initiative to deliver health and wellbeing service deploying a broad portfolio of digital tools at scale to 169,000 people. This was delivered through multi stakeholder communities consisting of health and care services, small and large industry, third sector, academia and government to harness knowledge across boundaries to enable innovative interoperable person centred tools and services through user co-design processes (Devlin et al., 2016). An evaluation of dallas found that there were challenges to heterogeneous partnerships reflecting common barriers to collaboration, such as different levels of comfort with the speed of change, with consumer engagement and cultural differences (Devlin et al., 2016).

New collaborative forms of governance … are needed to address the needs, goals and issues of all stakeholders and co design solutions.

6.2.3 Regulation, standards and guidelines

The path from digital innovation to approved digital therapeutic device requires innovators to follow regulatory pathways that evaluate technologies used in virtual care, through evidence of safety, effectiveness, and ethical conduct, before public distribution and use (Capon, Hall, Fry, & Carter, 2016). A review of digital health maturity internationally found protocols for regulating and certifying digital health devices and services is lacking (Mechael & Edelman, 2019). Regulations for software as medical devices, such as apps and AI algorithms, while in existence, sometimes struggle to keep pace with technological developments (Therapeutic Goods Administration, 2021; Dawson et al., 2019). Health and community service accreditation bodies also need to develop standards related to digital adoption to accreditation processes (G. Jones et al., 2019).

Virtual care is an area where the speed of growth of technology can outpace not only the development of standards for safety or effectiveness, but evidence. The virtual care sector is dominated by small and medium sized enterprises which, unlike large pharmaceutical companies, that are geared to demonstrate safety and effectiveness, struggle to meet obligations to demonstrate technical, clinical or cost effectiveness standards (Asthana et al., 2019; Sheena, Ray, & Rod, 2019). For example, mHealth is characterised by a large number of commercial developers and where the simplicity and cost effectiveness of the app development may mean empirical evidence of the effectiveness is overlooked and/or there is a lack of subject matter expert involvement (Capon et al., 2016).

There are also complex legal and ethical issues that need to be addressed in order to promote the adoption of virtual care models. The Australian Digital Health Agency (2020) reports that current policy and ethical guidelines for digital technology are lagging behind the development of new technologies. Ethical guidelines for applying

Ethical guidelines for applying technologies, such as AI in healthcare, will need to be developed to ensure that consumers benefit from their use with minimal risk.

technologies, such as AI in healthcare, will need to be developed to ensure that consumers benefit from their use with minimal risk (Australian Digital Health Agency, 2020). Issues such as the ability of clinicians explaining to consumers the basis for how a complex AI algorithm has made a diagnosis may be challenging (Davenport & Kalakota, 2019).

The process of transforming big data into knowledge enables third parties to infer and create personal information from individuals who may have not consented to this (De Lecuona & Villalobos-Quesada, 2018). An assessment of the personal and social implications of big data sets must be undertaken to understand how data generated may affect people's access to services and opportunities. The creation of new knowledge, lack of decision making transparency, coupled with potential risks, such as receiving distressing information directly from AI systems or incorrect information, means that careful attention needs to be paid to the human impact of new technologies and models of care (Davenport & Kalakota, 2019).

6.2.4 Funding

Initial investments in digital technologies can be large, as are adaptive change management, education and ongoing maintenance costs (De Rosis & Nuti, 2018). Financial incentives were a key driver in assisting English GPs to move to an almost entirely digitised system for most practices (Maguire et al., 2018). Ongoing investment was cited in a review of NHS digital policy as an important enabler in the context of slow and low productivity gains in the short term (Castle-Clark & Hutchings, 2019). Both digitally mature organisations, maintaining and building on existing programs, and those undertaking transformation need this financial support. A particular challenge at the local level is the difficulty, for organisations, in estimating costs around changes in work processes and training for staff (Hollmark et al., 2015).

Multiple reviews have identified underinvestment as a barrier that needs to be addressed to unlock technological opportunities (World Economic Forum, 2016). A review by the English National Audit Office on digital transformation in the NHS (Davies, 2020), found government and local health service investment insufficient to deliver on planned changes. A review of Australian aged care digital capability found limited local investment in technology infrastructure compounded by limited government funding or incentives for telehealth or telecare (Barnett et al., 2020a). An international review of digital maturity found most countries examined dedicated insufficient resources to digital health (Mechael & Edelman, 2019).

It is anticipated that the move to value based funding will see the rise in adoption of virtual care as providers explore digital innovations, especially in the preventive space, to address the financial risks they carry.

New funding models are a key enabler for the adoption of virtual care. Payments for care are being reformed in many countries with a shift from fee for service to value based or outcome-based systems (Greenwood et al., 2017; World Economic Forum, 2016). Fee for service models can create perverse incentives for low value or no value care. This volume based approach is centred on what clinicians do rather than what consumers need and is not suited to the provision of comprehensive integrated care, for example, for those with chronic disease (National E-Health Transition Authority, 2016). Value based systems compensate care providers based on measures such as patient outcomes and satisfaction to achieve the best outcomes at the lowest cost (Taylor et al., 2019). Virtual care can support this shift through providing efficiencies in cost and productivity while improving the quality of care and the level of engagement with consumers (Ronte et al., 2018). It is anticipated that the move to value based funding will see the rise in adoption of virtual care as providers explore digital innovations, especially in the preventive space, to address the financial risks they carry with value based care (Ronte et al., 2018; Taylor et al., 2019)

Other innovative models of funding proposed in the literature include (De Rosis & Nuti, 2018):

- Payment for the initial technological costs of development and adoption but recurring finance for successful innovations only according to predefined conditions;
- Co-financing with funds from government at all levels, hospitals, consumer associations, technology firms, and non-profit organisations; and
- Defining selection and evaluation criteria through participative processes.

User pay models, such as apps, insurance company pays or commercial business pays for technology that creates business are also models identified (Hollmark et al., 2015).

Given that virtual care innovations often involve small to medium sized business government procurement processes need to reflect this. An Italian case study of eHealth integration found public procurement processes were 'more adapted for ready-made solutions from big suppliers, not open to stakeholders' engagement, and not facilitating small innovative firms or innovations that can really enable change'(De Rosis & Nuti, 2018 p. 138). This finding has been echoed by others and highlights innovation friendly procurement processes are needed (Hollmark et al., 2015).

At a local organisation level, a report by McKinsey and Company (Jones et al., 2019) argues that decentralised departmental budgets, common among healthcare and community care organisations, can lead to underinvestment in innovative technologies that create benefits across the cycle of care. Therefore, organisations that have a central innovation budget can realise system wide benefits.

Healthcare has demonstrated much lower levels of technology adoption than other industries (Singhal & Carlton, 2019). Funding needs to target mechanisms to address low levels of adoption. The Aged Care Industry Information Technology Council undertook a benchmark assessment of the digital maturity of the aged care sector (both residential and community care) in mid-2020 and found low levels of engagement with advanced technology solutions, except in the areas of business intelligence and data analytics (Barnett et al., 2020). The report found a minority of aged care providers using SMART home technology and most of those were mainly limited to one or two devises, such as personal medical alarms, tablets/phones or GPS alarm wearable devices. These low levels of technology adoption, identified across sectors, reflect that adoption has occurred in areas where technologies fit into existing structure and models within organisations (Collins, 2020). This suggests that funding and specialised cross sector innovation hubs are needed to support the development and spread of innovative technology to overcome the inherent conservatism of health and community based providers (Collins, 2020).

6.2.5 Data security and privacy

A fundamental tension exists in virtual care between protecting data privacy and security, and sharing data to enable sophisticated analytics that underpin transformative models of virtual care. The focus needs to be on the development of safe and secure data transmission methods, education and regulation which allow consumers to have both confidence that their data is secure and used appropriately, and control over how their data is used by third parties (Imison et al., 2016; Taylor et al., 2019)

The significant amount of data collected on individuals from technologies such as Smart homes will need to be protected by privacy and security legislation that is frequently reviewed to reflect changes in technologies (Barnett et al., 2020). Literature indicates there is currently a lack of attention to where information is being stored, the level of security involved, and how it is being transferred (Capon et al., 2016). Concerns about privacy of data range from data collected in single technologies, such as Smartphone apps, to big data analysis.

Data collected on individuals … will need to be protected by privacy and security legislation that is frequently reviewed to reflect changes in technologies.

In a review of literature examining ethical issues in smartphone use Capon et al (2016) identified the inability to ensure anonymity and privacy of sensitive information and the accompanying lack of disclosure of these risks, including handling of data on users engaging in criminal activity, such as drug use, as the key ethical concern regarding the use of mHealth. The authors make a number of recommendations for mHealth data security and privacy which may be relevant to virtual health generally including:

- Third party access - Password protection or private inbox features should be utilised to prevent accidental third party access to the app/ device. Individuals should be informed of the potential for third parties to access their data, through legal means, or hacking;
- User anonymity - use of data encryption methods to reduce likelihood of third-party access to information, and any limitations of these methods must be relayed to users. Users need to be made aware if de-identification processes are not possible. Where possible, users should be given power to control how much information is collected; and
- Informed consent - users need to be informed of the risks and benefits of the technology in a way that is clear and understandable. This includes limits to confidentiality and privacy, for example, court orders or subpoena (Capon et al, (2016p. 54).

Big data sets integrate data from a wide range of technologies to support virtual care. Protections must be in place to enable transparency, control third party use, protect privacy and security of both single technologies and large data sets used in virtual care (De Lecuona & Villalobos-Quesada, 2018). The advent of General Data Protection Regulations (GDPR) in 2018 in the European Union, has seen the creation of comprehensive and unified data security laws addressing some of these security issues and giving consumers more control over their personal data (Dawson et al., 2019). Informed consent and the right to withdraw data access at any time are key elements (Ronte et al, 2018).

In addition to protecting the security of data collected from individuals through virtual care, protections must be in place to guard against adversarial attacks on virtual care technologies. Adversarial attacks, for example, can be inputs to an algorithm in an AI model that are intentionally crafted to bias or force the model to make a mistake (Finlayson, Chung, Kohane, & Beam, 2018). Finlayson et al (2018) describe their development of simple adversarial attacks that disrupt the interpretation of medical images. These attacks could also impact the AI processing of claims for care delivered. Information governance systems, developed internationally, that protect data across sectors and at all stages (collection, use and sharing) will require frequent review to keep up to date with technological innovations (Davies, 2020).

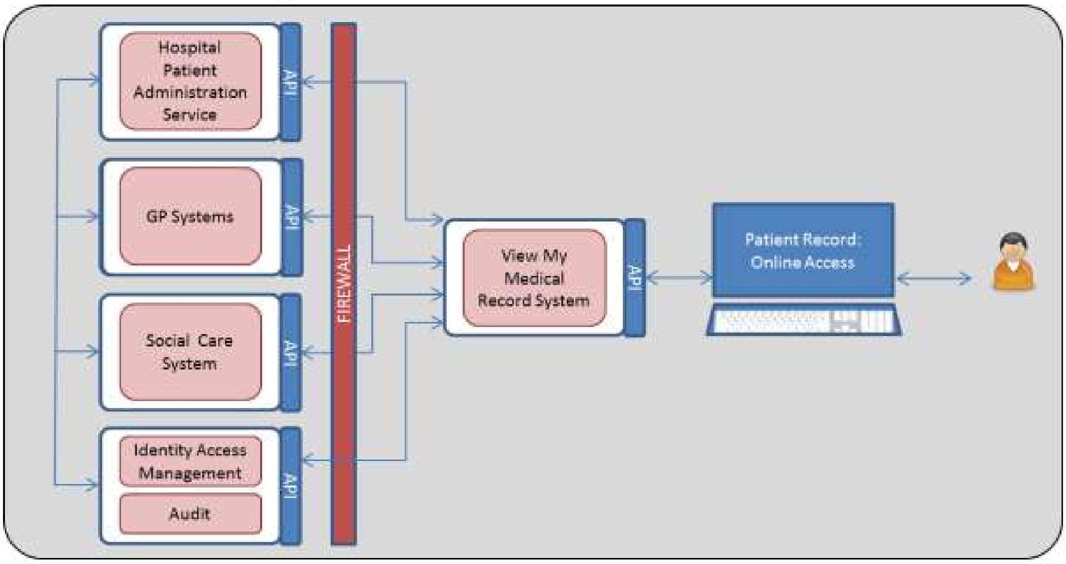
6.2.6 Infrastructure and Interoperability

Access to uninterrupted connectivity, based on reliable and secure Wi-Fi or broadband is essential for modern virtual care but is not always available.

For virtual health to be fully realised there must be integrated technology systems that communicate and exchange information, underpinned by robust infrastructure that ensures they operate in a stable way. Access to uninterrupted connectivity, based on reliable and secure Wi-Fi or broadband is essential for modern virtual care but is not always available (Dentzer, 2019; Mechael & Edelman, 2019). Access to technologies and sufficient data storage mechanisms are other key infrastructure challenges. Cloud technology provides an opportunity for reducing some of the infrastructure demands and costs through moving from individuals or organisations purchasing and maintaining hardware and software to a decentralised approach where users pay for remote access to services, such as storage and up to date software (Taylor et al., 2019). A key concern in cloud based technologies is ensuring the privacy and security of large volumes of stored data (Wachter, 2016). However, over time cloud based storage is becoming faster, more reliable, less expensive and more secure (Wenzel & Evans, 2019).

A key innovation is open digital platforms and architecture that allow providers to develop their own interfaces to individual care data that is held centrally in the cloud as used in the UK, China and Denmark (Jones et al., 2019). For example, AI needs access to high fidelity multi-dimensional digital data to work, therefore open data systems become a prerequisite (King, 2019). As part of realising this future, NHS England has developed an open architecture policy and supporting guidance for new systems to create an interoperable ecosystem of data allowing the 'right information to be available to the right user at the right time' as shown in Figure 11.

Figure 11: Example of interoperable open digital architecture from (NHS England 2014, p8)



This policy sets out the key expectations for healthcare organisations when developing, upgrading, or procuring their systems in the move to open architecture. In this way, open architecture supports a shift from locked down proprietary solutions to open sharing of digital products across systems (Devlin et al., 2016).

Fragmented sources of consumer data exist in various health and community care records and self-monitoring data. The need for electronic and integrated data is necessary if technology is to effectively transform traditional models of care (Singhal & Carlton, 2019). For information to cross traditional organisation and sector borders, interoperability of technology is required. Interoperability refers to the need for data to be structured and coded so that users, both sending and receiving information, will have a common understanding of what the data mean and can share data (Davies, 2020). For example, to move from manual data entry as part of remote monitoring devices to wireless automatic data collection requires standardisation and interoperability of devices (Hollmark et al., 2015). In the healthcare sector that mean data sharing across electronic health records and multiple disparate IT systems (Taylor et al., 2019).

A lack of standards in relation to data definition … leads to a multiplicity of definitions and data structures that limit interoperability.

Interoperability requires unique consumer identifiers along with common terminology to describe interactions with consumers, interventions, medicines and devices (Australian Digital Health Agency, 2017). A range of standards are also required to support and improve interoperability and electronic information exchange between a range of devices, computers, smartphones, tablets and health information systems (Spanakis et al., 2016). Currently there is a lack of standards in relation to data definition in primary and community care which leads to a multiplicity of definitions and data structures that limit interoperability. This has been noted recently in a review of ICT strategy in the aged care sector in Australia (The Architecture Practice, 2020). There is also a need for international standards for interoperability, as in the telecom market, that fosters open competition and a variety of services and products to be accessible internationally (Hollmark et al., 2015).

In summary: System level implementation factors

- Due to the lag time in demonstrating cost effectiveness, business cases need to address better care processes and safety and quality outcomes, rather than purely cost savings or the extent of digitisation. Virtual care effectiveness evidence is needed to support investment.
- National approaches to successful virtual care implementation are varied however middle out approaches that allow bottom up engagement with local variations and ownership within a top down national framework and standard are promising
- New forms of collaborative governance and leadership across government, providers, academia, private industry, consumer advocacy groups, clinicians and consumers are needed to address the issues of all stakeholders and co design appropriate solutions.
- Regulations for technologies used in virtual care are either lacking or sometimes struggle to keep pace with technological developments.
- Ethical guidelines must be developed to inform the assessment of the human impact of new technologies and models of care.
- New value-based funding models with a focus on patient outcomes and satisfaction to achieve the best outcomes at the lowest cost are a key enabler for virtual care adoption.
- Innovation friendly procurement processes are needed to cater to small to medium sized business innovators.
- Dedicated funding and specialised cross sector innovation hubs are needed to address low rates of adoption of virtual care in some sectors,
- Information governance systems that protect data across sectors and at all stages (collection, use and sharing) will require frequent review to keep up to date with technological innovations.
- Access to uninterrupted connectivity, based on reliable and secure Wi-Fi or broadband is essential for modern virtual care but not always available.
- If technology is to effectively transform models of care interoperability is essential
- Cloud technology can allow a decentralised approach where users pay for remote access to services such as storage and up to date software.
- Open digital platforms and architecture allow providers to develop their own interfaces to individual care data that is held centrally in the cloud.

Section 4: Synthesis

7 Synthesis

This rapid review has presented an overview of current and future virtual care models, and factors supporting their implementation. The literature on virtual care is vast and this review presents findings from a critical review of 81 peer reviewed and 51 grey literature documents from Australia and internationally. While this is a limitation in providing a robust evidence base, the intention of the rapid review is to highlight key themes and inform discussion of future directions in virtual care. The specific aim of the review was to understand how virtual care can effectively enhance existing models of care or contribute to new models of care.

The review first presented a conceptual framework for understanding developments in virtual care via three Horizons. Horizon 1 virtual care models, comprising digital technologies that substitute for existing work practices such as telehealth and digital information systems such as EHR, represent the building blocks of future developments in virtual care. While technologies used in Horizon 1 virtual care are familiar and have been around, in some areas, for many decades, the main challenge is one of widespread dissemination and integration into existing work practices. Horizon 2 represents the next stage in virtual care development where digital technologies enable enhanced models of care and new work practices. While this stage is reliant upon broad scale implementation and maturation of Horizon 1 technologies, enhanced models of virtual care are beginning to emerge across the continuum of care from prevention to maintenance. The final Horizon, yet to be realised, is one in which further development and maturation in digital technologies and infrastructure will allow transformed models of care.

The review then examined in more detail virtual models of care present in the literature under Horizon 2 and 3. Most literature identified and reviewed had a focus on Horizon 2, virtual care augmenting existing models of care and supporting task redesign, rather than new models of care in Horizon 3. Much of the evidence found related to single digital tools rather than comprehensive virtual models of care as has been previously noted in the literature (Devlin et al., 2016). The evidence presented, while demonstrating the promise of virtual care, is at times weak and contradictory reflecting the developing nature of many virtual care models described and the challenges of evaluating and comparing virtual care models that vary in design and the context in which they are applied. The ubiquity of the Smart phone means that areas such as mHealth have a larger and stronger evidence base. However, even here the challenges of virtual care evaluation are evident where the development of apps is less expensive than developing evidence of quality and efficacy. Further work is needed in developing approaches to evaluating and comparing virtual care models with regards to cost, and quality and safety. Evaluating virtual care outcomes will also require applying an equity lens with appropriate health equity measures (Crawford & Serhal, 2020).

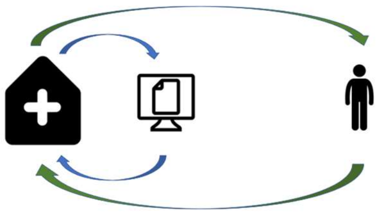
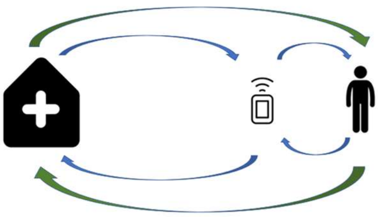
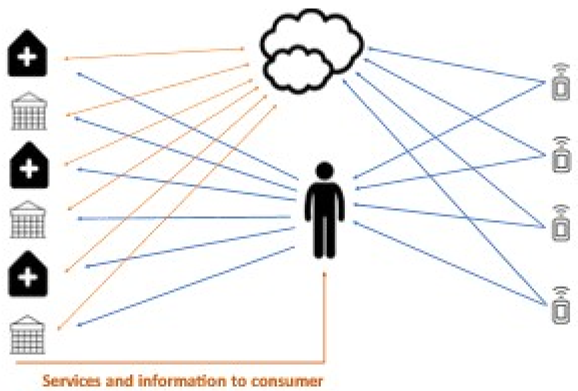
The role of virtual care models in empowering consumers to engage in self-care activities is a key theme and is consistent with policy shifts to person centred approaches. Care and information will increasingly be provided virtually at a time and place that is convenient to consumers, often in or close to the home, overcoming many of the traditional obstacles to access. The model of remote monitoring and management or intervention, with or without provider input, dominates Horizon 2 across the continuum of care using a range of technologies from mHealth to robots to Smart homes. Virtual care presents particular opportunities for effective personalised self-management of people with chronic disease who often fall through the gaps of a health system focused on an acute care model (Collins, 2020). This is reflected in a larger research base and stronger evidence for the benefits of virtual care models in chronic disease areas such as diabetes. Evidence is also beginning to emerge in other areas such as virtual hospitals, aged care and condition or disease screening programs.

There is a clear focus in the literature on virtual care in Horizon 2 connecting people rather than replacing staff. This finding is reflected in a Deloitte 2020 survey of health care consumers which found a majority want a relationship with their healthcare provider who listens, treats them well and takes time to listen whether that be in face to face or virtually (Betts et al., 2020). The adoption of Horizon 2 virtual care models will occur within the context of well-developed and trusted provider-consumer relationships. Virtual care can then allow more time for the provider consumer relationship through creating efficiencies in other areas and provide the consumer and care provider with better information to plan care. The workforce needs to be digitally literate to be able to promote and support consumers use of technologies in Horizon 2 virtual care models.

Existing technological innovations in healthcare have tended to address health improvement via technological substitution of components of care or augmentation of existing care models. Few innovations have attempted to address the social determinants of health despite this being the area where an upstream preventive approach will reap the greatest benefit to consumers and health budgets. Horizon 3 models of virtual care show promise in this respect. Horizon 3 is characterised by the use a broad range of consumer, care provider and non-care provider generated data from maturing and evolving interoperable technologies stored in the cloud. These virtual ecosystems use AI to analyse diverse data sets to deliver a range of consumer centric care services, and importantly, unlock greater understanding of the socioeconomic determinants of health. Key to this future is the ability to collect multiple data sets in a non-intrusive and user-friendly format. These approaches provide opportunities for new entrants experienced in digital technologies and service delivery to disrupt traditional health and care sectors and existing models of care. Clearly the significant risks for data ecosystems are their susceptibility to privacy attacks and the quality of data they use to make inferences, and the biggest challenge is up to date information standards, controlled data definitions and dictionaries to allow data sharing; and regulations and ethical guidelines that address AI developments (Spanakis et al., 2016).

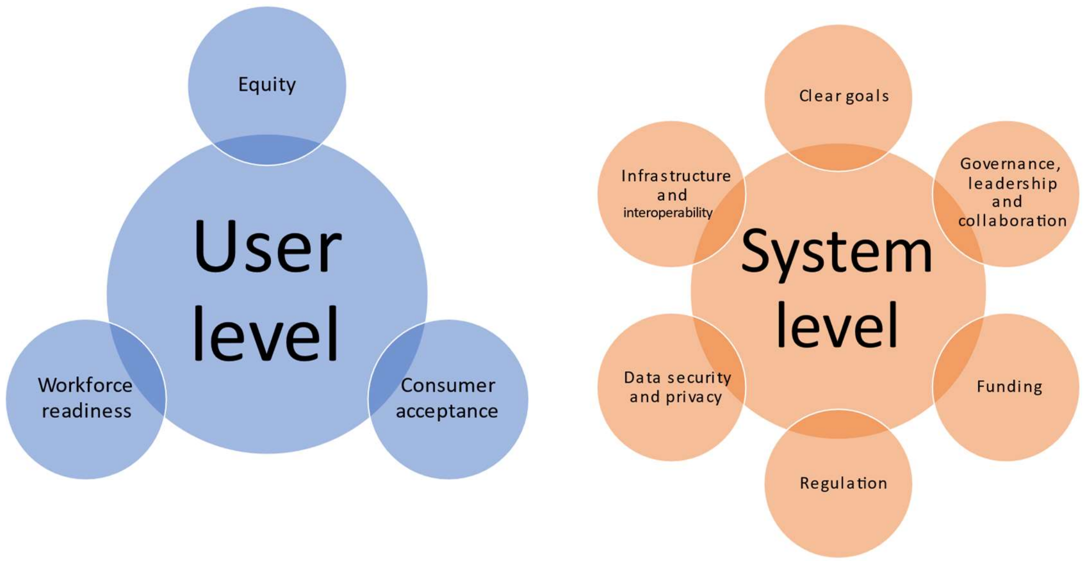
The virtual care models in the three horizons see a shift in the control of care from the provider increasingly focused on meeting consumer needs in Horizon 1, to increasing consumer control of data to promote self-care in Horizon 2 and finally a consumer centric model of personalised care in Horizon 3. The characteristics of these three Horizons are summarised in Figure 12

Figure 12: Three Horizons of Virtual Care

HORIZON 1		Building and consolidating a digital foundation within traditional models of care through digital data sharing between providers (e.g. eReferrals) and between providers and consumer (e.g. telehealth) enabling: • Improved efficiency of data sharing • Improved accuracy of information • improved decision making • Improved access to services • Reduced consumer risk
HORIZON 2		Enhanced models of care involving new work practices underpinned by remote monitoring and intervention, improved data accuracy, real time recording and increasing consumer access and control of data, which support self-care within an area of the care continuum through: • Data directly available from Device → Consumer + Provider • Data sharing mainly occurring via one or a limited number of devices
HORIZON 3		Maturing and evolving interoperable technologies will allow new models of care, yet to be fully defined. This horizon is characterised by the use of a broad range of consumer, care provider and non-care provider generated data stored in the cloud and analysed with AI to deliver a comprehensive range of services and information across the continuum to the consumer with a focus on personalised, primary, predictive, preventive and participatory care through data sharing via: • Device → Consumer • Device → Cloud + AI • Consumer → Provider/ Organisation • Provider/ Organisation ↔ Cloud + AI

Many virtual care innovations reviewed were tested on small samples yet only scaled virtual care models will achieve the benefits and impact for the community. The literature highlights the slow rate of adoption of virtual care in sector such as health and aged care. The second review question examined the critical factors that must be addressed in supporting implementation more broadly. Factors influencing implementation were identified at the user and system level (see Figure 13).

Figure 13: Virtual Care Implementation Factors



At the user level, this review highlights the need to move away from a technologically led development focus that brings in consumers at the end of the process to comment on ease of use, and towards consumer driven collaborative approaches that, from the beginning, respond to consumer needs and preferences. Development approaches need to include a range of consumers to understand and address the digital determinants of health and an assessment of digital equity to prevent deepening the digital divide. People must have equal access to digital care, an equal quality of digital healthcare and equal health outcomes from virtual care. To achieve this, strategies must also address developing consumers' digital skills and providing support to effectively engage in virtual care.

Readiness to adopt and engage with virtual care is vital to realising the benefits. This readiness must exist at a consumer, workforce and provider level. Workforce readiness requires planning to develop skills, new roles and promoting a culture that is accepting of virtual care models and can effectively use the resulting data produced to improve health outcomes. Leaders must develop and invest in strategic adaptive change initiatives aimed at preparing the workforce for a virtual care future. At the system level the time lag required to develop cost benefit evidence can provide a barrier for investment in virtual care. Stronger evidence of the effectiveness of virtual care models in improving care processes and quality and safety outcomes is needed to inform business cases for the transition to virtual care. Government also has a clear role in creating the conditions conducive to virtual care adoption. This includes developing standards and regulatory pathways for new virtual care models as well as developing value-based funding models and supporting investment both for immediate procurement, adaptive change and ongoing maintenance in order to realise improved consumer outcomes in the long term. Regulatory approaches must encompass data sharing and data security in order to address consumer privacy and data control concerns and promote consumer acceptance and adoption. Fundamental infrastructure requirements in the form of stable internet, access to technologies and secure and ample data storage are needed to enable all horizons of virtual care and are not yet always available. Future developments in virtual care require sophisticated interoperability and interfacing capabilities to enable connectivity and this requires significant technological development and the conditions to support this.

These implementation factors, which can be both enablers and barriers depending on how well they are addressed, are widely commented on in the literature and readily identifiable. Yet barriers to virtual care seem to persist over time resulting in slow rates of adoption and reflect the complexity of technological implementation. COVID-19 has forced innovation, adoption and integration of technologies into the health and community sector to overcome physical distancing and infection control risks. This widespread adoption has occurred quickly despite known implementation barriers. A Kings fund review of technology and innovation for chronic disease suggests we need to more fully understand the specific enablers of technology adoption during COVID-19 (Collins, 2020). However, COVID related virtual care adoption has occurred without the normal processes associated with best practice in technology implementations such as widespread user engagement and incremental improvements. Virtual care adoption seen during COVID -19 has also largely occurred within Horizon 1, involving substitution for existing work practices. Horizon 1 virtual care technologies, such as telehealth, are less disruptive to the workforce and work processes and therefore easier to implement than virtual care models in Horizon 2 and 3. The implementation factors identified in this rapid review need to be addressed to enable enhanced and transformed models of virtual care to be adopted at scale.

The rapid review highlights key areas further evidence is required to support future virtual care developments. Effectiveness evidence evaluating implementation, scalability, cost and adaptation to technology of virtual care models in real life settings is needed to inform implementation. Evidence around improvements in the process and outcomes of care will assist in developing business cases for investment where time lags in realising cost benefits provide barriers to providing information on cost effectiveness.

Conclusion

This rapid review of virtual care highlights a vision of the future with consumer-centric virtual care provided at a time, place and in a format of choice that will enable individuals to have greater control in improving their health and wellbeing. Realising this future requires strategic leadership guiding further work in co design, user readiness, regulatory and information governance controls and investment in infrastructure. Scale up and widespread adoption of virtual care models will be underpinned by stronger evidence obtained through effectiveness evaluations in real life settings informing what works for whom and in what context.

8 References

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For referencing purposes this literature review may be referenced as follows:

Brown, A. (2021). Reimagining healthcare in Australia: the journey from teleheath to 21st century design. [Manuscript submitted for publication]. Digital Health Cooperative Research Centre, Australia.

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