



The Future of Connected Home Health

Vision Paper / Collette Johnson / Plextek

The Future of Connected Home Health

Medical Vision Paper

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Current landscape and challenges



Figures released earlier
this year reveal that
14.2 million
people are waiting at
least a week to see
their GP, half a million
more than in 2015



By 2020 the
average home will
have more than
500
connected
devices
ranging from
washing machines
to light bulbs



42%
of 35-44 year olds are
worried about their
relatives not telling
anyone if they feel ill



18-24
year olds

are most likely not to
go to the doctor if they
are embarrassed about
their symptoms

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52%

of consumers would be willing to try virtual reality for group rehabilitation



Once virtual reality becomes more mainstream the challenge then becomes how it can be made into a generic health platform



As a direct result of constant monitoring there will be

no such thing as 9am-5pm healthcare anymore



A day in a hospital bed costs the NHS an average of £400



Our research discovered 42% of patients are discouraged from visiting the doctors due to waiting times.

Plextek recently commissioned a poll of 1000 consumers to explore their views on the current state of the NHS and to dig a little deeper into their opinions on Virtual Reality technology and its potential use in healthcare. This research found that 42% of patients are discouraged from visiting the doctor due to waiting times and are choosing to 'put up with' illnesses or poor health without seeking help. The ever increasing strain on GPs and the impact this is having on the public has further heightened the need for new approaches to treatment that will give patients more independence to accurately self-monitor, diagnose and treat medical conditions in the comfort of their own homes.

With the cost of healthcare having risen faster than inflation during the last decade due to increases in the prices of drugs, medical devices, and hospital services, there is also a global need for more affordable healthcare solutions.

Our previous report '*Patient of the Future: 2020*' looked at the significant progress the medical industry can make in terms of innovative care models that are less reliant on this budget-constrained, government-funded health system.

In this report, '*The Future of Connected Home Health*', we take this vision one step further, to focus on how our homes will be able to provide us with easy and reliable self-monitoring and rehabilitation systems. We will look at specific use cases within the smart home of the future, before uncovering how VR technology is enabling the future of connected home health, bringing technology that was once restricted to hospitals into the mainstream.

8.85%

The global home healthcare market will grow at a CAGR of 8.85% during the period 2016-2020
(Sandler Research)



\$349.8bn

The global home healthcare market will be worth 349.8 billion USD by 2020
(MarketsandMarkets)



The current home health landscape

Currently health monitoring in the home involves individual 'piecemeal' smart health gadgets that provide an ongoing wellbeing assessment to the user.



Smart health consumer products are becoming more commonplace thanks to popular examples such as Apple's health app and fitbit smart watches. More and more electronics companies are launching independent devices, a good example being the Philips Health Watch, due to launch in September 2016, which has the ability to track heart rate, activity and even sleep patterns. By connecting to the Philips HealthSuite app, users can measure their wellbeing and learn how to make better lifestyle choices with a customised programme.

French consumer electronics company Withings is also shifting its focus to concentrate on connected health with over 100 million activity and sleep trackers already sold.

However, none of these technologies are designed for clinical use and therefore don't have the ability to diagnose medical conditions. More innovative steps are needed in order to make true health monitoring in the home a reality.

Department store John Lewis announced in April 2016 that it is to unveil a smart home section at its Oxford Street store in London to "demystify the concept of the smart home", a resultant outcome of the company experiencing an 81 per cent increase in sales of smart home products in the past year. While this example is not specifically about healthcare it's a critical part of making connected technologies part of the public consciousness.

Key considerations towards making smart home health a reality

At end user level, better education is essential to gain public trust and acceptance of smart home health.

For large sections of the public there is a natural hesitancy and even fear about new technologies that may make the idea of not booking in to see the doctor a challenging concept. Initially there may be some scepticism that, within the NHS, smart home health is just a cost-cutting measure, a shortcut, and not the equivalent standard of treatment as visiting the doctor or hospital. This will need to be overcome.

On a more functional level, education is needed to ensure patients can navigate any difficulties they might have using home health medical devices to self-monitor, with advice to help them get to grips with whether results are 'normal' or 'abnormal' for them.

At the product design level, one challenge for device manufacturers is deciding what form home health devices should take. This involves finding the balance between

devices' features and their ability to fit naturally into everyday consumer lifestyle. In the majority of cases patients will naturally prefer to keep their medical conditions private. They will want small, discrete devices that patients can wear beneath clothing, devices that replicate home furniture/everyday appliances or that can be hidden away when not in use. For example, a person being monitored in their home for type 2 diabetes might be self-conscious, as people suffering with this condition are often presumed to be unwell because of 'over-eating'. If devices do not allow discretion patients may not want them in their home.

Getting the right balance between simplicity and functionality in the design of the devices is also key – we don't want to overwhelm the user by monitoring too many things, yet the device shouldn't be so basic that it isn't fit for purpose. It's about finding the balance between the two

and making it accessible yet useful. Simplicity is an important factor in devices that monitor children, especially babies' vital signs, due to such risks as sudden infant death syndrome (SIDS).

A final consideration is the issue of connectivity and big data i.e. the regularity with which medical devices take and share data with medical professionals who then have to analyse it, and deciding an appropriate course of action. Current home connectivity automatically sends data every 28 seconds, but is this really necessary? A hospital patient would only have their vital statistics recorded every half hour, so twice every minute seems excessive in the home. Consistent standards for how and when this data is shared with medical professionals is critical before smart home health can progress.



1
PART

The Future of Connected Home Health



By 2020, how will medical technology be part of our home?

In certain areas medical technology is already making its way into the home through smartphone apps. For example, Physio Track is used to track and monitor the rehabilitation of patients. The app prescribes specific exercises and routines tailored to the patient's situation, all while being completed in the comfort of their own homes. However, this must be taken one step further with integrated, built-in systems that can help the vulnerable and non tech-savvy patients.





With **76% of those surveyed for our research admitting to being worried about their elderly relatives living alone**, healthcare providers could go beyond just a simple app by partnering up with smart home companies. Together they can create alert systems that monitor if a patient/homeowner's daily routine is broken, or appears to have been disrupted, and alerts designated family members or medical professionals. This kind of technology is already available, it's just not widely known about. Different sensors in the home are able to monitor different activities, for example recording the times lights are switched on or when showers are used. All this data is then pulled together in a central hub and analysed to recognise a household's daily habits. This kind of technology is extremely appealing as a way of giving peace of mind to relatives that cannot be constantly monitored in the home.

In five to ten years' time a third of all smart homes will be equipped with elements of health-related tech and in ten years' time they will have health carefully built into our everyday home routine, starting with existing and typical household appliances, such as kettles or fridges. At the touch of a button, as well as the normal functions of the appliance, devices will also be able to record valuable data, such as the user's temperature or strength of muscles. Currys already sells a range of fridges that you can control with your smartphone, allowing you to check food, troubleshoot issues and more – soon, programming to stop it being opened during a certain time period. We'll also see showers that are able to perform a non-invasive health check for subtle changes in health status when the patient steps inside. Already we are seeing beds on sale fitted with sensors to monitor for various conditions and symptoms.

This data will have the capability to be shared across multiple devices within the home, including TVs and smartphones, with alerts or pop-up reminders to ensure the patient's wellbeing is at the forefront, while still providing ultimate control and responsibility of an individual's health. Although the cost of this technology is high at the moment, in the future we'll see the costs come down and the mainstream consumer adoption happening.

The integration will also not be limited to electrical devices, taking a number of different forms such as rugs or flooring with inbuilt sensors that can detect a foot drag which could indicate certain health conditions e.g. dementia or COPD (chronic obstructive pulmonary disease).

Wearables will continue to lead the way and this could be in the form of socks, glasses and earrings being used to read vital signs. The possibilities are endless for wearables, not just for 'everyday' clothing but even for items worn in the house such as a cooking apron that can identify and call for help if it detects that the person wearing it has fallen over.



Research

The current consumer demand for health monitoring in the home:



23% of 55-64 year olds would be less stressed if their home could help with their healthcare



76% are worried about their elderly relatives living alone, with **41%** most worried about them suffering an emergency such as a heart attack or fall



42% of 35-44 year olds are worried about their relatives not telling anyone if they feel ill

As devices become part of everyday living, it's important they are integrated into the home, to make patients feel entirely at ease. Making them as invisible as possible ensures patients feel 'normal' without risking any further complications to their health.

How will the connected home change the medical industry by 2020?

How the connected home will look in the future, drawing on the specific technology use cases in the future (2020 and beyond):

2020

The connected home is not something we should think of as futuristic, it's here and now. According to Gartner, by 2020 the average home will have more than 500 connected devices, ranging from washing machines to light bulbs. The technology is readily available to allow our home appliances to communicate with one another and they can even anticipate our routines and personal preferences. Developing everyday appliances to specifically help the patient and therefore fit into the connected home is the next immediate step for the medical industry.

A hip replacement patient recently became the first in the country to be discharged from hospital on the same day as his operation as part of a 20 patient trial that will see post-op care carried out in the home. This breakthrough is set to save the NHS millions as more than 95,000 hip replacements are performed by the NHS in England each year, with each

one typically involving a hospital stay of three to five days. A day in a hospital bed costs the NHS an average of £400 and increases the chance of a patient developing heart problems or picking up the MRSA superbug. With the connected home looking to aid this process by monitoring the patient and offering inbuilt rehabilitation checks such as wound healing and infection control, it won't be long before it's normal for a patient to be able to go in for major surgery in the morning and be home again the same day.

By the same token, it will also become normal to send and receive data and stats constantly at home, communicating your progress with your doctor and sharing your vital signs with them for monitoring. Applying big data analytics is essential for triaging this patient-generated data stream, identifying what's clinically important and routing it to the appropriate provider.

It will also become the norm for consultations with doctors and specialists to take place via video conference in the home with the same level of care and treatment you would expect to receive in the hospital or doctor's surgery.

However, when it comes to paying for this treatment, home monitoring is still an unknown area. For instance, if a patient is on early discharge, the bill should be paid by the secondary care organisation, but that could pose a potential risk for the patient getting moved over to the community care and social care teams. As such, reimbursement and responsibilities for this should now be defined as it could become a more confused area for the payer. The biggest concern at this point in time is that the patient and their family will end up footing the bill if healthcare organisations do not plan ahead for this and step up to the plate by putting in the appropriate measures.



Why the connected home can replace healthcare services

The connected home will be a major enabler in helping the NHS to replace certain healthcare services, freeing up beds for just the most serious cases and easing the pressure on GP surgeries and A&E departments. It will empower patients with long-standing health conditions who spend their life in and out of hospitals undertaking tests, monitoring, rehabilitation or therapy, and give them freedom to care for themselves in a safe way.

Constant home monitoring will also provide accurate insight into patient rehabilitation and enable consultants to better track each patient's progress. Home health technology will continuously check for vital signs and everyday non-invasive health checks will be possible without the need for a doctor. This could improve the early detection of heart problems by looking at subtle changes in heart rhythm patterns and enabling preventative intervention before the patient suffers a heart attack or other such cardiac event.

With technology in the home monitoring daily routines it will be possible for this technology to immediately spot any abnormal behaviour, ensuring you're not going to the doctor or A&E department unnecessarily. The knock-on effect of this will see people taking better care of themselves as they will also be able to understand their pattern of behaviour and spot triggers that cause them to feel unwell. By tracking behaviour patterns people can diagnose symptoms early before they worsen and become a bigger issue that requires potentially invasive treatment.

As a direct result of this constant monitoring, there will be no such thing as 9am – 5pm healthcare anymore. We will still need the visibility of our doctors but we don't need a physical place to go and see them. Waiting times can be dramatically reduced, treatment can take place faster and patients can return to health quicker.



Saving money – the real business case

At the moment the cost of an appointment with a consultant can cost anywhere between £250 to £400 depending on the specialism required. When you factor in how many appointments each day are either lost or missed by patients, the cost to the NHS is staggering. In contrast, the cost of connected home monitoring for patients would be about a tenth of the current NHS spend – with no overheads.

What's more, many patients have to stay in hospital when they don't need to e.g. those having physiotherapy or regular medication. With a night in a hospital bed costing the NHS about £400 a day, allowing patients to recuperate at home, fully supported by medical staff and monitored remotely in the same way as they are in hospital, the average cost per patient could be down by 60%. Extrapolated to every patient over a year, the potential savings are enormous. By freeing up the medical professional's time in hospital it will allow them to better focus on their speciality and individual patients, perhaps even allowing more time for research.



Research

36% have **waited up to a week** for a GP appointment,
29% have **waited up to 2 weeks**

17% of 18-24 year olds have **waited 5 weeks**
for a GP appointment

20% of 35-44 year olds have **waited 3 weeks**
or more for an appointment

Females are most concerned about the length
of time they have to wait for an appointment (44%)

18-24 year olds are the age group most likely not to go to the
doctor if they don't know or are embarrassed about their symptoms

25-34 year olds are most concerned out of all
the age brackets about the appointment time wait, with 47%
putting them off going to see the doctor

What must happen to reach this vision?

Policy changes

Policy changes will need to occur in order to completely facilitate this vision of connected home healthcare. There are many questions that device manufacturers and the government will need to think about.

Many people will understandably be worried about litigation, therefore it is imperative both consumers and the industry know where the buck stops. This as yet uncharted territory will need the requisite attention and investigation lest it become a legal minefield for patients and professionals alike. Every conceivable scenario must be carefully considered, so that no loophole can be left open to exploitation.

- ❓ Where will all the data being gathered sit and who will have control of it?
- ❓ How do we share the data being gathered from consumer devices in an appropriate and helpful way with medical professionals?
- ❓ How can doctors ensure that the data they are receiving is viable, and how will medics interact with it once it has been received?
- ❓ Who does the blame lie with if an error occurs in the data collection? Is it the doctor for not acting on it? The device manufacturer if equipment fails?
- ❓ How much responsibility is handed over to the patient?

Data protection: the fears of the consumer

In 2017, data protection laws will change – instead of being auto-enrolled to grant permission to share data the emphasis will be much more on allowing people the choice to 'opt in' for data sharing. In the medical environment this could mean important records are deleted if patients chose not to or forget to.

Having this choice of data sharing opens up the important debate surrounding who owns the rights to all the data being gathered across the multiple home devices. The patient or the health service? Who would and could data be used by? Ultimately the patient owns their own data, yet this grey area occurs when the health authorities buy the technology and, as such, own the system. This opens up a debate about whether external companies have certain rights to the data and creates big questions around how they will use it. Patient education is crucial to avoid this,

as media hype has led to misconceptions of how data is used and is therefore holding back the potential of such technology. Data ownership could actually be the make or break for the connected home.

If data is used incorrectly, what happens if someone else gets hold of the data who hasn't been given permission to use it? If someone with a serious health condition had their data stolen, the consequences for that person could be disastrous and make them vulnerable to all types of issues. For example, if your health data was leaked into the public domain, could your employer use this against you? Could a car insurance company get hold of it and increase your premiums?

Ultimately manufacturers and, more importantly, government policy makers should be the ones to hold responsibility for ensuring that clear guidelines are set in terms of what can and cannot be shared and who is left accountable if the data falls into the wrong hands.

Consumers will not just have an emotional response knowing their private data is in the hands of someone else, they need to understand the legal implications and how to protect themselves.



Research:

33% are worried about the security of personal data contained on their smartphone, tablet, laptop or computer



2 PART

Virtual Reality – the connected home health enabler

The use of Virtual Reality (VR) in the home is not limited to gaming.

Mental health and depression is rapidly being treated through the use of VR headsets, allowing vulnerable patients the opportunity to be treated with dignity in the home, where they feel safer and more comfortable, but with the same quality of care they would receive in traditional therapy sessions.

Physiotherapy treatment is also now being conducted via VR, particularly among those who would otherwise have needed complex rehab plans. Young people, who are familiar with the use of VR in gaming, find it very engaging and less invasive than normal methods, sometimes even speeding up their recovery time.

VR can also be used as an education tool in the home to teach patients and their families or carers about hygiene and conditions like obesity in an impactful way. Children can have information about serious treatments explained to them in a more experiential and engaging way that they are more likely to retain.



Why would VR be beneficial?

VR systems in the home will empower users to work through rehabilitation / therapy at their own pace rather than being limited to specific appointment times for hospital treatment. This could speed up recovery in lots of scenarios from a patient learning to use a prosthetic limb to someone recovering from a stroke.

Many people also have negative connotations about hospitals so being able to provide access to treatment without having to step inside a hospital building is very compelling. Of the consumers we surveyed, 52% said they would be willing to try VR for group rehabilitation within the home and 78% feel current rehabilitation methods are not effective.

VR will also enable those who struggle with opening up to strangers to have the ability to gain the benefit of group therapy treatment anonymously. With the use of avatars in a virtual group therapy session, patients will be able to receive the same level of treatment, with the feeling of being totally safe in their anonymity.

Another benefit to using VR within the medical industry is in training the doctors of tomorrow. As the elderly population increases, so too does the need for doctors specialising in geriatric care. Medical students may not have any personal experience with what it's like to be over 60 which could lead to a disconnect between patient and student. A project called "We Are Alfred" from

Embodied Labs uses VR to help bridge that gap and immerse students into a hypothetical patient's life complete with audio-visual impairments. The beauty of this project is that it gives the doctor the experience of the patient outside the doctor's office — such as their relationship with their family — and to feel firsthand what it's like to be told you have an impairment.

How cost-effective could this solution be to the NHS / patients?

Mental health in particular is putting the NHS under intense strain. According to NHS England, mental health problems impose a total economic and social cost of over £105 billion a year.



What's even more worrying is that only a quarter of all those with mental illness such as depression are in treatment. The use of VR as an alternative solution will not only be incredibly cost effective, but also means patients can be treated at a time that is most convenient for them within the home. Patients prescribed VR equipment would have it available 24/7

so the most vulnerable people can get help the moment they need it. They don't have to take time off work, or wait for an appointment in advance. This kind of immediate access to treatment could truly end up saving lives.



What are the challenges that come from using VR?

The benefits and potential of VR are compelling but there are still some challenges which need to be overcome in order to make VR treatment at home completely accessible. Firstly, headsets need to be suitable for everyone. Low cost, accessible viewers like Google cardboard, which sync with smartphones, are helping to overcome this challenge and bring costs down, but there is still some way to go for the full VR experience to be accessible to the mass market.



Given how new and unusual VR still is to many people there are some important unknowns to iron out. What is the protocol if someone 'freaks out' or becomes emotional when they're unsupervised at home and there is no one to help calm them? Will it require extra training and money to be able to handle those situations?

Much attention has been given to Sony's PlayStation VR which is set to launch in October 2016. With amazing graphics, headsets like these are sure to help move VR into the mainstream and play

an important role in overcoming initial fears or preconceptions people may have about using this type of technology. However, as VR is set to play such a vital part of the future of our healthcare system, it is therefore imperative the technology is taken seriously and not just as a gimmick. This should be made easier with other gaming companies, such as Nintendo Wii's stroke rehabilitation, already incorporating health benefits into their systems, opening up the connection between medical benefits and games.

Once VR becomes more mainstream the challenge then becomes how it can be made into a generic healthcare platform. This is not something that will happen overnight, but within a few years it's certainly possible. And, when it does it will be an incredibly powerful tool.



Research

78% feel current rehabilitation methods are not effective

Almost 1 in 5 patients are interested in using VR in the home for rehabilitation

Men are more interested in VR as rehab than women – 1 in 5 males, 1 in 10 females

35-44 year olds are the most interested age group in VR rehabilitation with 59% showing some level of interest

70% of 65+ year olds said they would not be interested in using VR, highlighting the lack and difficulty of patient education in this age bracket

52% are willing to try VR for group rehabilitation

Conclusion

Of the billions of dollars spent on healthcare each year, 75% to 80% of it goes on patients with chronic illnesses such as diabetes, heart disease, asthma and Alzheimer's Disease (source: Accenture Technology Labs). These conditions could all be easily monitored and treated in the home environment with connected home health technologies.



Clearly, in order to reach this vision for connected home health a number of changes need to happen. But even with innovative new healthcare models there will always be a need for hospitals, GP surgeries and physiotherapy practices as patients will still need to receive a certain amount of face-to-face interaction.

There needs to be a heavy focus on the education of doctors, nurses and the patients themselves about the benefits of connected home health. Healthcare professionals need to be made to feel secure that their jobs are not being replaced by technology. Connected home health is a mechanism to relieve the pressure on staff currently pushed to their limits and ultimately deliver better, more efficient patient care. It's an opportunity – not a threat.

The population as a whole is moving towards one of technological dependence, relying on it to fit in with their lifestyle and fit around their needs – the same goes for their healthcare. The members of generation 'Z' have grown up with technology all around them, and as they move into their professional careers and buy their own homes, connected home healthcare will go from being a welcome addition to an expected utility.

With the arrival of home healthcare comes the demise of the nine to five healthcare system as we know it. Patients will no longer be at the mercy of long wait times for a simple appointment to see their GP and hospital overheads will be dramatically reduced. Sounds ideal; we just need to create the technology ecosystem to enable it to become a reality.



About Plextek

Based near Cambridge, UK, Plextek specialises in providing solutions for complex engineering challenges.

By efficiently using a broad range of skills, Plextek delivers innovative solutions that meet the highest standards for robustness, reliability and ease of manufacture. Key markets include Defence, Medical & Healthcare, and Security, as well as a presence in IoT technology, and the design and manufacture of volume products.

In business for over 25 years, Plextek's market-focussed expertise ranges from innovation and concept development to product and system design and equipment manufacture and supply. Trusted by organisations worldwide, our teams deliver maximum value from our clients' investments in technology. For more information visit

www.plextek.com



Plextek



About Collette Johnson

Collette's focus at Plextek is solely on medical business development and helping companies with their strategic positioning relating to product development.

Prior to working at Plextek she worked at NHS Innovations with a lead role in bringing together industry and clinical organisations for product adoption and was also the programme lead for the national SBRI healthcare programme. Whilst in this role she focused on the mhealth and telehealth space and developed a network bringing together, industry, clinical and academic stakeholders.

She also worked in a strategic role in healthcare at Cambridge Consultants for world-leading corporate organisations and highly innovative start-ups.



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