E-HEALTH AND MOBILE APPS IN THE NHS

Abstract

This resource details how mobile phone applications are currently being used as an "e-health" solution to supporting healthcare delivery within the NHS. The potential opportunities and barriers to wide-scale use within the NHS are explored, as well as potential Healthcare Science. A summary of the apps catalogued within the NHS App Library is given, alongside suggestions of alternative ways they could be used to manage the COVID-19 crisis. The barriers to integrating e-health solutions to NHS pathways are explored, as well as potential solutions for successful adoption.
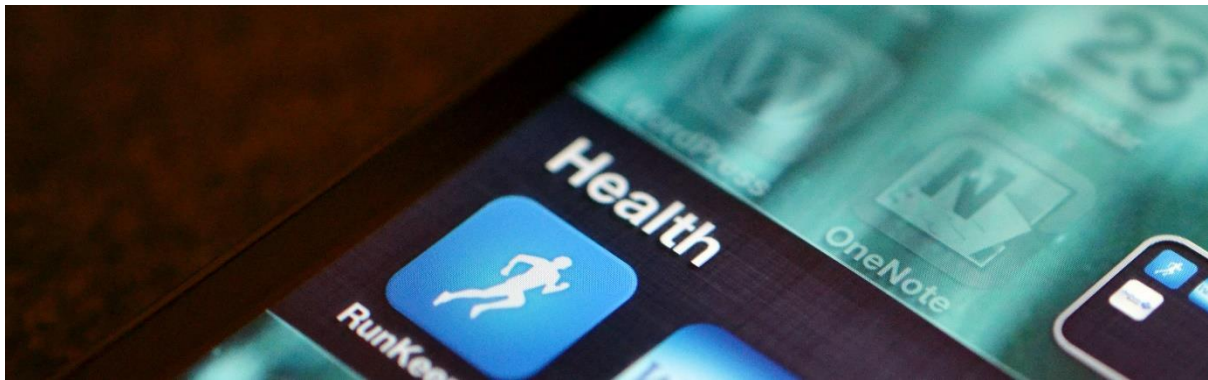
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Ehealth and Mobile Apps in the NHS

"Mobiles are now part of the fabric — every day in everybody's life. So, if you're not looking at mobile solutions, then you're not really looking at all solutions."
Mal Postings Global CTO — IT Advisory Ernst & Young

As a nation, the UK has the highest percentage of smartphone users in the world, with 83.9% of the population (an estimated 55,504,000 people) owning a smartphone. Mobile applications (apps) account for the majority of time users spend on their smartphones, accounting for 89% of mobile media time with the remaining 11% spent web browsing.

Of the millions of applications available for smartphones, over 327,000 are dedicated to health and well-being. This is unsurprising as the use of mobile technology in healthcare has seen accelerated growth in the past decade, largely due to advances in wider accessibility and affordability of portable technology. This growth has led to a new kind of patient healthcare known as electronic health (ehealth) or sometimes referred to as mobile health (mhealth). An advancement from earlier desktop and internet-based healthcare models, ehealth is able to take advantage of the multiple sensors and image capturing modalities readily available on most mobile phones, and is more accessible and affordable due to exponential growth in technology innovation creating an over-saturated marketplace.

A recent review on the prescription of clinically useful mobile apps by Gordon and colleagues (2020) covered the essential components necessary for healthcare professions to be successful when integrating mobile apps into medical and personal care. This model provides an interesting framework to examine the strengths and weaknesses of the current NHS approach to ehealth. The model also highlights opportunities to maximise advantages of the potential cost and care benefits of current and future ehealth integration.

Additionally, the current COVID-19 crisis has shown us that additional and innovative ways of working are necessary in these difficult and unprecedented times. Astute use of the many applications currently available in the NHS may be able to alleviate some of the pressures felt by patients and healthcare professionals. To this effect we have examined the apps currently available via the NHS library, summarised their features and offered potential alternative uses to improve patient care.

Current Uses

There are currently 91 apps available on the NHS Apps Library which have been assessed and approved by experts with technology and policy backgrounds to ensure they comply with national standards, regulations and industry best practice. The apps have been designed to help patients manage their own health and wellbeing in a variety of ways. Apps can be searched for based on the health condition they cater to. A more detailed catalogue of what each app offers can be found [here]. Although most apps have been specially designed to provide information or support around a particular condition, there are a few overarching themes that each app is aiming to achieve. These include linking healthcare and patients remotely, allowing patients to access their own health records and prescription information, home monitoring of their symptoms, and providing support for mental health.

Apps for Monitoring Symptoms

A key area where digital apps have been employed is in the measuring and monitoring of symptoms. These range from very specific (measuring one biochemical marker e.g. albumin and creatinine ratio to monitor diabetes) to general monitoring of heart rate, blood pressure, glucose levels, sleep patterns and general symptoms (e.g. classifying breathing difficulty from mild to severe). A table containing example monitoring apps, their features, and potential alternative uses during COVID-19 can be found in Appendix 1.

Allowing Remote Access to Patient Information or Prescriptions

Many apps are available focused in the primary care sector, aiming to link patients to their GP's through access to online medical records, ordering of repeat prescriptions, booking appointments allow free ordering and delivery of repeat prescriptions. A list of these, their features and potential uses during COVID-19 can be found in Appendix 2.

Linking Healthcare Professionals to Patients Remotely

There are a number of apps that allow patients to access medical advice from a qualified healthcare professional, without having to attend a formal appointment at a GP or hospital setting. The apps range from linking patients to their own dedicated health coach to a qualified CBT therapist over text. Apps of this type have been tailored suit the needs of their specific patient population from teenagers to pregnant mothers. These apps aim to improve equality and accessibility to high quality healthcare advice, no matter where the patient is. They may also help to ease hospital waiting list times, as the workload is distributed to a more community-based model. In a time when many people with chronic health conditions are being urged to shield indoors, apps such as these are vital in protecting these vulnerable patients, while still connecting them to the healthcare advice they may need. These can be found in Appendix 3.

Delivery of Treatment Programme Through Mobile Apps

Many apps have been created to facilitate the online delivery of full treatment programmes. These programmes range from diabetes education and lifestyle changes, self-management of specific long-term illnesses such as chronic pain and lymphoedema, access to mental health therapists and full courses of CBT and mindfulness meditations, and smoking

cessation programmes. Advantages of these apps are that the patient can engage with the content wherever, and whenever is convenient for them. Although many clinicians feel that the patient-clinician relationship will not be as strong in the absence of face-to-face appointments, many of the apps provide a personal coach or healthcare professional that regularly follows up and interacts with the user. Without limitations of attending hospital appointments at certain times, in certain locations, this option can help to make important services more accessible to certain groups. Such apps will become increasingly important during COVID-19 as vulnerable patients continue to adhere to shielding precautions. A more detailed list can be found in Appendix 4.

Linking Healthcare Teams and Disciplines via Secure Messaging Applications

The importance of instant, secure communication within multidisciplinary teams is essential for efficient and confidential treatment of patients. As more services adapt to partial remote working, being able to receive advice from consultants and colleagues who are not physically present at the point of care will enable peer review and MDT working even under present restrictions. All apps developed for this purpose are GDPR compliant and have various levels of security to ensure that the only individuals accessing patient case information, photos and information are the clinicians directly involved in their care. A more detailed list can be found in Appendix 5.

Mental Health

There are 22 mental health apps currently on the NHS Apps Library. They revolve around self-help for mental health control and cover a range of areas from anxiety, self-harm, mindfulness, relaxation techniques, mood tracking and expressing using evidenced based therapy techniques such as cognitive behavioural therapy (CBT) and dialectal behaviour therapy (DBT). The sheer volume of apps can be overwhelming for clinicians and patients seeking help. We have categorised them into four groups by their intended purpose and provided summaries for each in Appendix 6. They include:

- **Anxiety and low mood management**: Be Mindful, Beat Panic, Big White Wall, Chill Panda, Feeling Good: Positive Mindset, My Possible Self, Silver Cloud, Silver Cloud, Stress and Anxiety Companion, WorryTree.
- **Self-harm**: BlueICE, Calm Harm, DistrACT.
- **Sleep**: Sleepio, Sleepstation, Pzizz.
- **Emotional well-being training for kids**: eQuoo, ThinkNinja, Thrive.

Building Communities

The value of maintaining social connectivity through digital means has been demonstrated most clearly by the current COVID-19 crisis. Apps that connect people and build communities will become increasingly important as the public continue to maintain social distancing and shielding precautions. HealthUnlocked app connects people with the same health condition, providing a support network to share advice through. Big White Wall is an anonymous community where people can share how they are feeling and see they are not alone. Further details can be found in Appendix 7.

New Ideas for Current Apps in the COVID Crisis and Beyond

The Need During COVID-19 Pandemic:

The current COVID-19 pandemic has rapidly changed the way we interact, prioritise and work as healthcare scientists. There has been an urgent call for new and innovative ways of ensuring patients still have access to our specialised services, without compromising their safety. With lock down measures in many countries involving limitations on the number of times individuals can leave their homes, reduced public transport services, and general advice to minimise social mobility, many people have the risk of becoming less able to access the healthcare they are entitled to. The very first (out of seven) principles that guide the NHS is that "the NHS provides a comprehensive service, **available to all**". To achieve this, novel ways of reaching patients remotely have been prioritised across the specialisms.

Telephone and video platforms have allowed appointments, often referred to as teleconsultations, to be carried out remotely between the healthcare professional and the patient. Telemedicine has enabled patients in the community to still receive clinical care from healthcare professionals, without leaving their homes. Introduction of these virtual appointments are a safe and effective way for clinicians to triage who needs to be urgently seen for a face to face appointment, who can be provided with health advice remotely, and guide the diagnosis or treatment options for each patient. The platform of choice for carrying out these teleconsultations varies between GP surgeries, NHS Trusts and specialist departments. This adoption of technology in place of face to face appointments has been instrumental in keeping both patients and staff safe from each other and reducing the transmission rate of COVID-19 through the population. Also facilitating the social distancing measures that are so essential to minimising the R rate.

Apps such as Patients Know Best could potentially be used to enable patients to be seen by any available doctor or healthcare professional. The Patients Know Best app can store medical notes from any connected healthcare provider, store patient details on treatments, medication and allergies, can host online consultations and allows care plans to be edited with the online clinician. These features could be used to take the strain off more intensely hit areas (London, Birmingham etc.) by making use of medical professionals in less affected areas who have more capacity.

Mobile apps that disseminate information to the general public and amongst healthcare professionals have also been essential to providing patients with health advice remotely. Condition specific monitoring apps explored in above sections have been used to provide patients with key information about their health condition, while apps providing patients access to their personal medical records, allow them autonomy over managing their appointments and prescriptions.

Alternative Uses:

The COVID-19 crisis has forced us to reassess the frameworks in which we have been working and ask whether there is another way of delivering care - both in the current climate and in the future. For immediate use, we should be looking at how ehealth apps that are currently available and have already undergone NHS Digital approval, can be used in novel and innovative ways. For example, the current government guidelines stipulate that hospital inpatients should not have more than one visitor to minimise how many people are allowed into hospital wards. This restriction is necessary to minimise spread of COVID-19, but also means that inpatients may feel higher levels of isolation and anxiety as they are not allowed to see their family and others within their personal support networks. In parallel, the caregivers and family members who would usually be able to visit their friends and relatives in hospital are now unable to do so. Some patients are able to maintain lines of communication with their families themselves through phone calls, video calls over facetime or WhatsApp, or texting. However not all inpatients will have the smartphones capable of this, or the technological knowledge to use these apps independently.

Different hospitals have tackled this issue in many different ways. Some have set up a specific family and friends hotline run by redeployed volunteers so that messages can be taken from patients' family members and conveyed to the ward staff and on to the patient at a convenient time. The volunteers are able to pass on messages and print out photos from family members to give to the patients, as well as phone family members back with updates from the ward staff. This intermediate hub of communication allows messages to be conveyed between inpatients and their families, without going directly to the staff nurses on the ward who are already stretched with acute medical priorities.

Another potential avenue of communication would be to use apps that are currently designed for linking premature babies that are in neonatal intensive care units (NICU) with family members who may not be able to visit them. Apps such as Integrated Family Delivered Neonatal Care (IFDC) allow the clinicians looking after the baby to upload photos and updates on the baby's health condition. The parents or family members outside of NICU are then able to view these updates on the app's secure diary. vCreate is another app with the same aim of connecting relatives with premature babies while they are still in NICU. vCreate has the added functionality of allowing video clips to be sent by care staff to the parents to provide a more dynamic insight into how the baby is doing.

These apps (further detail in Appendix 8) have the potential to be used to update the relatives of COVID-19 patients on their medical progress while they are still in intensive care units (ICU). COVID-19 patients on ICU often may have ventilators and therefore may not be able to speak to their relatives themselves, and current visitation restrictions prevent relatives from seeing their loved ones in person. This method of updating family members could help significantly in conveying important information to patient relatives, while adhering to the strict limited visitation policies still in place. These apps could primarily be used on ICU wards but have the potential of becoming a surrogate for visitation for all patients while the risk of infection spread is still high.

Additional Applications of Interest

Communication during the COVID-19 pandemic has evolved drastically to provide patients with access to the care they require, without compromising their safety. Methods of communication have changed between patient and clinician, between colleagues, and with the public. Innovations and repurposing of current platforms have enabled video calls between family, remote teleconsultations for patients, and mass dissemination of important public health information.

The MicroGuide app is an example of how the strengths of existing platforms have been employed to react to the fast changing nature of the COVID-19 pandemic. MicroGuide was originally launched as a Medical Guidelines app to improve antimicrobial stewardship. Healthcare professionals were able to input the patient's diagnosis and view the recommended antibiotic prescription, dosage and duration. The success of this app enabled clinicians to engage in evidence-based prescribing more easily, with the aim of reducing overuse of antibiotics and antibiotic resistance. Since its launch in 2013, MicroGuide has expanded to accommodate Medical Guidelines for emergency medicine, oncology and pain management amongst others.

The accessibility and the immediate updating of information for all users are the key strengths that have allowed MicroGuide to be used in the response to COVID-19. Users download the app for free, and subscribe to a "medical organisation", for example their NHS Trust. They can then download any of the Guidelines that their Trust has published, with the ability to favourite tabs and view offline. Each time the Trust updates their guidance, all users will be alerted and the latest version is automatically downloaded onto the mobile device. This means clinicians will always have the latest guidance at the point of care. At Sheffield Teaching Hospitals NHS Foundation Trust, MicroGuide has been used to disseminate COVID-19 information Trust-wide. All staff have been asked to download the app which will allow them to view guidelines on PPE and infection control, as well as more specialist guidance such as renal replacement therapy for patients with COVID-19. The automatic updates feature is key for providing COVID-19 related information, as guidance is changing day by day as we learn more about the virus.

In addition to the communication successes, the COVID-19 pandemic has also caused significant breakdown in communication. The use of face masks and other necessary PPE unfortunately remove the communication cues that many individuals with hearing loss rely on. Non-verbal cues such as lip reading, and facial expressions heavily supplement the individual's ability to follow what is being said. However, clinicians without hearing aid experience often assume that if the patient is wearing their hearing aids, they should be able to hear. With almost one in six people in the UK living with hearing loss (Action on Hearing Loss, 2011), this should be an issue prioritised on a much wider scale. The proportion of elderly patients requiring hospital care for COVID-19 also overlaps with the proportion of the population with higher rates of hearing loss, with over 40% of people above 50 years old, and 70% of those over 70 years old being hearing impaired (Action on Hearing Loss, 2011). Therefore, providing supported communication is essential for this already vulnerable population.

Fortunately, there are many mobile applications that can help in bridging this communication gap. Speech-to-text apps such as Live Transcribe (Android) and Hearing Help (Apple) enable what the clinician is saying, to be captured as text for the hearing-impaired individual to read. This real-time transcribing provides a more robust way of communication, where the patient has the opportunity to fully understand what is being said, using a method that does not rely on their handicap. Features of these apps allow text to be enlarged for those with vision impairments, and the transcription to occur continuously, or only when a button is held down.

One of the cornerstones of modern medical practice is obtaining informed consent from patients before procedures are performed. The General Medical Council states that communication "in a way, patients can understand" is crucial to obtaining informed consent. To address this, a new library of communication flashcards has been created called CardMedic. This free catalogue has easy-read flashcards that communicate important information using clear, simple language. The flashcards were created specifically for patients in intensive care units, so have flashcards for BiPAP/CPAP procedure, to asking whether the patient is comfortable.
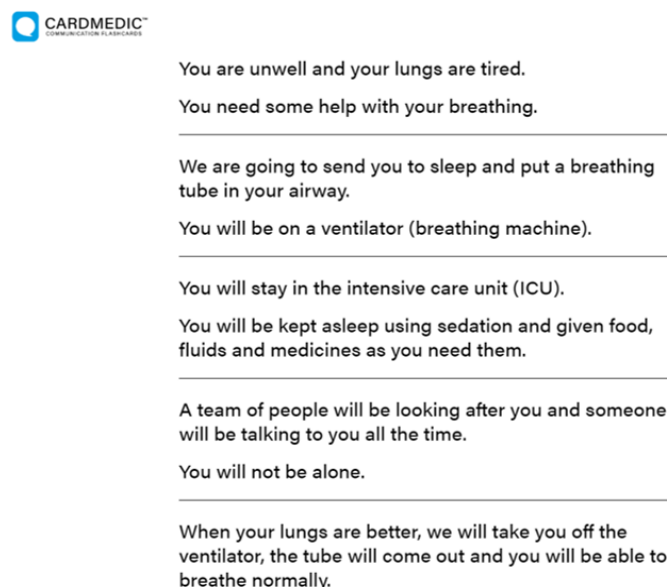

CARDMEDIC
COMMUNICATION FLASHCARDS

You are unwell and your lungs are tired.

You need some help with your breathing.

We are going to send you to sleep and put a breathing tube in your airway.

You will be on a ventilator (breathing machine).

You will stay in the intensive care unit (ICU).

You will be kept asleep using sedation and given food, fluids and medicines as you need them.

A team of people will be looking after you and someone will be talking to you all the time.

You will not be alone.

When your lungs are better, we will take you off the ventilator, the tube will come out and you will be able to breathe normally.

Fig. 1: Cardmedic Interface (Accessed via https://www.cardmedic.com/intubation)

Respiratory

ResApp is an Australian based Ehealth company which specialises in diagnostic solutions for respiratory disease using mobile technology. The company has reported good initial findings from its computer learning based algorithms (ResAppDx-EU) on acute and chronic respiratory illness management and on the diagnosis of sleep apnea. This technology works by listening to a patient's respiratory sounds and comparing these to "signatures" developed by cataloguing respiratory sounds of known clinical diagnosis over years of research. By comparing the sounds, the technology is able to diagnose the individual with acute respiratory issues (upper and lower respiratory tract infections) or an exacerbation of their known chronic issues (COPD and Asthma).

Interestingly, a smartphone application using this technology could be incoming after deal with global health product manufacturer RB. The software has been used in the COVID-19 crisis to help triage in support centres in Australia and been integrated into video chatting technology to provide a remote respiratory consultation during the COVID-19 crisis. Importantly, the ResApp software (ResAppDx-EU) been approved for European markets as a class IIa medical device. It is important to note that the company is still collecting research on their software, a breakdown of their initial findings for sleep apnoea, acute respiratory and chronic respiratory are available to view.

Peak flow rate is a well-accepted monitoring and diagnostic measurement for patients with asthma. Smart Peak Flow is an electronic peak flow monitor (£40-60) with an accompanying free mobile application that will track and monitor a patient's peak flow and give simple to follow advice. The Smart Peak Flow medical device could replace traditional plastic peak flow monitors, that while cheaper, often have poor compliance or poor mapping of results. Smart Peak Flow addresses these issues by setting reminders for individuals to test their breathing, coupled with automatic mapping results for the patient and clinician's reference. Most importantly, Smart Peak Flow has been shown to be far more accurate than traditional peak flow and is a certified medical device in the EU. However wide scale use of the device and app does involve an initial investment. Currently this has been endorsed by Imperial College London and Harvard Medical School.

The app has good reviews with ease of use cited as it's major advantage. It can be used via Bluetooth or with a headphone jack depending on the mobile device it is coupled to. A demonstration of how the app is used can be found here. While this device is aimed at asthma monitoring and attack prevention, it may also be useful in COPD patients. Peak flow in COPD is less clear, however research has shown a relationship with daily peak flow instability is linked to increased negative health outcomes. Therefore tracking peak flow can help to predict COPD exacerbation. During the current COVID-19 crisis COPD patients are especially vulnerable to infection and should be monitored more closely. Having a remote monitoring system may give patients the confidence to seek help sooner or clinicians the ability to pinpoint when respiratory function started to decline, improving care and limiting hospital stays.

Radiotherapy

Radiotherapy is a complex multi-stage process involving input from oncologists, physicists, radiographers, technicians, dosimetrists and various other staff members. In order to meet the demands of treating large numbers of patients, the radiotherapy pathway must be highly efficient. Digital apps can help oncologists to perform simple tasks, allowing them to save time and speed up the treatment planning process.

A comprehensive review of 31 radiation oncology apps, performed by two trained oncologists, showed that there are high-quality apps available for android and iPhone users that cover different areas of radiation oncology. Such areas include dose calculations, clinical calculations, staging and a combination of all of these.

For dose calculations, apps such as eLQ can carry out radiobiological calculations . The eLQ app comes with a useful tutorial, a complete library of alpha/beta values that are required for the calculations and useful links that can provide the user with additional information. With the eLQ app, the user can select an organ at risk, or a predefined α/β value, and enter total prescribed dose, initial dose per fraction, and new dose per fraction which allows the equivalent dose to be calculated. The linear quadratic model is then applied to predict the biological response to radiation when fractionation is altered. This innovative tool was created by The French Society of Young Radiation Oncologists (SFjRO) with the aim of "providing radiation oncologists with a ready-to-use tool that fits in a lab coat pocket". The eLQ app enables the biological equivalent dose for radiation therapy treatment to be calculated quickly and accurately to ensure the prescribed dosage will be safe for the patient.

There are many other dose calculation apps similar to eLQ. An app called Dosimetry for example allows unit conversions, particle ranges, dose and decay rates can all be simply calculated by inputting parameters such as the activity, distances and material. All commonly used radioisotopes are selectable from drop-down menus within the app apart from more recent developments, such as lutathera. Although probably best adopted from a training standpoint to check own calculations and verify results from other sources, the app provides possibility for on-the-go back-of the envelope calculations occasionally carried out by scientists in routine work. Specific auxiliary tools have been developed for use in oncology. These include OnCalc and RadOnc Reference which can help oncologists quickly perform clinical calculations to obtain a patient's body mass index, body surface area, creatine clearance values and other dosimetric and clinical calculations quickly.
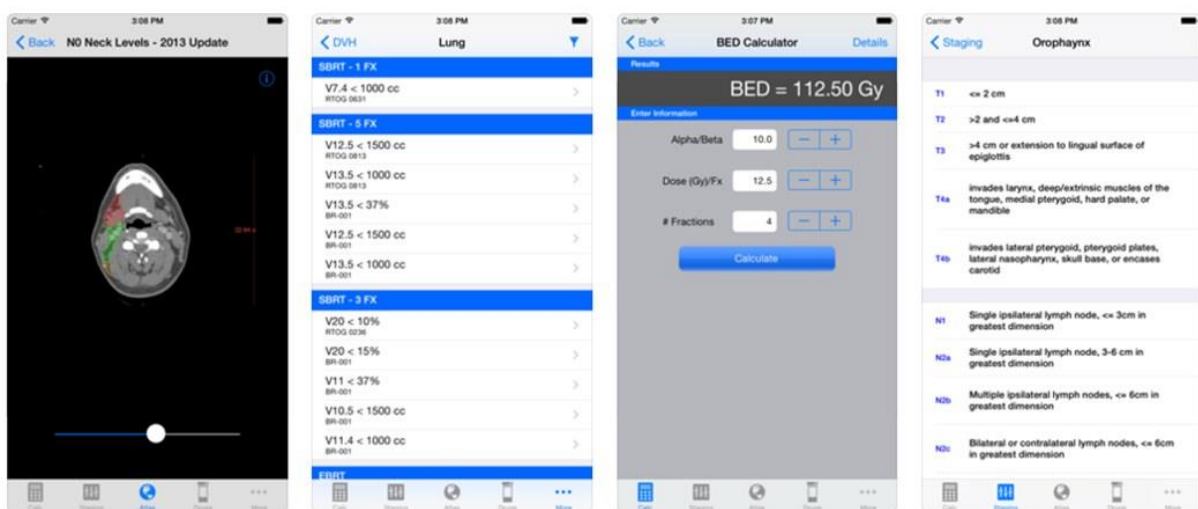

Fig. 2: RadOnc Reference Interface (Images sourced from the App Store https://apps.apple.com/us/app/radonc-reference/id563419791#?platform=iphone)

The convenience of mobile apps has been harnessed to disseminate essential Clinical Practice Guidelines to oncologists around the world. The National Comprehensive Cancer Network (NCCN) released the NCCN Guidelines® App in 2010 to improve up to date, point

of care access to their guidelines. Over 2 million guidelines had been downloaded through the app in 2018 alone by users across the globe. Improving access to Clinical Guidelines through apps such as this, increases the uniformity of oncology practice internationally, by ensuring oncologists are basing clinical decisions off evidence-based informed guidelines. The NCCN has tried to remove barriers to inequal access to oncology expertise by making all their guidelines and apps free to access and download from anywhere in the world. Having access to the most up to date versions of these guidelines, wherever they may be, ensures that patients are receiving high quality care, no matter where they are seen.

NCCN has also launched an additional free version aimed at helping patients and their caregivers understand their cancer care, to facilitate informed, two-way discussions with their oncologists.

Medical Physics

Understanding Medical Scans is an app developed by the National Institute of Biomedical Imaging and Bioengineering. The app is split into various areas for medical scans: PET/SPECT, CT, MRI, US and X-ray. The app is written in basic English for use of reference for both medical professionals and patients, covering the theory behind the scans, the justification for choosing each along with risks, types and research in each area of imaging.

The Physics Toolbox Sensor Suite app utilises the mobile or tablet device's inbuilt sensors to allow data to be recorded for a whole host of parameters: GPS/ compass/ magnetometer/ light-meter/ audio oscilloscope. Once selected, the choices bring up a time variable plot of the parameter in all 3-dimensions, that may be recorded and kept as a .csv file. There is scope for a range of application across many departments: e.g. the magnetometer could be used to crudely estimate the fringe fields of MR machinery, or alternatively assess field effects of near-by equipment. The app also features a ruler (in cm and inches) that could be used in-field if the user forgets to bring their own; although the ruler length is limited by your device size therefore is not a useful swap for tape measures.

Ultrasound (US)

Philips Lumify is a portable tele-US solution consisting of a US probe and downloadable app. The equipment can be purchased or rented at a small price tag for medical grade equipment (~£5,000 + VAT). The US probe come with a free tablet, but any Android device can be connected via the USB port. The probe charges through whatever device it is connected to, making it a light, manoeuvrable hand-held system. Although initially costly, this system has been a useful addition to care facilities especially in US/GP/emergency departments. Used primarily in emergent situations, it could expand the abilities of point-of-care ultrasound (POCUS) to allow for triage at the bedside or swift in-field diagnosis. This may prove an especially useful piece of kit within the current COVID-19 crisis as we focus on lung POCUS. Image quality has been recorded to be similar to other US systems in most respects. However, the image quality will be compromised at deeper structures and so is not suitable for larger patients. Philips are currently allowing a free trial of the system for 3 days to ascertain whether the equipment fits into your own clinical setting. Note: it does not work on apple systems.

Factors for Scale-Up Success

Although we have explored the seemingly endless possibilities that ehealth apps offer, there are major obstacles that can prevent digital health solutions from being successfully adopted at scale.

Greenhalgh et al. (2017) suggest that the success or failure of ehealth solutions can be attributed to four main categories: personal motivation, personal values, engagement and recruitment of users, and finally the overall quality of the technology. The NASSS (non-adoption, abandonment, scale-up, spread, sustainability) framework was developed to aid assessment of new technologies, situations and systems for each healthcare app entering the market. The framework is split into six primary domains, with subcategories and key questions to consider for each.
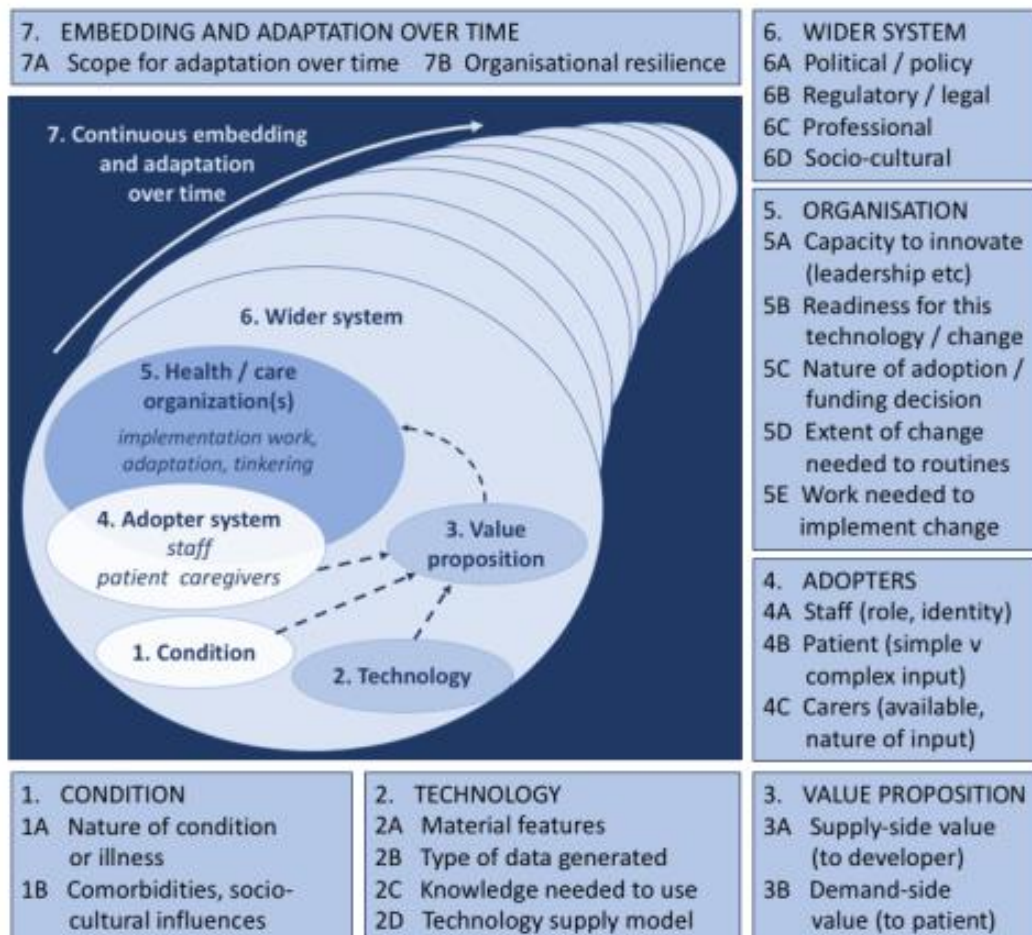

Fig. 3: The NASSS Framework. Greenhalgh et al. (2017)

Fig. 4: Model for integrating healthcare apps into clinical practice (Gordon et al 2020)

Regulatory Environment and Clinical Value

Like mainland European healthcare organisations, applications run in association with the NHS must adhere to EU data protection laws (EU GDPR). In addition to data protection laws, the EU has published medical device regulations 2017/745 which cover ehealth applications, drafted in 2017 to be fully implemented in May 2020. As it is a legal requirement, data protection is a top priority and NHS Digital thoroughly vets mobile apps before they are added to the NHS Apps Library to ensure that all those included are safe for patient use. All apps on the NHS library must also pass security checks and are required to update the library of any software updates which may threaten their compliance with set standards. The technical assessment also evaluates evidence supporting use of the app with patients and critically assesses the overall clinical value of the mobile app. However, the required level of "clinical value" that each app must meet is not explicitly stated by NHS Digital. This potentially could be problematic in regulating the quality of apps accepted into the NHS Apps Library, but also may simply be a reflection of the difficulty in creating a set standard to assess the myriad of apps that will each have varying uses and degrees of complexity.
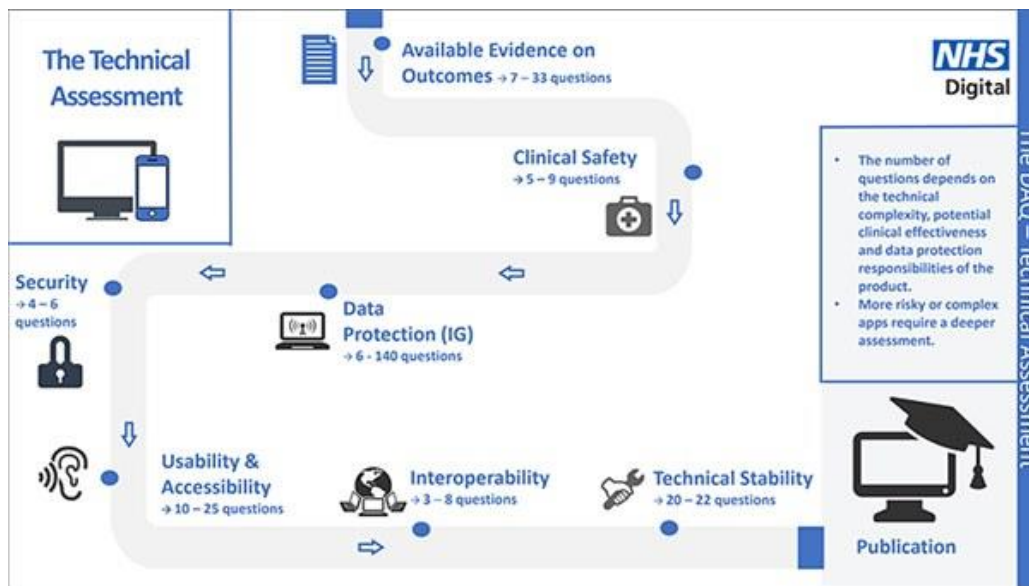
Fig. 5: The technical assessment performed by NHS library on clinical applications (taken from https://digital.nhs.uk/services/nhs-apps-library/guidance-for-health-app-developers-commissioners-and-assessors/how-we-assess-health-apps-and-digital-tools)

Digital Formularies

Gordon and colleagues (2020) suggest that a digital formulary of sorts is needed to help healthcare professionals navigate the plethora of ehealth apps available to streamline access to only evidence-supported, safe-to-use and clinically useful applications. Currently, the NHS Apps Library is the closest resource to fulfilling this digital formulary role. 91 applications are included in this library, which acts as an accessible online catalogue of ehealth apps that meet NHS guidelines approved for use in supporting healthcare settings. Apps can be easily searched for and filtered by category or specific health conditions by anyone with internet access, allowing both clinicians and patients to find apps suitable for their needs.

Current limitations of the NHS Apps Library is that it provides many options for each category, without any guidance towards which app may be better. For example, there are 11 apps for diabetes monitoring, with similar features for tracking symptoms, providing diet and lifestyle education and facilitating self-management. While the availability of these apps are fantastic resources for facilitating self-management of chronic conditions such as diabetes, the sheer volume of apps may make healthcare professionals more reluctant to choose and prescribe applications. Without a comprehensive digital formulary, clinicians have no way of evaluating the evidence base to select one diabetes app over another, which on the surface appears to provide the same features and service.

Another resource that may fill the digital formulary role is provided by the Organisation of Health and Care Applications (ORCHA). ORCHA has a more extensive library of health and wellbeing apps which are all rated out of 100% for their compliance to data protection, security and clinical usefulness among other important factors. While ORCHA admit their primary checks are not completed to the same level as NHS digital, they do provide a good level of detail in their reviews. Importantly, they constantly review applications on the app stores meaning they have an extensive library of health apps substantially larger than the NHS Apps Library. ORCHA also time stamp apps which have not been updated in 18 months, which helps users to avoid outdated software. The ORCHA website could be used

as an intermediary for showcasing new ehealth apps that have potential uses in clinical practice, before they have been officially endorsed by NHS Digital. Additionally, NHS digital could use the information on ORCHA to highlight applications of interest and contact the developers to join the NHS Apps Library.

With set standards in place and the growth of ehealth looking increasingly profitable for companies and clinically useful for professionals, we must look at what we currently do poorly, learn from it and adapt our way of working to get the most from the ehealth phenomenon.

Small issues at the user level, may elude to more significant challenges when attempting to upscale and integrate prescribed applications into internal healthcare systems. Without proper understanding of the wider healthcare systems the apps are being integrated into, there is the risk of increasing the cost and work implications without adding significant clinical value. The best people to identify where the pitfalls and opportunities in integrating new ehealth apps into internal healthcare IT systems are the clinicians who use the current IT systems every day. In recognition of this, NHS digital has made efforts to encourage innovation that originates from healthcare workers themselves. NHS Digital have provided guidance and resources to assist healthcare workers to develop their own apps or IT solutions to address issues in their practice that have the potential to be solved using innovative technology. There is also guidance on how new ehealth apps can be commissioned or adapted from the NHS Apps Library, to make use of apps that have already been developed and assessed. We would welcome innovators and problem solvers to browse through these pages and think about how ehealth might positively change how you work day-to-day.

Integrated Services

Face-to-face patient care is often time limited and the time available must be used as efficiently as possible. If apps and ehealth initiatives are to be successful in the long term they must save time and streamline the care process by being fully integrated into current healthcare systems. If this is not the case, it is likely that ehealth will only be utilised by tech savvy healthcare professionals willing to do the extra work. Gordon and colleagues (2020) cover this need in more detail using a detailed working example of a smoking cessation app prescription. The main points they identified as being crucial to a successful integrated ehealth app were:

- The app must be searchable and orderable (similar to medication)

- The app should be integrated into the clinical systems

- Healthcare professionals should be able to indicate why they have been prescribed and how they should be used

- Healthcare professions should be able to set parameters in the app which are available to the patient at time of download

- The app should appear on medical records as a current treatment

- Data generated should be available to the patient and healthcare professionals

Integration of external application systems should be the long-term goal for ehealth advocates, however the integration of internal medical systems across Trusts may be necessary before this occurs. Anyone who has treated a patient seen across two hospital Trusts will know the frustrating inconveniences of having non-integrated medical systems

and relying on phone calls and emails to gain vital information. The depth of this problem is widespread and well-illustrated in the image below from research by Warren et al (2019).
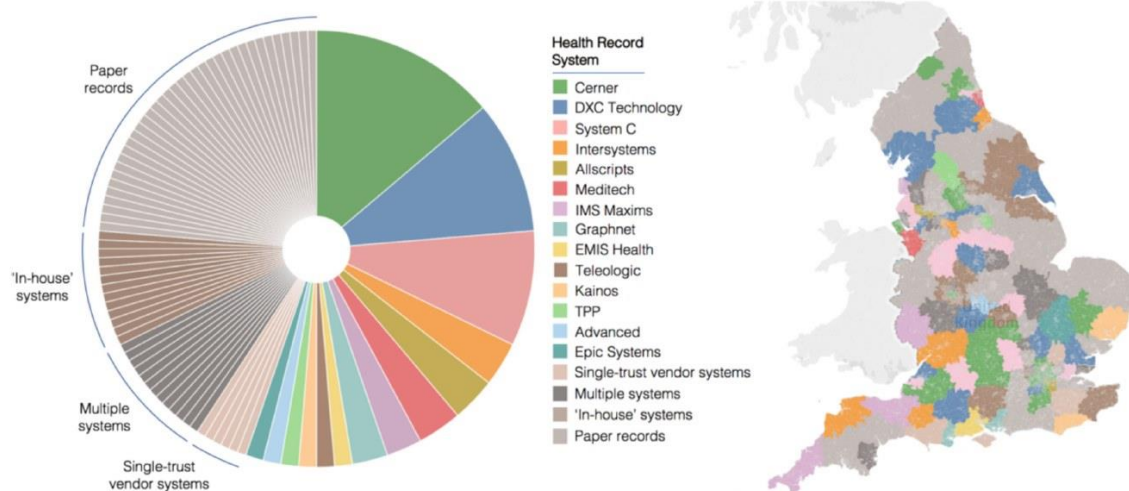

Fig. 6: Frequency of use of health record systems by trusts and distribution of health record systems in NHS England. (Warren et al., 2019).

Sharing between trusts further afield is avoided on a legality front due in part to the time taken to attain national approval and the complexity of holding the overarching responsibility as the host Trust. An increase in collaboration between various Trusts who wish to adopt a more consistent digital approach to protocol could be an alternative out of this "innovation hole".

Different Trusts utilising different software hinders the medical record sharing between Trusts and nationwide, even when Trusts use the same software, they often tailor it to local needs which again hinders integration of services. If the National Health Service cannot integrate internal services to ensure patient records are securely transferable between Trusts, it is difficult to see how these systems could integrate external applications to improve patient care. This is a further barrier to ehealth implementation, as it limits the convenience of mobile applications if the information needs to be transferred or transcribed over to the patient's medical records manually. A response to Warren et al (2019)'s research written by two junior doctors, points out that software already exists such as Fast Healthcare Interoperability Resources (FHIR) that work to integrate different systems for medical use and is supported by the top 3 systems in use across NHS Trusts. Ensuring that all trusts use software which is compatible with FHIR or a similar application could be the first step in the long road to full integration.

Moving applications out of a locality also increases the difficulties and complexities of scale-up. For example, many departments have in-house Excel spreadsheets that could form the basis of a remote application. However, as legislation dictates, once used in diagnosis or treatment these tools become classified as a medical device. The additional standards and requirements associated with medical device classification translates into a reluctancy of scale up of these effective internal applications.

Education and Awareness of Healthcare Staff

Despite the large numbers of ehealth apps available today, ehealth has not yet permeated mainstream healthcare delivery. One limitation to the widespread adoption of ehealth apps

may be the lack of awareness and confidence prescribing amongst healthcare professionals. Kayyali et al. (2017) found that only 56% of pharmacists in their study were aware of ehealth apps and of those who were aware, only 60% recommended them to patients. Although this was a small-scale qualitative study, the trends seen may reflect the wider perception of ehealth within the NHS.

We propose that education will be the key to addressing the gap between ehealth app availability and utilisation. As use of ehealth apps is a relatively novel concept, it is not routinely included in formal education and training courses available to healthcare professionals, nor is it currently widely marketed by the NHS. Clinicians qualified to prescribe treatments and medications may benefit from access to online learning or classroom teaching modules on the topic of ehealth apps and their value and use in healthcare settings. These e-learning modules could be developed by NHS Digital in collaboration with trusted developers. The required learning modules could be staged in tiers depending on the knowledge needs of the healthcare professional (for example, level 1 Awareness of Applications, level 2 Prescribing and supporting use of ehealth, Level 3a Specialist Applications). The learning modules could be added to their internal training record which all NHS employees are already required to complete before commencing new roles and update annually. Including ehealth training modules to the Trust's required internal training would enable increased awareness and training throughout the organisation. The requirement of annual refresher modules will enable clinician's knowledge to keep pace with the rapidly expanding number of ehealth options.

Patient and Professional Support

As we can all attest to, computer and technology literacy varies widely depending on a variety of factors including age, social background, mental capacity and other factors. While wrongly prescribed applications may not be as physically dangerous as wrongly prescribed medication, they can give the patient misinformation or a false sense of security leading to the mismanagement of a serious condition. As such, information and support for using new ehealth apps must be available to the patient, both at the point of care and beyond, to keep them safe and ensure the high standard of care is maintained throughout their treatment. It is interesting to consider how and by who this support could be delivered. Given the cost of a medical consultant's time, it is unlikely that technical support would be high on the list of priorities during clinic. The responsibility may fall to nurses and nurse practitioners, who already manage large patient groups in nurse-led clinics and have the relevant medical expertise to support and prescribe treatments to patients.

In my own experience as a Respiratory Scientist Trainee I have witnessed first-hand that this model of nurse-led provision and support with ehealth apps can be implemented successfully. Within my scope of practice, I have seen the Senior Respiratory Nurse in charge of leading the County Durham and Darlington Sleep Service utilise a treatment monitoring mobile application in the sleep service pathway with a high level of success. This has become even more important during the crisis and has allowed urgent sleep patients to be started on treatment using a reduced initial consultation but additional off-site support using the app and phone consultations.

Another avenue for providing support to patients and staff could be adding the creation of easy to access support videos for all NHS approved apps. The responsibility for creating these resources could lie with the app developer and become an additional prerequisite to becoming registered in the NHS Apps Library, or alternatively could be completed centrally by NHS Digital. Lastly, when providing ehealth, it must be recognised that a large percentage of the public that need help with chronic illness and health concerns are older

and may have additional technology needs. This is not to say that older individual will not use technology but app developers and those hoping to increase uptake should be aware of the additional accessibility needs to accommodate older individuals' reduced cognition, physical ability and motivation.

Staff Support

Improving staff awareness and education on application use will do little to improve uptake if they still are not confident in their application literacy. Similar to the support offered by IT services when individuals need to train on internal applications (WinDip, PACS etc), IT support for ehealth applications and systems should be available to support technologically challenged healthcare providers. These sessions could be provided by the Trust IT departments or in combination with tech savvy clinicians, to ensure both the clinical and technical aspects are covered.

'Around the clock' help desks have been shown to be effective at supporting successful adoption of new apps. This is particularly pertinent for remote monitoring or support based apps which will require further recruitment and training of additional staff. Here, a reflexive approach is important to develop the app in parallel with the users needs and skills.

Technical Considerations

Another barrier to use may be the user's internet broadband speed and capacity. High powered applications such as those used for remote biomarker monitoring, are especially reliant on good internet connection to run the app smoothly. Broadband capabilities vary extensively and cannot be predicted by region, or WiFi carrier. Realistically, this issue may never be addressed, however it is important to consider as often this issue may affect patients who live in more rural areas, who would also benefit from external home monitoring the most. This element is therefore important to assess before roll-out, and especially with each new software update to prevent good ideas and technology not working when taken back to the patient's home.

Another feature that has been linked to successful long-term use is a wider range of customisable options. This customisability allows the app to work *for the user* and their specific, often changing, needs. There is however a balance between more features and capabilities, and the overall complexity of navigating the application.

The digital literacy of the user will also affect the successful adoption of new ehealth solutions. The knowledge and skillset of the user creates an important barrier in terms of app functions and capabilities. This is likely a significant contributor to the abandonment of more-complex apps. Although the evidence base is sparse, available literature references the correlation between increased complexity of apps are correlating to lower likelihood of success in the healthcare workforce and further afield, regardless of individual app function.

Initial tutorials and navigation panels have been incorporated to overcome potential gaps with user digital literacy and the app capabilities. Most tutorials walk the user through navigation, use and purpose of features within the app with the intention of familiarising the user with the app's interface. This should be applied to all apps regardless of their target audience to allow safe, fast and efficient use.

Payment Models

In order for adoption of ehealth solutions to be successful, the app developers and advocators must be aware of the socio-economic factors that will influence how accessible the app will be for the target audience and clinicians. This pertains not only to the initial cost

of the app to download but associated 'add-ons' and equipment necessary for effective running.

Many applications are free to download and use, however some will require upfront payment or subscription. App developers rarely make applications purely to solve social or healthcare issues. Most are developed to turn a profit while providing their service, although charity developed applications may be the exception. This brings up an additional challenge for selecting apps for use within the NHS, as the efficacy and safety of applications must be balanced with their cost effectiveness.

The main issue with free applications is that they need to make money somehow. This usually involves in-app purchases made by the user or inclusion of sponsored advertisements. In-app purchases pass the cost on to the consumer. Patients may feel pressured into making purchases as the application is prescribed via their health professional. Paying for access is also problematic as it has the potential to perpetuate health inequalities as those with more disposable income are able to pay for increased access, better services and are ultimately better treatment through the hierarchy of access created by paywalls. These issues are largely nullified by revenue accruing from in app advertisements rather than user purchases. However, as ads are based on a person's personal preferences (via their internet searches and phone content), it is hard to know if these in-app ads are exposing the patient to unhelpful and potentially exploitative third party sites and apps.

Finally, there are applications which require payment to download, but can be accessed for free with a GP referral or prescription, moving the purchase cost onto the NHS / healthcare provider rather than the patient. This could be considered as the safest but least cost-effective payment model. However, there are methods that can be implemented to reduce costs for the NHS, such as commissioners licensing an app for block periods of time. This involves a sum of money being paid to the app developers/ company who provide a licensing code. This purchasing strategy is usually substantially cheaper than multiple one-off payments.

Conclusion

We are amidst an app revolution. The meta-analysis of the literature provided by Greenhalgh et al (2017) posed several hurdles to successful app adoption, however the largest barrier identified was the dynamic interaction between all factors. It will not be a one-size fits all scale-up and adoption plan. Each application will require in-depth consideration of many different factors unique to the technology itself, the purpose of the device and the specific clinical setting it will be used in. This ongoing investigation into the feasibility and sustainability of digital apps within healthcare settings will continue as the utility of telehealth and remote ehealth technology continues to increase under circumstances, such as the current COVID-19 pandemic.

The increasing knowledge of the digital world has opened many opportunities for independent living, remote monitoring and diagnosis, relieving stress from primary care services and encouraging patient autonomy and responsibility over their own health management. We may see a change in modern healthcare as we know it, moving the gatekeeper of health from the GP to the mobile phone. Though apps have the ability to revolutionise service delivery, changing the current culture will take a considerable amount of time. A little support in the short-term from the healthcare workforce could result in a large-organisational shift in the long haul.

References

Calero, J. J., Oton, L. F., & Oton, C. A. (2017). Apps for Radiation Oncology. A Comprehensive Review. *Translational oncology*, *10*(1), 108–114. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5300110/

Card Medic. https://www.cardmedic.com/intubation)

Covid-19: The Communication Needs of D/deaf Healthcare Workers and Patients are Being Forgotten. https://www.bmj.com/content/369/bmj.m2372 https://www.hl7.org/fhir/overview.html

Gordon, W.J., Landman, A., Zhang, H. *et al.* (2020). Beyond Validation: Getting Health Apps into Clinical Practice. *npj Digit. Med.* 3, 14 https://www.nature.com/articles/s41746-019-0212-z

Greenhaugh, T. et al. (2017). Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies. J. Med. Internet Res. 1;19(11) https://pubmed.ncbi.nlm.nih.gov/29092808/

Healthcare resource guide: European Union. (2019). https://2016.export.gov/industry/health/healthcareresourceguide/eg_main_108582.asp

Improving Data Sharing Between Acute Hospitals in England: An Overview of Health Record System Distribution and Retrospective Observational Analysis of Inter-Hospital Transitions of Care - https://bmjopen.bmj.com/content/9/12/e031637

Improving Data Sharing Between Acute Hospitals in England: An Overview of Health Record System Distribution and Retrospective Observational Analysis of Inter-Hospital Transitions of Care , A Response https://bmjopen.bmj.com/content/9/12/e031637.responses

Smartphone Statistics. (2020). https://review42.com/smartphone-statistics/

Top Countries by Smartphone Users. (2019). https://newzoo.com/insights/rankings/top-countries-by-smartphone-penetration-and-users/

Wildenbos, G.A., Jaspers, M.W., Schijven, M.P. and Dusseljee-Peute, L.W., 2019. Mobile Health for Older Adult Patients: Using an Aging Barriers Framework to Classify Usability Problems. *International journal of medical informatics*, *124*, pp.68-77. https://www.researchgate.net/publication/330405804_Mobile_health_for_older_adult_patients_Using_an_aging_barriers_framework_to_classify_usability_problems

Appendix

Appendix 1: Mobile applications for monitoring symptoms

App Name	Description	Opportunities for Alternative Uses During COVID-19 Crisis
ACR Digital Urinalysis	**Summary:** Tests concentration and ratio of albumin and creatinine (ACR) in urine to monitor diabetes. **Features:** • home test kit is provided by healthcare provider • subject uses a urine dipstick and uploads a photo of test kit on the app • a computer vision algorithm analyses the sample • results are automatically updated to electronic patient record • free	Could this app, or the framework of it, be used for other laboratory sciences? Could it be developed to test/ monitor other conditions using a similar home test kit and computer analysis to provide monitoring of other biochemical indicators important for monitoring disease progression and treatment efficacy? If so, there is significant value in the current COVID-19 crisis in being able to continue to monitor patients without requiring a hospital appointment. Home test kits and supporting apps such as this one will also play a key role in increasing efficiency of pathways and shortening time spent in appointments if the clinicians have access to the patient's test results before they attend their consultation appointment.
Corona-Help.UK	**Summary:** A self-reporting tool used to improve understanding of symptoms and management of COVID -19. **Features:** • Asks symptoms, social distancing, postcode and age • Anonymous • Free	
Digital Health Passport	**Summary:** The digital health passport app is designed to help young people with asthma take control of their condition. **Features:** • Create asthma action plans • track symptoms • access NHS Support • free, but access is through invite only	Could this app be used by vulnerable COVID-19 patients? Track symptoms and get advice on when to stay home and rest and when to seek medical attention. Could it be applied to monitoring positive COVID-19 cases, to better track at what stage people develop respiratory symptoms.
Engage warfarin self-care	**Summary:** Help and support for warfarin users. Self-test international normalised ratio (INR) at home. INR results update	The integration of the INR results with the patient record system allows the care team to closely monitor patients without them attending hospital

	to patient records in real time and are accessible by healthcare professionals who can send dosing schedules directly to the patient based on the INR results measured with the app. **Features:** • INR home self-testing kit • results update in real time to patient records • information on how diet and lifestyle affects INR • reminder to take tablets and date of next test • free	appointments. They can then update and prescribe accurate dosing schedules for these patients, without them having to leave their houses which may be particularly important for those who are in at risk groups and shielding from COVID-19 exposure.
GDm-Health	**Summary:** Monitoring diabetes during pregnancy if at risk of gestational diabetes. **Features**: • monitoring blood glucose • viewable by hospital midwife • presents as graph, and explains readings to patient • information about gestational diabetes, diet and fitness • free	Apps such as these will be important for monitoring patients while clinics are reduced during phase 2 and 3 of the COVID-19 response. Data collected and monitored through this app by NHS midwives ensures that at risk pregnant women continue to receive the care and monitoring required, but their risks of attending unnecessary hospital appointments may be reduced.
Healthcare Anywhere	**Summary:** Take control of your health. Get expert advice and support when you need it. **Features:** • track symptoms, treatments, injections, set healthcare goals • advice from health coaches • free with a referral	
Liva UK	**Summary:** Manage comorbidities (e.g. diabetes, heart problems and obesity) and find support. **Features:** • monitor symptoms • share data with your GP • access customised lifestyle plans, info and support • online consultations with a personal lifestyle coach • free	

Appendix 2: Mobile applications for allowing remote access to patient information and prescriptions.

App Name	Description	Opportunities for Alternative Uses During COVID-19 Crisis
NHS App	**Summary:** Store all your health information in one place, book GP appointments, order repeat prescriptions, symptom checks, access personal medical records and check the recently added COVID-19 advice section. **Features:** • Book, cancel and view GP and hospital appointments • View medical records • Order repeat prescriptions • Check symptoms • Get instant advice • sign up to the organ donor register • Check most up to date COVID-19 advice	Is this app being pushed as the recommended space for patients to store and access their medical records? There appears to be a variety of apps that allow patients to book and change their appointments, order repeat prescriptions and view their medical records. This includes apps such as Evergreen Life, Should Trusts implement a policy to advocate use of the NHS app exclusively?
Engage Consult	**Summary:** Patients answer questions about their symptoms allowing GPs to triage before phoning the patient, booking an appointment, or providing a prescription. Patients are also able to book appointments, order repeat prescriptions and have online consultations with their GP through the app. **Features:** • symptom questionnaire sent to GPs • order medication • medical record access • free for participating GPs	Could this concept be applied to specialisms in the secondary healthcare sector? Obtaining information from the patient about their symptoms before their appointment will make the history taking aspect shorter, decreasing face to face contact time and therefore risk of spreading COVID-19. Use of apps such as this we hope will increase efficiency of the patient pathway and reduce waiting lists as departments begin to open up and address their backlog of waiting patients.
Healthera	**Summary:** Access local pharmacy services, appointments, prescriptions and clinical advice **Features:** • Order free delivery of repeat prescriptions • Clinical advice from pharmacist • Book appointments for flu jabs	There are currently multiple pharmacy applications on the NHS App Library, which all have similar features and provide the same service of enabling people to order repeat prescriptions from home and access clinical advice. These apps include Echo Pharmacy (for Lloyds pharmacies) and Co-op Health App (linked to certain GP surgeries). These are particularly important for

		those who are less mobile, self-isolating or shielding during the COVID-19 pandemic.
Patients Know Best	**Summary:** Instant access to personal medical records and information on treatments, medication and allergies **Features:** • Stores medical notes from any connected healthcare provider • Online consultations • Track symptoms • Edit care plans with your clinicians online	Could we use this app, coupled with a video chat app so that individuals can be seen by any available doctor / health professional? This could take the strain off more intensely hit areas (London, Birmingham etc) by making use of medical professionals in less affected areas available.

Appendix 3: Mobile applications for linking healthcare professionals to patients remotely.

App Name	Description	Opportunities for Alternative Uses During COVID-19 Crisis
SOS QR	**Summary:** Health emergency preparedness application. Gives you a QR code which can be scanned and show your personal emergency plan. **Features:** • Emergency responders scan QR code and can view record without personal information e.g. if patient is unconsciouss or incoherent • Pressing SOS will call/text/ email your emergency contact with your GPS location • Translates records into other languages when travelling# • 99p a month or £8.99 a year	This would be extremely useful information for ED staff to have when assessing COVID-19 risk level. Could this be used for individuals to document their emergency plans if they are at risk of COVID-19 death? Also, could individuals track symptoms and medicines on this so when taken to hospital they just need to scan the code to get a better recent history?
HealthUnlocked	**Summary:** A social-media based app for individuals with chronic conditions / wanting to improve their health. **Features:** • support network • shared advice • free	Could this app be used to connect people who are isolating or shielding from COVID-19? It could help to connect people with similar conditions and experiences away from the larger networking boards for more intimate discussions. Community volunteers could also connect through the app to decrease loneliness and help foster stronger communities.
Chat Health	**Summary:** A confidential messaging service that allows you to chat anonymously with healthcare professionals (Ages 11-19). Allows teenagers to ask anonymous questions and receive answers from the most appropriate healthcare professional which may be a school nurse, counsellor or sexual health practitioner. **Features:** • Staff respond to messages with information, advice, and signposting to relevant services • Aimed at teenagers • Anonymous • Normal text charges apply	

Health Help Now	**Summary:** Find the right treatment when you are feeling unwell whatever the time and wherever you are **Features:** • signposts to closest appropriate health service based on symptoms, location and time of day. • free	Can it be used to signpost people to COVID-19 test points? Help triage who should get tested?
Family Assist	**Summary:** Information on pregnancy and birth. **Features:** • Ask healthcare professionals questions and receive email responses directly • Access NHS advice at each stage of pregnancy • Free	Providing healthcare advice and care to pregnant women, without them attending a hospital appointment, protects them from unnecessary exposure to higher risk clinical environments during the COVID-19 crisis. It also facilitates ease of access to clinical advice for expectant mothers who may not be as mobile.

Appendix 4: Mobile applications for delivery of treatment programmes remotely.

App Name	Description	Opportunities for Alternative Uses During COVID-19 Crisis
iPrescribe Exercise	**Summary:** Creates a 12-week exercise plan based on health information entered by the user. It then sets the duration and intensity of the exercise based on this information. Used for improving overall health, or to manage specific long-term health conditions. **Features:** • User can select a specific chronic illnesses, medications, underlying health conditions • Measures resting heart rate • Assesses fitness level through a 6 minute walking test • Uses information to generate a risk profile for the user • Curates a tailored 12-week exercise programme for the user • Free	The founders are offering their app free to organisations that wish to monitor patients remotely during pandemic. Could the calculated risk profile be used to assess those at higher risk of becoming seriously ill from COVID-19? Can this app be used to provide suitable home exercises for people who were due to undergo physiotherapy exercise regimes before clinics were paused due to COVID-19 restrictions?
NHS SmokeFree App	**Summary:** An app that is supposed to help individuals stop smoking by setting a 28 days goal and providing support in the form of tips and motivational writing. **Features:** • Simple design which allows you to put in how much you spend on cigarettes and how much you smoke calculating how much you save per day and week. • Gives an extensive list of tips on how to keep motivated including posting pictures of people you are quitting for. • Sends phone notifications to keep you aware of progress. • Free	This app has potential for smoking cessation but needs to be combined with a hospital-based system. Many trusts have outsourced smoking cessation as it is labour intensive. A home monitor system, updated by a smoke cession team (respiratory nurse for prescriptions, HCA for support and system monitoring. This app could be used to provide in-depth smoking cessation information including medication use and charting of patients after cessation. Pre assessment questionnaires to save face to face time. A similar model to current sleep apnoea treatment with CPAP.
Pathway through Pain	**Summary:** Online course for self-management of chronic musculoskeletal pain. **Features:** • Pain recovery activities such as relaxation and sleep • Pain relief techniques such as guided relaxation and mindfulness	

	meditation • Understand the causes and mechanisms of chronic pain • Practise simple stretches and pacing techniques that improve your body condition • Gradual approach to increasing your pain tolerance • £40 or free via referral
Leso	**Summary:** Connect with a mental health therapist and receive a course of Cognitive Behaviour Therapy (CBT) via instant messaging through the app. **Features:** • Receive a designated qualified CBT therapist • Engage in a course of CBT through the app without having to attend face to face appointments • Free (in limited areas)
Be Mindful	**Summary:** Online course to help reduce stress and anxiety using mindfulness based cognitive therapy **Features:** • 10x 30min sessions of mindful meditation and tasks • £30
mapmydiabetes	**Summary:** Information, guidance and self-help tools to support people in the management of their type 2 diabetes. **Features:** • Structured education course endorsed by the National Institute for Health and Care Excellence (NICE) • Diet and exercise coaching • Recipes • Set goals and targets and keep track of progress • share highly secure information with your GP practice to keep you updated with your diabetes results, appointments and medicines online • Keep up-to-date with other services available in your area
Changing Health	**Summary:** A lifestyle coaching app aimed to help people with type 2 diabetes lose weight, eat better and move more. **Features:** • Diabetes education course • Personal lifestyle coach who will create diet and exercise plan • Personal coach will monitor progress and follow up progress
Low Carb Programme	**Summary:** Information and recipe ideas to help you better manage type 2 diabetes. **Features:** • Tailored recipes and plans • Food diary/ health tracker • Community forum • Free (with referral) or £14.99 per month/£69.99 per year

Appendix 5: Mobile applications linking healthcare teams and disciplines via secure messaging applications.

App Name	Description	Opportunities for Alternative Uses During COVID-19 Crisis
Siilo	**Summary:** Medical Whatsapp. Siilo currently conforms with GDPR regulations and is as simple to use as WhatsApp. **Features:** • Encrypted messaging for medical professionals. • Image sharing ability to link to a computer via QR codes to retrieve files. • Cases creation on chat. • Team builder for secure team information sharing. • Images saved on the app not on the server. • 5-digit pass code. • NHS email verification. • Free	Linking with other healthcare providers for faster communication. Exchanging observations from care homes to hospitals for a more complete picture. Care staff being able to contact doctors with patient concerns. Whatsapp as an application does not conform to GDPR guidelines as it uploads contacts and backs up information on a non-EU server therefore confidential patient information cannot be shared on this platform. The shortfalls of Whatsapp in the NHS are covered by Siilo here. Success stories of Siilo being used in a London NHS hospital have also been reported. Fully secure communication is essential before healthcare professionals can fully embrace messaging applications into clinical care, currently using messaging application puts the focus on the individual to be savvy enough to disable settings which are activated on installation or use vague and non-identifying information which can lead to miscommunication.
Pando	**Summary:** Quick and secure information sharing app. Can share information, tasks and images with individuals and teams. **Features:** • Message 1-to-1 or teams- securely send images • Create tasks and patient lists which images can be attached to and shared with other staff • Compliant with NHS digital, NHS England, GDPR, DSP • Free for NHS and Local Authority staff	Could this secure app be used to support staff in care homes? Care worker staff could use the app to message allocated nurses or doctors with regards to specific health problems or symptoms displayed by the residents they are looking after. The care staff could use the app to convey information, share images and videos of rashes, coughs, or other symptoms, which the healthcare professional will be able to examine and assess remotely. This could provide more support to vulnerable individuals and staff in care homes. This could enable point of site care at the home and reduces the risk of COVID-19 being brought back to the care home with every hospital visit of a single resident.
Hospify	**Summary:** Healthcare	Could be used for peer review of clinical

	messaging application, similar to WhatsApp but is GDPR compliant. **Features:** • Secure 1-to-1 and group text and photo messaging • Password protected • Messages are automatically deleted after 30 days • Free	reports, clinic coordinating etc

Appendix 6: Mobile applications for mental health support.

App Name	Description
Be Mindful	**Summary:** Online course to help reduce stress and anxiety using mindfulness based cognitive therapy. **Features:** • 10x 30min sessions of mindful meditation and tasks • Cost: £30
Beat Panic	**Summary:** App to manage stress and anxiety. **Features:** • guide people through a panic attack or raised anxiety • cost: 99p
Big White Wall	**Summary:** Round the clock support from therapists to cope with stress and anxiety. **Features:** • Anonymous community • Take online tests to measure anxiety, depression levels • Online courses for sleep, smoking, anger management • 1-to-1 therapy with counsellors via webcam, audio or instant messaging • Free, but may need referral from GP in certain postcodes **Opportunities for alternative uses:** This app could be promoted to help "at risk" individuals during social isolation. Big White Wall appears to have a big online community which people can engage with anonymously. Addition of a domestic abuse section on here could help and support vulnerable individuals.
BlueICE	**Summary:** Self-harm reduction app, aimed at younger individuals. **Features:** • Mood diary tracking • Evidence-based activities to lift mood and decrease distress • Auto routing to emergency numbers if self-harm urges continue • Free
Calm Harm	**Summary:** Self-harm reduction app, aimed at younger individuals. **Features:** • Based on dialectical behaviour therapy (DBT) • Distraction techniques to redirect urges to self-harm • Free
Catch It	**Summary:** Managing anxiety and depression through CBT techniques to look at negative thoughts differently. **Features:** • Based on cognitive behaviour therapy (CBT) to help change reactions and thoughts • Records mood diary in 3 steps: • 'Catch it' records and rates your mood • 'Check it' asks you to take a moment to reflect on what you are thinking • 'Change it' asks you to think of a better way of dealing with the

	problem • Free
Chill Panda	**Summary:** Breathing technique app to help relaxation. **Features:** • Measures heart rate • Mood diary • Breathing activities, light exercises, fun tasks that facilitate relaxation • Free
DistrACT	**Summary:** Breathing technique app to help relaxation. **Features:** • Contact details for national helplines • Information explaining the urges behind self-harm • Self-help resources for alternative activities to self-harm • The chill zone collection of 'feel better' activities including art, books, films, music, poems, quotes, stories and online videos • Free
eQuoo: Emotional Fitness Game	**Summary:** An adventure game that is used to help increase your emotional fitness. **Features:** • Personality test • Psychological information in game format • Free, with in app purchases
Feeling Good: Positive Mindset	**Summary:** Use audio tracks to relax your body and mind, building confidence. **Features:** • 12 track Positive Mental Training audio programme • Free
My possible self: The mental health app	**Summary:** Simple learning modules to manage fear, anxiety and stress and tackle unhelpful thinking. **Features:** • 10 learning modules • Mood tracker • Information has been curated by world-leading mental health experts proven to reduce stress, anxious feelings and low mood in just eight weeks • The first 'Building Happiness & Well-being' module is free, the others are accessible with a monthly subscription
Silver Cloud	**Summary:** Eight-week course to help manage stress, anxiety and depression at your own pace. **Features:** • 8-week course of cognitive behaviour therapy (CBT) to change thought patterns and feelings • Topics are chosen by the therapist for you to work through at your own pace • The therapist will check in with you about once every two weeks to review your progress. • Videos, activities, quizzes, audio guides and your own online

	journal. • Free with referral, access granted for 1 year.
Sleepio	**Summary:** Online sleep improvement programme based on Cognitive Behavioural Therapy for insomnia (CBTi). **Features:** • CBTi programme created based on your answers to an in-depth questionnaire • Each week you log in and meet "The Prof", your virtual sleep expert. • 6 core sessions • Daily sleep diary that helps you track your progress. • Tested in rigorous clinical trials and evaluated by NICE.
Sleepstation	**Summary:** 6-week online course for people who struggle to fall asleep or stay asleep through the night. **Features:** • Complete a 7-day sleep diary • Information is reviewed and personalised advice is given • 6-week online course for sleep improvement • Access to a team of sleep experts • Free with GP referral
Stress and Anxiety Companion	**Summary:** Handle stress and anxiety with breathing exercises, relaxing music and games to help calm your mind. **Features:** • Uses cognitive behavioural therapy (CBT) techniques • Helps you identify your anxiety and stress triggers and transform negative thoughts into positive ones • Free with in app purchases
ThinkNinja	**Summary:** Mental health app designed for 10 to 18-year-olds to allows young people to learn about mental health and emotional wellbeing and develop skills they can use to build resilience and stay well. **Features:** • Uses cognitive behavioural therapy (CBT) techniques • AI-driven chatbot (the WiseNinja) that acts as a mentor • Goal setting – the ability to set and revisit specific goals • Mood rating – a daily mood rating that allows you to track your mood • Techniques for beating stress, dealing with negative thoughts, coping with difficult feelings, and how to relax and improve sleep • Free *In response to increased anxiety about the coronavirus, new content has been added to help*: • Address fears relating to the virus • Cope with isolation and stay connected to family and friends • Deal with concerns about personal health and the health of family members • Build mental strength • Develop coping techniques to use during the crisis
Thrive	**Summary:** Thrive uses games to track your mood and teach you methods to take control of stress and anxiety.

	Features:
	• CBT programme
	• Calm breathing techniques, relaxation, meditation
	• 'Mood meter' tracks mood, situation and emotional reactions
WorryTree	**Summary:** Uses CBT techniques to help you notice, note down, and challenge your worries and create an action plan for managing worry.
	Features:
	• Record your worries in the app and categorise based on work / family/ love / school etc. The app then uses CBT techniques to:
	• Ask you to answer a series of questions and make decisions about your worries
	• Help you challenge your worries and decide if you can control them or not
	• Give you ways to distract yourself from your worries and move on with your day
	• Help you create an action plan to take control of your worries

Appendix 7: Mobile applications for building communities.

App Name	Description
Becca breast cancer support	**Summary:** Support for those living with, and who have survived breast cancer. **Features:** • Advice on adapting your life after breast cancer treatment • Relevant and trustworthy advice • Tips on a range of subjects including health, exercise, food and what is now normal for you. • Daily blogs by people living with breast cancer • Free
MeeTwo	**Summary:** A safe and secure forum for teenagers wanting to discuss any issue affecting their lives such as mental health, self-harming, relationships and friendships. **Features:** • Anonymously get advice from experts or other teenagers going through similar experiences • The user posts messages about any issue they are struggling to cope with • They receive supportive responses from other teenagers and guidance from MeeTwo experts designed to build confidence, increase wellbeing and improve emotional resilience. • Every post and reply is moderated to make sure only positive feedback is published. • Directory signposting to specialist support groups that can offer further help.

Appendix 8: Mobile applications for video communication between patients in hospital and relatives.

App Name	Description
Integrated Family Delivered Neonatal Care (IFDC)	**Summary:** An app that allows parents of premature babies to get updates and understand the treatments available for their baby. **Features:** • timeline to track baby's weight, length, feeds, skin-to-skin contact with pictures and entries by parents while baby is still in NICU • free
vCreate	**Summary:** Receive video updates from staff if your child is n hospital and you cannot be by their side. **Features:** • Staff securely send video clips of babies in neonatal units so parents can see them outside the hospital • Sponsored by hospital charities and local businesses • Free