Chapter 1: Introduction to Digital Health

Dr Chris Paton, BMBS, BMedSci, MBA, FFCI\textsuperscript{a, b}
Dr Meriel Bladon, BMBS, BMedSci\textsuperscript{b}

\textsuperscript{a}University of Oxford, Oxford, UK
\textsuperscript{b}University of Otago, Dunedin, NZ

What is Digital Health?

“Digital health” is a difficult term to define. Many aspects of modern life “went digital” many years ago and we have since stopped referring to their “digital” aspects. This will probably soon be true for healthcare too. An e-Prescription will soon simply be called a prescription; a tele-medicine consult will just be a plain old consultation with your doctor; and digital radiology will go back to – you guessed it – radiology. During this transition period though, it might be helpful to think about how the digital versions of tools and techniques used in healthcare are different from their paper or face-to-face versions. We also need to talk about the new opportunities that digital technologies present for new practices and procedures that were not possible before. Robotics, artificial intelligence, and genomics are all opening up new avenues for research and clinical practice that go far beyond what we though were possible just a few years ago\textsuperscript{1}.

Our definition is that digital health is the application of information technology in the healthcare domain. This includes systems used by healthcare providers in hospitals and clinics but also applications (apps) owned by patients.

So, at its simplest, digital health just refers to digital versions of the information systems that have been in place in hospitals, clinics, and patients’ homes for many years. The diagram below shows some of the core information systems you might find in a modern hospital:
FIGURE 1: HEALTH INFORMATION SYSTEMS

Outside of the hospitals walls are a wide range of consumer smartphone apps (often linked to self-monitoring devices), government digital services, new AI-driven diagnostic systems and research databases that all fall under the label of digital health. We will describe the history and current state of some of the most common categories of healthcare information systems in the next chapter. But, before we do so, it might be useful to answer the question of “why digital health?” in addition to the “what?”.

WHY DIGITAL HEALTH?

Why did hospitals around the world go out and spend billions of pounds, dollars, euros and renminbi on shiny new computers and the software to run on them? What were they trying to achieve? Often the answer would boil down to financial incentives. Either saving money through making processes more efficient or enabling healthcare providers to increase their revenues through more effective insurance claims and billing procedures. Another big driver of digital health, particularly in countries that have socialised healthcare systems, has been government initiatives. The UK government over the course of 10 years spent some £14 billion on a range of digital health initiative under the auspices of the National Programme for Health IT. The Obama administration in the US oversaw the implementation of the HITECH Act, created by President George Bush to use stimulus funds after the 2008 global financial crisis to invest more than $20 billion subsidising and incentivising hospitals and individual doctors to begin to adopt new digital health systems.

Regardless of initial motivations, the digitisation of healthcare offers some remarkable opportunities to go beyond the financial drivers. Perhaps we can also use these tools to make
healthcare both more efficient for providers and provide better care for patients. In 2007, a group of healthcare leaders from around the world gathered at a workshop organised by the Institute of Medicine to discuss how the digitisation of healthcare could be best utilised to improve the health of patients. From that workshop, a new concept emerged, that of the “Learning Health System”\(^\text{7}\). The idea is quite simple at its core: Use the data routinely generated by digital health systems such as Electronic Health Record (EHR) systems to inform decision-making at multiple levels (clinic, hospital, region, nation, worldwide) to enable the healthcare system at each level of learn and improve\(^\text{8-11}\). For example, data from an out-patient clinic could show that the patient mix had changed in recent years and an adjustment to the staffing was needed to better meet the needs of patients. At a higher level, the data from multiple hospitals’ EHR systems could be used to identify the outcomes of patients who had been enrolled into a clinical trial.

Figure 2: Learning Health Systems use routine data to support clinicians to improve care.

Learning healthcare systems have the potential to accelerate the adoption and influence of evidence-based medicine (the idea that clinical decision making should be informed by the “current best evidence” rather than expert or personal opinion). Evidence-based medicine (EBM) has traditionally used the evidence by randomised-controlled trials (RCTs) to generate research evidence which is then synthesised through a process of systematic review and meta-analysis before being translated into evidence-based clinical guidelines that doctors and allied healthcare professionals can use to treat patients. Several significant challenges have emerged as this approach has gathered scheme. Not least of these is the cost and inconvenience of conducting large-scale RCTs. Many treatments in medicine have quite small
effects (perhaps only successfully treating only a small percentage of patients who take them). These small effects can add up to large numbers of real people if enough people take the medications but detecting these small beneficial effects requires thousands of people to participate in trials, with half the participants receiving the new treatment and the other half being treated with a placebo. These trials can take years and vast sums of money to conduct. Perhaps then, conducting trials using EHR systems for recruiting, allocating and following up patients, a LHS can rapidly advance our knowledge about which treatments work best and who should be taking them. This latter point may be enabled by another new development, personalised medicine. By linking a patients’ genome with their data in their EHR (a so-called “digital phenotype”), we could start to draw conclusions how different genetic combinations influence how effective different medications are. Perhaps in the future, the types of drugs we are prescribed (and their dosages) will be determined by a genetic blood test prior to treatment.

THE GROWTH OF DIGITAL HEALTH

The use of digital systems in healthcare goes back for decades. We will explore some of the interesting history of EHR systems in the next chapter, but to understand our current context it is worth recapping how digital health has gone from relative obscurity to its present state of ubiquity.

![Figure 3. Office of the National Coordinator for Health Information Technology. 'Hospitals Receiving Incentive Payments for Electronic Health Record Adoption or Meaningful Use,' Health IT Quick-Stat #18. dashboard.healthit.gov/quickstats/pages/FIG-Hospitals-Receiving-Payments-for-MU-and-Adoption.php. February 2014.](image-url)
Perhaps the largest influence on the growth of digital health was the HITECH Act mentioned above. As the world’s stock markets collapsed in 2008, governments fell back on Keynesian stimulus programmes to prevent the kind of mass unemployment and economic disaster seen during the Great Depression. In the USA, a package of funding amounting to nearly $700 billion was implemented, design to address areas of chronic underinvestment while ploughing newly “printed” money into the devastated economy. Some $20 billion of the stimulus funding was directed towards digitising hospitals and clinics through the HITECH Act. In return for receiving payments for purchasing EHR software and computer equipment, doctors and hospitals promised to use them to meaningfully improve the care of patients – so called “meaningful use”. They would need to meet a range of different clinical objectives over a period of time in terms of using the systems not just for collecting billing and insurance related data but to digitise medical notes, blood test results and other clinical activities. This stimulus accelerated the growth a number of existing digital health companies which have gone on to become leading EHR suppliers around the world. New companies were also set up to fill in the gaps and offer new kinds of digital health systems. This US-based stimulus has had ripples around the world with many countries now adopting the major US EHR vendors for large government and private sector hospitals and clinics.

In more recent time, the Coronavirus pandemic has again shifted the healthcare world towards digital solutions as doctors were forced to stop conducting face-to-face consultations and instead have adopted a range of telemedicine systems from smartphone apps to remote consultations booths. The crisis has also required central governments to implement new databases, registries and digital infrastructure to support track-and-trace systems. Populations have been encouraged to download and use Covid-tracking apps that require people to enter any flu-like symptoms they have, test results and have been used in combination with QR codes to track movements so that contact tracing can expedited if needed. Google and Apple joined forced to develop an app platform that used Bluetooth to alert users if they came in contact with a positive case, however, this has not been widely implemented.

CURRENT DIGITAL HEALTH CHALLENGES AND OPPORTUNITIES

As this book is being written, we are still in the midst of the Coronavirus pandemic, but it looks like the shift to digital health systems will stay. Patients find telemedicine a convenient alternative to many types of consultations and the increase support from central governments for data sharing and digital services seems unlikely to be wound back. The trend for EHR adoption, and particularly the dominance of a limited number of systems which have started to show their age, has brought a recent flurry of articles and reports about systems that are difficult and time consuming to use and may be the cause of medical errors and missed
opportunities. However, it seems unlikely that clinicians would support a return to paper-based medical notes and governments and clinician groups are starting to join forces to address the current challenges with usability and interoperability (sharing of clinical data between systems and facilities). We will go into these issues in detail in later chapters of this book.

Figure 4. A screenshot from DHIS2’s country-level dashboard showing data on immunisations in Sierra Leone.

As systems have matured in high-income countries (HICs), low- and middle-income countries (LMICs) such as Kenya and Vietnam have started to adopt digital health systems. Systems that collect regional data on health indicators such as newborn mortality rates, vaccinations and cases of infectious diseases such as malaria have been implemented in most LMICs around the world. A system called District Health Information Software version 2 (DHIS2) has been developed in collaboration with governments, international donor agencies and academic groups in the US and Europe. DHIS2 is released as open-source software removing the costs of licence fees (although many costs of implementation remain such as hardware, training, connectivity and customisations). Another open-source system, OpenMRS, has also been widely adopted across more than 50 LMICs for managing community care clinics used for diagnosing and treating HIV patients and supporting maternal and newborn health.

HEALTH INFORMATICS: THE SCIENCE OF DIGITAL HEALTH

An introduction to digital health would be lacking without a discussion about health informatics. Health informatics is the scientific discipline that investigates how data and digital
technologies are used in healthcare. The term “Health Informatics” has been around for many years, and many have tried to define it. Perhaps the most eloquent definition is by Prof Bill Hersch: “My definition of informatics is the discipline focused on the acquisition, storage, and use of information in a specific setting or domain.” Many health informatics courses and departments are currently re-branding as “digital health” or “health data science” but it is likely the term informatics will continue to be used in academic settings for some time.

REFERENCES


