Future Healthcare Journal 11 (2024) 100021

Contents lists available at ScienceDirect

Future Healthcare Journal

journal homepage: https://www.sciencedirect.com/journal/future-healthcare-journal

Unit cost and hope: Increased NHS resilience through tech-enabled transformation

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Introduction

The pace of advances in the biological and data sciences continues to accelerate, having direct impact on the daily lives of most people on the planet. These twin scientific revolutions have accelerated innovations in healthcare, which is great news for patients. In the past few years we have witnessed new life-changing treatments for auto-immune disorders, sickle cell disease, cystic fibrosis, obesity, cardiovascular disease and dementia to name just a few. And on the healthcare delivery side more and more people can access their records, make appointments that fit their schedule, and receive effective computer-generated personalised advice for mental health conditions, all on their cell phone.

At the same time, the healthcare systems of nearly every country are straining to keep up with demand. For most OECD countries, the aging of the baby boom, with its attendant accumulation of multiple chronic conditions, has generated much of the increasing demand. The number of people reaching age 85 will keep increasing until the mid 2040s, bringing ever increasing need for services. The press regularly wrings their hands over the financial burden this places on the younger generations for funding both healthcare and social care without much in the way of solutions.[1] Less attention has been paid to the challenges created when the delivery system is asked to deliver the rapidly increasing number of medical innovations safely and effectively to this expanding population. In other words, innovations themselves contribute substantially to healthcare's capacity problem. Every innovation (diagnosing or treating a condition) requires more infrastructure and more time from the people delivering healthcare. Given the high reliance on people to deliver healthcare services, the pace of innovation is outstripping the workforce's capacity to deliver those innovations. Healthcare needs a new chassis.

To be fair, not all innovation adds to delivery burden. The delivery logistics for new vaccines, for example, require some added infrastructure but those new logistics are much less burdensome on the delivery system than the attendant hospitalisations from vaccine preventable diseases.[2] In fact, it is tempting to point to prevention as the solution to our healthcare capacity problems. While prevention lowers the slope of the rising healthcare consumption curve, it nonetheless does not appear to lower lifetime demand for services. We will all still acquire conditions and consume healthcare as part of the aging process.

Despite this caveat, the current healthcare delivery system simply cannot keep pace with the increasing numbers of people requiring multiple services combined with the increasing number and complexity of new diagnostics and therapeutics. Our challenges with access to care, untenable waiting lists, and clinician burnout, are all symptoms connected to the widening gap between clinical needs of the population and health system's capacity to deliver them.

Unit cost and hope

Can we narrow the gap? The concept of unit cost may be helpful in thinking about this question. If we define a single health service delivered to someone in need as the 'unit' of service delivery, then what will it take to make it easier to satisfy that need? Part of unit costs are the costs of transaction.[3] Anyone with a medical need trying to navigate the healthcare system will understand transaction costs – the time and energy required to get an appointment scheduled, a test result, or a treatment. Reducing the friction in getting services is the same as saying in monetary terms that the goal is to lower unit cost – provide a service to the person in need much more efficiently.

In healthcare, cost can often be understood as a proxy for workforce since a majority of costs in healthcare support the people working in healthcare. Similar to other industries, healthcare needs a tech enabled transformation, lowering transaction costs (so lower unit cost), but healthcare's transformation will look very different from other industries. The NHS has too few professionals already, so any technology transformation will need to make the work of delivering care more efficient and the workforce more resilient. Three characteristics of healthcare highlight differences with other industries: the diversity of services grouped together in healthcare is arguably more complex (over 10,000 diagnoses) than in other industries, the personal aspects of caring in healthcare delivery, and the risk to human life.

Another important difference from other industries is the highly professional nature of the workforce. Physicians, nurses and other allied health professionals are highly trained, in short supply, and deeply unhappy with their work life. The combination of the public's need for more services, the stress generated by the risks delivering healthcare, managers pushing for greater productivity, and fiscal watchdogs tightening the purse strings has led to historically low morale, premature

This article reflects the opinions of the author(s) and should not be taken to represent the policy of the Royal College of Physicians unless specifically stated.

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https://doi.org/10.1016/j.fhj.2024.100021

departures from the workforce, and industrial action. So while lowering unit cost is a requirement for improving access and outcomes, tech-enabled transformed care *must also deliver a sense of hope to the providers currently experiencing unrelenting demand for their services*.

What, then, is the solution? While technology is itself a major contributor to the problem, the adoption of technology that re-engineers the chassis – lowering unit costs - is also the only solution.

Infrastructure, priorities, and essential capabilities

Any attempt at technology-enabled transformation of the NHS must begin with current state. The quality of NHS digital infrastructure is highly variable and disorganised. The benefits of a more organised and simplified technology infrastructure are clear: national-level procurement lowers acquisition and run costs while simultaneously lowering the burden of connecting thousands of disparate subscale software solutions. When Manchester University NHS Foundation Trust installed an enterprise-level electronic patient record last year they were then able to turn off over 600 software applications and reassign the workforce tending those contracts and system connections. A simplified tech landscape also improves cyber security. The majority of incursions into NHS data have been through small scale software solutions deployed at the local level. Simplifying the technology infrastructure to improve digital infrastructure resilience, procurement leverage, and cyber security while keeping data sharing and access decisions local is essential. Despite several well-functioning national technology platforms, England may be too large for (and culturally suspicious of) more national solutions. One path forward would be to have teams of national, regional and local NHS technologists work closely to organise technology within each ICS. That way as local software licences expire, ICS leaders move to only one instance in every software category, a policy referred to as managed convergence.[4]

The NHS tech landscape includes not just workflow software like electronic patient records (EPRs) but also hundreds of separately procured and maintained databases. The recent national procurement of a federated data platform[5] continues the journey toward achieving greater value for tax-payers and simplifying the database ecosystem. The federated architecture permits more rapid spread of technology innovations while maintaining local control of data access.

Appropriate use of the public's tax funding for technology requires that we be explicit about our priorities for what we are trying to accomplish, and follow procurement rules that demonstrably deliver on those priorities. For technology to improve health outcomes and reduce unit cost they should meet these five criteria:

1. Address a nationally identified clinical priority
2. Reduce the friction in patient interactions with their healthcare providers
3. Reduce the number of steps in a clinical pathway
4. Releases cash within a year (including the cost of the technology)
5. Provide real world evidence for meeting the four criteria above

Knowing that today's technology will soon be outdated, and that there are multiple paths for delivering a technology-enabled service, the essential elements of tech-enabled healthcare should be defined functionally – by the service they deliver. Table 1 lists the essential functional elements of tech enabled healthcare (direct care and population health). Currently the NHS has *some* of this functionality available to *many* patients and clinicians, but major holes remain.

The healthcare innovation landscape

After better organising the technology infrastructure, establishing our strategic priorities for technology acquisition, and getting the basics in place, where should we focus our attention? The nomenclature of healthcare technology has not been standardised, so any attempt to organise the thousands of technology 'solutions' will have limitations.

Table 1
Healthcare technology basics for direct care and population health.

1. Universal use of electronic patient records (EPRs) by providers in both health and social care
2. Universal patient access to their own personal records (from all sources), including delegated access
3. Universal clinician access to complete patient records of the patient they are treating (no matter the source location of those records)
4. Universal provider and patient access to preventive services data (vaccines and screening)
5. Universal self-management of appointments online
6. Universal online prescribing and prescription renewal
7. Universal access to trustworthy guidance on self-management of personal health and care

Table 2
Key categories of healthcare technology transformation.

a. Clinical service line specific (clinical pathways)
b. Cross-cutting clinical
c. Metrics and analytics
d. Operations and administration

Table 3
Clinician benefits of tech-enabled transformation.

- Technology that reduces steps for patients, reduces their work in navigating the system, generates the impression that clinical services are working for them.
- Technology that doesn't require clinicians to sit at a keyboard and feed the electronic patient record (ambient documentation) and frees up clinicians to focus time and energy on their patients
- Technology that alerts clinicians to opportunities to improve patient care and reduces stress associated with needing to know everything (an increasingly impossible task)
- Technology that prioritises patient needs so clinicians are spending their time where the greatest health benefits are.
- Technology that measures and reports outcomes rather than process in order to align everyone's interests (including administrators) around what matters most for patients.
- Technology that reports comparative practice variation, providing clinicians with insight into opportunities to improve care.
- Technology that reduces overhead processes and costs resulting in more resources available for patient care.

Nonetheless, the approach used here emphasises clinical applications (the delivery of a service) rather than type of technology (Table 2). Of course, many software solutions will cross over these categories. In addition, AI and related techniques have been included under each heading instead of being treated as a separate category. In describing the innovation landscape it is important to understand what tech transformed healthcare will mean for the clinicians. Table 3 summarises what clinicians should demand from the technology they and their patients use. The technologies described below must make the delivery of healthcare safer, more effective, and more efficient. They must also generate greater workforce resilience through simplifying workflow processes and dramatically lowering screen time and increasing face time.

Clinical service line (pathway) technologies

The care of individuals requires the application of specific diagnostic and therapeutic interventions to each specific problem. In the UK the series of steps for gathering data (symptoms, objective findings, diagnostic tests) as well as the application of therapies is commonly referred to as a pathway.[6] Every pathway can be made more efficient through technology, and very often that technology is specific to a single pathway. For example, AI guided software can:

- pre-read an imaging study before being signed off by a radiologist.
- assess concerning child behaviour through computer analysis of a short video obtained by the parent.
- determine from a picture if a skin lesion is worrisome.
- assess heart function using stethoscope heart sounds

- assess sleep apnoea using a sensor taped to one's throat at home

The data required for the development of these decision support tools are relatively limited (pathway specific) and the outcomes are easy to define and measure. This simplifies the regulatory approval process, though regulators are still grappling with how best to certify AI-based medical device technologies that self-improve over time. Nonetheless, these technologies face some additional adoption challenges. First, with so many options, and when each technology applies to a limited number of pathways, how do NHS clinical leaders and management decide which ones to purchase? Only through the adoption of dozens of these will they have a major impact, so what does the adoption process look like? Do we simply allow budgets and market forces to drive choices (as the current situation), a largely stochastic process, or can we organise and accelerate adoption? There are multiple potential policy approaches available. Including clinician champions will be essential.

Cross-cutting clinical technologies

At least three technologies have the potential to impact every clinical role and patient in healthcare. These are sometimes referred to as platform technologies, and include patient facing decision support applications, multi-modal clinician decision support, and ambient documentation. The critical barrier to all three of these is the need to aggregate large amounts of data in order to train the computer.

Patient decision support

While viewing your personal medical records, renewing medications, and scheduling appointments is increasingly common online, as described above, these are just the basics. Patient-facing applications have considerably more potential. Possibly most consequential will be the ability to download an application that will answer medical questions using a patient's own confidential health information. At present personal digital access to medical records uses a virtual private network (VPN). This protects the information from being used by the device or other applications on the device. Technology exists that would enable the user to choose to have their information reviewed, becoming native to the device for an instant, performing an analysis, and then serving up the results of the analysis without retaining any of the original data. Of course, the information made available to the personal decision support application could include key indicators such as current vital signs from wearables. Barriers to putting this tool in the hands of all patients are more legal than technical, but patient consent for every use as well as guaranteed removal of all personal health information puts the development and deployment of such tools within reach.

Multi-modal clinical decision support

In his first book published in 1968,[7] Michael Crighton predicted that computers would soon support clinician decision making. Over 50 years later computers remain primarily an efficient information repository and a convenient communication tool. The decision support tools described above under pathway transformation use sensor technologies combined with AI to support analyses pertinent to a fairly narrow question: is this lesion cancer? Does this patient have sleep apnoea? The bigger prize is to use all the different types of data – patient symptoms, imaging, blood tests, medications, etc. – to diagnose the patient and provide treatment recommendations. Multi-modal refers to the inclusion of many different types of data as well as the sequencing (location on a timeline) of that information. As the repository for all a patient's information, the EPR will likely be the focus on which this new wave of CDS will be built.

To imagine the power of this technology, consider the work of clinicians in an intensive care unit (ICU). Each day in every ICU in the world, teams of doctors and nurses spend hours reviewing all the data acquired on a single patient over the prior 24 h. They are faced with analysing very large amounts of information for every patient in the unit. Despite the numerous people checking and the long hours, we know some data points are missed, patterns are not recognised, and outcomes vary considerably. The same is true for millions of simpler clinical encounters that occur every day in the NHS. Multi-modal clinical decision support is the clinician equivalent to the Patient App technology described above. It's what Michael Crighton (and many people since) predicted would be coming to medicine. It is hard to imagine a greater boost to the quality of medical care if all clinicians were alerted in real time to potential opportunities to improve the care of the patient they are treating.

Ambient documentation

Most clinicians spend a substantial fraction of their time, sometimes 40%, documenting their work. Ambient documentation combines voice-to-text technology (now very well established) with large language models to produce clinical grade documentation – a physician's note, a referral letter, a patient summary, etc., – all within seconds of the completion of an encounter between a patient and a clinician.[8] Ambient documentation will be widely available within the next several years. Like all similar AI tools, it still requires the clinician to authenticate the contents ('human-in-the-loop') because the output is a legally defined document assigned to the individual clinician. Nonetheless, reading and editing a note takes much less time than generating the note in the first place. Physicians have rightly complained for decades that computers have slowed them down – becoming typists managing the hundreds of input fields in a patient's chart. Ambient documentation will finally deliver to medical and social care the efficiency gains that computers have delivered in other industries. The potential for this technology to dramatically improve clinicians' work life – allowing more time with family or patients and even seeing more patients – is difficult to overstate.

Frontline operations & administration

The full potential for AI to reduce administrative work (and therefore administrative positions) remains to be determined, though estimates of 20–40% are common. There is no reason to expect the impact on healthcare will be different. Realising this step-change in efficiency would free up resources for more clinical patient facing work or reduce healthcare expenditures. The challenge will be to identify the specific opportunities, implement the new tech-enabled workflows, and manage the personnel transitions. For the NHS, making sure that most (if not all) administrative processes occur at the ICS level rather than the trust (managed convergence) is one straightforward opportunity. The NHS still collects and reports data manually in many locations.

At an operational level, real time data acquisition on utilisation of expensive assets such as operating theatres, hospital beds, virtual wards, and residential care homes can now be managed centrally by the ICS. The analogy here is with an air-traffic-control system. Examples are already in place and proving their potential.[9] The biggest benefits will come when all beds within an ICS, those in both the NHS and social care, are included. This is just one example, but the concept can of course be applied to any service, including comparative performance of diagnostic centre throughput, outpatient specialty services, and GP practices. What locations of care delivery are the most productive and what can others learn from them?

Technology and population health

Technology will also play a key role in transforming public health, so much so that the historical distinction between personal health services and public health becomes blurred. The delivery of preventive services (vaccines, screening, lifestyle advice) is no longer just the provenance of the GP. Safe and effective delivery require only qualified personnel, clinician access to the right information, and content personalised to each individual. Data and analytic techniques can now permit screening advice to be based not on age, a crude surrogate for risk, as it is now, but on each individual's risk calculated from several variables including genetic predisposition. The UK's Pharmacy First initiative is just one

example of using multiple touchpoints to deliver services, maximising patient convenience and minimising barriers. The NHS is building the capacity to message patients through their personal devices on eligibility for vaccines, screening tests, and, if requested, behaviour modification. The NHS App will eventually enable self-service appointments at the most convenient location.

Unlike the primary prevention services described above, secondary prevention requires delivery of chronic illness care services to those with known conditions. The greatest near-term health gains for the population fall within this category of services. For example, secondary prevention of CVD requires that eligible patients receive the full complement of disease modifying agents, in this case control of blood pressure and lipids. Raising the percentage of eligible patients who have met their goal (eg, from 80% to 90%) would lower the overall mortality from preventable illness, reduce health inequalities, and free up hospital capacity currently being used for preventable cardiovascular events. As with primary prevention efforts (eg, vaccines), these services can be delivered safely and effectively in a pharmacy or at home as long as the pharmacists or other professionals have access to key information within the patient's health record.

As noted at the outset, the greatest pressure on the NHS comes from the rapidly increasing number of frail older people with multiple chronic conditions. While all the tech-enabled services listed above will reduce the burden of this cohort on the delivery system, both the individuals and the delivery system as a whole benefit from an additional service – high risk care management. This service uses aggregated health data to identify people with the highest risk for admission to hospital and proactively manages their health and social care to avoid recurring acute events and assist with comfort at the end of life.[10] Interoperable patient record systems (or use of the same record system) enable this set of services to be managed in close coordination between GPs, home hospital, and social care. Success of these services is dependent on continuity of relationships, information, and the personalised management plan.

Analytics and metrics

The NHS has a big opportunity to improve performance through much more extensive and sophisticated use of its data assets. While the timeliness of data has improved recently, NHS managers typically track performance against historical baselines with little insight into the drivers of variation. Productivity metrics from clinical pathways (the RTT system) don't include innovative services provided outside of established referral patterns, hampering the spread of innovation. Truly comparable (risk adjusted) patient outcomes are often years out of date when they become available. What is the alternative? Michael Porter's outcomes framework[11] has until recently been largely aspirational due to practical hurdles and expense: outcomes typically require chart review and close patient follow-up. Modern data extraction, infrastructure and analytic techniques now put near real-time risk-adjusted comparative outcomes within reach. Consistent with this framework, the NHS should report data on patient experience – each of us should get a text asking a few questions about the service we just received when we leave a clinical encounter, just as we do when we leave a hotel. The NHS should also report risk-adjusted surgical and secondary prevention outcomes for the entire ICS.

Conclusion

The delivery of health services in the UK, both at the individual and population levels, is facing a crisis. With outcomes worsening and provider capacities stretched to breaking, healthcare needs a new chassis – one that is capable of delivering many more services with a similar number of people. Healthcare professionals, burned out from unending clinical need and constant pressure for greater productivity, need to spend more of their time actually caring for the people under their charge. While the explosion in technology is part of the problem – biotechnology will continue to produce even more cures and relief of suffering, requiring more provider resources – technology enabled transformation of the delivery system itself is the only solution. Setting out on this journey requires understanding current state, clinical and technical priorities, and an appreciation of the challenges and opportunities specific to individual clinical service lines, cross-cutting clinical processes, analytics and administration. If put to use, AI is a core tool in all of these areas and has arrived just in time: while the components of better, more efficient care have been known for decades, AI enables practical solutions that will lower unit cost and support the patient and provider decisions, leaving more time for the human aspects of caring. Transforming roughly 12% of a country's economic activity is a big challenge and should be approached with considerable humility. While execution risks for this strategy are high, the risks of status quo are considerably higher.

Declaration of competing interest

I am staff physician at Massachusetts General Hospital, an Adjunct Professor of Medicine at Harvard Medical School, a Senior Executive Advisor to NHSE and serve on the NHSE Digital Data and Technology Committee. From 9 May 2021 to 15 September 2023, I was the inaugural National Director of Transformation at NHSE. I am also a self employed advisor to healthcare technology investors.

References

1. Williams GA, Cylus J, Roubal T, *et al. Sustainable Health Financing with an Ageing Population: Will Population Ageing Lead to Uncontrolled Health Expenditure Growth?*. CopenhagenDenmark: European Observatory on Health Systems and Policies; 2019.
2. Largeron N, Lévy P, Bresse X. Role of vaccination in the sustainability of healthcare systems. *J Mark Access Health Policy*. 2015;3:10.340.
3. Williamson OE. The economics of organization: the transaction cost approach. (PDF). *Am J Sociol*. 1981;87(3):548–577.
4. Cresswell K, Sheikh A, Williams R. Managed convergence' in health system digitalisation. *J R Soc Med*. 2022;115(8):284–285. doi:10.1177/01410768221098274.
5. https://fdp.england.nhs.uk/home.
6. http://www.cpa.org.uk/information/reviews/CPA-Rapid-Review-Effectiveness-of-care-pathways.pdf.
7. Crichton, M, *Five Patients*, Ballantine Books, ISBN 0-345-35464-8
8. Tierney AA, Gayre G, Hoberman B, Mattern B, Ballesca M, Kipnis P, Liu V, Lee K. Ambient artificial intelligence scribes to alleviate the burden of clinical documentation. *NEJM Catal Innov Care Deliv*. 2024;5(3).
9. https://www.hsj.co.uk/technology-and-innovation/the-role-of-electronic-bed-management-technology-in-driving-capacity-improvements/7034927.article.
10. Powers BW, Chaguturu SK, Ferris TG. Optimizing high-risk care management. *JAMA*. 2015;313(8):795–796. doi:10.1001/jama.2014.18171.
11. Porter M. What is value in healthcare? *N Engl J Med*. 2010;363:2477–2481. doi:10.1056/NEJMp1011024.