

# Hospital Innovations for the Next Decade-

## *The Promise & Challenges*

### Abstract

Ultimately, healthcare innovation leads to improved clinical care, with new technology improving the efficiency, effectiveness, quality, and affordability of healthcare. With ever increasing demand on health systems all around the world, the ultimate goal of healthcare innovation is to improve the ability to meet public and personal healthcare needs through the optimisation of the health systems performance. Within this article, we will discuss hospital-based innovation within the next decade which yield scalable solutions within the fields of preventative, treatment, and infection control healthcare innovation.

Governments are faced with tough choices since medical innovations hold both promises and perils. These innovations are happening across multiple dimensions, including core sciences, drug development, care delivery, and organizational and business models. In particular, medical technology related innovations are blossoming, with medical technology patents more numerous and growing at a faster path than pharmaceutical patents for the last decade.

Despite this enormous investment in innovation and the magnitude of the opportunity for innovators to both do good and do well, all too many efforts fail, losing billions of investor resources along the way. [1] Barriers to disruptive innovation is often the public themselves acting through fear, enacting stringent regulation, supported by established professionals afraid to lose income and hospitals their investment in expensive systems. [2]

Keywords: Hospital innovation, medical technology

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## Background

Health systems across the world, irrespective of their underpinning political ideology, funding and reimbursement models, face a perpetual challenge of balancing demands for new technologies, growing burden of disease in an ageing and increasing unhealthy populace - with the finite nature of resources, more acute since most economies exist in a downturn following the COVID-19 pandemic. In difficult times, there is a need for biomedical engineers, clinicians, and healthcare industry leaders to work together to develop novel diagnostics and treatments to fight the major ailments and expedite the development of portable, rapidly deployable, sustainable and affordable therapies or systems.[3] However, the enormous pressure for rapid licencing and deployment of novel therapies and technologies makes the governance of innovation extremely complex, posing a risk to people and organisations. It is imperative that innovations resolve and not create problems for health care systems both in inadvertent, unpredictable harms or unaffordable financial outlay.[4]

It is increasingly recognised that the health inequalities that have existed across the global north and south, are also being aggravated within nation states, and sometimes across a few miles of distributed multiple-deprivation within cities. Innovations must reduce and alleviate such disparities both within populations and across the global north-south divide.

### *Innovation & Challenges*

Innovations within healthcare are new therapies or interventions that departs from standard practice, and where the safety and efficacy may be unknown. Innovation is often a slow process from invention to adoption and to wider diffusion.[5] It took the telephone 64 years, electricity 45 years, computers 23 years, mobile phones 16 years, radio 12 years and the internet 13 years to achieve 40% consumer adoption. [6]

Medical innovation depends on extensive interactions between universities and industry, with knowledge and technology transfer flowing in both directions, with public health and economic benefits. [7] Yet there are recognised challenges in the self-reinforcing dynamics between technology, medical specialisation, individualisation of disease and the concentration of resources in academic teaching centres. Although particular technologies may contribute to cost-savings under certain conditions,

the continued introduction of new technology supports inflation, through new treatments introduced for previously neglected or undiagnosed conditions; existing conditions are diagnosed and treated with new, more expensive means; new technologies adding to, rather than replace existing ones; therapeutic indications for new or existing treatments enlarging over time; and new devices reinforcing or amplifying the need for qualified personnel adding to the burden of training. [8]

Often the way medical innovation is financed, designed and commercialised engendered dependency, exacerbating the risk to sustainability of established healthcare systems.[9] Economic evaluation of any innovation is therefore essential to avoid inefficient allocation of resources, taking money away from where cost-effective therapies which may not be provided or reimbursed. Any incentives for innovation can be adversely affected.[10] Given the many unknowns, including unknown risks, but also the potential benefits for the individual and possibly later for society, innovations are important, but the ethics implications must be considered. [11,12] Evaluation and monitoring of innovations requires a rigorous, fit-for-purpose, and formal system of assessment to protect patient safety and prevent unexpected adverse health outcomes, it will only succeed if it is supported and championed by health system leaders and respects the need for education, training, and societal culture.[13]

### **How innovation involve hospitals**

Modern medicine has evolved with the hospitals occupying centre stage in providing care and usually the main platform for delivery of phase 2 and 3 trials, yet these organisations are rarely addressed directly and explicitly in innovation studies. Instead, they are treated as contexts, partners, indirect selection mechanisms, and users in investigations of industrial development and the commercialization of science.[14] Hospitals are adopters and users of new technologies, potential developers of processes and organisational innovations. In addition, they are an integral part of the education system in which new practitioners are trained, so they can be loci of clinical experimentation and large research and development institutions in their own right.

Integral to medical education is the requirement that all doctors and now nurses, midwives and allied health professionals are trained in the basics of research, designing trials, understanding results from

trials and reviewing the scientific literature. The traditional division between bench research and clinical research has become integrated with translational research and the support for clinician-researchers. Hence, frontline clinicians need to be given time and resources to trial new and grounded innovations. Clinician-scientists based in hospitals contribute to new idea generation through experiential learning in clinical practice and research (both basic and clinical) by identifying problems and potential solutions. They often do so in collaboration with universities and firms under a variety of institutional arrangements.

Healthcare systems are complex, adaptive, interconnected, autonomous and often unpredictable. What binds them together is a shared purpose (i.e. patient outcomes), relationships, a loose framework of rules and deep grounding in values. Although the personnel in organisations such as the NHS do seem to have the basic skills to successfully implement innovations, there often appears to be barriers such as failure on the part of senior management to successfully communicate the desires and needs. Moreover, a lack of encouragement or motivation, resistance to change and blame culture are quite prevalent across the sector which prevents innovative systems or strategies from being utilised in a systematic manner.[15]

However, some challenges still need to be overcome—notably, a decline in pharmaceutical R&D productivity and a prolonged process for deploying health innovations due to complex health ecosystems. The convergence of digital and biological technologies is disrupting healthcare and increasing the importance of data integration and management across the healthcare ecosystem. New digital health strategies need to focus on creating data infrastructure and processes for efficient and safe data collection, management, and sharing. Emerging markets have a unique opportunity to leverage medical innovations and invest in new healthcare delivery models to close the healthcare gap with more developed markets. Caution should be taken to ensure that new health innovations, and their related costs, do not exacerbate the health gap between the rich and poor. To maximize the potential for future health innovation, it is important to encourage collaboration across key actors, increase funding from public and private sources, establish and maintain a skilled health workforce, and carefully

evaluate the costs and benefits of medical innovations.

### **Why healthcare innovation is important:**

Healthcare innovation ultimately (by definition) leads to better patient care, improved health outcomes and efficiency. High quality and affordable healthcare for all is important for sustainable economic growth and the overall quality of life of citizens. While significant progress has been achieved across many dimensions over the last decades, significant gaps in access to quality healthcare for large parts of the global population remain. Medical innovations are critical for closing the gaps in global healthcare provision.

The importance of such innovation can be seen in different ways:

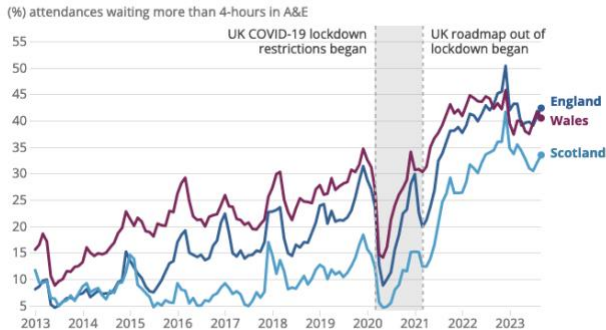
1. Healthcare innovation can improve patient outcomes through the provision of enhanced, better quality treatments options, ensuring equitable access to care and improving care coordination.
2. Innovations can also lead to improvements in population health through preventative healthcare innovations which will be explored further below. These innovations mean our population can lead healthier lifestyles through the use of technology to detect and prevent the early onset of disease
3. Healthcare innovation is also necessary now more than ever to reduce the spiralling healthcare costs seen worldwide. Despite initial R&D costs, they are able to provide additional treatment options, of which may be less expensive, and also improve the efficiency of which care in health systems is delivered.

### **Why healthcare innovation is needed:**

The paradigm of healthcare delivery is changing and is poised for a big leap forward, moving outside of the four walls of the traditional hospital and instead, moving care into the community. The global pandemic highlighted the struggles of the current health systems around the world, and they are now under more pressure than ever before. In the UK, hospital waiting lists have never been so long, with six million patients awaiting treatments in the UK waiting times in A&E are at their worst levels in 20 years[16], queues of 75 people awaiting each hospital bed in India, and similar backlogs are being seen elsewhere around the world.

**Figure 1: The percentage of A&E attendances waiting more than four hours has increased over time in each country of Great Britain**

Monthly percentage of Accident and Emergency (A&E) attendances waiting longer than four hours in England, Scotland, and Wales, from January 2013 to September 2023



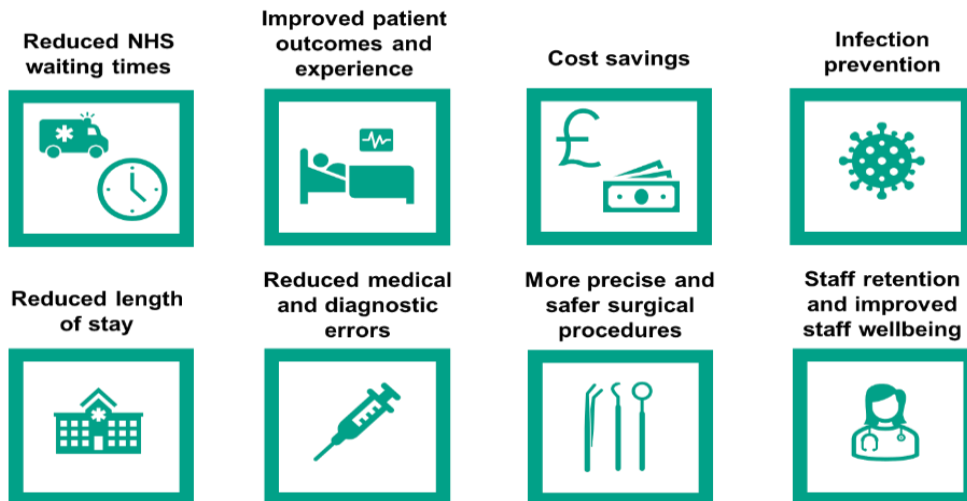
Source: NHS England, Public Health Scotland, and Welsh Government

The demands on the clinical workforce is, possibly the highest on record. It's predicted that by 2030, the global demand for health workers will rise to 84 million from the current 66 million, a projection that is three times faster than the equivalent population increase. [17] This growing gap between demand for health services and the availability of resources is only increasing the pressure on the only strained workforce, something of particular concern given the link between staff wellbeing and the quality of patient care.

Not only is the demand for healthcare workers at its highest levels, but healthcare systems around the world are also demanding significant financial resources. With the unstable inflationary environment and the knock-on effects of the covid-19 pandemic, the inflationary costs facing the healthcare system are rapidly increasing. In particular relation to the UK, the severe financial pressures on the NHS are showing no signs of easing, with healthcare expenditure increasing on average by 7% in real terms each year and are only set to continue/increase. [18] Between 2010/11 and 2014/15, UK NHS health spending increased by an average of 1.2 per cent a year in real terms and

increases are set to continue at a similar rate until the end of this parliament. This is far below the annual growth rate of 3.7 per cent in previous years, and is not sufficient to cover growing demand. As budgets tighten, NHS organisations have been struggling to live within their means – acute trusts ended 2015/16 with a deficit of £2.6 billion. However the lack of funding is intensifying the challenges faced within the system such as the quality and availability of patient care and with increasing inflation, the elective care backlog, rising energy costs, and the ongoing costs of the pandemic means healthcare innovation is required more than ever before.

Without healthcare innovation, it will be near impossible for health systems to provide the most basic level of care for a population of this size in an efficient, effective and sustainable manner. The COVID-19 pandemic has only exacerbated the need for innovation to ensure drugs get to market quicker, those in most need of care are able to do so efficiently and effectively. Here is a summary of just some of the many benefits healthcare innovation brings and how it may be the solution to the pressure faced by health systems.



Accelerated by the COVID-19 pandemic, healthcare innovation is progressing like never before and technology now is disrupting healthcare in more ways than imagined. Hospitals will therefore evolve to reflect the ongoing changes in the way healthcare is delivered and paid for. The answer to the question ‘how can today’s health systems relieve all this pressure, at scale, for good’, may just be innovation in healthcare.

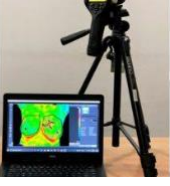
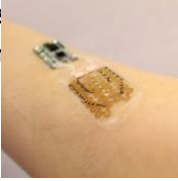

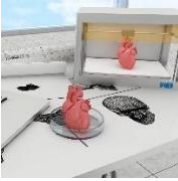

### Frugal Innovations

The overall health sector in India is valued at over US\$ 200 billion, growing at a compound annual growth rate of 22.9%. Healthcare delivery consisting of hospitals, diagnostic laboratories and pharmaceutical companies make up over 65% of the market.[19] Rising income level, increased job opportunities, access to international markets and rapid technological advancements have accelerated the growth of this industry. Thus, “new normal” in healthcare ecosystem will be about how healthcare delivery will innovate in the coming decade and what it means for both patients and healthcare providers. Frugal innovation is distinctive in its means and its ends. Frugal innovation responds to limitations in resources, whether financial, material or institutional, and using a range of methods, turns these constraints into an advantage. Through minimising the use of resources in development, production and delivery, or by leveraging them in new ways, frugal innovation results in dramatically

lower-cost products and services. Successful frugal innovations are not only low cost, but outperform the alternative, and can be made available at large scale. Often, but not always, frugal innovations have an explicitly social mission.[20]

### Three buckets of healthcare innovation:

We focus on the following 3 categories of healthcare innovation: prevention, treatment, infection control. Despite the challenges and bottlenecks in healthcare innovation, there are many examples of innovations below that can be seen to make a profound impact on the world's health systems. While asynchronous medicine may be established in specialties like radiology and dermatology, there is little research regarding the use of asynchronous medicine in areas of medicine that traditionally rely on the physical doctor-patient interaction such as primary care, internal medicine, geriatrics, and psychiatry. Asynchronous medicine has the potential to be significantly disruptive to our current healthcare processes, as well as more clinically and economically efficient.[21] recently developed technologies for better handling of image information: photorealistic visualization of medical images with Cinematic Rendering, artificial agents for in-depth image understanding, support for minimally invasive procedures, and patient-specific computational models with enhanced predictive power.[22]

PREVENTION	TREATMENT	INFECTION CONTROL
 <p><b>NIRXAI breast cancer screening</b></p> <p>It is a non-invasive, radiation-free breast cancer screening tool that uses machine-learning algorithms, big data analytics, and thermal image processing for early and accurate detection of breast cancer</p>	 <p><b>Smart bandages</b></p> <p>Smart, automated flexible wound dressings assists with the body's natural healing, containing sensors, a drug carrier and micro-processor that triggers drug delivery.</p>	 <p><b>Cleaning robots</b></p> <p>The robots are able to clean large open areas in hospitals, disinfecting surfaces by applying ultraviolet (UV)-C radiation to kill microorganisms.</p>
<p><b>Epigenetic testing</b></p> <p>Looks at biological genes and aging to see what lifestyle and medical interventions you need to take to live a longer life. Could also change the genetic code of cells to prevent them from becoming cancerous?</p>	 <p><b>3D Bioprinting for organ transplants</b></p> <p>Organ bioprinting uses 3D printing technology to assemble cell types, growth factors and biomaterials to produce a bioartificial organ that imitates the natural counterpart.</p>	<p><b>Indigo LED lighting and Germicidal Ultraviolet (GUV)</b></p> <p>UV product used for disinfection. This is a subtype of UV radiation which has proven effective in fighting COVID-19</p>
<p><b>The AT04A vaccine reduces total cholesterol vascular inflammation [23]</b></p> <p>AT04A vaccine induces an effective immune response against PCSK9 in APOE*3Leiden.CETP mice, leading to a significant reduction of plasma lipids, systemic and vascular inflammation, and atherosclerotic lesions in the aorta.</p>	<p><b>Exoskeletons</b></p> <p>wearable assistive device that alters user limb-joint dynamics. It will soon augment human walking and running during everyday life. Used to build personalised implants and prosthetics, anatomical models, and medical equipment</p> 	<p><b>Bacteria resistant surfaces</b></p> <p>Bacteria resistant finishes – building materials coated or impregnated with copper has been shown to reduce infection rates in hospitals, as copper has antimicrobial properties. Using copper oxide-impregnated bed sheets, pillowcases, scrubs and hospital gowns can also help reduce the spread of infection</p>

## Conclusion

Knowledge and innovation in the area of health are inextricable elements of universal human history. Hospitals are often regarded as combinative providers of diverse and dynamic services, able to go beyond their own institutional boundaries by becoming part of larger networks of healthcare provision, which are themselves diverse and dynamic.[24] Historically, the NHS with its unique network of hospitals and universal access, state funded healthcare has been a world leader in inventing and testing potential innovations but the challenge of managing burgeoning resource -demand gaps, dependence on diverse and non-collaborative political will focussed on short-term gains, an incessant cycle of reform-funding-defunding, makes it impossible for ensuring innovations are taken up across the whole healthcare system remains. [5]

Several studies have documented health-related innovations initiated by lay people, specifically the phenomenon of patient innovation and its potential to improve patient well-being and the health care system. [25] Hospitals should adopt strategies for employee encouragement, analytical approaches, and formal reward systems to ensure that the adoption and spread of innovations. Artificial intelligence (AI) innovation in healthcare has emerged as an increasingly significant area of research. AI, digital data collection, and computer infrastructure advancements have empowered humans to address complex healthcare challenges.[26] Of critical, but often overlooked, importance is the response (and acceptance or rejection) of patients to new models of care.

Once adopted sustainability innovations need to employ rigorous methods of continuous evaluation (e.g., objective evaluation, judgement of implementation quality or fidelity). Very little research has examined the extent, nature, or impact of adaptations to the interventions or programs once implemented.[27] There needs to be an appreciation at all levels of the importance of strategic leadership, competitive intelligence, management of technology, and specific characteristics of the hospital's change process to the hospitals success in implementing innovation. It covers the integration of AI, telemedicine, genomics, and patient empowerment. These shifts promise a healthcare ecosystem that is more efficient, accessible, and personalized than ever before. However, they also present challenges,

including data privacy, ethical considerations, and equitable access.

Navigating this evolving healthcare landscape will require a thoughtful balance of innovation and ethical practice, ensuring that the future of healthcare benefits all segments of society.[28] Patterns of innovation occurring in less economically developed countries (LEDCs) that have been historically overlooked by the innovation studies literature, including the literature on innovation systems.[29] The future calls for more prospective research on the implementation and sustainability of health care innovations.[30]

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