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VOLUME 22 • ISSUE 4 • € 22

ISSN = 1377-7629

Connected Patients in Light of Big Data

THE JOURNAL 2022

Diogo Neves, Henrique Martins
Linking Patients With Data: Brain-Computer Interfaces and Healthcare Innovation

Eugene Fidelis Soh et al.
Flipping Healthcare Through a Population Health Stack

Srdjan Babic et al.
Data Science in Modern Healthcare

Francisco Maestre et al.
DICOM Metadata - A Useful Resource for Big Data Analytics

Jörg Schwarz
How to Utilise the Massive Amount of Health Data Collected by Consumers to Improve Health Outcomes

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Editorial

Connected Patients/Informed Clinicians: It's All About Data, Analytics and Technology

Stephen Lieber
Chief Analytics Officer
CHIME, USA,
HealthManagement.org
Editor-in-Chief, Health IT

Patients and their families today are expecting more transparency and involvement in their care than ever before. They want to engage with their health, to access their medical records, and to be informed about clinical decisions and options. Clinicians and administrators also have heightened expectations about the data, analytical tools and technology available to them. They seek more personalised patient information to implement the right treatments faster, better data to save them clinical and administrative time and money, and more powerful technology to give them the tools to achieve better outcomes. To meet the expectations of patients, clinicians and administrators, healthcare delivery organisations are undertaking significant efforts to create digital engagement tools for patients, to turn data into usable and understandable information and to implement advanced technology for better care. These efforts underscore how data, analytics and digital information technology are critical assets in healthcare today for enhancing patient experience, reducing costs, improving outcomes, and improving clinician experience.

In this issue, our contributors discuss the effective collection, management, analysis, interpretation and utilisation of patient data and how this data can be secure, how patient privacy can be protected, how data accessibility can be improved for both clinicians and patients and what issues healthcare professionals face with access, transfer and sharing of this data.

Diogo Neves and Henrique Martins talk about linking patients with data and the use of Brain-Computer Interfaces, their potential application in different psychological and neurological disorders and the use of data and AI to take BCIs to the next level. Eugene Fidelis Soh and co-authors highlight the need to flip healthcare and redesign entire systems using population health stack supported by five key enablers: care, finance, workforce, digital and data, and engagement.

Srdjan Babic and co-authors discuss data science, how it has brought forth exciting advancements in healthcare and how it can continue to be used to positively advance healthcare. Francisco Maestre and co-authors provide an overview of new ways to represent data by combining patient access and DICOM information, advanced use of medical imaging metadata, analysis of radiation dose and image segmentation and deep learning for feature engineering to enrich data.

Jörg Schwarz discusses why big data is underutilised in healthcare and why it makes sense to utilise it for healthcare improvement. He also explores how to achieve data privacy and security with big healthcare data. Betsabe Melcon and co-authors explore why healthcare has not been able to make the most of data science and why it is important to address the problem of low-quality health data and identify new ways of acquiring this data to overcome this problem.

Ashley MacNaughton and co-authors highlight the need to redesign outpatient services and how this transformation needs to break down traditional barriers and focus on optimising patient experience and outcomes.

Simona Agger Ganassi discusses the key elements of good public administration capable of confronting current challenges with autonomous responsibility and for healthcare managers to better utilise healthcare data, make appropriate use of advanced technologies and move from the traditional hospital-centred model by applying the One Health principle.

Daniela Pedrini talks about EcoQUIP+, a collaborative EU-funded project in the field of healthcare to develop and diffuse new concepts and methodologies and to encourage and enable innovation in the supply chain to bring forward cost-effective solutions and deliver high-quality care.

Richard Dasselaar talks about the use and application of Artificial Intelligence and the Internet of Things in healthcare and how the benefits of AI can be realised in the short- and long-term. Kencee Graves shares her experience during COVID-19, how the pandemic presented a frequently changing situation for health systems, and how successful management required a flexible and creative approach within a healthcare team.

We hope you will enjoy this issue. As always, your feedback is welcome.

Happy Reading!

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Subscription Rates (6 Issues/Year)
One year: Euro 106 + 5% VAT, if applicable
Two years: Euro 184 + 5% VAT, if applicable

Production & Printing
Total circulation 50,000
ISSN = 1377-7629a

Verified Circulation
According to the standards of International Business Press Audits.

HealthManagement.org
is independently audited by TopPro Audit

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Cover Story: Effective Workforce Transformation

The healthcare workforce has faced significant challenges in recent years. The pandemic, an ageing population, an increase in chronic diseases, advancing technology, staff shortages, etc., are transforming the healthcare workforce. What new skills are required by healthcare workers? What are some effective strategies for sustainable recruitment? Which best practices can help engage strong talent? What changes can help healthcare workers thrive and reduce burnout?

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Srdjan Babic has subspecialised in vascular surgery and angiology. He has published more than 100 peer-reviewed articles, co-authored the Guidelines for Good Clinical Practice published by the Ministry of Health of the Republic of Serbia, and wrote several chapters in medical textbooks used at the Faculty of Medicine, where he also serves as an assistant in the department of Surgery and Anesthesiology. Dr Babic works at the Institute for Cardiovascular Diseases "Dedinje" in the Department of Vascular Surgery.

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How to Utilise the Massive Amount of Health Data Collected by Consumers to Improve Health Outcomes 225

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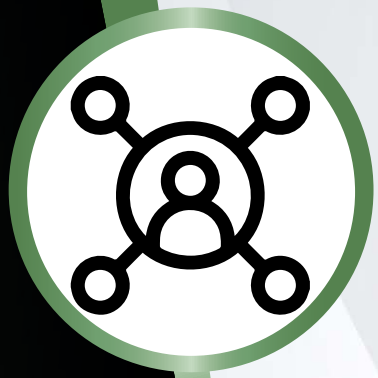

Conected Patients
in Light of Big Data

Linking Patients With Data: Brain-Computer Interfaces and Healthcare Innovation

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Patients can be directly linked to data. Brain-Computer Interfaces (BCIs) are an emerging neurotechnology with potential applications in different psychological and neurological disorders and there is a rising interest in its use to address current unmet clinical needs. Despite their therapeutic potential, BCIs are mostly limited to research stages and their translation into mainstream clinical applications and widespread adoption is lagging. Data and AI can be used with the potential to take BCIs to the next level, but these tools also come with challenges that need to be addressed.

Key Points

- New technological approaches such as Brain-Computer Interface (BCIs) solutions may address current unmet clinical needs and improve patients' quality of life.
- Most innovations in healthcare are incremental and there is a gap between their conceptualisation and their adoption into healthcare systems.
- A collaborative environment from all the stages of research and development of BCIs in healthcare contexts is needed to improve the chance of making these devices available for every patient in need.
- When developing BCIs engineers need to prioritise security, reliability and usability for easier adoption in healthcare.
- Healthcare professionals should be patient advocates, demanding BCIs to be patient-centred, have a tailored approach to each case and never forget ethics.
- Management priorities should lie in integration of this technology into healthcare pathways, foster collaboration both between multidisciplinary areas of science but also engaging and collaborating with other stakeholders and have a continuous improvement plan
- Managers play a pivotal role in the successful adoption of BCIs as they may act as awareness raising agents and facilitators of multidisciplinary collaboration between areas of science, multiple stakeholders and patients, bringing them to the centre of value-generating future care.

Introduction

Patients can be directly linked to data via Brain-Computer Interfaces (BCIs). Through them people are ultimately linked to computers via data, with data analytics and artificial intelligence (AI) playing a big role in this linkage.

Illness or injury that results in damage to the brain and its functions can lead to serious dysfunction and disability. Although new functional connections may be formed, the brain has a limited capacity to repair damaged tissue (Baldwin et al. 2013).

High global incidence of neurological and mental health disorders generates considerable economic burden, not only through direct healthcare costs but also in lost productivity (Baldwin et al. 2013; Simeral et al. 2021). There is a paucity of effective treatments for some of these disorders which means the accumulation of unmet health and healthcare needs.

Innovative approaches that counteract the varied impacts of these diseases on social, economic and everyday life of patients and their families are needed (Camargo-Vargas et al. 2021). Novel neurotechnologies offer potential routes to meet some of these needs, but pathways to mainstream innovative and effective treatments are still a challenge.

Hospital and healthcare managers should be seen as innovation agents, particularly when technologies that are promising and could open windows of hope to certain groups of patients are maturing but need some help to become mainstream. It is important for health management to know about cutting edge neurotechnology as this is likely to be one of the future differentiating factors in large healthcare organisations and not just some academic health centres.

Brain-Computer Interface (BCI) (Figure 1) is an emerging neurotechnology, that is defined as "a communication system in which messages or commands that an individual sends to the external world do not pass through the brain's normal output pathways of peripheral nerves and muscles", providing "an alternative method for acting on the world" (McFarland and Wolpaw 2002).

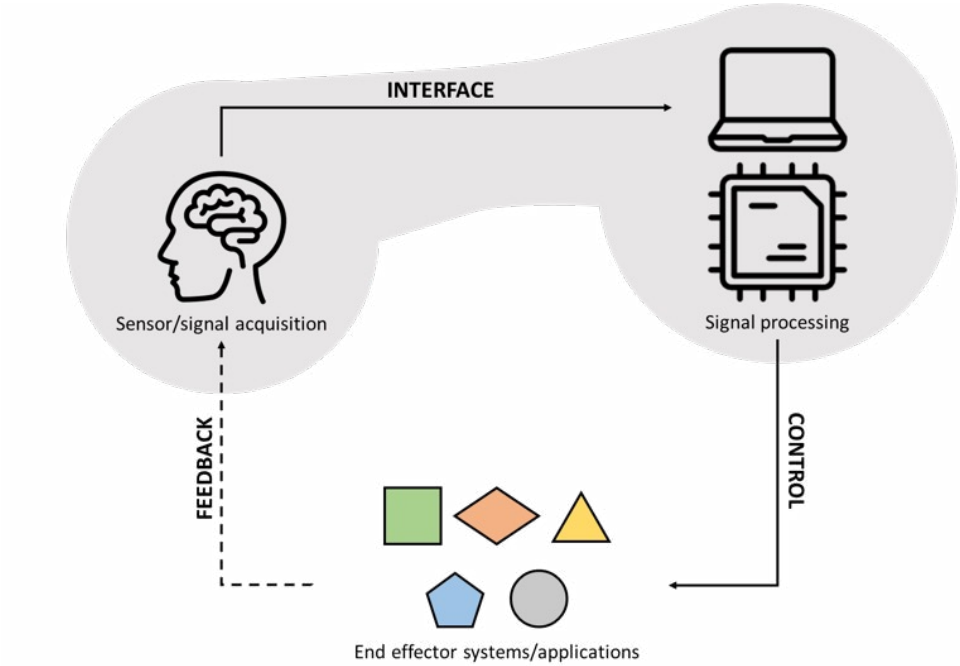

Figure 1: A simplified representation of a generic Brain-Computer Interface system

BCIs for Rehabilitation and Restoration

BCIs' potential applications to clinical conditions include rehabilitation and partial restoration of lost neurological function (Bockbrader et al. 2018). Most of these potential applications correspond to medical conditions that have no satisfying current therapeutic options.

BCIs are used to replace lost neurologic function by restoring patients' ability to interact with and control various environments and activities. For example, mobility devices or neuroprosthetic limbs and orthoses (Bockbrader et al. 2018). They can also be used with rehabilitative therapies to help restore normal central nervous system function by synchronising brain activity that corresponds to movement intent with actual movements and sensations generated by end-effector devices, inducing brain plasticity (Bockbrader et al. 2018).

BCIs have been used as investigational assistive devices for individuals with chronic paralysis from multiple causes, including cervical spinal cord injury (SCI), spinocerebellar degeneration, amyotrophic lateral sclerosis (ALS) and brainstem stroke (Bockbrader et al. 2018).

From a care perspective, BCIs may assist users to communicate, control prostheses or wheelchairs, and

support rehabilitation (Baldwin et al. 2013); therefore they might be significant to help managing, and in the future even treating, these conditions (Camargo-Vargas et al. 2021).

Table 1 provides a broad view of the potential clinical applications of BCIs. While this this is not an extensive description of all potential clinical applications or studies of BCIs in healthcare, it serves as a set of illustrative examples.

Clinical application	Current state of research	Authors & Year
Limb neurorehabilitation in stroke	Stroke literature for functional restoration through BCI-augmented therapy is more robust. This literature is more focused on the use of non-invasive BCIs in therapeutic plans for neurorehabilitation for the upper limb. There is less evidence supporting lower limb applications in stroke patients.	Bockbrader MA, Francisco G, Lee R et al. 2018 Carvalho R, Dias N, Cerqueira JJ 2019 Chen S, Cao L, Shu X et al. 2020 Wu Q, Yue Z, Ge Y, Ma D et al. 2020 Pichiorri F, Mattia D. 2020 Bhagat NA, Yozbatiran N et al. 2020 Kruse A, Suica Z, Taeymans J, Schuster-Amft C 2020 Mane R, Chouhan T, Guan C 2020 Bai Z, Fong KNK, Zhang JJ, Chan J, Ting KH 2020 Camargo-Vargas D, Callejas-Cuervo M, Mazzoleni S 2021 Baniqued PDE, Stanyer EC, Awais M et al. 2021
Control of assistive devices in Locked-in Syndrome	Due to the impairments this condition brings to patients, this is a condition where patients and their families seem to have a large acceptance of the use of these devices, resulting in several studies of BCIs application to LIS. Better results in LIS patients have been achieved when using invasive devices and it seems in the future the tendency is to continue to study and use invasive devices for people with this syndrome.	Bockbrader MA, Francisco G, Lee R et al. 2018 Vansteensel MJ, Jarosiewicz B 2020 Vaughan TM 2020 Rupp R 2020 Willett FR, Avansino DT, Hochberg LR et al. 2021 Chaudhary U, Mrachacz-Kersting N, Birbaumer N 2021 Moses D, Metzger S, Liu J et al. 2021
Motor recovery after spinal cord injury	For motor recovery after spinal cord injury, evidence for the efficacy of BCI-augmented therapy is preliminary.	Bockbrader M, Annetta N, Friedenberg D et al. 2019 Pichiorri F, Mattia D 2020 Conde V, Siebner HR 2020 Szymanski LJ, Kellis S, Liu CY et al.
Phantom-limb pain in amputees	This and other applications of BCIs to healthcare contexts are still at a very early stage of research.	Yanagisawa T, Fukuma R, Seymour B et al. 2018

Table 1: Summary of BCI applications in healthcare

While BCIs adoption seems to be lagging in clinical contexts, direct-to-consumer BCIs seem to be in a new phase of hype as an extended reality technology (Hall and Baier-Lentz 2022). These direct-to-consumer devices can be used by citizens as wellness devices. Some authors claim they can even impact users' health and could be used to improve physical, mental, and social well-being (Thomas et al. 2013; Faller et al. 2019; Coates and Wexler 2020).

The spread of direct-to-consumer BCIs raises even more concerns about confidentiality and security of personal brain data. Cybersecurity risks are known and are real in both healthcare and in general contexts. Data security, data misuse and privacy breaches are a real risk, so it is essential to establish safeguards at the system level to minimise these device risks, and preferably an institutional rather than an individual ad-hoc approach should be stimulated by policymakers and health managers to counter these risks by assuming, accepting and embracing these technologies.

Widespread Clinical Adoption of BCIs

Although BCIs have demonstrated potential use in clinical settings, including patients home, the use of these devices is still confined to research contexts (Baldin et al. 2013; Bockbrader et al. 2018; Hall and Baier-Lentz 2022).

Currently, BCIs are recognised as a technology with potential to influence the future of healthcare and medicine and have been gaining spotlight, raising more investment to research (Future Today Institute 2022). Nonetheless, large and mainstream clinical adoption is lagging as several challenges need to be addressed.

In the healthcare sector, innovations like BCIs have the potential to improve some patients' quality of life (QoL), but they also offer a challenge to existing providers and systems to its adoption. Most innovations in healthcare are incremental and disruptive innovations are rare (Flessa and Huebner 2021). The more disruptive a new technology is, the bigger the gap between its conceptualisation and its adoption into healthcare systems (Vomero and Schiavone 2021) and these technologies often face hurdles in their commercialisation that impact their clinical adoption (Pulliam et al. 2022).

Neurotechnology is a complex field and calls for a more comprehensive and multidisciplinary approach for its development and adoption (Stieglitz 2021). Not only is there a need to stimulate interdisciplinary work between Health and Engineering, Social and Behavioural Sciences but to also know how to engage patients and caregivers well throughout the Research and Development (R&D) process. The discussion of a clear path, which considers guidelines and agreed standards, towards translation of BCIs to clinical practice, may facilitate adoption by health systems when these devices reach the appropriate maturity level for large-scale adoption.

To mature neurotechnology in the context of the health heavy regulated sector takes time, investment and stamina from multiple stakeholders. The need for integration of different areas of knowledge and to improve technological literacy is not only beneficial for these technologies and innovations but can contribute with new perspectives and approaches which can bring more innovation and other improvements to health systems. Healthcare is said to be conservative and slow in adopting changes, requiring robust evidence for safety and clinical benefits. This is likely to be the case for the widespread adoption of BCIs.

Table 2 briefly resumes some challenges and opportunities to consider while introducing disruptive technologies, like BCIs, into healthcare contexts.

Main challenges	Main opportunities/solutions
Health ecosystem is often not innovation friendly and lacks change-oriented strategic vision.	Foster collaboration and cocreation, while involving multiple sciences and fields to plan and create strategies to bring important innovations to healthcare contexts
Gaps in funding research and translation to clinical settings	Address funding gaps with innovative approaches, including exploring public-private partnerships and innovation partnership contracts
Lack of clear regulatory, reimbursement and legal paths	Improve dialogue with all the stakeholders and create fast-tracks and clear and parallel guidelines to use disruptive technology
Poor literacy and public awareness about BCI devices	Raise awareness, improve literacy and build trust by engaging patients as communicators

Table 2: Challenges and opportunities/solutions for the use of BCI in clinical practice

When thinking about the translation of BCIs into widespread adoption in clinical settings it is important to take into consideration the continuous investment to fund research and improvement of the device, as well as understand how healthcare professionals and patients will react differently to the innovation in the specific context of implementation.

Multidisciplinary efforts, engaging patients and healthcare professionals more and a framework embodying clinically relevant outcomes for patients are needed for progress to be made. Also, a clear Health Technology Assessment (HTAs) methodology for BCI technology would be useful for a better classification and characterisation of the different BCIs' clinical applications that have better evidence of being closer to a translation into healthcare practices. This evaluation would include clear information and indications regarding the condition to be addressed as well as potential risks and expected benefits.

This may be a small step but will always be a step towards the creation of clinical guidelines and future integration of this neurotechnology in the health systems leading to a wide clinical adoption.

A range of opportunities where BCIs may provide significant health, societal, and economic value speak to the long-term potential of the field. Many of these applications are still in the pre-clinical, experimental, or theoretical stage.

Now is the time to be aware of these future trends and start to prepare for better adoption of enabling BCI technologies in healthcare. It is also a time to facilitate the generation of additional evidence about clinical outcomes to boost future of health policy in this field. Finally, it is time to tackle barriers to widespread clinical adoption of BCIs and catalyse opportunities across the healthcare ecosystem while stimulating a culture of innovation that accelerates the deployment of BCI-based solutions for use in clinical settings.

It is also important to show benefit for potential users by agreeing on health outcome definitions and measurement in light of these very complex therapeutic interventions. This comprehension will also be enhanced by an agreement on standardised approaches to presenting information and on criteria that are linked to context and recognise that they are overlapping and could require emphasis depending on the decision-making actor and perspective.

A simple 3x3 model for development and translation of BCIs in healthcare (Figure 2) is proposed, assuming three priorities for three distinct scientific areas that need to work in collaboration and coordination: Engineering, Medicine and Management. Engineering should prioritise security, reliability and usability of BCIs when developing them. Medicine critical aspects include patient-centredness, a tailored approach to each case and the management of risks and ensuring clinical benefits while not forgetting ethics. For Management the priorities are integration of this technology into healthcare pathways, foster collaboration both between multidisciplinary areas of science but also engage and collaborate with other stakeholders and have a continuous improvement plan.

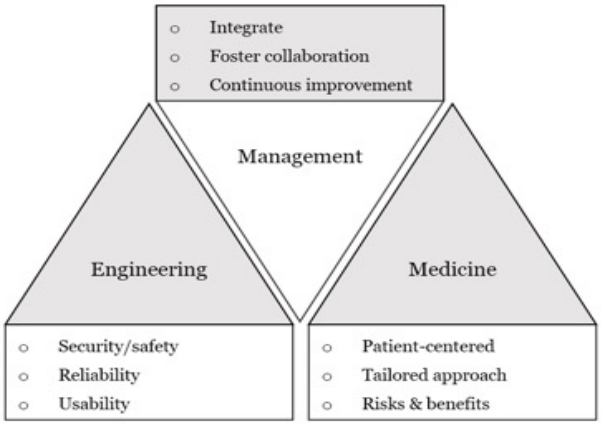

Figure 2: 3x3 model for development and translation of BCIs in healthcare

Glimpse into the Future and Brain Data

BCIs seem to be at a turning point. In recent years research has been raising the bar and its potential for clinical use seem stronger. A new phase of hype and even adoption of BCIs as a direct-to-consumer device may help BCIs stepping out of the lab-bench and successfully achieve widespread clinical adoption. Promising trials and positive outcomes with relevance for the patients are laying the foundation.

When (and if) BCIs reach clinical practice (regulated as "advanced" medical devices, almost always involving some AI technologies, and hence under AI regulation scope as well) and if clinicians will readily accept these changes and prescribe the devices remains to be seen. The integration of medical doctors in the teams developing BCIs may bring some confidence to other clinicians, but other initiatives to raise awareness and knowledge of these devices as well as their integration in clinical guidelines may push further its adoption.

This adoption will not depend only on clinicians. Engaging with a wide variety of stakeholders, understanding their perspectives and winning confidence and support will help to guide progress for the use of BCIs in healthcare contexts. To understand particularities of the health system itself and how it can adapt towards patients' needs, to guarantee it is the best solution possible and tailored to the patient needs and demands, meeting their expectations, but also to ensure equity of access for the those that may need them, would be crucial to the successful implementation of BCIs as a therapeutic tool.

A widespread clinical adoption of neurotechnologies like BCIs faces several ethical and legal concerns (Ienca 2021). One of the most increasing concerns represent the availability of brain data acquired by BCIs, which combined with the application of AI to brain data analysis, poses a challenge for ethics and governance (Ienca et al. 2021).

On one hand, an increasing volume and variety of brain data may be crucial for research and to advance the scientific understanding of the human brain and provide preventive, diagnostic and therapeutic solutions for patients with neurological or psychiatric disorders. On the other hand, brain data is still data and part of a wider digital ecosystem, being therefore subject to the same risks and vulnerabilities as other digital data.

Brain data obtained by BCIs will have the power to support evidence-based decisions, but this data still needs to be shared so it may contribute to new discoveries in the research of brain mechanisms. We argue this data should be shared, but how to do it is still unclear. Use of biodata banks, where patients are able to consent to their brain data usage for research purposes may be one way. Patients might be more willing to share data if its use is for their benefit or benefit of future patients. However, it is important to acknowledge that this willingness may shift if there is data misuse by the organisations.

An informed consent from the patients for the use and availability of their own brain data, while respecting privacy, are central parts on building a sustainable future for brain (health) data.

It is also important to start this discussion in the dawn of the European Health Data Space and how this brain data should be integrated not only in the personal space of the patient but also be digitally available for organisations and professionals responsible for the care and for other researchers. The amounts of data acquired and generated make it obvious that its analysis will require automation. AI tools will be responsible for not only analysing and categorising data but will also play a role on future developments by, for example, understanding hidden patterns in this data and extracting meaningful markers from the data obtained from the brain.

Implications for Hospitals and Healthcare Managers

In healthcare, successful innovations bring clear benefits when compared to what is currently done, and often possess two key qualities: they are both usable and desirable (Kelly and Young 2017).

New clinical technologies have the potential to bring important benefits to healthcare; however, achieving an optimal spread of new clinical technologies into healthcare has proved to be far from straightforward (Llewellyn et al. 2014).

Successful implementation of technology depends on negotiating the changes this requires to staff activities and adapting implementation to the wider organisational and social context (Llewellyn et al. 2014).

Hospital and healthcare managers may have a pivotal role to play in the successful adoption of BCIs into widespread clinical contexts. As referred before, their role as facilitators of collaboration between multidisciplinary areas of science, collaborate with other stakeholders and define a continuous improvement plan would be part of a successful adoption. On the other hand, they may also act as facilitators of the awareness in communities where they are integrated into, contributing to bringing patients to the table to establish a plan that brings value and addresses their needs.

Understanding data as foundation for increased quality and accelerated improvement and safety, leading to better and more suitable to the users' devices, should make healthcare managers have a comprehensive approach to data governance. Data-driven interventions while ensuring highest data protection standards and a secure data space providing access to quality-checked, anonymised health data for medical research and development will contribute to better patients' life and to raise trust in AI and its potential in the field of neurotechnology. To have a patient-centred approach to brain health data, should premise patient participation in the decisions regarding their data, in a shared responsibility process.

Besides this, hospital and healthcare managers must also think ahead in the future. The current trend on domiciliary and telehealth care may change the current picture of health facilities. If these trends grow in the future, hospitals may redefine part of their role and act, for example, as a hub to integrate healthcare professionals, other professionals acting in health like engineers, academia, industry and all the relevant stakeholders. On this note, they have a key role in starting a cycle of valuable innovation adoption with consequent gains for the patients and for the healthcare system.

Co-creation and collaborative environments may shift the current landscape towards a more innovation friendly ecosystem which would comprise more value for the patient, but also more value for the society and for innovative businesses with valuable propositions. Science and technology alone will not change healthcare or the world. Instead, a strategic vision and leadership are needed in order to surpass barriers, innovate and successfully implement new strategies to past, present and future problems.

Conflict of Interest

None. ■

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Flipping Healthcare Through a Population Health Stack

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Key Points

- The traditional model of healthcare has become unsustainable. To address new needs of an ageing population, health systems are flipping healthcare and redesigning entire systems to move from volume-based to value-based incentives.
- To flip the health system to a Population Health System, three strategies to align, aggregate and anchor all actors in the system, namely the payer, provider and patient/resident helps health systems to achieve the triple aim.
- Five models of care have been identified and stacked to form the Population Health Stack.
- The Population Health Stack is supported by five key enablers, namely Care, Finance, Workforce, Digital and Data, and Engagement.

The traditional model of healthcare has been reactive and focused on centre-based resources needed to care for patients. This model of "patients going to where the care is, because that is where the money is", has become unsustainable. This is particularly so for developed countries and health systems that are concurrently facing ageing populations, increasing burden of chronic diseases and years spent in poor health, rising healthcare costs and shortage of healthcare manpower. To address this, there is a global movement across health systems pivoting towards population health. Specifically, systems are flipping healthcare from siloed treatment to integrated prevention and management, and redesigning entire systems to move from volume-based to value-based incentives. Models where "the care and hence money follows the person" are also being promoted. The aim of the flipped model is to address the health of the population, bridge health and social care, and align payers, providers, and patients towards health. This is expected to achieve better alignment across the system, towards the triple aim of improving health outcomes, bending cost growth trajectories and provide care experiences that patients value.

While such broad change is deeply disruptive across payers, providers, and the population they serve, it is inevitable and necessary to ensure relevance in addressing needs for the population. For context, most health systems were designed for a time when populations were young and healthy. To ensure easy access when needed, policies and systems were designed to keep care affordable. Coupled with strong public health efforts to address social determinants of health (e.g. housing, education, communities, transport, the environment, and the economy) (Lovell and Bibby 2018), healthcare was a minor contributor (10%) to health (Bibby 2017), and little more than a repair shop and safety net. Healthcare utilisation and costs to the system would also generally be low in such young and healthy populations. However, in an ageing society with high living

standards and ongoing efforts to address social determinants of health, the healthcare needs of the population are drastically different.

In a 2018 Singapore-based review, it highlighted financial security, employability, dementia, depression and social-emotional well-being and support, as issues faced by the elderly in the developed country that traditionally has a strong focus on public health (NPVC Knowledge and Insights Team 2017). In an ageing population, the new social drivers for health, like living with frailty, dementia, disabilities and social isolation are deeper and more complex than what most health systems were used to. As these very health systems (where hospitals act as safety nets for primary and community care models) were not designed to support ageing-in-place, this results in full hospitals, where discharges are constrained by the lack of suitable community-based options to help support residents with their needs. This is especially so, as frailty is a key driver for longer length of hospitalisation (Juma et al. 2016), and high mortality and institutionalisation within 12 months (Chong et al. 2018). Without flipping healthcare to population health, it is envisioned that hospitals (the most expensive healthcare setting) will be burdened with significant challenges in managing complexity, acuity, and frailty, resulting in unsustainable health systems.

Triple Strategy Towards Triple Aim

To flip the health system to a Population Health System, there is a need to Align, Aggregate and Anchor all actors in the system, namely the payer, provider and patient/resident. This triple strategy in re-designing the health system incentivises the behaviours of all actors towards health, reduces the fragmentation, and provides stackable value across the system. With alignment, the system encourages health-seeking behaviours with shared agreement across actors on care

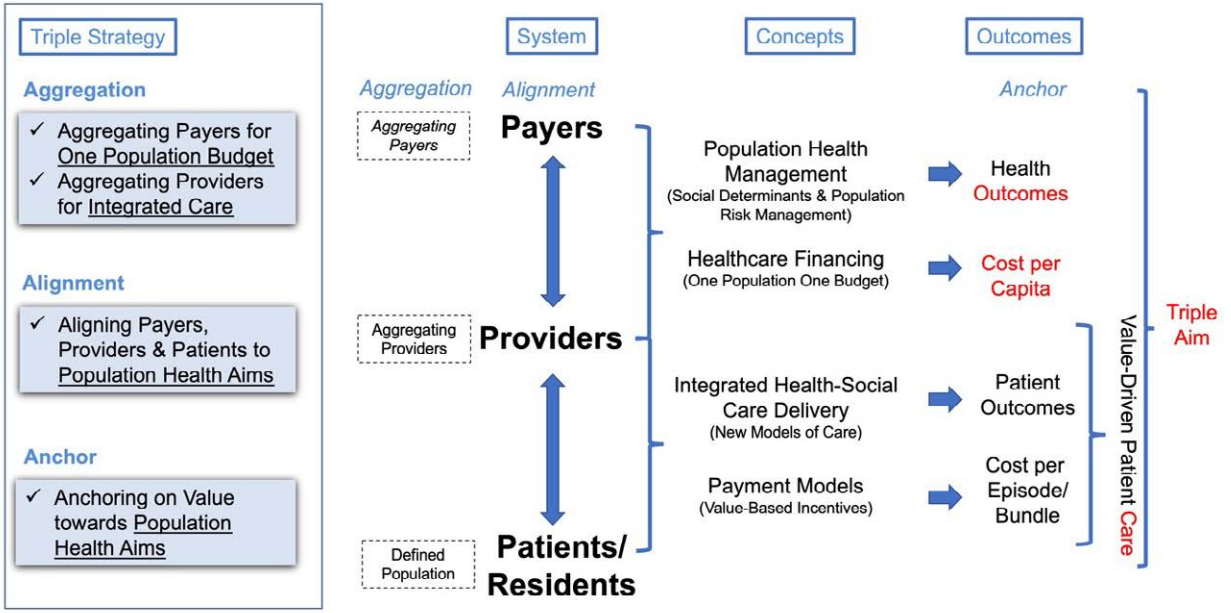

Figure 1: Triple Strategy for Triple Aim

goals and payments. In aggregating budgets across payers and integrating care amongst providers, the high inefficiencies of today's fragmented budgets and healthcare systems can be reduced with a one budget, one system, and one population approach. In anchoring care on value, it provides a universal language across the system from value-based patient care delivery to the triple aim of population health (Berwick et al. 2008).

In rolling out the triple strategy, there are four concepts to aggregate actors, achieve alignment and anchor on value. Firstly, between Payers and Providers, the Population Health Management looks at risks, needs and interventions which allows us to manage population health risk and achieve population health outcomes. It is supported by a Healthcare Financing to achieve one budget for the population served. Next, amongst Providers across the system, an Integrated Health and Social Care Delivery seeks to join up care. Lastly, this is accompanied by Payment Models that incentivise providers and patients towards shared goals. Together, these four concepts drive value for the population towards the triple aim of population health outcomes, care experience, and cost per capita (Figure 1).

Stacking Up Care in a Population Health System

Much has been written about health systems that are focusing on improving population health, through the development of integrated care and financing models (Akderwick et al. 2015). To integrate health-social care delivery for a population health system, five models of care were selected to form the Population Health Stack; the selected care models must work in tandem

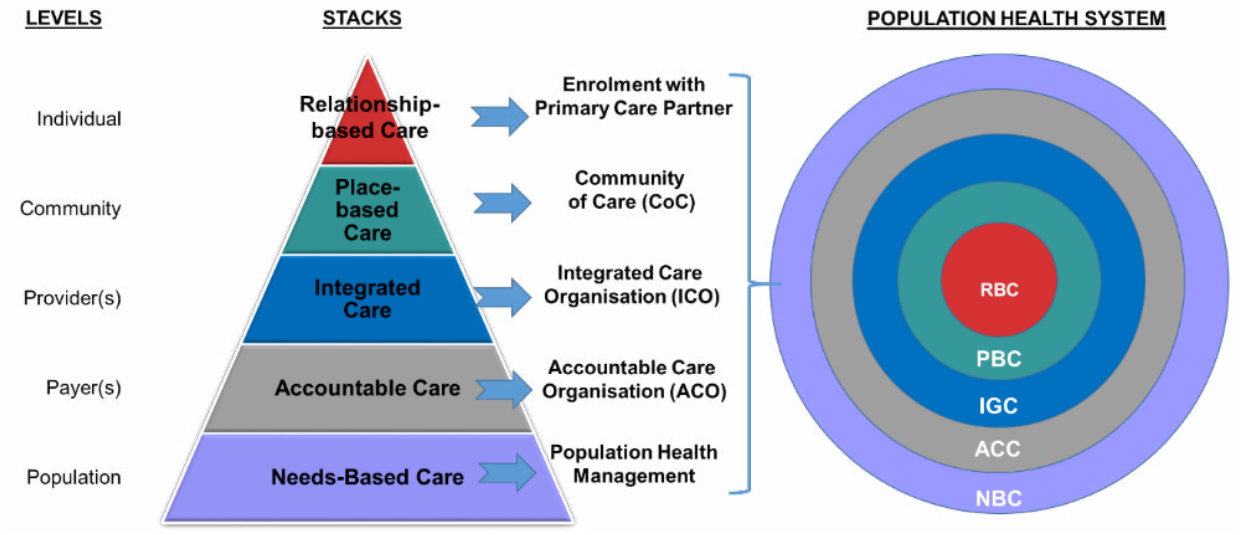

Figure 2: Population Health Stack – Stacking up Models of Care as a Population Health System

at different levels of the system to drive population health, while caring for the individual resident (Ham 2018). The use of a "stack diagram" for a population health system seeks to illustrate how care of the individual eventually stacks up to the health of the population (Figure 2). This provides clarity on how the different care models can be planned and organised across the different levels of the health system to achieve the triple aim.

At the top of the stack is the ***Relationship-Based Care*** **(RBC)** model. The RBC model describes the longitudinal care relationship between the resident and his/her primary care provider. The model empowers the resident who chooses to be enrolled in the relationship, to own his or her health. The primary care provider would then advise the resident to co-create a care plan that would strongly feature preventive health elements. This close relationship with a primary care provider, is expected to enable each resident to better understand his or her health profile with periodic reviews, set care personalised goals, and navigate the co-created care plan that is jointly agreed upon.

Surrounding the resident and primary care provider, is the ***Place-Based Care*** **(PBC)** model. The PBC model seeks to build partnerships with health and social care partners, into a geographical-based Community of Care (CoC) to support the health and social care needs of the local residents in a defined geographical area (approximately serving a few thousand residents). This approach ensures that care is localised to the needs of the residents at a neighbourhood level, and the availability of programmes offered by local health and social care partners.

The ***Integrated Care*** **(IGC)** model adopts a life-journey approach to design programmes that join up care for residents. With common features like preventive health, pre-disease, to end-of-life care, and the use of disease management, case management and care coordination enshrined in all programmes, the resulting integrated care programmes are cross-setting and drives the triple aim for sub-populations or disease-based cohorts. These integrated care programmes are supported by an Integrated Care Organisation (ICO) that serves as a network of providers (or an integrated care provider) that sees to the care needs of the residents (approximately 250 thousand to one million residents).

Integrated Care is best supported by an ***Accountable Care*** **(ACC)** model. In the ACC model, an Accountable Care Organisation (ACO) receives a budget for the care of a defined population (approximately one and a half to two million residents), and is held accountable for the health outcomes for that population. As the ACO is able to aggregate budgets at a much wider level (e.g. health and social care), it can achieve better alignment of the provider(s) to the payer(s) through a "one budget one population" approach. In this one budget approach, the ACC model would work with different financing models, from tax-based subvention to insurance models, to aggregate payers across the system. Downstream, the model allows providers to focus on the most appropriate integrated care, and promotes the use of value-based patient and provider payments to ensure the shift away from a fee for service and episodic care approach.

The base of the population health stack is a model that identifies the health risks of a defined population, translates that to needs, and designs resources and interventions that are targeted for each segment. This ***Needs-Based Care*** **(NBC)** model is the basis of population health management and underlies the development of a population health system. It shifts the focus upstream to look at needs and sets out the goals of the system aligned with the triple aim. With more weight given to effective risk adjustments in healthcare, several methods have been developed and implemented. These models range from simple models based

on demographic characteristics (e.g. age and gender) to sophisticated models like the Johns-Hopkins Associated Clinical Groupings (ACG) and Patient Needs Groups (PNG) that take into account risk factors such as pharmaceutical or diagnoses (The Johns Hopkins University 2022; Stuch et al. 2022). Through these methods of identifying risks and needs, it helps health system administrators' better plan resources.

Collectively, the Population Health Stack provides a systems language to illustrate the models of care that need to be developed at each level of a Population Health System. It enables clarity in planning and coordination, so as not to be at cross-purpose in transforming the healthcare system into a population health system.

Key Enablers for Transformation Towards a Population Health System

Beyond the models of care, there are five key enablers to successfully flip healthcare towards a population health system. They are: Care, Finance, Workforce, Digital and Data, and Engagement. In Care Transformation, the required shift is from a largely linear approach, to a complex-adaptive approach in redesigning care beyond the centre-based care settings, into the community.

Redesigning care requires an integrated box of tools from lean healthcare, design thinking, and organisational development. Lean is Left-Brain and focuses on reducing waste and optimising processes. Design thinking is Right-Brain which looks at ethnography to understand behaviours and interactions. Organisational development is the Brain Stem and it enables a deep learning cycle to build organisational health across the system to enable health and social change. In redesigning care, a whole-brain approach is needed.

Finance Transformation seeks to align financing and payment models to achieve best system outcomes at a sustainable cost to the system (Figure 3). Value-based healthcare provides a universal language from the technical value of an episode of care to the triple aim of Population Health (Gray 2017). In financing models, capitation is a strong lever to drive value-based outcomes on a per resident basis, and risk pooling on a per capita basis. In payment models, value-based payment models and incentives for enrolees, can align residents and providers to health outcomes. At the system level, shared value contracts allow for shared savings across all actors in a population health system (Figure 4).

Workforce Transformation is key to scale and sustain a Population Health System. The redesign of jobs for healthcare professionals extends from individual job redesign, to team-based job redesign, trans-disciplinary job redesign to digitally enabled job redesign (Soh et al. 2021). The current "many (providers) to one (patient)" workforce model at hospitals pivots to a "one (provider) to many (residents)" workforce model in the community. This is enabled by introducing trans-disciplinary roles and the use of digital technologies to enable care to be delivered anytime, anywhere.

Digital and Data Transformation has a triple strategy

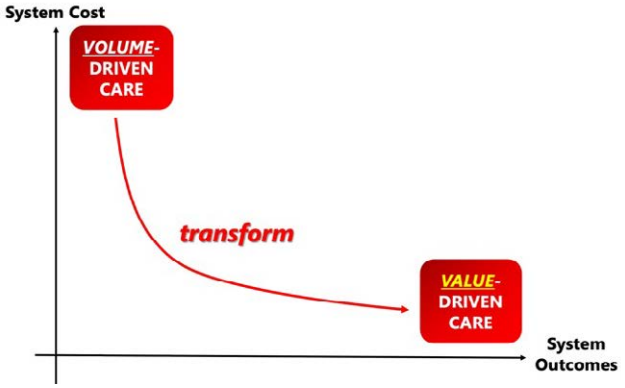

Figure 3: Value-Driven Finance Transformation

of data, tools, and records. First, a population health registry with a health-social data analytics infrastructure. Second, Business to Business to Customer (B2B2C) digitalisation tools with a resident relationship management system. These tools can allow for care coordination and social prescribing with health and social care partners. Lastly, while the electronic medical records (EMR) system serves the provider and documents the transactions, a resident health records (RHR) system can empower residents to own their health, care goals and care plan. Such a RHR system can be built using a trusted digital wallet system that allow residents to share data with providers and stackable for citizenry functions.

Engagement underlies the need for payers, providers and residents to develop strong relationships across the population health system (Soh et al. 2020). For payers and providers, this is achieved through partnerships. For residents and caregivers, engagement drives activation for health. Activated residents own their health, are supported by their caregivers, communities and care providers.

Flipped Healthcare Towards a Population Health System: A Case Study of National Healthcare Group (Singapore) for Central and North Singapore

The Singapore health system is a mixed financing system that has achieved universal health coverage (Lee 2020). In 2021, the Ministry of Health (MOH) (Singapore) appointed the National Healthcare Group (NHG) (Singapore) as the regional health system for Central and North Singapore[1], with an assigned population of 1.5 million Singapore residents.[2] With an aim to flip healthcare and drive population health, in 2021, NHG reorganised and adopted a geographical based ACO-ICO structure, with NHG functioning as the ACO, and three zones; Central Health (CH); Yishun Health

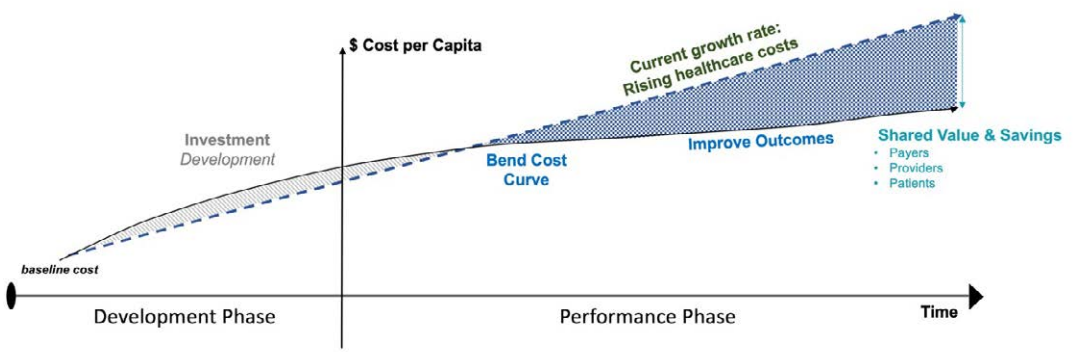

Figure 4: Driving Shared Value and Savings for Financial Sustainability

(YH); and Woodlands Health (WH), designated as ICOs that are in charge of working with their network of providers to care for their populations of approximately 250 thousand to one million.

Applying the strategies and population health stack described above, the following are some key highlights of NHG's transformations (described using the population health stack framing):

- **Relationship Based Care (RBC)** – In conjunction with MOH's (Singapore) Feb 2022 announcement to introduce resident enrolment to primary care providers (PCP) under Healthier SG, NHG has worked closely with the ministry and PCPs serving Central and North Singapore to promote enrolment. Efforts include ground up designing of care plan and financial incentive elements, two-way specialist referral operational workflows, and ensuring that private PCPs are supported by ICOs to ensure that the PCPs are equipped to retain and promote long lasting relationships with their residents. This is a major shift from the current processes, where residents could be lost to tertiary settings due to one-way referrals, or lack of incentives for residents to retain with their PCPs.
- **Place-Based Care (PBC)** – CoCs, a concept originally conceived by the Agency for Integrated Care (AIC) (Singapore) was expanded and scaled up for Central and North Singapore, to support the local needs of the residents. As there was a very broad definition of what CoCs should be (which could be implemented by different stakeholders for their own needs), NHG developed a common definition and framework to enable a common working model and language to facilitate the conceptualisation and operationalisation of CoCs in Central and North Singapore. The NHG definition is "a network of service and strategic partners and activated residents, working collaboratively in the neighbourhood to deliver needs-based and place-based care". The three features that each CoC would have are "Activating for Health", where residents are empowered to own their health and build a caring community; "Ageing in Place", for residents to live well in the community and avoid hospitalisation, and; "Anchoring care with partners" through place based partnerships, asset mapping and development and support health and social care.
- **Integrated Care (IGC)** – Traditionally, care delivery in Singapore is relatively institution-based, with pockets of integration efforts. Building on past and ongoing efforts in care integration, NHG brought together cross-sector inputs to develop the NHG River of Life concept for addressing care needs from Living Well, to Living with Illness to Hospital and Crisis Care, to Living with Frailty, and Leaving Well. All pathways will incorporate interventions and transitions across the segments of care that are collectively agreed by partner providers. For a start, NHG has decided on five key integrated care programmes that adopts the River of Life concept towards the triple aim of their respective sub-populations, namely: Metabolic Disease, Musculoskeletal, Chronic Respiratory and Mental Health conditions and Cancers. These were identified on the basis of most impact on population health outcomes and guided by the findings of the National Burden of Disease 2017 (Singapore). This is further enabled through the reorganisation of NHG into ICOs, where the planning and development of the sector are overseen by one network comprising of primary, tertiary and community care providers within the geographical area of influence.
- **Accountable Care (ACC)** – Furthering NHG's reorganising as the ACO for Central and North Singapore, in 2022, MOH (Singapore) announced that they would be changing the public healthcare funding model from a largely fee for service to a capitation model. With this allocated per capita population budget, NHG will function as a subpayer that assesses and manages our assigned population's health risks. Beyond the most visible aggregation of the public sector subvention, NHG will also explore the possibility of aggregating other payers across the system, including that of residents themselves.

- **Needs Based Care (NBC)** – NHG has actively used data and digital tools in care delivery. As a next step, we will use shared population health management tools that allow population-level risk stratification and segmentation, and individual-level health and social assessment tools to design personalised care targeted at individual needs. Ongoing efforts include a regionalised population health registry that brings together residents healthcare records for comprehensive analysis, and meso and macro level planning.

Enablers

➤ **Care** – NHG's change management strategy for our ACO-ICO transformation is a phased, multi-year effort. Care Redesign is underpinned by a suite of innovation and improvement tools for change. NHG has adopted an extensive tool kit of lean, design-thinking and quality improvement tools to enable clinicians and administrators to come together to redesign care and adopt a value-based co-creation approach. In 2019, NHG's subsidiary, Tan Tock Seng Hospital, opened the Ng Teng Fong Centre for Healthcare Innovation (CHI) to drive change through a systems approach, termed the Innovation Cycle. The Innovation Cycle comprises of Care Redesign, Technologies and Job Redesign in every innovation and improvement effort. This is underpinned by NHG Learning & Organisational Development's KOLP framework (Knowledge-Organisation-Leadership-People) to build an organisational culture that catalyses and drives change. NHG aims to inculcate three key mindsets:

a. Partner our Central North residents on this journey to Add Years of Healthy Life.
b. We will do so by building an affordable health system that focuses beyond Illness to Wellness and delivers relationship-based care from cradle to grave for our residents.
c. Collectively with our Staff and Partners, we strive to build a resilient community where residents are empowered to live well and age with dignity.

➤ **Finance** - To enable the objectives and plans for our Care Transformation, NHG's finance transformation for population health is premised on the principles of value-based funding and payment models, and alignment of stakeholders to achieve common goals through shared accountability. While capitation funding from MOH is a big step, the age-based adjustment model is best suited at an ACO level due to sufficient economies of scale. Hence, NHG is also embarking on a cross sector review and fine-tuning of funding to ICOs and payments to partner providers, to ensure system sustainability, while ensuring that providers are adequately compensated.

➤ **Workforce** – To address the significant manpower challenges faced by the healthcare industry and in response to the evolving care models in the transformation towards a population health system, NHG embarked on a workforce transformation effort tied to its redesign of the health system. This was led by CHI, through co-learning with healthcare, industry and academic partners across Singapore and internationally. This co-learning network enables healthcare professionals and partners to bring their thoughts, their ideas and their passion, and turn possibilities into real world solutions, which empowers the healthcare workforce for the future. As a next step, NHG aims to bring together our partners to co-design and develop the community workforce of Central and North Singapore. The hospital adopts a many-to-one workforce model, whereas for sustainability and productivity, we need a one-to-many workforce model if we are to shift care into the community. This would be through the NHG Cares Institute (NCI), which is envisioned as a network of community, innovation and training partners who together can design the community health workforce for the future, and activate residents and their communities towards health.

➤ **Digital and Data** – An imperative enabler, NHG aims to build a digital village populated with user-centric and data-centric micro-services or micro-applications that would serve the B2B2C (Business-to-Business-to-Consumer) needs of our residents and providers. To do so, NHG's digitalisation efforts look to support four key shifts. First, from serving patients to serving all assigned residents. Second, from building patient stickiness to providers, to that of the community in a place and relationship-based care model. Third, beyond the institutional level to integrated network of care providers. Lastly, to shift residents from passive recipients of healthcare to empowered owners of their own health. This transformation focuses on key design principles of user-focused, stackable, asset-light digital solutions for population health delivery, supported by secured sharing verifiable and portable information. Current focuses include a population health registry, customer relationship management platforms for both residents and partner providers.

➤ **Engagement** – The foundation of an effective and sustainable ACO and ICO begins with a shared vision and building trust among all players. To do this well, we have designed engagements across national, regional, community and individual levels. At the resident facing front, we have ongoing resident discovery sessions (for insights), and are committed to ensure that our efforts are appropriately targeted through branding, engagement channels and activities. Taking a step to simplify our branding, we will also bring all resident

engagements and population health products under a single brand name. At the provider facing front, the engagements are three tiered. Relationship managers with individual partner providers; the creation of a strategic collective leadership council (POPCollect) with key partners, and a large scale Population Health Connect (POPConnect), an annual co-creation and community of practice of healthcare workers to develop a model of health and advance our Population Health movement in Central and North Singapore.

The NHG journey to flip healthcare towards population health is still in its early stages, and we would continuously evaluate the performance of our organisation as we advance into population health for our residents.

Conflict of Interest

None. ■

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Data Science in Modern Healthcare

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Data science has brought forth many exciting advancements in healthcare; however, it is important to recognise what data science is and how we can continue to use it to positively advance healthcare.

Key Points

- Data science is an intersection of computer science, mathematics, and domain expertise.
- Artificial intelligence encompasses machine learning and deep learning which are the building blocks of data science.
- Data science has several applications in modern healthcare which can aid in decision making, lead to earlier diagnosis, and allow us to better practice evidence-based medicine as physicians.
- When sharing data it is important to know the FAIR guiding principles and the differences in databases that are open access, selected access and closed access.

Introduction

Modern society has evolved over time with the help of computers and technology to gather data and be used to open avenues for further research. In order to understand how data is being used in healthcare to improve outcomes and patient quality of life every day, it is important to dig deep to understand the roots of data science and data management.

What is Data Science?

In order to understand what exactly data science is, it is important to take a step back and understand what a database is. A database is an organised collection of data that is stored and accessible electronically. They can range from being small to large, requiring different storage methods. A small database can be stored on a file, while larger databases can be stored on computer clusters, cloud storage, and servers. Without a database, data science would not be possible.

Data science is a field of study that is focused on dealing with vast volumes of data using modern techniques and tools to find patterns, obtain meaningful information, and use this information to aid in decision making. Data science can also be looked at as an intersection of computer science, mathematics, and domain expertise. Within this intersection lays software, data analysis, and machine learning. Data science can also be considered the powerhouse of the evolution of artificial intelligence which can be split into three categories: artificial intelligence, machine learning, and deep learning. Data science encapsulates machine learning and deep learning.

Machine Learning vs Deep Learning vs Artificial Intelligence

As we step forward into a society where there is an increasing use of machine learning, deep learning, and artificial intelligence, the terms are often wrongly used interchangeably. Hence, it is important to make a clear distinction between the three terms and encourage the correct usage.

Data science encompasses deep learning and

machine learning. Beyond that, artificial intelligence encompasses all three (data science, deep learning, and machine learning). Given we have defined what data science is, we will start from small and level up to the big picture of artificial intelligence.

First, deep learning is a subset of machine learning where vast amounts of data stored in databases is continually analysed and based on this information a layered structure of algorithms, artificial neural network, is used for the system to "learn." Next, machine learning is where the performance of those algorithms can improve as they are exposed to more data over time. Finally, artificial intelligence is where a programme can use the information from deep learning and machine learning to act upon the data, adapt, sense patterns, and aid in decision making.

Over the past few years, data science has an increasing presence in the healthcare field with the introduction of smart-watches with ECG monitoring capabilities, computer-aided diagnostics, and several other technologies. These technologies in healthcare can help us reach a diagnosis at earlier stages, point out abnormalities on a medical image that would otherwise be missed by the human eye, save time, and even aid in decision making.

With the proper use of artificial intelligence in healthcare, we can improve safety, quality, and outcomes of future patients. As physicians, we can practice evidence-based medicine and use artificial intelligence as an extra tool to help guide decisions and even use the data constantly being collected to update guidelines and improve outcomes.

Within data science it is important to recognise the importance of sharing data which can lead to further advancement of artificial intelligence. In healthcare environments where there is a lot of confidential data, it is important to recognise some key guiding principles that should be followed for sharing, and how data should be stored and shared.

Data science can be considered the powerhouse of the evolution of artificial intelligence which can be split into three categories: artificial intelligence, machine learning, and deep learning

Data Science and Healthcare: To Share or Not to Share?

In data science there are common guiding principles that should be followed (FAIR). FAIR is **f**indable, **a**ccessible, **i**nteroperable, **r**eusable. Furthermore, it is pivotal to consider the privacy and discoverability of data. In data collection, it is important to consider how data is shared. Particularly in healthcare management, this is a widely debated topic.

Databases can be classified into three different types: open, shared, and closed. These types of databases mainly vary in the way the data is shared and who has access to the database.

On one end of the spectrum is open data where data collected is available to everyone to use, view, and even publish based on this data. For data to be truly considered open, it is pivotal that there are no restrictions from copyright, patents, or other mechanisms of control. Some benefits of open data is that its use and re-use can provide data to researchers and other data scientists who traditionally would not have access to this type of data. Open data can positively contribute to research in that this data can be viewed by many researchers that can offer varied perspective on the data and draw the most out of it. While there are many advantages to open data, there are a lot of concerns that surround this type of managed data when it comes to humans, and particularly in healthcare management.

In healthcare, it is pivotal to pay attention to confidentiality and privacy and usage can be limited. In addition, in regard to human data, open access databases can be commonly misused and even be interpreted by individuals that do not have proper knowledge in the field.

On the other far end of the spectrum is closed data. This is where data can only be viewed by those within a particular organisation where the data is being collected. This also means that the data is not shared beyond the organisation.

In between open and closed data is shared data. This is where data is closed with the exception that it can be shared only within a certain group of people for a specific purpose.

Within healthcare, it is critical for centres to have their own data collection and a closed data approach. In the case of a multicentre collaboration for a research project, data can potentially be considered shared given that certain precautions are taken to ensure that privacy is maintained for sensitive data (data that can be used to identify an individual, species, object,

process or location that introduces a risk of discrimination, harm or unwanted attention).

When working with sensitive data, before sharing the data, it is pivotal to hide any parts of it (identifiable) to make it non-identifiable. This is to ensure that the data cannot be misused, and that patient data remains confidential.

In regard to human research, the data collected can be categorised in three forms: identifiable, re-identifiable, and non-identifiable. Identifiable is where based on the data, it is very clear who the patient is. Re-identifiable is where patient data is de-identified or anonymised to a certain degree; however, it is still possible to identify an individual if you have access to all of the data. For example, in healthcare management, this would be the difference between having the patient's name versus a number that their name and other sensitive information is linked to. Lastly, there is nonidentifiable data where data is de-identified/anonymised to the degree that by using the data the specific individual cannot be identified. When considering the sharing of data, especially with human data it is important that dependent on the degree that the data is shared the data is properly anonymised.

In data science, there are common guiding principles that should be followed - findable, accessible, interoperable, reusable

Conclusion

In today's modern world where data is constantly being collected and analysed using algorithms, it is pivotal to understand how this occurs. The advancement of technology along with the creation of databases have given rise to a new field of study, data science, which has entered into various sectors, particularly healthcare. As data science continues to evolve within healthcare to aid in decision making and help improve safety and outcomes for patients, it is important to recognise the keen differences between artificial intelligence, machine learning, and deep learning as well as how data should be stored and shared. While the future of data science in healthcare may be very exciting, it is crucial for us to not lose sight of the importance of keeping patient data confidential, refraining from misusing them, and understanding the limitations of such technologies.

Conflict of Interest

None. ■

Expanding the Use of Remote Technologies in Healthcare

Sourabh Pagaria I Executive Vice President & Managing Director, Southern Europe I Siemens Healthineers

Health systems could reduce inefficiencies and achieve growth by strategically deploying telehealth technologies throughout the patient pathway. Remote technology can impact how caregivers deliver care. Health-Management.org spoke to Sourabh Pagaria, Executive Vice President & Managing Director of the Southern European business of Siemens Healthineers, on the benefits, challenges and future trends of remote patient monitoring in healthcare.

What is your vision of a telehealth model in the future?

During the pandemic, telehealth was a lifeline for patients who needed to consult with doctors. As many as 46% of patients used it in 2020 (Meinhardt and Staehr 2021). Some define telehealth as a combination of technology and devices used to remotely obtain information about a patient's health status, which aids in determining whether or not an intervention is required (Galiero et al. 2020). This is how most people think of telehealth today: a patient is talking to a physician using a mobile device. Without a doubt, this is a leap forward in providing access to physician consultation. But there is more to telehealth than virtual consultations. Telehealth connects care teams and empowers caregivers to deliver care more effectively while providing the convenience that patients increasingly expect. Moreover, health systems can reduce inefficiencies and achieve growth without expanding their footprint by strategically deploying telehealth technologies throughout the patient pathway.

The current use of telehealth gives patients the ease and accessibility to obtain consultation remotely, but remote technology can considerably impact how caregivers deliver care by overcoming challenges such as geographical distance and expertise shortage posed by the traditional hub-and-spoke setups.

Hospitals can leverage experts across the entire network and provide patients with early diagnosis by utilising remote technologies for various disciplines. For example, with the advent of telepharmacy and remote

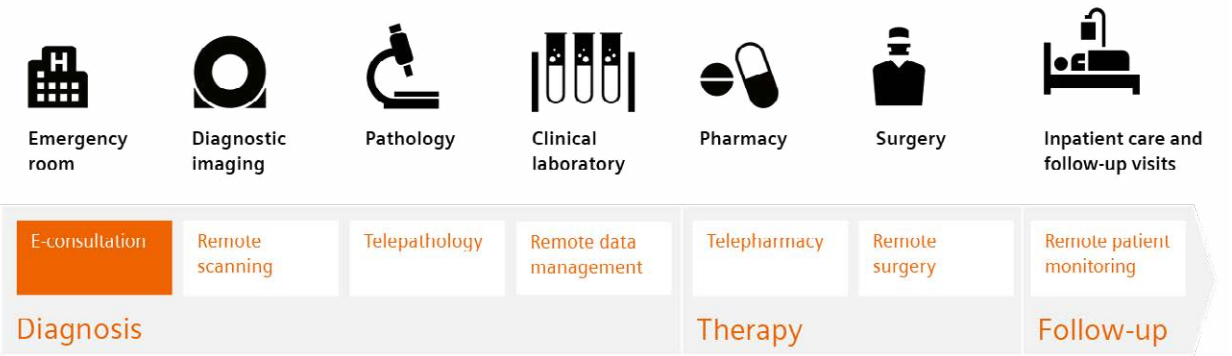

Figure 1: Expanding telehealth along the continuum of care.
Telehealth today mainly complements the consultation between patients and physicians. Expanding the use of remote technologies to different disciplines in diagnosis, therapy and follow-up can bring more convenience to patients and efficiencies to caregivers and help hospitals grow. Source: Siemens Healthineers Insight series

surgery, patients no longer need to receive treatment and advanced care from specialists only on main campuses but also close to where they live and work.

Remote patient monitoring (RPM) is an important component of telehealth. What elements should be considered to optimise it?

The so-called digital front doors enable providers to remotely monitor patients' signs and symptoms, identify when they are at risk and provide individualised care management programmes.

It all starts with engagement. Patients must be willing to contribute to the collection of data required by providers. Providers will have the data they need to provide better care if patients agree to wear wearables and other measuring and monitoring devices. Furthermore, the generated data can be aggregated and stored in an electronic health record, where patients can access, manage, and upload their health information to be shared with providers. A best practice example of this philosophy is the telehealth solution for monitoring patients with cardiovascular diseases developed by the Heart and Diabetes Center North Rhine – Westphalia (in Germany). Patients carry certified medical devices that transmit vital data to the Heart and Diabetes Center round the clock via a smartphone and a secure data connection while specialist staff at the centre collect and study data and discuss it with the patients in planned, regular phone calls, coaching and training them. This form of continuous monitoring allows for faster reaction time, guideline-oriented care and higher adherence to therapy.

What are some of the key benefits of RPM?

Remote patient monitoring is one of the most promising solutions to improve care, reduce costs and create efficiencies as it helps patients, physicians, and caregivers monitor and manage ongoing care, especially in a patient's home. Specific applications include tablet-based patient education, videoconferencing with health care providers, and devices to prompt and track diet, exercise and medication adherence (Hodin 2017). Let me explain this with a concrete, implemented project. I'm talking about the eight years partnership Siemens Healthineers signed with the Hospital do Espírito Santo de Évora (HESE), a major hospital in the south of Portugal and the primary inpatient care facility in Alentejo, the largest region in the country. Alentejo is very rural, and the population consists largely of elderly individuals. The main cause of death is cardiovascular disease. To better respond to the needs of the local population, HESE partnered with us to implement two integrated solutions: the modernisation of the cardiac catheterisation laboratory (cath lab) and the addition of a new cath lab. Second, a telehealth programme for remote care management was developed to serve patients with cardiovascular conditions before and after interventions, such as transcatheter aortic valve implantations (TAVIs).

Remote monitoring allows hospital staff to care for patients in their homes before and after an intervention. Moreover, **remote monitoring of patients in their homes has significantly improved the quality of medical care**, especially in a sparsely populated region like the Alentejo, as well as made **contact more personal and direct**, which gives older patients in particular more confidence and security.

Although a low rate of digital literacy is a reality in the heart failure patient population, the remote care management programme encourages patient engagement and adherence, reduces hospital readmissions, and utilises artificial intelligence (AI) to streamline workflows. At home, patients have access to 24/7 support, if necessary, which improves their experience as there is no need to travel long distances for regular check-ups, and continuous care is possible despite living in different areas.

Which digital tools are essential for providing remote care?

Advances in smartphone technology, as well as healthcare provider information and communications technology infrastructure, have enabled the development of new clinical pathways involving **app-based remote patient monitoring**, allowing patients with chronic diseases to report on their condition from outside of the hospital, where they spend the majority of their time, putting the patient, rather than the hospital, at the centre of the care pathway. Mobile apps can provide a more valuable, real-time dataset by enabling a much faster feedback loop between patients and their care teams. In addition, **remote data management** technology allows laboratorians to manage increasing testing demands while providing more convenience to patients. Furthermore, with the ability for employees to view real-time data analytics and remotely access instruments for maintenance and troubleshooting, laboratory personnel can have complete oversight and control of multiple laboratories from any location. Remote patient management can also help diagnostic imaging. For example, the University of Missouri HealthCare System in the United States uses a **remote scanning solution** that allows medical staff to connect remotely to scanner workplaces and assist personnel in another location.

Another tool to be considered is **remote robotic-assisted surgery,** which can eliminate long–distance travel for patients. It also has the potential to provide greater access to patients, especially in rural areas. Robotic-supported interventions and surgical procedures do not remove humans from the care delivery process. Instead, these advancements in

technology and science will **improve clinical quality, patient and clinician safety, and access to lifesaving and life-extending services**.

What challenges can be encountered when working on continuous real-time monitoring for patients/areas that are not connected/mobile/tech-savvy?

To effectively use digital tools and approaches in healthcare, a mindset shift and adequate training and tools are required. The digital divide must be acknowledged: not all patients own a compatible device, have adequate internet or telephone connectivity, or possess the digital skills required to use the technology.

Supporting patients through training and technical setup was beneficial during COVID-19, but new delivery models that combine face-to-face and digital services must be inclusive. And that is exactly what we did with the project in Portugal: as part of the programme, patients, families, and caregivers are educated on the remote care management solution and have access to ongoing support.

An increased level of patient engagement must be supported by resilient, high-performing supply chains. Otherwise, stock-outs or late deliveries would make these solutions meaningless and damaging to patient health. Manufacturers should consider alternative sourcing when possible. When it comes to their experiences, patients are no longer willing to differentiate between industries. As a result, patients hold hospitals to the same or similar standards to which they hold their favourite pizza chain or online retailer. As a result of the emphasis on virtual care, products and services are now being delivered to homes and locations other than hospitals. Then, hospitals must reimagine their distribution networks, including how they negotiate and collaborate with suppliers to determine the best channels to ensure the right patient receives the right products, at the right time, in the right quantity and quality (Bradley and Mangan 2021).

Do you think virtual care pathways can build patient-provider relationships as effectively as traditional care?

The basic healthcare interaction has been very human for as long as there have been doctors and nurses. This traditional human gatekeeper has served healthcare well for generations, but its limitations are becoming increasingly apparent in today's world. Patients are increasingly approaching healthcare as consumers, expecting the same quick, convenient, easy, and affordable service they have come to expect in other aspects of their lives. In addition, the increased adoption of digital technologies like telehealth and self-monitoring devices like wearables are challenging the traditional physician-patient relationship in many ways.

A survey showed that only 36% of people under 45 now make their family doctor their first point of call for common medical issues. It is clear that patients are seeking alternative front doors (Nessim 2018).

Given this premise, the patient-provider relationship will be strengthened when digital technologies are used because patient outcomes may be better, faster, and more meaningful. At Siemens Healthineers, we believe that knowledge is power and that the more you know about your patients, the better care you can provide. e-health platforms that connect different healthcare providers, allowing them to share relevant data via teleconsultation, **improve collaboration and communication across care teams and patients, resulting in better and more timely outcomes**. Applications for care collaboration and patient engagement can benefit both patients and healthcare providers by facilitating interactions between care teams and their patients for timely and precise decision-making, empowering patients to actively engage in their healthcare to enable meaningful participation. One example of successful implementation of this approach is the "Online Consultation" Project" of Salzburger Landeskliniken (SALK) that is enabling virtual patient care to improve patient experience and expand access to healthcare by utilising our eHealth Virtual Visit solution that empowers patients to consult with their physicians virtually and securely from the comfort of their home and with scheduling flexibility.

Adding online consultations to the healthcare services offered by the Salzburger Landeskliniken will bring many advantages and benefits for the patients. It is much easier and more convenient for patients to make follow-up appointments. Not only will they save the time and expense of long travel and waiting times associated with an outpatient appointment, but they can also make appointments conveniently, for example, at home in their familiar surroundings. This creates a new form of proximity to the patient.

In your opinion, what are the top five challenges of monitoring patients remotely?

In my opinion, challenges could be:

- **Reimbursement pathways** for mobile health tools that have traditionally been a barrier to implementation.
- Healthcare providers must **invest in ICT infrastructure** that can rapidly translate data from apps into actionable and meaningful insights for clinicians – without becoming an additional administrative burden.
- Providers will need to **invest in different skills for digital workflows**, or new roles will be required within healthcare settings to support the digital patient journey.
- **Confidence in these tools** could be achieved with the use of digital formularies.

- Healthcare providers and developers will need to continue to work together to **prioritise the standardisation of apps** so that they are interoperable across health systems. As regulations differ across geographies, this will require taking into account factors including different IT architecture, connectivity requirements, and data sharing and communication standards.

RPM has a very high reliance on technology. Who bears this cost, and is this investment worth it?
Last June, **Value in Health**, the official journal of ISPOR—The Professional Society for Health Economics and Outcomes Research, announced the publication of a series of articles assessing the value of remote patient monitoring in addressing challenges in patient care. In the introductory editorial of the series, it is stated that "The findings from these studies suggest that RPM solutions can be cost-effective compared to usual care, although these findings may be disease-specific, context-specific, and require scale-up to achieve cost-effectiveness". Moreover, Insider Intelligence estimates 70.6 million U.S. patients, or 26.2% of the population, will use RPM tools by 2025. And now, RPM devices are becoming smarter and more affordable (Dolan 2022).

So, it's clear that RPM is here to stay, and healthcare providers, as well as medtech companies, should work together to create enduring value–generating partnerships to bring an innovative business model that helps provider organisation leverage technologies to upgrade their organisation both in the near term – to cope with emergencies - and in the long term, by investing in strategic digitalisation efforts. Our value partnerships approach, for instance, combines our strength in holistic medical technology management and digitalisation into a long-term performance-oriented engagement focusing on creating value. With our sustainable healthcare consulting and transformation services, as well as our future-proof design planning, we are well positioned to co-create a solution with and for our customers which will generate clinical, operational and/or financial benefits.

In your opinion, will healthcare adopt a hybrid care pathway (using both analogue and digital systems), or will the care pathway of the future be completed digitised?
Expanding the use of telehealth or remote digital technologies along the patient pathway to enable caregivers to diagnose and treat patients from another location offers the possibility of a new business model to gain greater efficiency. Moreover, the use of telehealth in patient engagement during follow-up allows caregivers to give timely, proactive care to patients for better outcomes. On the other hand, it is also quite clear that technology (i.e. Artificial Intelligence) will never replace a physician. It will be a support, making medicine more efficient, more precise and more humane. It will relieve doctors of routine work and allow them to focus on tasks AI cannot take care of: investing more time into an individual patient and making better-informed critical clinical decisions. ■

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DICOM Metadata – A Useful Resource for Big Data Analytics

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This article provides an overview of new ways to represent data combining patient access and DICOM information, advanced use of medical imaging metadata, analysis of radiation dose and image segmentation and deep learning for feature engineering to enrich data.

Introduction

Data is the world's most valuable resource and it is possible to find data everywhere. In medical images, data covers not only gigapixel images, but also metadata and quantitative measurements (Aiello et al. 2021). DICOM (Digital Imaging and Communications in Medicine) is a clear source of medical data, since it is the current standard for storing and transmitting medical images (Aiello et al. 2021) and related information (Savaris et al. 2014); this means it contains raw data imaging and all metadata related to the procedures of image acquisition and curation (Aiello et al. 2021).

Idonia is a medical imaging exchange platform that facilitates the collection, storage, delivery and visualisation of medical images for medical centres, professionals and patients. Over 140 million medical images (DICOM) have been processed and delivered up to today. But with that, a necessity arose: studying the medical data contained in them in order to see if any conclusions could be drawn from such examination. This was possible thanks to the Idonia Magic Link, a tool to deliver medical images to patients that replaces the use of CD/USB, which simplified the process of accessing the data.

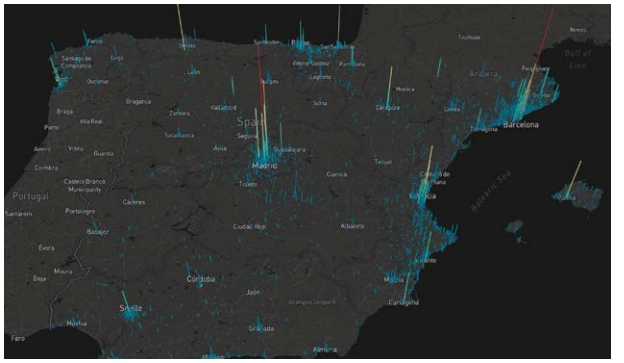
Data Lake for Medical Imaging Activity

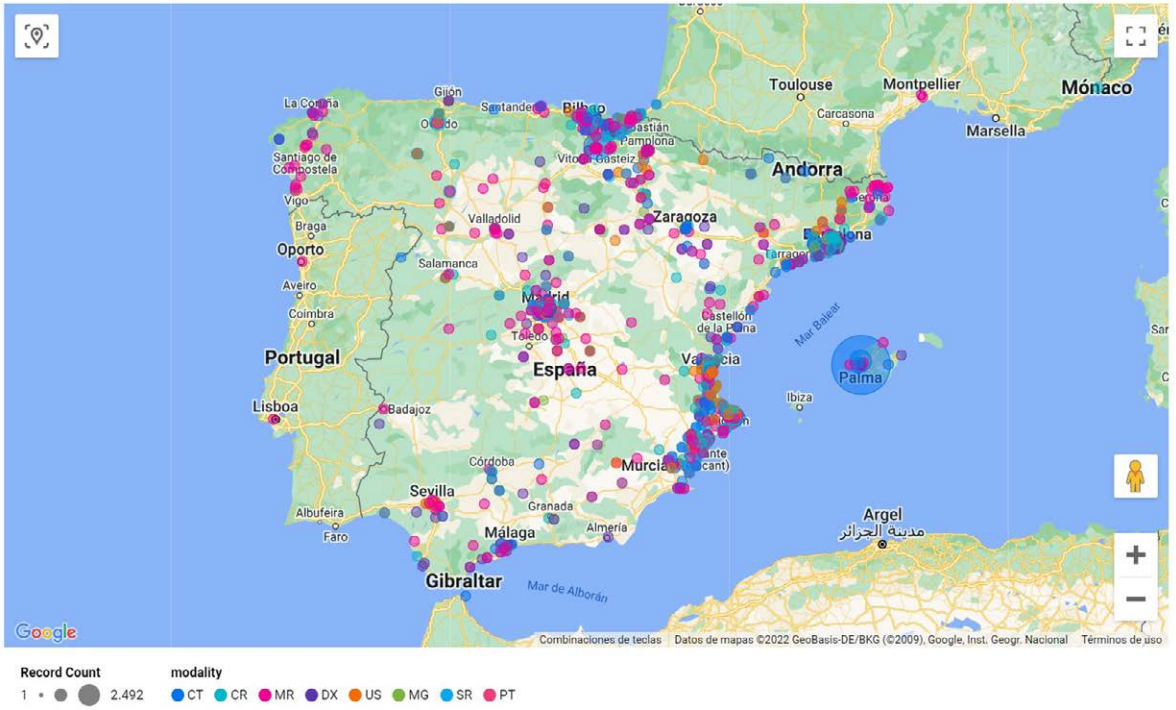
After two years of research, Idonia created the Idonia Data Lake under an R&D project supported by the CDTI (*Centro para el Desarrollo Tecnológico Industrial*) from the Ministry of Science and Innovation of Spain. The purpose of this tool was to analyse all the information provided by the clients –hospitals at most– to provide them with relevant and new information about their own data.

The first analysis was done around medical imaging activity combined with some information stored in DICOM images, such as the imaging technique, manufacturer of the medical device, the patient's body part examined and modality of study, etc. This information was shared with clients via the development of a command centre functionality that went beyond traditional dashboards; it also contained access information from both professionals and patients.

The picture below shows an example of information from patients accessing their medical studies through Idonia Magic Link.

It was also possible to generate a medical device activity map, that provided some useful information about medical devices, generated information, their





activity and remote access to their generated content.

Data Analytics Around Radiation

After years of studying medical related information, it was found that the most relevant data relied on radiation dose parameters, and from this, the idea of developing a digital tool to analyse radiation-related data originated.

In the current defined Directives and Regulations, no limits on the radiation dose are stipulated for patients undergoing diagnostic or treatment procedures. There is proof that ionising radiation has direct implications in human health (ICRP 1990), which is why measures need to be taken as soon as possible.

These actions start with being able to quantify the radiation received by a patient in studies over time, which can be done by means of a DICOM dataset of metadata. With the available DICOM data, it is possible to quantify radiation by the estimation of the effective dose, a parameter that serves as a dose descriptor that contemplates the biological sensitivity of the irradiated tissue and reflects the risk of a non-uniform whole-body exposure (AAPM Report 2008).

The purpose of the research project (Sorrell et al. 2022) was to extract and analyse the data and compare it with the SEPR (*Sociedad Española de Protección Radiológica*) and the ICRP (*International Commission on Radiological Protection*) recommendations. The problem with DICOM is that it is only a standard, which means it is not mandatory to implement and its use is pretty open. The result of this is differently structured/organised data sets, which make data analysis a complex challenge. Since the information is valuable, different techniques can be applied in order to collect that information.

Radiation-Related Information

The imparted ionising radiation to a patient has always been the main concern in radiology since there is substantial evidence of adverse effects due to radiation exposure. *Image Gently* and *Image Wisely* are two initiatives that tend to optimise the act of radiating a patient to make sure that the radiation dose is only the necessary – and never more than what's strictly necessary – to produce images with a good enough quality for the diagnosis (Sorrell et al. 2022).

The process of ionisation that occurs when imparting radiation to a patient necessarily changes atoms and molecules and may thus sometimes damage cells. This may result in preventing the cell from surviving or reproducing, or subsisting as a modified cell; both outcomes have profoundly different implications for the organism as a whole (ICRP 1990).

Historically, the quantities used to measure the amount of ionising radiation have been based on the gross number of ionising events in a defined situation or on the gross amount of energy deposited, usually in a defined mass of material. The *Absorbed Dose (D)*, for example, is defined as the energy absorbed per unit mass, and the units used for such measurement are Grays (Gy) (ICRP 1990). The problem with this is that it does not take into account the biological effects of the tissue when exposed to radiation, and this is something to always have in mind when studying radiation dose.

The Equivalent Dose (H) is the absorbed dose averaged over a tissue or organ (rather than at a point) and weighted for the radiation quality that is of interest. This has to be done because the probability of stochastic

effects depends not only on the absorbed dose but also on the type and energy of the dose. Even though the equivalent dose is only multiplied by a no-units factor, the units to express it are different from the absorbed dose; now it is given in Sieverts (Sv) (ICRP 1990).

The European Council Directive 2013/59/EURATOM, of 5 December 2013, establishes uniform basic safety standards for the protection of the health of individuals subject to occupational, medical and public exposures against the dangers arising from ionising radiation. It defines medical exposure as the exposure incurred by patients in order to be diagnosed or treated of any disease. In disparity with the dose limits for professional workers and the public in both occupational and public exposures, neither the Directive nor any of the Spanish Regulations establishes any limits on patient dose. In fact, in Article 6.1, it says that the radiological protection of the exposed patient will be optimised in order to keep the individual doses *as low as reasonably possible* (ALARP). Article 6.2 follows up with this and establishes that, in medical exposures, dose restrictions will only apply with respect to the protection of caregivers and volunteers involved in medical or biomedical research.

CT Scanners

Let's take Computed Tomography (CT) as an example. CT scans consist of a computerised x-ray imaging procedure in which a narrow beam of x-rays is aimed at a patient and quickly rotates around the body.

CT images are based on the different x-ray absorption rates of the various organs of the human body, which is why it provides both good soft tissue resolution (contrast) as well as high spatial resolution (Zhanli et al. 2009). To ensure the best resolution, the dose imparted must be considerably high; in fact, the dose imparted in CT exceed those from conventional radiography and fluoroscopy and the use of CT continues to grow, often by 10% to 15% per year, which leads to a discussion of radiation risk versus medical benefit (AAPM Reports 2008). At the end of the day, what matters are the long-term repercussions of radiation exposure, which is why the American Association of Physicists in Medicine (AAPM) has defined several dose parameters to provide guidance on reasonable CT dose levels on routine examinations (AAPM 2008).

Radiation on CT Scanners

In radiophysics, it is complicated to determine the dose received by a patient, individually, which is why they have focused on defining statistical averages for population dosimetric studies and Diagnostic Reference Levels (DRL) to optimise radiological procedures.

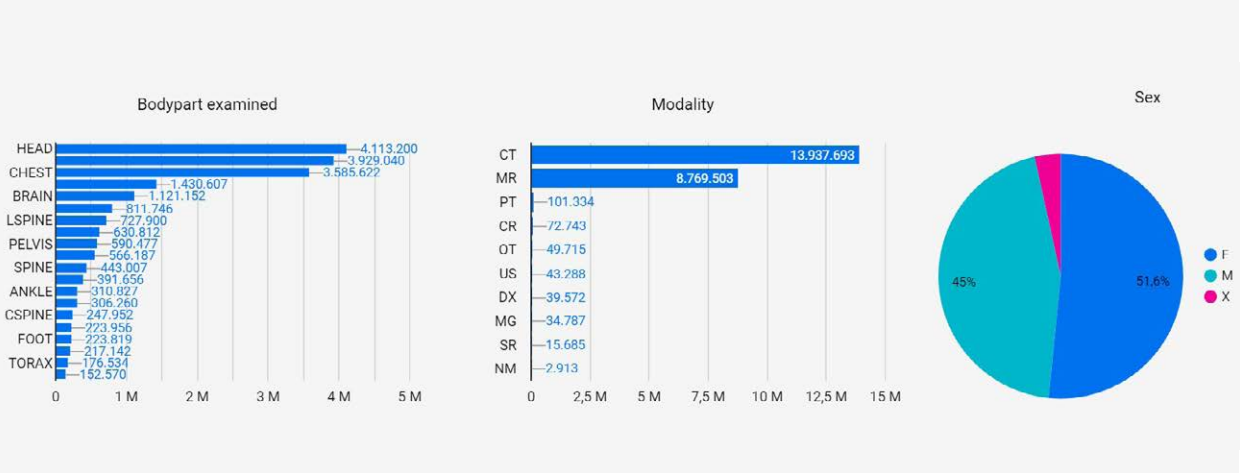
DRLs are defined in Article 4 of the EU Directive as dose levels in medical radiodiagnostic or interventional radiology practices, among others (Sorrell et al. 2022). They use a dose index magnitude in order to quantify the ionising radiation used to obtain a medical image. In CT images, DRLs are the CT Dose Index (CTDI) and the Dose Length Product (DLP) (AAPM 2008).

DICOM Standard

DICOM is the current standard for storing and transmitting medical images (Aiello et al. 2021) and it is defined as the international standard for medical images and related information. It was originally developed by the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) (Savaris et al. 2014). Its first publication, in 1993, revolutionised the practice of radiology, allowing the replacement of x-ray film with a fully digital workflow (Aiello et al. 2021).

The DICOM standard comprises a set of specifications regarding structure, format, and exchange protocols for digital-based medical images. In other words, it defines the formats for medical images that can be exchanged with the data and quality necessary for clinical use (Aiello et al. 2021). This means it contains raw data imaging and all metadata related to the procedures of image acquisition and curation (AAPM 2008).

DICOM images consist of textual metadata (Kathiravelu et al. 2021); in fact, a DICOM file contains both the image and a large variety of data in the header (Aiello et al. 2021). Physically, the content of a DICOM file can be seen as structured at the data element level (Savaris et al. 2021), which means that the information recorded on the file are the attributes; these shall be ordered by increasing data element tag number and shall occur at most once in a data set (Aiello et al.



2021).

Idonia Data Lake already obtains and analyses some relevant information from DICOM metadata.

Radiation Data Stored in DICOM Images and SR Documents

DICOM metadata also includes diagnostic reference levels such as the CTDI and in some cases, the DLP, which could be used to estimate the Effective Dose. After a large inspection of over 1.5M anonymised CT images, it was found that out of the vast amount of information available, the necessary information to extract out of DICOM images for the estimation was not as broad (Sorrell et al. 2022). For a complete radiation dose-related study attributes found on the DICOM SR are also necessary.

The Effective Dose can be estimated with the formulas defined by the AAPM in their 2008 journal (AAPM 2008), which means the standardised data that matters is:

- either with the body part Examined, the CTDIvol – volumetric CTDI– and the scan length; or,
- the body part examined and the DLP.

As it turns out, not all the information is stored in the same place, and as mentioned previously, it is not always available. Apart from the DICOM image, healthcare centres may send Structured Report (SR) documents, where a lot of the radiation-related data is stored, including the Scan Length and the DLP. Since this information is not always sent, it is not accessible in most cases, which leads to the development of several alternatives to estimate the effective dose. Some of these studies include artificial intelligence algorithms for image segmentation –in order to define the scan length– and body part recognition –in case the body part examined is unknown (Juszczyk et al. 2021).

Conclusion

The delivery of medical images in a secure and efficient way is a necessary functionality up to date, and especially, patients are taking benefit from it. Accumulating those delivered images in a cloud infrastructure, and analysing the data generated around them may bring great benefits for medical centres to better understand their patient profiling and medical activity. An infinite loop of value is created.

DICOM files contain both the image and a large variety of metadata. This metadata provides valuable information for many different applications, including a radiation-related study. At the presented project, a very extensive radiation dose study was performed by means of the DICOM metadata. It was done in collaboration with some Idonia clients with the idea of analysing a vast anonymised DICOM images dataset to see if any radiation dose-related conclusions could be drawn from such examination. This entailed a large inspection of the DICOM standard in order to be able to identify the data relevant for the study; only then it would have been possible to estimate the effective dose for an ionising radiation risk control.

The data exploration executed was remarkable throughout and allowed a deep understanding on how DICOM files are constructed. The value of aggregating all the information from different sources in one common dataset (Data lake) opens new possibilities to analyse or enrich the data that can benefit all data providers. Image segmentation and deep learning can be used for feature engineering techniques in order to enrich data when it's not available over the base of common data set information.

DICOM has some very interesting medical metadata available, thus it can complement a Big Data and Analytics project in the medicine scope. The Idonia medical imaging delivery service based on cloud technology allows to combine disparate information like the remote accessibility from patients and professionals with the DICOM metadata. This unique way to analyse the information is just a first step but the potential is huge. The aggregate information obtained from different sources through cloud infrastructure not only enriches the data source but provides more potential capabilities for deep learning data analytics.

Conflict of Interest

None. ■

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How to Utilise the Massive Amount of Health Data Collected by Consumers to Improve Health Outcomes

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This article discusses why big data is underutilised in healthcare and why it makes sense to utilise it for healthcare improvement. It also explores how to achieve data privacy and security with big healthcare data.

Key Points

- In a value-based care environment, data has a very high value because it can be used to achieve the quadruple aim: improve patient and provider experience, improve medical outcomes, and reduce costs.
- For value-based care to work, it is important to be proactive about the health of patients, and remote patient monitoring is a great tool to identify early signs of any emerging health issues.
- Remote patient monitoring is a healthcare specific form of big data, as a high volume of data in different formats (variety) can be collected from devices installed in the patient's home or on the consumer (wearables).
- Modern APIs that are usually based on machine learned algorithms can perform this filtering for various types of diseases and, therefore, add a broad spectrum of proactive care capabilities through monitoring to an organisation.

Introduction

The discussion about big data in healthcare always has a predictable format, especially in Europe. It laments the massive amount of data that is collected about patients, bemoans the security concerns, and evaluates the risks. At the same time, we see that in 2019 alone over 51 million units of fitness trackers were sold in the United States – and that is only 42% of the global market. That means that over 120 million fitness trackers were sold globally, including in super privacy conscious Europe. And what data do these fitness trackers collect? They collect heart rate at rest and under stress, geolocations, speed, and sometimes even blood oxygenation or blood sugar levels. My Apple watch can even run an ECG. So obviously consumers are willing to collect this data and pay for it in the name of fitness. This data is usually stored in a cloud environment (i.e., for Fitbit trackers or Apple watch), and nobody is upset about it, not even the same people who are so upset about healthcare data security and privacy. Well, I am upset about it! I am upset that all this data is not used more productively as an integral part of a preventive healthcare system. In this article we will discuss why big data is underutilised in healthcare today and then, once we understand why it makes sense to utilise big data for healthcare improvement, we can discuss how to achieve data privacy and security with big healthcare data.

Big Data is Multidirectional

The conventional wisdom is that healthcare providers

collect a large amount of data in a multitude of different data formats about their patients, which meets the very definition of "Big Data". Big Data is defined by a large amount (volume) of different formats (variety) and by large speed (velocity). The truth is that much of this provider generated healthcare data has been unusable for machine reading because it was unstructured or semi-structured. But the progress in AI and ML over the last two decades has made it possible to interpret medical images by using feature extraction algorithms to make sense of the information hidden inside the images. Another large pool of unstructured data are natural language texts, such as progress notes or radiology reports. These can now also be machine interpreted, for example to transcribe a conversation between a doctor and a patient and turn it into structured medical records. High velocity of data is usually machine generated data, such as data from biometric devices – but here is the problem. Traditionally patients are only hooked up to devices occasionally, as in once a year for the physical. Or of course while in an intensive care unit during hospitalisation. But the goal of a modern, value-based healthcare system is to keep people out of the ER and ICU using preventive care methods. And this is where the utility of data from remote monitoring devices lies, including data from fitness trackers.

Instead of measuring my heart rate once or twice a year during the annual check-up, wouldn't it be more useful for my physician to see how my heart is doing every day, during exercise and while at rest? Wouldn't a physician want to see trends, so they could intervene if the heart rate trends upward, to pick but one example? The frustrating thing is, I am already collecting all this data, but quite frankly it goes to waste.

The thesis of this article is that we should not only consider Big Data as the data collected during the occasional interaction with healthcare professionals, but really, Big Data in healthcare should also be all the data collected by consumers about their health every single day. Next, let us explore why the data is currently NOT used.

Clinical data is very valuable, because it is the foundation of risk assessments and escalation prevention

Fee-for-Service vs Value-Based Care – The Data Aspect

Many western economies have implemented a fee-for-service healthcare model in which healthcare providers have a very transactional relationship with their patients. They see a patient, perform a service, and charge for the service they perform. The data these providers collect is mainly for the purpose of documenting their service and substantiating their financial claims. The value of data is relatively low in such an environment because data is rarely utilised for added value purposes. That is why in countries like Germany, healthcare data exchange is still performed by yes, you read that right in the year 2022, fax. Oddly, data protection gurus seem to deem the fax transmission of data to be super secure, because they do not object to it, whereas electronic data exchange is heavily regulated. But that is another story, which we will get back to in the security chapter.

In a value-based care world, providers have an incentive to keep patients out of the hospital, so they want to prevent health status escalations. And for that, they need data. They need data to assess the risk of a patient population, stratify risk cohorts, and devise plans to manage these cohorts according to their needs. In such an environment, clinical data is very valuable, because it is the foundation of risk assessments and escalation prevention. It turns out, it is also good for patients – who would not choose a daily regimen of atorvastatin over a trip to the ER with a myocardial infarct because of clogged arteries?

In the United States we have been on a journey towards value-based care for over 20 years. It is a slow transition, but it is gaining momentum as we have more and more data that it works. And the government and other stakeholders have also clearly understood that in a value-based care world, data exchange is essential to keep people as healthy as possible. While HIPAA, originally enacted in 1996 to allow the exchange of healthcare information in certain cases, was a first step, the Affordable Care Act of 2009 made it mandatory for hospitals to keep and exchange electronic medical records in certain standard formats so that information could flow between care providers, and it also provided access to information for patients. The recent 21st Century Cures Act from 2016 built on this and now makes it mandatory for providers and payers to share information among each other and with the patient – if a provider refuses to share data, they violate the information blocking rule. This legislative journey

demonstrates how important the sharing of data has become in a value-based care world to improve clinical outcomes, patient, and provider experiences, and reduce costs at the same time (quadruple aim).

One reason why data from remote monitoring devices and fitness trackers is not widely used is that in fee-for-service markets there is simply no incentive and no reimbursement mechanism for providers to use it. But even in value-based care models, remote monitoring data is currently still underutilised, and this has infrastructural causes.

Big Data from Remote Patient Monitoring

Over the last decade or so we have gotten pretty good at aggregating clinical data in various Electronic Medical Record (EMR) systems. This is good during hospitalisation preventing medical errors, for example prescribing a drug that is inappropriate for a particular patient because of their medical history or other medications, and it is also good during transitions in care, when a specialist knows the medical history of a patient that was referred to them. These EMRs also record lots of biometric data during a visit or a hospitalisation, but most consumers are most of the time not in a hospital connected to a system that feeds data into the EMR – introducing remote patient monitoring.

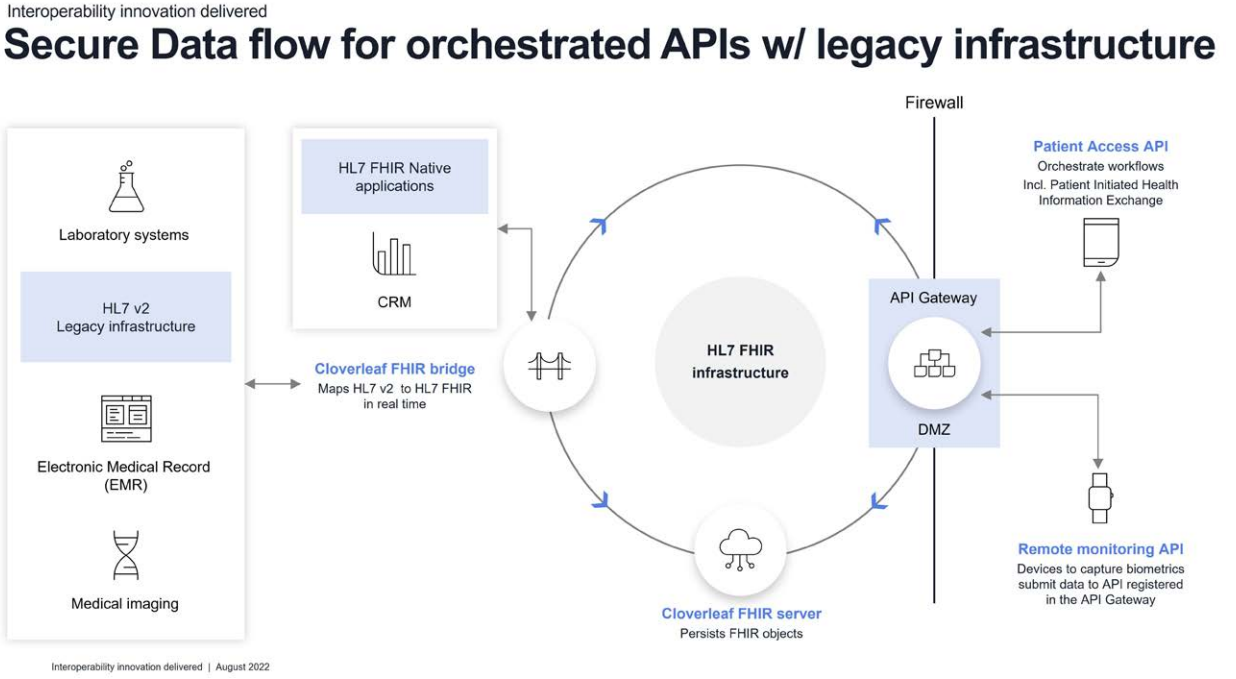
Remote patient monitoring truly generates big data. It is machine generated, structured data of high velocity and volume. Take for example Vironix.ai, a little start-up in the United States, that has developed a remote patient monitoring application. The idea is to use inexpensive devices and publicly available APIs to collect and send a continuous stream of data to their AI platform, where noise is separated from actionable data to identify pulmonary or cardiovascular issues. Noise in this context means that most of the time data will show that everything is normal – whatever normal is for each individual patient. When the algorithm flags an abnormality, a care provider will look not at all the data, but the specific information and automated analysis that is useful for a physician. If all remote data would be funnelled unfiltered into the EMR, it would overwhelm the capacity of the care providers to interpret it and create new operational cost. If, however, useful data is filtered into the EMR, it can then be put into context with all the other data that is already in the EMR for clinical decision-making, documentation and billing.

That leaves us with two problems – how do you identify useful data, and how do you get it into the EMR? Surprisingly, there is a single answer for both problems: APIs

The Modern World of Orchestrated APIs

Modern applications are built to utilise microservices through Application Programming Interfaces (API). This allows a service/application to learn new skills by interfacing with another service/application for a particular skill. A scheduling application can for example use an API to incorporate a triage service to allow a user to schedule the appropriate service by answering a few questions. The scheduling application keeps focusing on scheduling, and the triage application is focused on interpreting the user responses to find the appropriate service provider.

In the case of Vironix, the Vironix application is good at receiving and interpreting the remote monitoring



data for signs of pulmonary and cardiac problems; there are other, similar applications that can interpret remote monitoring data on blood sugar fluctuations, or pacemaker data for signs of arrhythmia. All these applications need some data (for example patient demographics such as age, BMI, weight, MRN and so on) to improve their filtering accuracy, and they generate data (filtering useful data from noise). The job of these applications is to identify useful data, and by using APIs, hospitals and care managers can flexibly add many different skills through an API orchestration layer. The API orchestration layer takes care of security and provides data to and receives data from those specialised applications. It also should be able to translate the data seamlessly between different data formats. Many modern APIs require data input in HL7 FHIR format, whereas legacy healthcare infrastructure utilises HL 7 v 2.x – so the key for organisations that want to utilise big data from remote patient monitoring today is to put the right infrastructure in place to let the data flow between their existing systems and the infrastructure that interfaces with the big data world of remote monitoring devices.

Security of Big Data in Healthcare

Fax transmission is very unsafe – I need to repeat this here because it is still the standard for data exchange in many healthcare environments. Fax data is not encrypted – anyone could spoof a phone number using VOIP and then intercept fax transmissions. Once a fax reaches its designated target, there is zero control who reads the fax or what happens to the fax. It really could not be more unsafe to transmit personal identifying health information (PHI).

In the U.S., we have HIPAA since 1996 and the HIPAA privacy and security rules since 2004 which mandate that PHI access must be limited to authorised health professionals in the pursuit of providing care for the data subject. With electronic information we can do this – data is encrypted at rest and in flight, access is controlled through password protected accounts, and any access is logged for auditing.

In the world of APIs, lots of data needs to cross the firewall and be imported into the network, and it could be possible for malicious actors to hide some compromising data inside the data streams from remote monitoring devices. These devices are, after all, out of the control of healthcare professionals and therefore vulnerable. That is why it is important to build an API orchestration layer with strong security measures, such as authenticating data sources and providing a different, shielded virtual network environment for every API.

At Infor, we built an API Gateway where each API is registered with the specific data it can retrieve and publish, and it is shielded to those specific data stores through controlled routing; at the same time, the API Gateway connects the different registered APIs through our Infor Cloverleaf FHIR Bridge technology with legacy HL7 v2 infrastructure (be that based on Infor Cloverleaf - the leading healthcare data integration platform in the U.S. and many European countries - or any other HL7 v2 interface engine), optimising both the flexibility of modern APIs and providing very high security.

Conclusion

In a value-based care environment data has a very high value because it can be used to achieve the quadruple aim: improve patient and provider experience, improve medical outcomes, and reduce costs. For value-based care to work it is important to be proactive about the health of patients, and remote patient monitoring is a great tool to identify early signs of any emerging health issues. Remote patient monitoring is a healthcare specific form of big data, as a high volume of data in different formats (variety) can be collected from devices installed in the patient's home or on the consumer (wearables). However, this data needs to be filtered for useful nuggets of information before the data is then fed into the existing electronic medical record infrastructure. Modern APIs that are usually based on machine learned algorithms can perform this filtering for various types of diseases and therefore add a broad spectrum of proactive care capabilities through monitoring to an organisation. Allowing massive amounts of data to flow from outside the firewall into the secure network of a healthcare provider organisation requires a secure API orchestration infrastructure, such as the Infor API Gateway. Furthermore, APIs require data from the existing legacy EMR, and they feed usefully filtered data into the EMR. For that to work, it is useful to have a FHIR to HL7 v2 real-time bi-directional translational tool such as Infor FHIR Bridge connected to the Cloverleaf API Gateway to ensure a seamless and secure flow of data from the wrist of the patient to the screen of the physician. Only when this secure pathway and intelligent filter mechanism is put into place can the vast potential of biometric data collected by patients be utilised to keep people healthy and out of the ER or ICU.

Conflict of Interest

None. ■

Enterprise
Imaging

Across the Regions, Agfa HealthCare is Making Image Sharing a Reality

An overview of large-scale, multi-site health IT projects which demonstrate how Agfa HealthCare has strategically and operationally guided clients, who make use of its flagship Enterprise Imaging platform, to fulfill complex requirements and bring to success tangible outcomes.

Key Points

- A well-designed Enterprise Imaging platform enables healthcare networks to leverage technology to support their national or extended-region goals.
- Agfa HealthCare's Enterprise Imaging platform, VNA and XERO Viewer enhance image sharing and collaboration.
- Agfa HealthCare has proven its ability to support large-scale, multi-site health IT projects across states and extended regions.
- These projects enable everyone in the healthcare continuum to benefit from convergence, advanced collaboration and modern image management technology: from patients to radiologists, from clinicians to referring physicians, and from IT to hospital management.

With robust governance, a converged Enterprise Imaging platform, strong clinical workflows and an outcomes-based service approach, Agfa HealthCare has proven its ability to support large-scale, multi-site health IT projects across states and extended regions.

Patient care today has moved far beyond the individual hospital or health organisation. Diagnosis, treatment and follow-up may be in the hands of multiple specialists at multiple healthcare sites, and increasingly across states and extended regions.

This reality requires close collaboration and communication between everyone involved in the patient's care, combined with access to the medical information which they need - irrespective of the time or location. Secure, effective and sustainable data sharing, which includes imaging data, has therefore become a high priority.

For many years, Agfa HealthCare has supported customers in their large-scale goals - whether for a private healthcare network growing and expanding its reach, an independent health provider looking to benefit from collaboration across an extended geographical area, or a national initiative aiming to support an entire healthcare infrastructure.

This article describes some great achievements: real-life projects which demonstrate how Agfa HealthCare has strategically - and operationally - guided clients, who make use of its flagship Enterprise Imaging platform, to fulfill their very different requirements and, ultimately, bring to success tangible outcomes.

Enterprise Imaging Across the Board

A well-designed Enterprise Imaging programme enables healthcare networks to leverage technology to support their national or extended-region goals. Images, data, clinical workflows, automatisation tools, IT resources and business intelligence become converged. Advantages reach far beyond archive consolidation and viewing, which deliver true clinical, operational, and financial benefits. A clear roadmap turns a countrywide or multi-state vision into reality – leading to increased clinical performance, reduced complexity and improved TCO.

"Our consolidated Enterprise Imaging platform is ideal

for countrywide or extended-region projects, delivering the benefits that healthcare providers are looking for across sites, states, and more. Enterprise Imaging seamlessly scales, to support the hospital group's evolution and growth, and enable it to quickly adapt to changing needs," says Franz Tiani, Vice President, Agfa HealthCare.

Point-of-Care Images and Data Across the Region: Yorkshire Imaging Collaborative, UK

The Yorkshire Imaging Collaborative (YIC) provides eight different NHS trusts across Yorkshire with a single unified radiology image- and report-sharing network. Using its XERO Exchange Network (XEN), Agfa HealthCare has created a true federated network - without traditional image sharing solutions or even a VNA.

XEN makes every patient's full set of images, plus associated reports, available at the point of care at any of the YIC hospitals. There are no vast image downloads, rather the solution enables intelligent web-based streaming of images and reports, locatable and retrievable by the healthcare professional, who can find the patient's regional record and images with just their NHS number.

The XEN network went live in four weeks. The connected hospitals, which collectively cover a patient population of over 3 million, were able to increase turnaround on specialist consultations, speed up turnaround on multidisciplinary teams and diagnose patients transferred between sites at a much quicker rate than was previously possible.

"The XERO Exchange Network allows Yorkshire NHS Trusts to collectively access radiology reports and view all images across our entire region, completing the clinical history and helping us to write a more accurate report," says Dr Daniel Fascia, Clinical Lead for YIC.

A National Medical Imaging Archive: LUXITH, Luxembourg

Luxembourg's National Medical Imaging Archive (ANIM) provides all 15 sites of the country's four hospital groups with easy and secure access to images, through a 'shared medical file' (Dossier de Soin Partagé/DSP). Delivered as a managed services model, the single medical imaging archive, which is built on Agfa HealthCare's Enterprise Imaging platform, VNA and XERO Viewer, enhances image sharing and collaboration. In all, 300 TB of legacy data were migrated, and over 860,000 medical images are archived each year.

Agfa HealthCare collaborated closely with the agency responsible for the project, LUXITH G.I.E. With careful planning and robust programme management from all players, implementation only took a few months, despite the ongoing COVID-19 pandemic. The national VNA now supports integrated care across the entire healthcare sector in Luxembourg, and enables image sharing across all specialties.

"Doctors and patients can access the patients' images easily and securely, without any extra effort from the hospital. In addition, the hospitals have freed up archiving infrastructure in their own systems, which they can use for other, value-added purposes," says Christophe Nardin, director of LUXITH.

Country-Wide PACS: Estonia

Estonia's Pildipank provides a nationwide platform for image transmission, archiving and access for all of the country's healthcare institutions. Together, these healthcare facilities produce some 1.6 million studies each year: a number that grows about 10% annually.

Agfa HealthCare acted as a partner to help establish the nation-wide PACS, which was set up with Tartu University Hospital (TUC) and North Estonia Medical Centre (NEMC). Agfa HealthCare designed an IT system that met the defined KPIs targeted at leveraging the customer's existing investments, especially the VNA. Furthermore, the Agfa HealthCare PACS was able to integrate with the existing RIS of the different hospitals.

Advanced tools, including XERO Xtend viewing capabilities, Business Intelligence, and dose monitoring software further support Pildipank to meet its end users' expectations.

During the 20 year relationship, Agfa HealthCare has continued to support the customer, to scale up the existing Agfa HealthCare IMPAX® solution to the current volume of 1.6 million studies each year by gradually transitioning from the entry level solution to a nation-wide platform. The recent upgrade to Enterprise Imaging brings new functionality for the clinicians, advanced administration tools and business intelligence with high availability of the platform.

"From the beginning, Agfa HealthCare was able to support an IT design that met our KPIs and leveraged our other investments," says Andrus Paats, the CEO of Pildipank. "They showed us they could meet our functional requirements without issues during the evaluation sessions. And the XERO Xtend functionality with advanced viewing capabilities in particular has been very well received by our end users. But equally as important as the technology, is Agfa HealthCare's strong commitment to service and partnership. We are confident we can rely on both the solution and on Agfa HealthCare as a vendor and look forward to continuing our relationship."

"Large-scale, national-level projects such as these examples enable everyone involved in the healthcare continuum to benefit from convergence, advanced collaboration and modern image management technology: from patients to radiologists, from clinicians to referring physicians, from IT to hospital management. As an example, clinicians gain fast, simplified access to a single and comprehensive imaging health record, while automated workflows improve the performance of radiologists helping them to focus on the tasks which require their attention the most. IT departments experience reduced complexity and duplication, and easier resource and infrastructure management. For hospital management, the advantages include support for strategic growth across broad geographical areas, improved productivity, increased clinical satisfaction and integrated care across the continuum. For the patients, who are at the heart of healthcare, these projects can play a role in enabling faster diagnoses and informed treatment decisions, thanks to enhanced multidisciplinary cooperation and access to the expertise of specialists - wherever they are. I am delighted that these projects so clearly and concretely demonstrate how we are transforming the delivery of care by supporting healthcare professionals across the globe with secure, effective and sustainable imaging data management," comments Franz Tiani, Vice President, Agfa HealthCare. ■

In Search of Gold in Health Data

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The low quality of health data is at the core of why we are not making the most of data science. However, new ways of dealing with acquiring those data can overcome this situation.

Key Points

- High-quality health data are essential for healthcare delivery, health research and innovation.
- However, two key problems must be addressed: one concerning electronic health records access and interoperability, and second, the use of continuous private data generated from individuals.
- The second problem can be addressed by creating a chain of trust for this data and ensuring its efficient transfer from the individual to data users with security and compliance with quality standards.
- It is important to recognise the importance of personal health data and to explore new ways to guarantee secure and reliable access.

Not so long ago, someone told us data was the new gold. And they were damn right.

Just like gold, data has raised great expectations. Data analysts are becoming the new gold seekers. We expect them to find all those accurate data-driven decisions and predictions that will dramatically transform our enterprises and lives. We believe that the picture will be perfectly clear if we gather a sufficiently large amount of data. And well, maybe it is true, or at least partially true.

The possibilities that data analytics offers in healthcare are huge. Since health is one of our most valuable possessions, we are probably talking of diamonds instead of gold. But, just like diamonds, not all data collections have the same value. There is something every data analyst is conscious of: if you want to reach valuable conclusions, you need high-quality data. It's not enough to have a great amount of data; it has to reach quality standards.

What do we mean by data quality? Data quality reflects how well data serve our purpose. Unfortunately, it means that collecting great volumes of data does not unavoidably lead us to great results. We have to ensure that our data shows accuracy, completeness, consistency, validity, uniqueness and timeliness. Despite big expectations, health data is nowadays lacking in virtually all of them. Of course, data can be cleaned out, but we must be aware that cleaning methods often have a negative impact on our results and may distort our conclusions.

Data quality is at the core of why health data are so

difficult to deal with, and before we can sit and get game-changing solutions from them, we must face at least two problems.

The first problem is clinical records. Electronic Health Records (EHR) are the main source of health data. But they provide a heterogeneous bunch of structured and non-structured data from many different sources with many different formats since the use of customised EHR systems is frequent despite the CBHC 2011 Directive. Yet interoperability is critical if we want to reach next-level objectives. Seeking this interoperability, initiatives like the MyHealth@EU platform or Fast Healthcare Interoperability Resources (HL7 FHIR), an open source standards framework for healthcare data, aim to facilitate the transformation from one system to another: Medicare's Blue Button 2.0 is HLFHIR's best-known use case. The recent publication of the Proposal for a Regulation of the European Parliament and the Council on the European Health Data Space (EHDS) aims to ensure a solid framework that supports health data interoperability through the EU. The European Council recognises the urgency of this task and has decided to prioritise the construction of this EHDS. Much work is done, but data integration is undoubtedly a difficult task in this scenario.

The second and main problem is that EHR can only account for a small part of our needs. High-value data originating in patients' daily life are very difficult to collect. Those data that provide information about health behaviours, lifestyle, and socioeconomic and environmental factors, are mostly out of reach. However, their impact on health outcomes seems to be out of the question, not only for the well-known Social Determinants of Health (SDOH), defined by the Word Health Organization as "the conditions in which people are born, grow, live, work and age" but also for a large amount of data generated from the individual. Without this data, the picture is painfully incomplete.

Factors that make reliable personal data difficult to obtain are various, but one of them is the mistrust of public opinion about its use. The idea of indelible labels that may compromise a future hiring or a health insurance contract will surely discourage people from sharing that data. And this mistrust can only grow over time, limiting an analyst's access to these sources.

Instead, if you have a logistics business, it is quite easy to collect data from your trucks: data concerning fuel levels, geolocalisation, truck speed etc., are readily available. With health data, the scenario is quite different: you cannot think of placing geolocators in people with multiple sclerosis or somehow manage to collect their grocery bills. Instead, you have to ask people with multiple sclerosis to share their data: where they live, work, pets they have, what brand of shampoo they use and how many beers they drink in a week. They have all the information you need - with a little help, they can give it to you with the right standards.

At this time, many paths open up before us. We can, of course, forget about this data or try to reach them, assuming their bad quality. Or we can engage in a direct dialogue with the data providers, the only ones that can guarantee its quality from origin: citizens.

One possible solution to our problem is to create a chain of trust for this information. This way, information will be transferred, fulfilling all required standards, to a trusted intermediary, who will be in charge of data custody. This entity can only be one of public trust and would be in charge, not only for guaranteeing data quality and availability for users but on the provider's side, will guarantee its security and terms of use.

People would deposit their personal data just like they deposit money, with complete confidence that the day they want it back (or make a transfer to another entity), it will be returned easily and unchanged. Users would acquire data packages from those entities; this way, data deposits would give a profit to providers, and users would have the high-quality data they need.

Because human behaviour only changes in appearance, the actual data market for personal information recalls the trading of bagatelles for gold by some distant conquerors. The story is not one to be proud of. The data provider must know he is not losing control over his data. This probably includes, among other questions, the certainty that the transfer of information is not permanent and that it can be revoked at any time.

Let's move on: if data is the new gold, are we ready to speak with their owners?

Conclusion

High-quality health data are essential if we want to support healthcare delivery and promote health research and innovation. With that objective in mind, we face two problems: the first one, concerning electronic health records access and interoperability, is under the scope of the European Health Data Space. The second one, concerning the use of continuous private data generated from individuals (SDOH and others), is far from being solved.

We propose a new approach to the second challenge, creating a chain of trust for this data so that they can be efficiently transferred from the individual to data users with security and, at the same time, guarantee compliance with quality standards. This entity in charge of data custody and transfer can only be one of public trust and would act as an intermediary between data providers and data users, maybe even managing revenues obtained from data sharing.

The time has come to recognise the importance of personal health data and explore new ways to guarantee secure and reliable access to them with high-quality standards.

Conflict of Interest

None. ■

Transforming Outpatient Services is Key to Delivering and Sustaining Elective Care Recovery

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Redesigning outpatient services will be key to recover elective services. To be sustainable, the transformation needs to break down traditional barriers and focus on optimising the patients' experience and outcomes. This needs a system-wide approach to reimagine operating and delivery models.

Key Points

- Balancing the competing priorities of reducing patient waiting times whilst making outpatient care more personalised and improving access for patients will be a challenge for all health providers and systems to deliver.
- The patient journey to receiving care in an outpatient setting can be a complex one, with multiple stakeholders involved, across multiple departments and organisations.
- Transforming delivery of outpatient services should begin before an appointment even takes place.
- Strategies to safely reduce unnecessary follow-up attendances could play a significant role in supporting elective recovery.
- Digital solutions have a crucial role in the delivery of transformation in outpatient services.

The NHS's delivery plan for tackling the COVID-19 backlog of elective care focuses on solidifying and embedding changes to ensure elective services are fit for the future. This builds on the long term plan which outlined the need to redesign traditional outpatient services to make them more sustainable. Balancing the competing priorities of reducing patient waiting times whilst making outpatient care more personalised and improving access for patients will be a challenge for all health providers and systems to deliver. Alternative models of care, leveraging the opportunities from digital technologies and establishing frameworks to make it easy for care providers to work seamlessly together are essential pillars to deliver on these aims.

Pre-appointment Processes – A Full Clinical Triage Model Should be the Default

The patient journey to receiving care in an outpatient setting can be a complex one, with multiple stakeholders involved, across multiple departments and organisations. Transforming delivery of outpatient services should begin before an appointment even takes place.

Leaders can start by putting in place robust, well designed and outcome focused pre-appointment processes. Implementing a full clinical triage model (supplemented by accessible and well defined referral pathways and criteria) will increase the number of patients who are seen in the correct healthcare setting,

- complete detailed capacity and demand modelling to ensure that adequate time is allocated for triaging referrals. This will be challenging to do without negatively impacting on waiting times in the short term unless alternative models for outpatient care are adopted at scale and at pace.

expected to grow significantly in prevalence) and around two thirds of over 65s will have at least two. Remote monitoring puts patients at the centre of recording and managing their condition, enabling them to avoid unnecessary appointments when their condition remains stable. For example, input-

New models of care need to be joined up with the entire patient pathway and balance the needs, wants and requirements of each individual patient

reduce administrative time rearranging appointments to the right clinic and increase outpatient capacity for patients requiring specialist consultations. For example, identifying patients who require investigations prior to their first appointment will maximise the opportunity for a decision to be made and treatment started at the earliest point in the pathway – potentially even negating the need for an appointment at all.

To make this successful and sustainable, leaders should:

- design clinical teams through careful mapping of the current pathway, future pathway and agreeing the transition plan to implement full clinical triage.
- standardise the processes within each speciality or care pathway across a system through clear guidelines, protocols and communication to those triaging and those who are referring.
- ensure clinical triaging is included in job plans as direct clinical care. By ensuring an appropriate amount of time is dedicated to triage activity, this will minimise the number of unnecessary appointments and support specialists to develop alternative management plans for patients.

Release Capacity for Clinical Triage by Reducing the Demand for Follow-Up Appointments

Follow-up appointments account for approximately two-thirds of all outpatient activity within the NHS. Strategies to safely reduce unnecessary follow-up attendances could therefore have a significant role to play in supporting elective recovery. In our experience, there are two alternatives that should be prioritised in every outpatient transformation programme:

- **Patient Initiated Follow-up (PIFU):** Empowering patients to make the judgement on whether they need a follow-up is a powerful tool to develop shared decision making and self-management. It can also reduce workload in primary care if the criteria to initiate a PIFU is well communicated and understood, giving the patient access to a specialist within a time-bound period without the need for a re-referral.
- **Remote monitoring solution:** Research predicts that, by 2035, 2.5 million people over the age of 65 (17%) will have four or more chronic illnesses (with arthritis, diabetes and dementia being diseases

ting data into a smartphone app or using smartwatches to track vital signs. This will be essential to a sustainable model of care, allowing multiple specialists to track multiple conditions and monitor key diagnostic indicators without necessarily seeing the patient. Equally, it will help in identifying warning signs earlier to prevent a potential admission and reducing the need for patients to come for an appointment to be told “all is well”. This will not be achievable with the current outpatient models of care.

Harnessing the Full Potential of Digital Solutions

The most common barrier to transforming outpatient service is technology. Many of the solutions to transforming outpatient services are not novel, but their full potential has been unrealised due to inadequate infrastructure which create barriers to change and discourage change to happen.

Healthcare providers need to ensure their IT and digital interfaces “speak” to each other, avoiding the need for multiple logins or handoffs between different

IT systems to enable both staff and patients to utilise different outpatient models based on need.

Equally important is having a clearly defined and resourced digital strategy that makes the best use of digital technologies but not at the expense of high-quality patient care and outcomes. To increase the adoption and success of digital enabled outpatient services, there are four things Trusts can do:

- harness the enthusiasm of early adopters – create change champions who can give real examples of the positive impact on their patient care.
- make the change easy for staff and patients – through co-design by understanding and removing/mitigating any potential barriers to adoption.
- increase the capability of digital technology – through investment where required, based on user feedback.
- continuously review and share success – through clear definition and quantification of KPIs, such as patient experience scores and impact on patient outcomes.

Transforming outpatients cannot be done in isolation. New models of care need to be joined up with the entire patient pathway and balance the needs, wants and requirements of each individual patient. But one size will not fit all and some models will be more applicable to some specialties than others. For example, asthmatic patients who can remotely check and record their peak flow and respond to patient-reported outcomes digitally will not necessarily require an appointment immediately. This approach, as an example, serves to avoid unnecessary outpatient appointments which can positively impact their health and wellbeing when attempting to integrate this into busy social and working lives.

Digital solutions have a crucial role in the delivery of transformation in outpatient services. They need to be harnessed correctly to reduce potential unintended consequences such as a focus on digital first. For example, defaulting to a digital first appointment could contribute to a rise in follow-ups, and further add to the backlog challenge unless referrals are properly triaged.

Rethink Outpatients to Recover Elective Services

Although COVID-19 has disrupted elective services, it has also expedited several fundamental changes to the traditional model. Redesigning outpatient services will be a key driver of success to recover elective services. To be sustainable, the transformation needs to breakdown traditional barriers and optimise the patient's experience and outcomes. Implementing value-adding pre-appointment processes and embedding clinical triage are two vital components to this – as is harnessing digital technologies and solutions to enable change to happen. Without rethinking how to deliver the broader services during this critical time, the same cyclical changes will continue and prolong the much needed recovery in elective care.

Conflict of Interest

None. ■

Medical Imaging

How to Reach Gold Standards in Radiology Through Continuous Learning & Education - Affidea Case Study

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Rapid developments in radiology and technological advances offer unique educational opportunities that can set the clinical standards for better patient outcomes. Affidea is committed to providing clinical teams with the necessary education and tools to lead the future of radiology.

Key Points

- Radiology has a pivotal and decisive role in patient management.
- Affidea empowers its clinical community with a strong professional development plan for a triple-win situation: for patients, doctors and the company.
- Continuous medical education is the only way to provide safe, effective, and high-quality, specialised patient care.
- The educational plan at Affidea includes local and corporate initiatives and multidisciplinary meetings where radiologists and clinicians learn together.

Radiology is the core business of Affidea and the medical specialty, probably most sensitive to the ever-evolving nature of medicine. This is, in great part, related to the new technologies and methodologies used in radiology, and it is unquestionably important to keep updated on the most recent developments.

Radiology has a pivotal and decisive role in patient management. Clinicians rely on our diagnostic performance to make the most effective treatment decisions and achieve the best patient outcomes. By supporting education, Affidea empowers its clinical community with the necessary skills in the long run; a strong professional development plan that turns into a triple-win: for patients, doctors and the company.

In the last studies dedicated to healthcare management, including the one led by Healthmanagement.org, CEOs from the healthcare sector considered the availability of skilled staff to be one of their five top concerns. Continuous medical education is an absolute need and not just a nice-to-have. It is the only way to provide safe, effective, and

high-quality, specialised patient care.

Inward and Outward Benefits of Continuous Medical Education

Inward benefits reflect upon expanding knowledge and skills in sub-specialty areas, updating and uniforming standards of clinical procedures, replicating best practices and innovative projects across centres, and supporting clinical talent recruitment and retention processes.

The outward benefits include our strong reputation of clinical excellence and strengthened relationships with referrals and patients, health sector third parties and key opinion leaders (KOLs).

Affidea has committed to building up a consistent clinical team organised by subspecialty groups and a strong network of medical directors across 15 countries, with excellence-driven and educational-conscious experts and researchers and close connections with the most relevant scientific societies who are willing to share their expertise.

Sapere aude As Our Clinical Motto

This is to say that the investment in continuous professional development is Affidea's hallmark. For this, Affidea relies on a team fully dedicated to scientific education to set a consistent medical education programme tailored to our healthcare professionals' needs, preparing them for the road ahead.

The **Affidea Academy** was the starting point for all educational projects, and we are proud to say it has been progressively expanding.

The rationale is the never-ending need to upgrade scientific knowledge, which is the essence of excellence in clinical performance. Specifically, the project focuses on:

- establishing a virtual clinical onboarding, as well as professional development programmes;
- further developing subspecialty-related content to drive DI & Clinical Service Excellence;
- implementing and promoting the Affidea Clinical Academy and Clinical Knowledge Hub as in-house learning solutions;
- designing & delivering a series of scientific events for internal and external audiences to focus on new screening programmes, modalities and innovative products to support growth.

We believe that a communication-centred approach between the Education & Learning Team and the Clinical Community is a key to success.

Profiling the Clinical Needs for Tailor-Made Education

Progress comes through active listening to the needs of our doctors and through close communication. With this in mind, we profiled our clinical team through targeted surveys which provided us deep insight into their clinical needs and expectations while keeping an open channel of communication. Other factors have been considered, such as the specifics of each centre, epidemiologic data and technological solutions, with a special focus on opportunities for improvement and the most recent innovations. This is how we managed to build a tailor-made educational agenda that meets the needs of our clinical team and responds to the current challenges.

Different formats of educational events, such as webinars, hot topics, courses, and conferences, both live and on-demand, are provided.

The recently created Affidea Knowledge Hub, a digital environment that includes all clinical resources, is another valuable asset expected to prompt access to all scientific content developed by Affidea.

The educational plan at Affidea includes local and corporate initiatives, with preference given to multidisciplinary meetings, where radiologists and clinicians can learn together about a specific topic in their area of expertise, including radiotherapy, at 360°. All these projects have the added value of enhancing and standardising best practices and thus raising the bar under the scope of reaching gold clinical standards in all Affidea countries.

The feedback is highly rewarding. Following our most recent scientific events, we have achieved an NPS of 75%, and 95% of the participants mentioned that the learning from the courses provided would be included in their daily clinical practices.

Affidea has a strong legacy in partnering with national and European Scientific Societies, with regular participation in national and European-wide conferences. The most recent and outstanding achievement is the example of the Affidea Hungary Team, which has been accredited to become a training centre for specialists in a state-funded framework, strong evidence of the quality of the centres and the trust that doctors and national authorities offer them.

In conclusion, the rapid developments in radiology and the new advances in technology provide us with unique educational opportunities which are meant to set the clinical standards for better patient outcomes. It is up to us to provide our clinical teams with the necessary education and tools to lead the future of radiology with clinical excellence at the core. ■

Governance & Leadership

Healthcare Management and Healthcare Managers for Difficult Times

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Do we need small changes for big transformations in healthcare management? Do we need different managerial figures to face the complexity and difficulties of the present period? Good public administration and good public management, capable of confronting current challenges with autonomous responsibility; highly prepared public managers, trans-sectorial capacity to compare experiences and exchange data, appropriate use of the most advanced technologies, and specific for healthcare management, the ability to move from the traditional hospital-centred model to continuity of care, and to use the One Health principle as the guide of human and environmental actions against climate change. These appear to be the key factors that can successfully lead us to be successful during these difficult times.

Key Points

- One health is an approach that recognises that the health of people is closely connected to the health of animals and our shared environment. One Health as a driving concept has become more important in recent years.
- Climate change is undermining many social determinants for good health, such as livelihoods, equality, access to healthcare, and social support structures.
- Public administration is the non-political public bureaucracy operating in a political system; it deals with the ends of the state, the sovereign will, the public interests and laws.
- Public Management is in charge of delivering the service
- and programmes of the public administration. Its commitment is the research of maximising efficiency and promoting the best methods.
- Healthcare public management is the complex of norms, rules, and forms of organisation to run a single healthcare unit or complex unit in a defined territory or a system. Its operational role and functionality are, at the present time, extremely important.
- The recurrent economic crises produced a progressive change also in public management. New Public Management (NPM) was characterised by an emphasis on cost-cutting, competition and the use of methods and goals from the private sector.

Framework

We are in difficult times. It is not necessary to use many words to prove it: an unforeseen pandemic, an unexpected war, a worsening economic crisis, and the amplification of social inequalities. On top of the list are the dramatic challenges posed by our overwhelming enemy: climate change.

Scientists have demonstrated that the effects of climate change have penetrated all aspects of our

life. Until some time ago, a part of us, from scientists to researchers, from doctors to politicians, had reached a conclusion, a bit naively or too optimistically, that we were winning the battle against COVID-19, and our major objective was to return to the pre-pandemic status, simply taking into account some of the lessons learned.

In trying to understand where we are going and where we should be going, this article will focus on the field of public administration, paying specific attention to the health sector. The experience of COVID-19 has helped the diffusion of the consciousness that health is one of the most important factors, the strongest potential connector and influencer of many other areas. The paradigm One Health that the World Health Organization (WHO) and the European Union (EU) keep stressing, has made us more aware that the pursuit of human and planet health, on the one hand, and the fight against climate change, on the other hand, are two sides of the same coin.

In the framework of what we said above, we will explore the emerging need for change in public management, with a special focus on healthcare management. The selection of this theme for these reflections comes from, among others, these considerations. One comes from looking at a larger field than healthcare: public administration. Scholars dealing with this area have underlined that never before was there a greater need for highly performant public services and consequently for good managers running them. The same is certainly true for the public healthcare sector, especially after the pandemic.

Another consideration comes directly from the healthcare domain. We have seen in recent times loads of webinars, conferences, and articles focused on the lessons learned for hospital facilities, innovative models for new hospitals and/or revisions of the existing facilities, new materials for better resilience of hospitals etc., that can better develop concepts such as resilience, redundancy, improvement of materials and systems and other enhancements related to the physical infrastructures of healthcare, helping mitigation, energy efficiency etc., increasing preparedness for future pandemics and/or climate-related disasters. It is important to have a deep analysis of such subjects, but this is not sufficient for changing the delivery of care to people.

In fact, very little discussion is going on, to our knowledge, about management, governance, and the ability of public health systems to deliver healthcare. These are aspects appropriately called the "immaterial infrastructures" of healthcare. The attention is mostly on technology, digitisation, Artificial Intelligence (AI), Internet of Things (IoT), virtual reality, and telemedicine. These are also useful, but again, not sufficient.

In this framework, we will address our attention to public management, defining some characteristics that appear fundamental for public healthcare delivery. This also makes it necessary to consider the figure of a public healthcare manager, who has the task of laying down the ground principles, programmes and plans made by the healthcare policymakers.

Relevant Steps in the Evolution of Public Healthcare Management

We will concentrate on Europe, supported by the knowledge of a few countries with which we have more acquaintance. At the end of World War II, in most European countries, there were deep signs of destruction in the cities, including the hospitals. Progressively reconstruction went on, mostly based on old models and criteria. The quality of the hospitals of this period is well defined by experts in the French health sector:

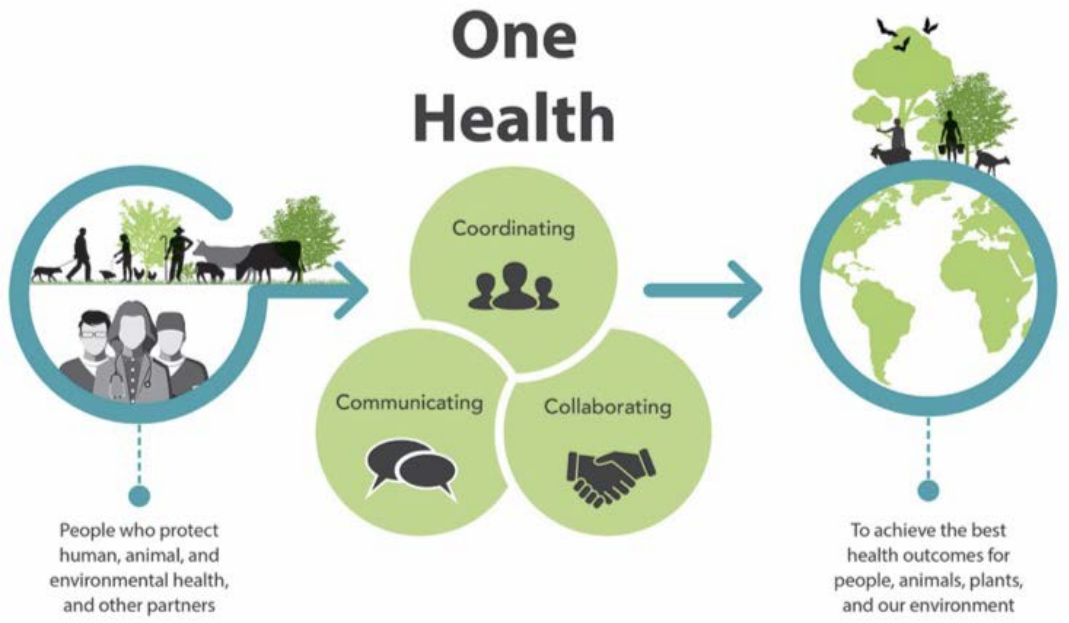

Figure 1: One Health. Source: CDC

HLM hospitals - buildings with the same low quality and construction metric costs as popular public housing. The care offered was old style, and the organisation was based on a model defined as bureaucratic and dependent on the national government for rules and financing. In many countries, the persons in charge of the general management had the status of an employee, with an executive role and very limited, if any, decisional power. The '60s, called the years of the economic miracle, witnessed a growing activity in many sectors. The '70s brought to the Western world the first petrol shock that produced a diffusive and unexpected economic crisis and a sudden reduction of public budgets that also touched the healthcare sector.

In several countries, however, tangible changes from the previous pre-war and immediate post-war continued. For example, in Italy, the SSN (National Health System with universal rights or healthcare) was finally established in 1979 and in Spain in 1986. In parallel were the reforms introduced by Margaret Thatcher in 1979 in the U.K. and Ronald Reagan in the U.S. in 1980. These started to be known and became attractive, mostly because they promoted measures of containment of public expenses, privatisation, and externalisation (contracting out part of the public services). Some drawbacks started to occur in countries where public financial support was more relevant for the healthcare sector. The healthcare sector came more under scrutiny because it was considered too expensive. The goal of hospitals becoming financially self-sustainable started to be considered normal at the political level and inside healthcare management. Logic and instruments produced and used in the private sector were introduced in public healthcare organisations. A typical example would be the change in Italian levels of health organisations: national government, regions, second level of power, and USL (local unit of healthcare). The latter was transformed into local health agencies ASL (with some regional variation of the name), having a strong economic imprint, with control on expenditure directly coming from the regions on which they were financially dependent.

The introduction of systematic logic and managerial instruments of the private sector in the public institution became the common guidelines, and public management was given the name of New Public Management (NPM).

In certain European countries, as in Italy, the non-discussed imperative became cuts. The reduction of the national budget for health produced fewer resources for the regions and ASLs. Cuts were made in employing new personnel, and substituting persons retiring; there was a reduction in hospital stay, elimination of small hospitals, and impoverishment of territorial infrastructures. All these factors left a permanent imprint on the public delivery of healthcare and, in recent times, were identified as largely responsible for the high level of COVID-19 diffusion and death rate, especially in Italy.

European countries with the Bismarck healthcare models of care had settled down originally with a private managerial logic, and they had possibly less need for adjustments. The NPM, however, started to draw criticism from many sides, especially when applied to healthcare, where it was seen as treating the patients as clients. Individuals seeking help for their health recovery were not simply consumers of government services. The recognition of the limits of the business approach, in conjunction with the political and economic crises at the end of the '90s, stirred the introduction of further changes visible in the healthcare sector. The public administration realised that the contraposition between public and private was no more possible. The public alone couldn't take the full weight of the growing need for health services. Referring to all sets of services provided by the public administration, Professor Rhodes stated that there was a need to develop "a non-hierarchical form of government in which public and private healthcare participated in the realisation of public policies and the consequent fulfilment of public needs" (Rhodes 1997).

The main characteristic of the approach to healthcare management was that it was focused on the creation of consensus and participation around public choices, more than guided by authority. This was referred to as "governance". Dr Donato Greco, in his presentation on the Italian Ministry of Healthcare programme "Getting Healthier", stressed that the programme was "based on the need for cooperation between various actors … national administrators and local ones (regional, provincial, municipal) the world of school, work and industry, healthcare professionals, welfare organisations of private nature: everyone is called upon to collaborate… skills and responsibilities of various sectors should interact in the interest of improving population health" (Greco et al. 2008).

The weaknesses of the governance approach became evident. The first issue that emerged was that governance was possible, or at least easier, to bear fruit in national and local environments where the social context is sufficiently cohesive and inclined to share. The other critical issue was the need for a different style of public management. As already mentioned, the subsequent crises and the current situation stressed the need to search for new parameters even more.

What Kind of Public Management Do We Need for Healthcare?

It is useful to start this part by stressing that innovation and improvements in healthcare management were considered necessary even before the dramatic, unexpected events in which we were suddenly immersed and are still struggling, with the pandemic still among us and the Russia-Ukraine war still producing destruction and death.

Changes, in fact, had occurred in these last decades involving not only European countries but the entire planet but had not significantly penetrated the world of

public management. A significant example comes from the healthcare front and concerns the low awareness shown until recently by hospital managers about the need to reduce CO_2 and GHGs in healthcare facilities, an intensive energy consumer, to help the fight against climate change. In a survey included in a co-funded EU project in 2013, specifically addressed to hospitals managers of eight EU nations regarding measures for energy saving and the attitude toward the introduction of renewable energy, it emerged that their concerns were about the burden of personnel and medicines on the budgets of their health agency. They considered energy as part of maintenance costs; therefore, only as an item of cost, not even sufficiently relevant as such. Some said that the energy matter was a technical aspect and *not part of their core concern as managers*. Fortunately, this attitude has changed, but the healthcare system can and must do much more to fight climate change.

Looking at the whole situation, the emergencies of the present moment and the pre-existing challenge of recovery, we conclude with Prof Mochi Sismondi that "public institution should become increasingly oriented towards results rather than fulfilment of standardised duties ..... and precisely define the objectives in terms of their impact on citizens and businesses.... Another fundamental aspect is that, at least European dimension in which public management must move; anyone still thinking in exclusively national terms or, worse, within the narrow confines of a region would be inexorably inadequate to interpret the present and plan for the future".

The present commitments, in fact, cannot be made only by a few countries. As the first step in Europe, the healthcare sector has to focus on increasing cohesion among European health systems. The public healthcare sector would harvest more results from greater interaction among healthcare systems. Considering, as an example, the common limits that have been established in the fight against rising temperatures, air, water and sea pollution etc. It is clear that such objectives require the collaboration of all European countries. Confrontation of different health systems can stimulate innovation and become a motivation for more appropriate use of the available technologies - from digitisation to AI and IoT.

We had occasion in other articles to stress the complexity characterising our historical period. Linear relations and the principle of cause and effect are insufficient to comprehend reality. The complex set of interconnections between and among different segments of our world requires the knowledge and use of the systems approach theory, a fundamental tool in understanding our present reality. Furthermore, having the possibility of help from data and advanced tools such as the ones provided by AI, we can also anticipate certain developments and get better prepared to mitigate their impact.

Formal rules (laws, regulations, etc.) together with informal rules (coordination tables, joint planning, codes of conduct and self-regulation) derived from the principles of governance of the public management are an important source of support but are simply fulfilling

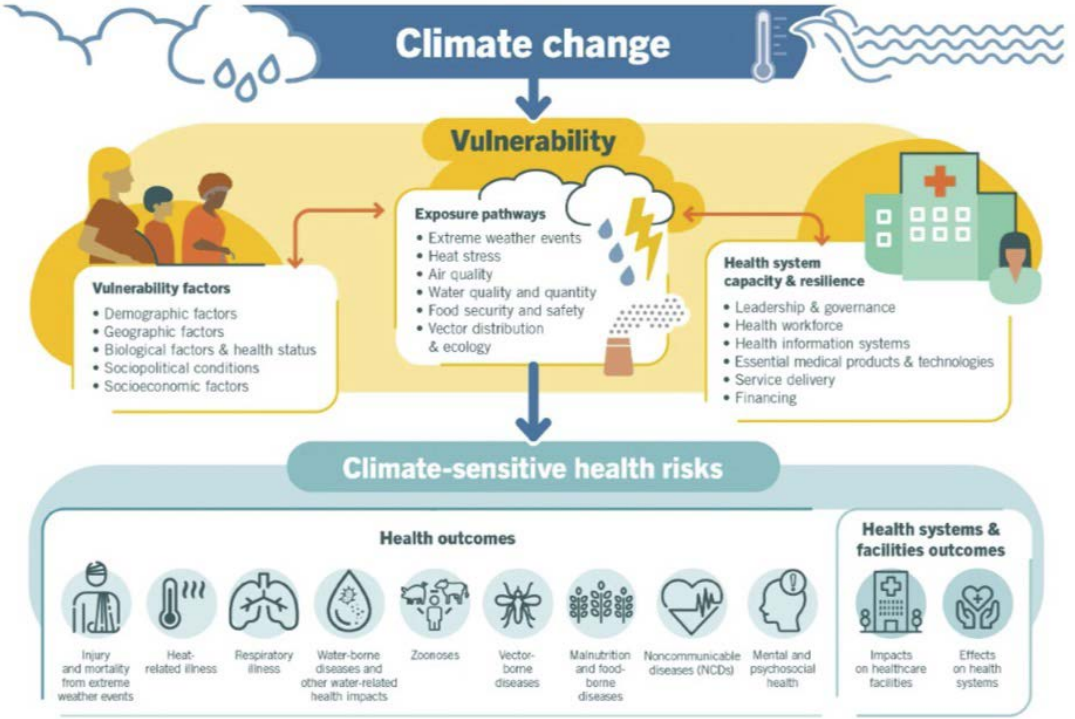

Figure 2: An overview of climate-sensitive health risks, their exposure pathways and vulnerability factors. Climate change impacts health both directly and indirectly and is strongly mediated by environmental, social and public health determinants. Source: World Economic Forum

their bureaucratic goals.

Type of Public Managers to Achieve Recovery in Difficult Times

Public managers have common characteristics, even when working in different areas, some more specific to their sector. At a round table talk of Forum PA, Dr Angelo Tanese, head of the Healthcare Public Agency n.1 of the Metropolitan Rome area, stressed the need for healthcare public management to take a leap from the present performance. The public manager has to lead this path, having the consciousness to be the connecting link between the political level that provides the roadmap, goals and financial related means and the aggregate of people, and the material and immaterial instruments that enable the realisation of the outlined programmes. The round table included contributions from other participants from different levels: national, regional, municipal, and the Institute for national statistics.

What was brought home from this discussion and direct conversations with others exercising the public manager's role in healthcare and other sectors? Let's summarise the ones that appear to be the most important requirements, especially for managing the current recovery and moving towards the "new normal" in this historical period, in which it is wise to assume the permanence (for how long?) of the present multiple problems:

- Sense of responsibility and, in parallel, demand some decision-making power.
- Vision and perspective longer than we are used to at present.
- Clear and transparent plans and the flexibility to make changes in case of sudden and unexpected events.
- Maximum attention to new technologies, considering that they are tools and to know them to ensure correct use and maximise their usefulness (e.g. the digitisation of healthcare).

Some personal characteristics appear to be important, not to say essential:

- Capacity to exercise daily leadership, showing positive motivation, inducing the same attitude in personnel at any level.
- Ability to exchange data.
- Collaborating transversely, that is, with people of other disciplines.

These are the essential factors for innovation:

- Planning with longer-term vision.
- Precision with flexibility and preparedness to unpredicted events.
- Acquisition of complexity tools and use of system analysis methodology.
- Speeding up digital transition and telemedicine.
- From hospital to the territory: the opening of the silos.
- Continuity of care: home as the centre of care.
- Participation in changes in the urban environment, seen as common ground with city policymakers for prevention.
- Ecologic transition: the awareness of the great contribution that healthcare should give.

Conclusion

Even if not as publicised as the events concerning the physical aspects of the health facilities, there is, at least among the professional insider's reflection about the necessary, important and urgent changes in public healthcare management, as well as in general, all the segments of public management and consequently, the fundamental figure of the public manager.

The same managers express the importance of the feeling of community inside and among public services, the need to increase the trust in public administration and public services and engaging themselves for a better quality of public activity. They conclude that all this is necessary, the fundamental remaining the capacity to interact and work on the same bases.

No manager succeeds alone. From the above-reported roundtable, an initiative was launched to build a cross-sectoral network of public managers, a platform at present for Italy, then scalable to Europe and involving the private sector.

Back to the questions posed in this article, we can say that while facing these challenging times, it is certainly positive to know that the insiders consider change necessary, but they also express the recognition of how difficult this change is and how high an engagement is required in keeping it. Furthermore, it is not only healthcare that needs to exit from its silos. Cross-sectoral collaboration is the right direction to go to tackle the dramatic problems of the present times, or at least some of them. It is time to apply the famous phrase attributed to Machiavelli, "never miss the occasion of a crisis", and certainly, we are in multiple ones.

Conflict of Interest

None. ■

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Public Procurement of Innovation - Guiding Healthcare Managers in Difficult Times

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The European Union has proposed innovation in the procurement of the public administration of all sectors as a strategic tool to accelerate change. Considering the volume of the annual public procurement, this has been seen as a way of influencing enterprises to be innovative. Public procurement is aimed to find solutions to needs still not met by what is offered on the market. Hence, the supply chain must develop products or processes not already available or implement innovative changes to existing ones.

Key Points

- Public Procurement of Innovation (PPI) is a procedure for public procurement that the EU requests to apply whenever the public requests a product or process not available on the market and wants to simulate the supply chain to be innovative when creating a new product.
- SMEs are small and medium enterprises, generally European, that enter the parameters of the EU with regard to the number of workers, net annual profit, etc.
- Prior Information Notice (PIN) is the document published in the official journal of the EU to alert the market about the launching of a tender.
- Market sounding is put in place after a period of informal market consultation to encourage the participation of SMEs in tenders.

The EcoQUIP+ (EQ+) project is a collaborative EU-funded project in the field of health. It follows another project, EcoQUIP, that constituted an important experience in developing and diffusing relatively new concepts and methodologies in this relevant domain. Gaynor Whyles, the scientific director of the project, stated, "Across Europe, practitioners and hospitals are facing similar challenges. By working together, we can encourage and enable innovation in the supply chain to bring forward cost-effective solutions".

EQ+ is constituted by a consortium of eight partners: Optimat, a consulting company with experience in the management of EU projects; Jera, a research and consulting company specialised in PPI and innovation; and EHMA (European Health Management Association), a non-profit organisation that focuses on supporting health management to deliver high-quality healthcare. Five hospitals from different countries will develop the framework of EQ+ and will coordinate and be supported by the three partners mentioned above. The hospitals' partners and their projects are:

AOU-BO	Azienda Ospedaliero Universitaria Policlinico S.Orsola -IRCCS - Italy	Innovative Solutions To Optimise The Outpatient Journey And Experience On A Complex Hospital Site
SUCHA	Zespól Opieki Zdrowotnej W Suchej Beskidzkiej -Poland	Ward Renovation
VUHSK MITA	Viešoji Ištaiga Vilniaus Universiteto Ligonine Santaros Klinikos - Mokslo Inovaciju Ir Technologi Agentura - Lithuania	Emergency Call and Response
CSPT AQuAS	Corporacio Sanitaria Parc Tauli De Sabadell (CSPT), with Agencia De Qualität I Avaluacio Sanitaries De Catalunya Spain - Catalunya	Personalised Surgical Processes
UHB	University Hospitals Bristol NHS Foundation Trust – United Kingdom	Zero Waste Operating Theatres
		Sustainable Waste Management

Table 1: Five European countries, six healthcare challenges, two of which are developed by Bristol.

The website gives details of each project. Every hospital's partner has been working on different unmet needs, with the methodology, organisation, and steps following the established and tested path of PPI. The Grant Agreement, giving the dates of the official beginning and end of the "action", marks the rhythm of milestones and deliverables. Furthermore, the consortium's programme envisages periodic meetings to analyse crucial steps directed by Gaynor Whyles, the Jera partner, and peer reviews among project leaders.

The Project of the University Hospital of Bologna Policlinico Sant'Orsola - IRCCS

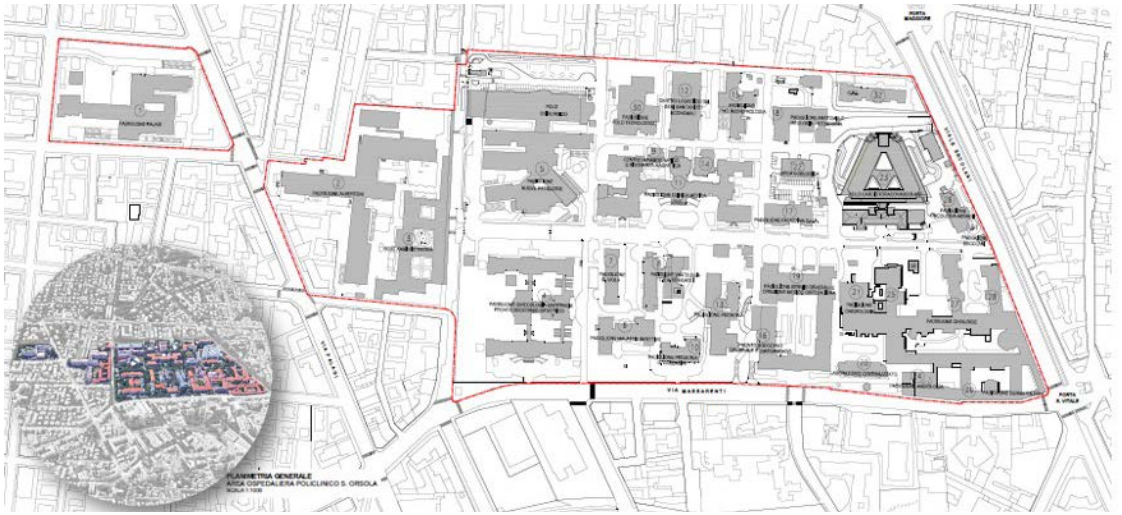
The AOU-BO (Azienda Ospedaliero-Universitaria di Bologna) is a large and complex pavilion hospital located in the heart of Bologna. The hospital complex is one of the largest in Italy, comprising 32 buildings (28 of them with a total of over 1500 beds dedicated to medical care), dating from the end of the XVI century. It occupies a large vehicle-free site of about 22 hectares (220,000 m^2), with a length of 1.8 km. The site is defined by major city streets and access via 16 different entrances.

AOU-BO is a national reference hospital serving a large population across the region and beyond. In 2019, the year before the pandemic, the hospital provided 4 million specialist medical services. This equates to around 4,000-5,000 outpatients visiting the hospital complex daily.

While outpatient services are an important part of clinical care and support, the volume of outpatients moving across the site under the present system presents a challenge and puts pressure on the whole system, including security, cleaning, transport etc. This gives it a particular set of issues regarding the outpatient experience.

The patients receive their appointments by phone, mail or message. Apart from general information about public transport links and parking facilities (largely outside the hospital campus), the journey to and from the hospital is the responsibility of the patient. Patients arrive at one of the 16 entrances, and from here, they are directed to their appointments largely through signage, with maps and directions available on the AOU-BO website. Some patients have difficulty following map instructions, and for patients with disabilities or other access problems, navigation and access across the site to the correct location presents a complex challenge. This is exacerbated by the frequency of construction and maintenance work which disrupt pathways and routes that may have become familiar to regular outpatients. This work can also render signage inaccurate, as routes may become impassable or unsafe during certain periods. Hence, it was clear that there was scope for improvement and innovation.

The Decision-Making Unit (DMU), created from the beginning, with the help of internal stakeholders, invested the initial months in identifying the unmet needs and the accurate definition of the new



requirements. In parallel, an inquiry was initiated to find external stakeholders, that is, hospitals that might have similar problems and who would be interested in following the project's development. This activity resulted in the preparation of a document called Statement of Demand (SoD) which stated that the first step of clarification would be regarding the unmet need of the AOU-BO.

As stated in the web presentation, six joint statements of demand were published "to continue to reach out across our peer networks to find other healthcare organisations, practitioners and hospitals with the same, or similar, need to support a period of consultation with the supply-chain and refinement of the wider demand".

The project will end with a tender, and each hospital will launch its quest for an innovative solution. Also, the AOU-BO, like other projects, will open a dialogue with the supply chain to further clarify the unmet needs without anticipating a potential innovative solution that should, according to the PPI methodology, come from the market.

The publishing in the European Union Official Journal of the PIN (Prior Information Notice), well known to whoever has experience with EU tenders, is not the launch of the tender but is intended as pre-notification that a tender will come out and some of its characteristics. The publication in EUOJ is evidence for the supply chain of the intentions of the promoter of the tender.

In parallel, the DMU of the Bologna Sant'Orsola hospital prepared the fundamental document called Prospectus that starts the real consultation with the potential supply chain. It is called Market Sounding Prospectus. This document and the PIN are both on the website in English and Italian. Here are the key steps:

Indicative Timeline

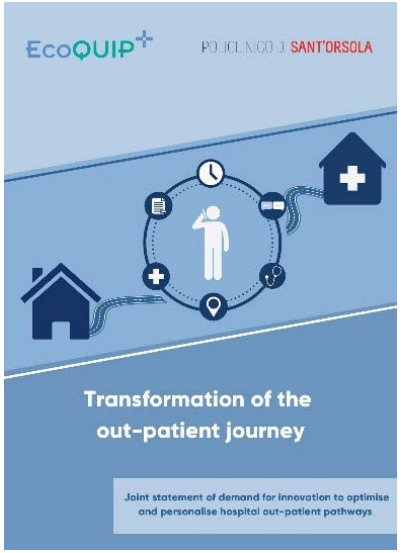
Market Consultation - period May-October 2022
Prior Information Notice - June 2022
Market Consultation Event - September 2022
Invitation To Tender - November 2022
Awarding Of Contract - Summer 2023
Mobilisation - Autumn 2023

The event concluding the market consultation is scheduled for 29 September and is open for registration.

Why Does the Sant'Orsola Project Deserve Attention?

The six projects of the EQ+ have good reasons to receive attention. These include:

- For the first time, the outpatient is considered the responsibility of the health management as they enter the campus and deserve attention to ensure they have a pleasant journey as a person first before being a patient.
- This is a more complex and demanding innovation for its realisation, not just buying a new piece of equipment or an innovative tool.
- An innovation that reinforces the interest of the person rather than the patient – an attitude currently promised but not effectively seen in reality.
- There is space for innovative solutions through



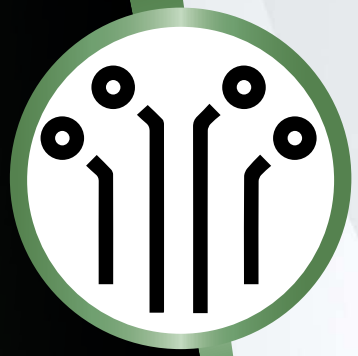
the combination of high tech and the third sector – a part of the social economy that will have to be considered in these difficult times for Italy, but also Europe, and the world.

These and even other reasons help us conclude that at the end of this process, we will achieve positive results and enhance the hope that PPI will help deliver healthcare and social recovery by utilising the strength of innovation.

The journey of the outpatient, supported through innovative solutions as explained above, will take place on a campus that, in agreement with the city of Bologna, will look like an urban park, not a hospital area and will also be used as such.

Conflict of Interest

None. ■



Successful Digitalisation Pathways

The Main Challenges of Digitising Medical Facilities and How to Overcome Them

Martyna Elsner I Senior Solutions and Customer Care Consultant I Comarch

An overview of the challenges and strategies for successful implementation of modern IT systems in medical facilities.

Key Points

- Hospital Information Systems (HIS) are designed to improve and digitise therapeutic and diagnostic processes.
- There are two types of medical systems that can be implemented: central systems and peripheral systems.
- Effective health IT systems improve the verification of data and increase the control, safety and effectiveness of patient treatment.
- Solution providers should ensure current updates and perform a security audit and detailed analysis of the implemented system to detect potential threats.

Changing laws. New regulations coming into force. Increasing demand from patients. These and many other factors make keeping medical records an ever greater challenge. For this reason, comprehensive IT systems implemented in medical facilities can help. However, will the implementation of a modern IT system in a medical facility not cause problems? We analyse this issue in this article.

Why Do We Need HIS Systems?

On the market of medical systems, there are many solutions that can be implemented in healthcare facilities. Their aim is to improve and digitise processes that have long been associated with carrying out therapeutic and diagnostic processes. Medical systems can be implemented as:

- Central systems, which are a kind of IT centre of a medical facility – HIS-class (hospital information system) systems.
- Peripheral systems – supporting the work of, for example, laboratory staff, radiological laboratories or central sterilisation room.

The main task of all these solutions is to relieve staff of the need to complete documentation manually, and to verify deficiencies on an ongoing basis. **Comprehensively completed medical documentation is the key to having full, up-to-date and consistent knowledge of the health of individual patients**. HIS-class systems often offer functionalities that aggregate the most important information in one place, to avoid the need for tedious searching of documentation. The IT system has all the information, which improves the ongoing verification of data, but most importantly allows you to increase the control, safety and effectiveness of patient treatment.

Introduction of a New Routine or the Fight Against Habit

Unfortunately, **the implementation of an IT system is an action that we can, in a sense, compare to a double-edged weapon**. Streamlining and relieving staff is achieved only after engaging pre-implementation analysis, stabilisation of the implemented system and conducting a number of training sessions for staff at various levels. Unfortunately, the habit of filling out paper documentation or using another system is often among the difficulties faced not only by the management of the computerised facility, but also by the IT team. It

is their duty to provide ongoing support for medical staff in the challenge of breaking deeply embedded routines. Humans are creatures of habit, and this fact must be faced in the process of modernising the work of a medical facility.

Outdated IT Infrastructure

Another often unexpected challenge that we encounter during the digitisation of the work of a medical facility is the **need to ensure sufficient parameters of computer equipment**. The hardware resources of the facility (the parameters of the server and the computers available in the wards or in the offices) may turn out to be insufficient, and in extreme cases there may be no such equipment at all. Then, at the stage of planning digitisation, it is necessary to reserve the budget needed for expansion or purchase of new equipment in order to ensure full efficiency and comfort at work. Probably all practitioners will agree that there is nothing worse than a "stuck" system that slows down work and makes everyone frustrated. One of the jokes widespread among IT staff says: "If you want to know the temperament of a person, sit them in front of a computer with a slow Internet connection" – and there is a lot of truth in it. Probably everyone has at least once become angry at a non-working printer or a slow computer. The reasons for slowing the work down may be insufficient hardware resources or simply an inefficient Internet connection.

Elderly Staff and Digital Competencies

When considering the challenges of digitisation, it is also worth mentioning the average age of medical staff. **The ageing society is reflected not only among patients, but also among the staff who have to take care of them**. Of course, from year to year there is another wave of doctors, who can be safely classified as generation Y or even Z – that is, having grown up in the world of digital technologies. For such people, the implementation of the system in general or its replacement is not a major problem. It can even be safely said that these are people who often support suppliers and have a real impact on the development of new functionalities. Unfortunately, not all generations grew up in such conditions, and the majority of employees are still of generations that did not carry a laptop for computer science in their schoolbag. They have invaluable knowledge and many years of experience, so are a treasure of the medical facility. Yet, preparing to work in a new IT system is not easy for them. It often requires more attention from the trainers and the IT department. We know from experience that, in many cases, they are ambitious people who want to prove that they can rise to the challenges of the digital age, which undoubtedly improves the training process.

Software Deployment and Update Time

It is worth noting that the selected system should be available in the latest technology. The purchase of an IT system is a considerable expense, so it should be a purchase for years and allow long-term updates to the latest version. A good solution is also to choose a web application, which covers the requirements of responsiveness. These two elements allow you to:

- Use the HIS system on any operating system.
- Launch the application from anywhere via a VPN connection.
- Use the application on any device – desktop computer, personal laptop or even mobile phone.
- Shorten and streamline the processes of installing and updating the system.

Cybersecurity and Privacy of Sensitive Data

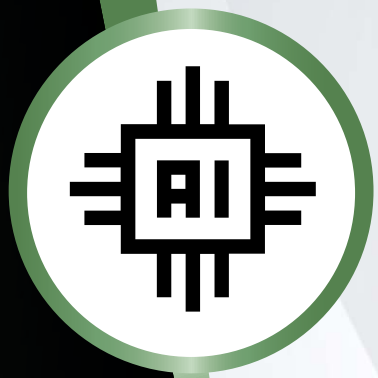
It is impossible to avoid the issue of data security when choosing a medical digitisation solution. The processing of highly sensitive data (medical data related to the personal information of individual patients) requires special security measures, in particular at a time of increasing cyber-attacks. During meetings with software providers, it is worth asking about the methods they follow to ensure the necessary security of their software. The methods that IT systems can offer for this purpose can be divided into two categories:

- In the context of control of the work of medical personnel.
- In the context of data leakage.

A solution that will allow you to ensure security in the context of data leakage will provide the necessary antivirus systems on the server infrastructure and computers available to staff. It is also worth making sure that the company offering the solution provides current updates, and it is good practice to perform a security audit and detailed analysis of the implemented system, which will allow you to detect potential threats. **Neither time nor money should be scrimped on where security is concerned**. Let's pay special attention to this.

Although the challenges posed by digitisation of the medical institution are many, the added value of such a process makes addressing them worthwhile. System selection, pre-implementation analysis, inventory of paths and documentation, implementation and training are complex and time-consuming processes. Many examples show, however, that **an efficient IT system and good knowledge of how to use it improve everyday work, reduce the number of paper documents generated, and save space that would otherwise be** allocated to archiving documentation. Complete medical documentation also allows you to avoid unfounded claims from patients. Such solutions give ongoing control of the status of medical services, verification of settlements with payers, and thus - **ongoing financial** control.

Let's return to the question from the beginning of the article – will the implementation of a modern IT system in a medical facility not cause many problems? With the right preparation and partner – no! It is worth preparing for the digitisation of the facility, in financial and substantive terms. Taking the appropriate steps will undoubtedly improve the entire process and ultimately help you go **smoothly through the individual stages** of implementation. This will guarantee satisfaction with the facility's work in the digital era. ■



AI: Opportunities Capabilities & Limits

Artificial Intelligence in Healthcare – Realising the Benefits

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An overview of the use and application of Artificial Intelligence and Internet of Things in healthcare and how these benefits can be realised in the short- and long-term.

Benefits of Artificial Intelligence in Healthcare

In an age of Artificial Intelligence (AI) and Internet of Things (IoT) in healthcare, it is impossible that there is no communication with each other. AI in healthcare gives us, as species, the opportunity to start measuring on and communicating of the whole thing.

The organism, and the organism environment; moving what we can see out of the realm of the conceptualised abstract to the realm of the physical. What we can measure, what we opinionate on, and what we can communicate and strategise on.

AI and IoT in healthcare reform, therefore, enables us to reach a new different level of magnification which can observe and measure our internal and external surrounding. In other words, we can learn to zoom in, or zoom out.

Around the globe, the global and regional health ecosystems can find great value in the adoption of Innovation and AI-driven health strategy-based solutions for patients and physicians, together.

The pragmatic benefits of AI are ominous. AI, at its core, is a tool for executing efficiency. The pragmatic, or practical implications of AI and IoT in healthcare are better outcomes for patient and their caregivers on the factuals (actual facts) that matter most to us - delivered real-time, or, ahead of time, in the case of early diagnostic or prognostic artificial intelligence.

Realising the Benefits of Artificial Intelligence

What exactly does "better outcomes for patient and caregiver" mean? It is a great question but is it dependent on the image of objectives of the ecosystem, or the image we as a society place of the individual patient or caregiver?

As a strategist, and innovation leader in the realm of digital transformation by logic strategy design and strategy delivery, I measure the outcomes of what we like to achieve, based on logic, and meaningful datapoints – those being improving health outcome and/or lowering costs.

In the case of AI, the most obvious realised benefits in the short term are cost savings and freeing up the valuable time of medical personnel, which is useful as the demand for medical personnel outperforms its availability. Secondly the medical potential of AI is improving health outcome by means of AI-driven, prognostic, early diagnostic or diagnostic capabilities.

The best step from ideation to strategic implementation is the value-based healthcare strategies coined by Prof Ing. Michael Porter (2006), Prof Elisabeth Teisbergand and Prof Robert Kaplan, It is most suitable for implementing Innovation and AI-driven health strategy on global or regional health ecosystem, level, population health, or individual health – zero distance to user.

$$\text{Patient value} = \frac{\text{patient-relevant } \textbf{outcomes}}{\textbf{costs} \text{ per patient to achieve these outcomes}}$$

Source: Porter 2010; Porter and Lee 2015; Stowell and Akerman 2015.

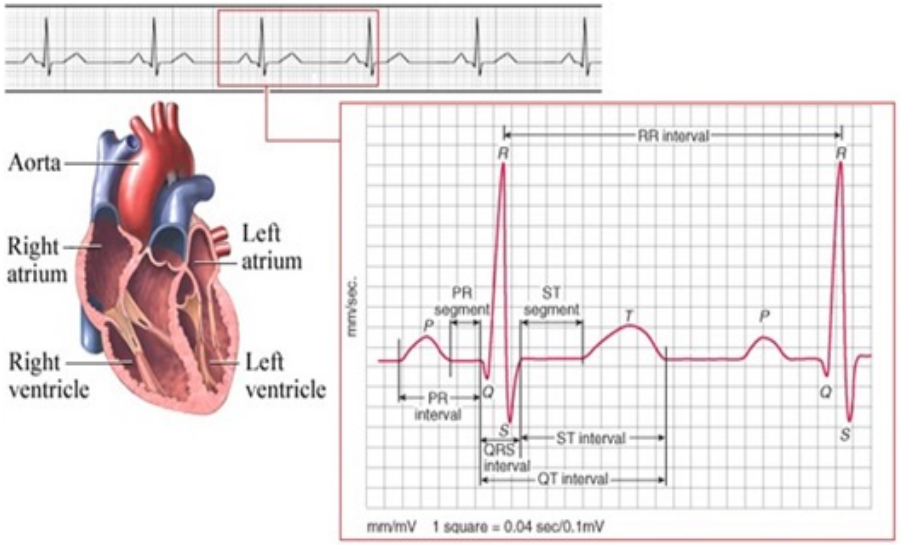
The benefits of AI in healthcare seem to help facilitate next to technological advancement, which is by design reactive to an AI and human centred driven proactive digital healthcare eco system where personalised digital self-care intervention is scalable and defined per measurable logic element and refinement per clinical area and its cost. It is based on outcomes and cost.

Therefore, logic digital health transformation leadership, "At Scale" starts with digital AI-driven (AI-ECG) self-care cardiology, as it is the costliest in both finance and human health. The theory being, the sooner we are able to recognise a disease, the lower the cost to care treating this specific disease.

Let's illustrate with an example. A stent (stenting or

shunting) is easier to place in an outpatient facility, and at lower cost then open heart (robotic & AI navigated) heart surgery within an academic hospital.

something the World Health Organization (WHO) calls "Universal Global Health Systems". It can help us realise our dream of an inclusive, egalitarian society.



Early diagnostics, AI ECG, is like looking at the ocean and predicting tomorrow's storm, by analysing the waves of today. Richard Dasselaar

If we zoom out again and focus on the digital transformation and AI strategies for global and regional care ecosystems, we will finally find an AI strategy where all nations, both affluent and otherwise can unite behind. It can deliver in culture relevant capabilities and leverage

Impact of Artificial Intelligence on Healthcare Staff

Artificial Intelligence will augment medical staff, or, in some instances replace it since there is limited need after automation to let people do repetitive tasks in a system where we have shortage of skilled medicals professionals. Or, in case of underserved or rural regions of our world, AI can augment, by providing first line of defense via digital self-care intervention.

Limitations of Artificial Intelligence

The only limitation I see at this moment is people's urge to limit innovation (club it to death) under the flag of safety and regulation. We should consider AI as a non-invasive tool, which delivers or excludes false negatives, or false positives. We should focus on giving our physicians and healthcare teams - highly respected and esteemed professionals - with the tools and capacities to treat their patients within their clinical domain, with the tools and mentality as a fighter pilot in the cockpit, having all kinds of precision diagnostic sensors. This would make the patient more educated, and the doctor, in control of the possibility to have a 10,000 feet perspective and zoom in on the finesse of advanced heartcare, and discuss the data driven outcomes with a team of medical experts by communicating. This is simply because in an age of AI and IoT in healthcare, it is impossible that there is no communication with each other.

Conflict of Interest

None. ■

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Clinical Care Management

Pivoting to Manage a Pandemic: Flexibility and Creativity in Teams

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The COVID-19 pandemic presented a frequently changing situation for health systems, and successful management required a flexible and creative approach within a team.

Key Points

- Lessons from Stanley McChrystal's "Team of Teams" were very helpful in adapting to COVID-19 as a health system.
- Flexibility was a key tenet in our health system's response as the threat COVID-19 posed was variable over time.
- In COVID-19, the strategies our health system used historically were no longer options. We had to be creative to solve problems as the environment changed.

Introduction

As a new virus, SARS-CoV-2, appeared in Wuhan, China, we saw images of healthcare workers in Personal Protective Equipment (PPE) and watched as the city shut down. As the newly described COVID-19 spread across the world, healthcare systems rapidly established task forces to prepare for an inevitable change in how we delivered care to our patients.

When I began work on the COVID-19 pandemic in early 2020, I had recently finished a palliative medicine fellowship, which I had completed while working part-time as a clinical faculty member and a full-time mother of young children. I was struggling to understand how to measure what I contributed on any given day. A friend and mentor suggested that I keep a bullet journal, and at the end of each day, I should write three things that I did. This would allow me to look back and understand that even the things that feel small can add up.

Now, two years into the pandemic, I still do this. On the first and second anniversaries of COVID-19 arriving in the hospital where I work, I read back through my journals and reflected on my experience as a leader, physician and parent. I write this piece on managing future pandemics as a distillation of those 700 entries, where three themes emerged: teamwork, flexibility and creativity.

Teamwork

In Team of Teams, General Stanley McChrystal describes the difference between complicated and complex (McChrystal 2015). To paraphrase, in a complicated system, there are a number of parts that interact in a predictable way. In a complex system, the multiple parts move in an unpredictable way. In the book, McChrystal describes that a complex system is inherently uncertain, and success in this type of environment requires agility. That agility is more commonly seen in small teams rather than large organisations, but McChrystal argues that by empowering teams to form with shared information and common parameters, even a large organisation can achieve the agility needed to succeed in a complex environment.

At University of Utah Health, our COVID-19 journey started in March 2020. We listed all of the resources that could become limited during a pandemic. As things were rapidly unfolding, we realised the importance of a single source of truth. We could not make decisions quickly if there were three different values for any given data point. We developed a "Daily Huddle Management Report" that listed staff illness callouts, medication availability, equipment availability, and COVID-19 rates in the community. The DHMR, as it came to be known, was published daily on the University intranet, allowing anyone in the health system to easily see the

data driving our decisions.

At this point, no particular area of expertise seemed especially relevant. In line with the disaster management structure, we appointed roles such as "Planning Chief" and "Operations Chief". Our data management specialists teamed with epidemiologists to become COVID modelling experts. Seeing Seattle and New York manage an influx of patients with COVID-19 made us realise that the most limited commodity in the pandemic was a staffed intensive care unit (ICU) bed. University of Utah Health is the only academic medical centre in the Intermountain West. It provides care to the most complex patients across a vast geographic area that covers from the United States border with Canada to Arizona and from Nevada to Wyoming. It is approximately equivalent to one million square kilometers, or the areas of Spain and France combined. To fulfill our mission, we needed more ICU beds. Our physician leaders partnered with nursing leaders, Infection Prevention and Control, Pharmacy, and Facilities & Engineering, to rapidly transform an acute care unit into a 24-bed Intensive Care Unit (ICU). This newly created ICU remained open for 8 months, caring for 20 additional critically ill patients per day. This ICU allowed to provide care to a few hundred additional patients during the pandemic.

Teamwork became critical throughout the next two years, as we rapidly formed teams across our system to determine how we would care for increasing numbers of sick patients. Conversations ranged from transferring patients between our psychiatric, cancer, and rehabilitation hospitals to pulling ventilators from ambulatory operating centres. Later in the pandemic, with the release of vaccines for COVID-19, we again needed a rapid and flexible team to provide our 20,000 employees two doses of mRNA vaccines in just a few months. This took the expertise of pharmacy and nursing, plus volunteering faculty and non-clinical staff.

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Flexibility

The COVID-19 pandemic brought many different challenges. The shutdowns and social distancing from March of 2020 are unforgettable for all of us, as we saw schools close and empty grocery store shelves. From the very beginning, flexibility was a critical piece of the University of Utah Health pandemic response. One example of this was during the shutdown, when the system's food service team had a full order of supplies but no visitors to cook for, they pivoted to selling staff groceries and take-home meals. Food was not wasted and University of Utah Health staff were able to obtain necessary supplies for their homes.

In disaster preparedness, a common approach is the PACE plan. PACE is an acronym representing Primary, Alternate, Contingency and Emergency (Ryan 2013). "Primary" describes a usual day situation, "Alternate" describes a less-optimal situation without any compromise or change in the outcome, and "Contingency" describes a condition where to be able to deliver care, resources must be stretched. "Emergency" refers to the last resort when a system lacks the resources to provide care for patients. In any emergency, resources and workflow vary by the level of emergency. For example, in "Primary," clinical staff work in the area of their expertise with normal ratios of staff to patients. As a situation changes sequentially, resources are more stretched. In an "Emergency" state, staff are working in different areas with more patients than usual. One example of an "Emergency" state would be field hospitals erected in many cities, staffed by military personnel. Throughout the pandemic, University of Utah Health utilised the PACE planning method. Our goals were two-fold; to best assess our resources and to stay out of an "Emergency" situation as long as possible. Our PACE plan had several different versions, one for each surge in the pandemic.

From March 2020 to January 2021, our enemy was primarily the Alpha variant of SARS-CoV-2. During this time, COVID-19 vaccines were unavailable to the public. Hospitals were caring for patients with respiratory illness, and ICU resources were strained. However, as this was early in the pandemic, many hospitals were well-staffed. Later, the ongoing pandemic began to take its toll and we saw staff members leave healthcare entirely. In Utah, the Delta surge spanned from July to December of 2021, and was only beginning to taper off when Omicron took hold in the United States. Now, while COVID-19 is less of a concern in the United States, we are managing its indirect effects – including the mental health needs and more severe illness after nearly two years of deferred health care.

Reflecting on his experience in World War II, in 1957, Dwight Eisenhower observed, "Plans are useless but planning is everything". In COVID-19, as in wartime, the situations are complex and the best course of action often cannot be determined ahead of time. This is where flexibility is essential – by using the information available in the planning phase to generate and implement a new plan. When the Omicron surge affected Utah, we rapidly had to pivot to creating capacity for acute care rather than ICU. The least damaging option for our patients was to postpone scheduled surgeries. However, as the Omicron surge waned, we were left with hundreds of cases in a backlog. With slim staffing, we were unsure how to address this. Reflecting on options used across the US through the pandemic, we applied for federal support. In March of 2022, a team of Navy medical personnel arrived to support the University. In a few weeks, we were able to complete about 25% of the surgical backlog, or more than 100 additional surgeries, and reduce our ED wait times. Our staff received a much-welcomed reprieve and were able to take their planned days off instead of working extra shifts.

Creativity

Creativity can be defined as the ability to discover novel ideas and solutions to problems (Hennessey and Amabile 2009). During the COVID-19 pandemic, much of what we recognised as the normal state of being was disrupted. In this environment, maintaining a functional high quality healthcare system required new ways of delivering care to keep both staff and patients healthy. University of Utah health implemented telehealth and virtual visits in a number of weeks – where these types of visits had been rarely done pre-pandemic. We developed ways to offer virtual consultation for patients with COVID-19, using iPads for specialists and patients to prevent transmission of SARS-CoV-2. Prior to the COVID-19 pandemic, U Health performed less than 10,000 virtual visits. In 2020 and 2021, over 300,000 virtual visits were completed per year.

Creativity was key in our ability to protect our staff from COVID-19. Early in the pandemic, many hospitals were unable to purchase PPE. Masks, gowns, and Powered Air Purifying Respirators (PAPRs) were in short supply. In 2012, the University of Utah established the Center for Medical Innovation, offering a platform for faculty and students in engineering, healthcare, law and business to partner. The result is an ecosystem that has developed hundreds of new medical devices in its fairly short life span. In early 2020, when health systems were low on PPE, University of Utah Health partnered with colleagues at the Center for Medical Innovation to develop its own PAPRs.

In addition, when masks were difficult to come by, Utah's two largest healthcare systems, Intermountain Healthcare and University of Utah, partnered with Latter-Day Saints Charities for a five-week volunteer initiative that created 5,000,000 masks that were processed, sterilised, and delivered to heath care systems. These masks remain in use throughout Utah.

Conclusion

The COVID-19 pandemic was a life-changing event felt across the world. Suddenly, we had to reimagine how we delivered healthcare. At University of Utah Health, our response to the pandemic was variable over time and necessitated teamwork, flexibility, and creativity. In the more than two years since COVID-19 entered our lives, University of Utah Health has cared for thousands of patients affected by the virus and vaccinated hundreds of patients.

These three attributes were how so many of us survived the pandemic as parents and as physicians. We were placed in situations that were complex and challenging outside of the hospital as well as in it; sometimes working from home while our children were on virtual school. We had to find ways to keep ourselves and our loved ones safe as the pandemic roared around us. In two years, we had five different childcare strategies. No single plan worked on any given day and very few of us were able to live through the pandemic alone. It took teamwork, flexibility, and creativity.

I was recently asked whether I felt ready for another surge, should BA.5 cause an increase in cases and hospitalisations in Utah. In case we see another surge, we are now more experienced than at any point during the pandemic. We have learned how our healthcare systems can and must pivot when things change. My hope is that the teamwork, flexibility, and creativity we used will help us re-invigorate healthcare in the future.

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Conflict of Interest

None. ■

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