



EY

Building a better
working world

How innovative infostructure can power the purpose of integrated care systems

Designing health information architecture to reach
a common ground of shared purpose

A photograph of a man and a young girl sitting at a desk, looking at a laptop screen. The man is on the left, wearing a dark suit jacket, and the girl is on the right, wearing a yellow sweater and a blue jacket. They are both looking intently at the laptop. The background is a blurred office or home setting with wooden shelves.

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INTRODUCTION

Integrated care systems (ICSs) tick all the right boxes – ideally providing equitable, well-connected and coordinated care across all aspects of a person’s health and social needs, resulting in healthier populations and more sustainable systems. Supported by a contemporary and innovative information infrastructure, ICSs differentiate by enabling and sharing insights through data at scale.

ICSs are a major step forward in better supporting people to live “healthy, independent and dignified” lives.¹ Collaborative systems that join up or integrate care for people, places and populations, ICSs are a long overdue recognition that working together, rather than in fragmented silos, achieves better outcomes.

In England, 42 ICSs now cover all areas and are the result of a steady shift in health policy over the past decade toward the joining-up of services to better meet the needs of local populations. ICSs are a major step toward value-based care and represent a reordering of the philosophy and the clinical and business models of health away from sickness toward wellness and population health. In a clear departure from the past, ICSs are founded on local or place-based integration, collaboration and multiagency partnerships. In practice, addressing the determinants of health by joining up the many threads of health, social and community services keeps people and populations healthier, independent and at home.

Globally, similar policy interest can be seen in the desire for better integrating care and adapting care delivery through such things as patient-centered care, shared decision-making, medical homes and social prescribing.^{2,3,4} In Europe, policy priority is directed toward responding to the needs of older people through sustainable integrated care models delivered by a coordinated array of providers.⁵ And, while not known as ICSs, similar moves to integrated systems can be seen, for instance, in Sweden, Denmark and Canada. (Refer to featured insight “Connected health technology sits at the core of all integrated care systems.”)





The vision for ICSs lies beyond providing better care in smarter ways. Embedding within ICSs how services are planned and paid for means that they lie at the heart of improving the health of whole populations and driving a more equitable distribution of health outcomes. As agents of change, ICSs push health and care systems toward a common ground of shared purpose. (Refer to featured insight “Integrated Care Systems.”)

The potential for societal and economic dividends is a powerful incentive for a shift in focus to integrated care. Although many things need to be in place to create and sustain ICSs, this paper focuses on what is foundational for ICSs to move from aspiration to transformation.

To unlock the power of ICSs as coordinated and collaborative ecosystems requires a new approach to health information architecture. This approach is one that not only spans the health and social dimensions of an individual’s life journey, but it also realizes the immense value of health data availability in accelerating novel approaches for better and more efficient health and care.

Infostructures, or information systems that can create, connect and share data, leveraging a semantic standard, at scale are key to modernizing health systems. As data becomes the core asset of health and care, it will be used by thousands of people for different purposes across time and space. The data element itself must embody a meaning commonly shared by all of those using it; otherwise, care delivery, analytics and research will not be without risk of error. Data accuracy is vital. Conceiving of information systems as infostructure means designing information architectures to deliver speed-to-value, or the continual development and rapid bringing to market of innovative products, such as new models of care.

Investment decisions need to be informed by a vision of how the future infrastructure will evolve to avoid becoming locked into old architectures. Systems need to be architected for longevity, but they must weigh alignment of previous systems and yet be open to incorporate future standards. Key to this is getting the data information and governance systems right, getting the infrastructure and architecture right, and creating an education and training environment to set the system up for sustainability.

An open platform environment, within and between enterprises and systems, is called for.

The NHS journey toward integrated care systems

CONTEXT:^{1,2,3} NHS England's then CEO, Simon Stevens, expressed concerns about the country's "fractured" health and social care system being built around the needs of organizations rather than patients.

Over the past few years, the NHS chief introduced a series of reforms, including the launch of sustainability and transformation plans in 2015. This was the UK's first major step toward integrated care, as the NHS and local councils formed partnerships across 44 areas in the country. The goal was to meet the needs of the whole population in an area, breaking down barriers between primary, secondary and social care.

In 2017, the NHS launched its first group of accountable care systems, which incorporated additional elements into the model, such as mental health and voluntary organizations. These accountable care systems subsequently became ICSs in 2018. There are currently 42 ICSs across England forming multiagency partnerships of NHS, local government, voluntary, community and social enterprise organizations.

KEY FEATURES AND GOALS:^{4,5,6} An ICS is designed as a three-tiered model, spanning systems, places and neighborhoods. Broadly, ICSs aim to:

- ▶ Improve care quality and patient experience through primary care playing a central role in coordinating joined-up care, leading collaborative arrangements that support operating at scale, and driving a shared vision of investing resources to improve population health and health equity

- ▶ Reduce health inequity via a data-led approach, drive stronger relationships with voluntary and community sectors, and deliver continuous support to vulnerable groups
- ▶ Leverage digital technology to improve health outcomes via population health management tools, real-time data sharing, remote access to primary care, workforce education programs and innovation hubs
- ▶ Address workforce shortage via a collaborative, resource-sharing approach
- ▶ Utilize physical assets (estates and buildings) to their full potential
- ▶ Provide better financial and governance support to social care organizations

FUTURE:⁷ The Health and Care Bill came into effect in July 2022, designating ICSs as statutory bodies. This primarily affects the planning and commissioning of NHS services:

- ▶ The types of services available, who provides those services and who can be cared for will be overseen by a board of directors in each area, the Integrated Care Board (ICB). A second statutory body, the Integrated Care Partnership (ICP) brings together the NHS, local authorities and others to focus on wider issues of health, public health and social care.
- ▶ There will be no competitive tendering process for NHS services. However, it is yet to be confirmed whether the NHS will become the default service provider or not.
- ▶ Private health companies will also have a role in decision-making, which may be significant in some areas.

¹ McConaghie, Andrew. "Just unveiled, the next big idea for England's NHS." Pharmaphorum. July 5, 2017.

² NHS. "NHS moves to end 'fractured' care system." June 15, 2017.

³ Brennan, Sharon. "ACSS get a rebrand as NHS England seeks 'next cohort,'" HSJ February 3, 2018.

⁴ Charles, Anna; Naylor, Chris; and Murray, Richard. "Integrated care systems in London. Challenges and opportunities ahead." The King's Fund. February 2021.

⁵ Charles, Anna. "Integrated care systems explained: making sense of systems, places and neighbourhoods." The King's Fund, internet May 11, 2021.

⁶ NHS. "What are integrated care systems?" Webpage, no date.

⁷ Thorstensen-Woll, Clair and Bottery, Simon. "Integrated care systems and social care: the opportunities and challenges." The King's Fund December 8, 2021.

JOINED-UP CARE MEANS WORKING DIFFERENTLY

Smart digital technologies that support care delivery and data that is fit for purpose (clean, standardized, provenanced and permissioned) are vital in creating the conditions under which local partnerships will thrive.

Foundational to the success of ICSs are integrated shared care records, patient-derived data and the consolidation of data for primary purposes, such as life-long risk stratification, and secondary uses, including research and population health. Clinical records that follow the patient across different service delivery systems and geographies support real-time clinical decision-making. A digital architecture also allows for ICS-based care plans that are shared between different health care providers. Digital tools and coordination of the flow of data from a vast range of sources allow ICSs to identify the best way to improve the health and well-being of their populations.

ICSs will evolve at different rates and with different levels of digital maturity; however, all will require a digital backbone that is built to sustain the model. Integrating care among the patchwork of health and social care agencies requires a networked and modular information framework. This should support digitally enhanced care models, seamless access to health information at the point of care, and appropriate automation of clinical and back-office operations, and be in a cloud-based environment for enhanced functionality and security.

The richness and variability of health and social care encounters demand information infrastructures that are sufficiently agile to accommodate the heterogeneity of many different existing systems. Such infrastructures also need to act as platforms of exchange. This means allowing the easy flow of data within and between systems and analytics capabilities that support the use of data for local needs, safely and securely.

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Delivering joined-up care means working differently – providing care in people’s homes, hospitals, clinics and the community with collaboration among agencies, data sharing and collective decision-making. Modern capabilities, such as passive remote monitoring, help people manage their care at home while providing more efficient care delivery. This happens under the oversight of a care team who provide exception-based interventions when indicated. This very different model of working requires different tools and different ways of thinking about the immense value of data.

Dr. Jim Ritchie

CCIO and Deputy Director for R&I, Northern Care Alliance

At a minimum, modernizing the operating environment should integrate the vast amount of health-related information about an individual into an integrated shared care record. Spanning complex care pathways across many different organizations, this should drive interorganizational information exchange that prevents errors, avoids inefficiencies arising from duplication, and supports primary care and health-at-home care models.



Diverse siloed data sets normally outside the clinical record need to come together to be practical and useful. Critical to this is data liquidity within and between systems and the information governance necessary for safe and secure data management and sharing.

Guidance from the NHS sets guardrails as to how ICSs are intended to operate, including local determination of digital and data capabilities within a common vision of national standards and system consistency.⁶ To this end, the NHS has signaled the intention to achieve universal electronic patient records (EPRs) across all ICSs. This includes a managed convergence or “leveling-up” of EPRs over time by reducing the number of EPRs across acute care, community services, mental health, ambulance services, primary care and social care.⁷ In the past, some have speculated that the ultimate goal may be a single national EPR system.^{8,9} EU countries are advancing integrated care in decentralized locations through using eHealth technologies, including electronic health records (EHRs) and remote monitoring and interfaces with social and welfare systems.¹⁰ National contexts vary; however, studies suggest that interoperable, regional EHR systems are more favorable in adopting integrated systems, rather than centrally managed, national EHR systems.¹¹

Managed convergence of existing EPR systems may be a quick way to achieve digital maturity, but it can present challenges of data lock-in and a non-extendible data model, which brings limited ability to integrate with community, mental health and social care settings. The ability to customize monolithic EPRs

to meet local needs can be technically difficult and expensive. Layers of modifications over time means that systems may be less agile in responding to changing models of care. Purchasing EPRs for all acute settings, let alone extending into an integrated environment with community and primary care solutions, is a significant investment that, for many reasons, may make only a marginal contribution to enhancing utility and interoperability.

As major investments, health information systems need to stand the test of time. This means not being constrained by elements that are holding back system modernization. Decision-makers face hard choices around what to pursue and where to invest scarce resources. This includes weighing whether existing monolithic EPRs in use in the acute health system can extend to satisfactorily meet the information needs of the community, mental health and social care domains, as well as providing an experience desired by both the individual and the clinician. Secondly, it needs to be ascertained whether such systems—often from different vendors—can jointly function as regional health information exchanges. Achieving the preferred experience of both the consumer and clinician builds the foundations of long-term partnerships between the consumer, the clinician and the organization. Positive experiences can help change patient behaviors, improve care outcomes, and reduce clinician burnout and turnover.

Successfully designing ICS systems requires careful thought concerning the underlying information infrastructure and a clear view of the big-picture outcomes to be gained through modernizing the operating environment.

Connected health technology sits at the core of all integrated care systems

EUROPEAN COMMISSION:¹ To unleash the full potential of health data, the European Commission is presenting a regulation to set up the European Health Data Space. This proposal supports individuals in taking control of their own health data; supports the use of health data for better health care delivery, better research, innovation and policymaking; and enables the EU to make full use of the potential offered by a safe and secure exchange, and the use and reuse of health data. This will be a health-specific ecosystem comprising rules, common standards and practices, infrastructures and a governance framework.

SWEDEN:^{2,3,4} In most of Sweden, counties oversee health care, while municipalities are responsible for providing homecare and social care. However, Norrtälje, a city in Stockholm County, is an exception. To meet the complex care needs of its aging population, the Norrtälje municipality and the County Council of Stockholm together launched an integrated care provider, TioHundra, in 2006. Instead of coordinating care across organizations, TioHundra merged multiple care providers and now operates as one large health and care system. This includes an emergency hospital, six primary health care clinics and a home health care organization. It also manages social care and home care organizations and runs nine nursing homes.

► ROI: Moving from negative operating results to a positive net result thus lowered delivery costs while improving care quality. Integrated care has resulted in uplifting performance, particularly in managing stroke and heart disease. Reduced medication prescribing and shortened emergency room wait times have been achieved, and workforce satisfaction is high. Patient data is shared throughout the organization with read-only functions in patient journals, and the organization has consolidated different patient record systems to a single (unified) record system.

DENMARK:^{5,6,7} The SAM:BO initiative in southern Denmark involves four hospitals, 22 municipalities and about 800 practitioners. It is an agreement-based, joint care model for the management of chronic disease and patients with complex needs. It specifies guidelines for communication and cooperation between agencies and focuses on integrated care pathways and effective transition between care settings. The goal is to improve continuity of care between hospitals and municipalities, especially at discharge, to help ensure seamless transfer of older persons from the hospital to the community. The primary tools used are information-sharing standards through an IT platform and clarity of roles and responsibilities of organizations and workers. Since its inception in 2009, this initiative has been credited with increased patient satisfaction and shorter hospital stays.

► ROI: The priority group for the service is the elderly, with multiple comorbidities that are costly to manage and require careful coordination. The guidelines and protocols allow both vertical and horizontal integration across primary, secondary and social care, which has resulted in high-quality care outcomes at lower cost. For example, municipal services can deliver care in a timely manner, post discharge. The average length of stay is considerably lower than in Denmark overall, and patient satisfaction measures also outperform those at the country level. Coordination through a shared electronic care plan and shared care portal has resulted in shorter lengths of stay and decreased bed-days of those who no longer need hospitalization. Service delivery efficiencies arise through using technologies, including providing virtual care tools to patients and providers; automation and intelligent logistics and sensors; and decision support tools.

¹ European Commission. European Health Data Space. Internet May 2022.

² Widen, Sofia. "TioHundra Case Study. Part One: Company Overview." Access health international. February 2015.

³ Back, Monica A., and Calltorp, Johal. "The Norrtälje model: a unique model for integrated health and social care in Sweden." *Int J Integ Care*. 2015 Apr-Jun; 15:3016.

⁴ Hotopf, Max. "Interview: Peter Graf, CEO, TioHundra." *Healthcare Business International*. Policy Summit February 15, 2020.

⁵ World Health Organization. "Denmark. Country case study on the integrated delivery of long-term care." WHO Regional Office for Europe series on integrated delivery of long-term care. 2019.

⁶ ECHAlliance. "South Denmark eHealth ecosystem is ECHAlliance Ecosystem of the month - September." 13 September 2021.

⁷ Lupianez-Villaneuva, Francisco and Theben, Alexandra. "Strategic intelligence monitor on personal health systems Phase 3 (SIMP3). SAM:BO (Denmark) case study report." European Commission, 2015.



CANADA:^{8,9,10} The Ontario government is building a connected health care system centered around patients, families and caregivers. Introduced in February 2019, Ontario Health Teams (OHTs) are groups of providers and organizations, including hospitals, doctors, and home and community care providers, who work as one coordinated team, no matter where they provide care. Fifty-one OHTs operate across Ontario, with partnerships across more than 1,000 providers. The model is designed to deliver seamless experiences across providers and settings in a continuum of care. Primary care is foundational to OHTs. The model assumes a digital first approach of both digital choices for patient care, health information and communication, and information-sharing tools among providers. This includes adopting technical standards, such as HL7 FHIR for messaging and Open, RESTful (web applications); and digital tools, such as Wait Times Information System, care dashboards, eReferrals and Health Report Manager (HRM), which are all linked by unified electronic health record. Population health management is also a focus.

- ROI: A key goal is to transform how health and care are provided and funded through an integrated care model that improves outcomes and experiences for patients, draws upon the key expertise of providers and covers the full continuum of care. The system is under development; however, hoped-for outcomes include a performance framework that delivers quadruple-aim goals. This framework includes performance against selected indicators (patient and provider experiences, health outcomes, value and efficiency); enhancing patient and provider-reported data; collaborative quality improvement plans; and standardized, system-level performance indicators.

⁸ Ministry of Health. Ontario Health Teams. "Guidance for Health Care Providers and Organizations." No date.

⁹ Ministry of Health. Ontario Health Teams: Guidance for Health Care Providers and Organizations. Webinar, April 8, 2022

¹⁰ Ministry of Health Ontario Health Teams Virtual Engagement Series OHT Performance Measurement Framework. March 2021.

BUILD FOR THE FUTURE

The enduring vision of a shareable electronic health record at a national scale comes up against the problematic experiences of many in attempting to build and implement such systems in practice.^{12,13}

Getting the information backbone of the ICS ecosystem right is mission-critical, and infrastructure must be designed for the future with the entire system in mind. This means sufficient flexibility to benefit from emerging technologies (e.g., artificial intelligence, augmented and virtual reality, hyper automation, decentralized identities and digital twins); digital-first consumer and workforce experiences; and the capability to integrate within a national system. By extension, this also adds robustness to future innovation curves that are yet to emerge. At the local level, tapping into domain expertise to drive the information model gives rise to new personalized care pathways where health and wellness come together.

The future vision should be that of systemically and semantically architected open systems, built from an ecosystem mindset, that accommodate a plurality of approaches and information needs. This should be a dynamic infrastructure, where data is captured in a smart way, adheres to a shared semantic standard tailored to the specific use case and moves data through modern interfaces, like RESTful web APIs. In this infrastructure, health data captured in EPRs will need to be able to flow through this standards-based information backbone, either directly integrating with the backbone API or by publishing vendor-controlled data objects in a format that can be mapped against it, like HL7 FHIR, which is designed for extracting data.

Open architectures are one way that the tension between bottom-up innovation and data exchange and top-down standardization and uniformity can be resolved. Composable health care infrastructure allows incremental design whereby real-time adaptations can be made at the time of need.¹⁴ A composable infrastructure means trading technically outdated (parts thereof) applications, such as the clinical repositories from monolithic EPRs with bespoke data models and poor APIs for applications that connect through rich APIs to carry out a clinical function. This allows innovation at the margin to create novel solutions while having stable core systems. For example, all three of the largest Nordic vendors of EHR systems in Norway (DIPS), Sweden (Cambio) and Finland (TietoEvry), and the largest vendor of EHRs for elderly care providers in the Netherlands (Nedap), use a vendor-neutral data repository based on openEHR.¹⁵ Dedalus, a supplier of clinical and diagnostic solutions in many European countries, has recently committed to openEHR.¹⁶

The system should be federated, where the architecture is one of multiple interconnected nodes and shared principles, governance and open standards. Such an architecture allows shared infrastructure services to scale incrementally over time, links different domains together, and provides the means to share sensitive health data safely and securely. If built on an open hybrid cloud platform that mixes on-site and third-party cloud computing infrastructure, standard functions, such as patient identity management and verification, can be provided nationally while allowing for locally led workstreams and applications. In such arrangements, integrated shared care records become part of federated architecture that connects nationally. This delivers a more resilient result than a centralized record and allows for health data to be used for multiple purposes, such as research and population health. A big advantage is that

repositories can stay under the immediate control of the individual provider, and data will be shared only when this is allowed by the data stewards of the individual notes. In other words, this is privacy by design. The NHS Spine is a good example of supporting IT infrastructure that joins together over 23,000 health care IT systems in 20,500 health and social care organizations.¹⁷ Other examples with local variations in architectures and implementation strategies can be found in Scotland,¹⁸ Norway¹⁹ and Catalonia.²⁰

Build on the installed base

Few opportunities exist for greenfield sites; therefore, new uses and users must be interwoven with the pre-existing built environment, the installed base. Changes and innovations are naturally constrained by what is already in place and what can realistically be realized.²¹ As a result, a single procurement or project will not achieve a transformative vision. However, leveraging previous investments where they can add value goes some way toward avoiding creating more data debt, where messy data governance and management lead to suboptimal decisions and applications.²² This also applies to technical debt, or the implied cost of additional rework caused by choosing an easy but limited solution over a better approach that would take longer.²³

The primary strategic question facing ICS decision-makers is how to best build scale with sustainable technology choices that suit both national and local purposes, considering the

installed base, enabling infrastructure and future model of care and infrastructure needs. Recently reported is the decision of a Florida-based health care system to spend US\$65m to switch from one monolithic EHR system to another to allow access to patient records irrespective of location.²⁴ The cost of switching from one siloed system to another is something that few can afford, and it begs the question as to whether health systems can continuously switch or change as needs evolve or choose to work with a vendor-neutral data layer instead.

Further complicating this is the NHS target of achieving HIMSS level 5 for all ICSs by December 2023,²⁵ bringing additional burden to sustainable change. The total cost of ownership and time to achieve of moving to a single system platform are prime considerations, including such things as licensing, technical support and the need for legacy data conversions. Any future state considerations must address the IT portfolio mix, as well as plan for advanced analytics, personalization and care coordination through artificial intelligence, computer vision, IoT/IoMT and natural language processing. Lastly, it is not enough to simply strive for level 5. To have an impact, the NHS must focus also on governance and stewardship; building organizational capability; ensuring security and privacy; enabling information sharing and integration across ICSs; enabling data and analytics; and, probably most importantly, creating a consumer experience and engagement in this digital world based on human-centered design principles.



THREE BUILDING BLOCKS TO CREATE THE RIGHT ENVIRONMENT

Creating the right environment for ICSs to thrive will be built upon the information architecture, core features, and shared common terminology and standards.

1. Infostructure information architecture

For a truly integrated ICS system, a data environment with no connection restrictions other than permissions and security is needed. This, in turn, necessitates an open platform architecture that allows for the storage and linking of structured and unstructured data and determines how data flows. A decentralized and networked infrastructure will unify disparate information from multiple sources and make sense of it. This means capturing and linking all relevant data, regardless of where it is created and stored.

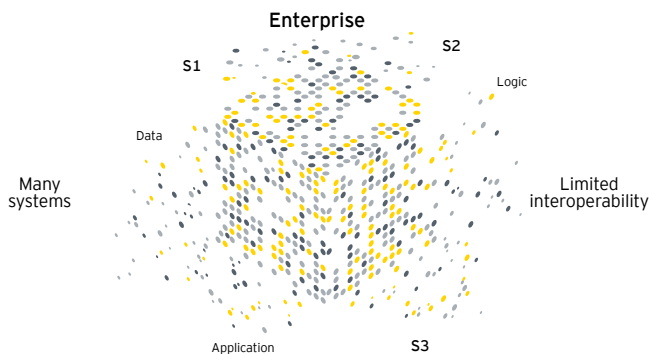
The optimal platform separates content and technology and will be vendor-neutral, distributed and modular – incorporating third-party, as well as legacy, systems. It provides a stabilizing framework for maintaining governance mechanisms, including standards, interfaces and rules. The architecture should be separated into different layers that organize transactions and interactions: the data layer, the application layer and the logic layer:

- ▶ The **data layer** is standardized in terms of format, nomenclature, terminologies and definitions, which allows it to flow into other systems.
- ▶ The **application layer** requires a fully systemic design of workflow based upon triggered events of care or intervention (e.g., clinical workflows).
- ▶ The **logic layer** contains sets of rules that define boundaries and exceptions and can form workflows.

As Figure 1 shows, the information architecture of the future will shift from many fragmented systems with limited interoperability to a more harmonized arrangement.

Figure 1: Health information architecture today and tomorrow

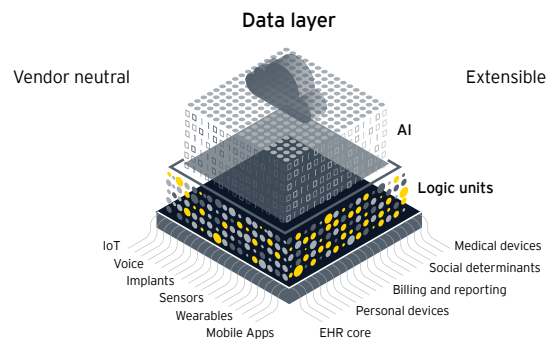
Today's health information architecture



Health information architecture that is siloed and disconnected prevents the true exchange of data in ways that help improve care.

Source: Ernst & Young LLP

The health information architecture of tomorrow



When it's quicker and easier to share deeper data, everyone serving the patient benefits.



2. Core features

Architecting for the future requires a reference framework around technology, data and end-user primacy.

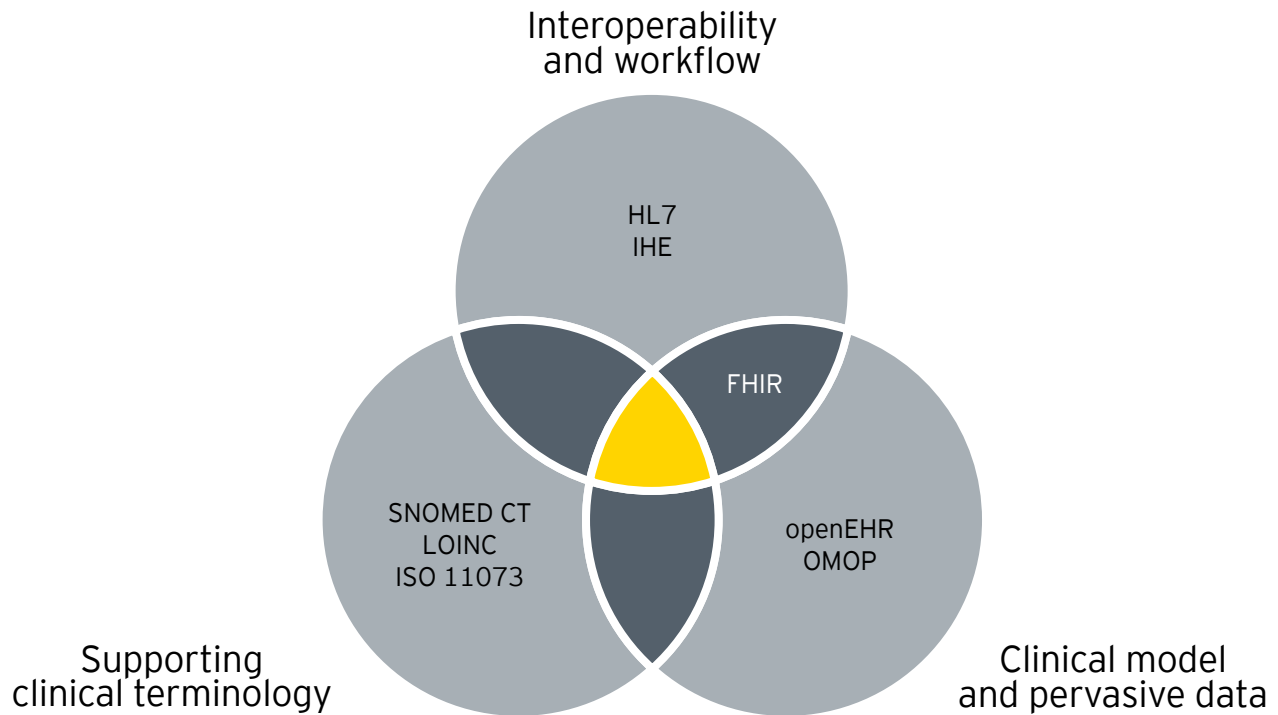
CORE FEATURES	
User-centric	Built around consumer trust, preferences and control of their own health, lifestyle, behavior and social data for engagement and better health outcomes. From a business and operational perspective, customizable and adaptable systems of clinical and operational data.
Governed	Shared principles and rules that guide and safeguard health data use and sharing practices to protect privacy, enable efficiencies, promote quality and foster research.
Interoperable	Common rules govern access and content referenced to internationally accepted open standards. A set of community sourced common data models is used for storing and sharing data.
Portable	Applications or logic developed on top of the data layer should be able to run with no change on any independently developed implementation of the data layer.
Federated	Data is created at multiple points in a united network. Data provenance is fully documented and data are sufficiently liquid to move within and across systems in the federation.
Vendor neutral	The data layer is based on vendor neutral standards. Anyone implementing a node to store and share care information may elect to use any technology from a vendor of their choice supporting these standards.
Flexible	An architecture that is modular and built on micro-services with no need for reconfiguration. Allows for plug-and-play integration of devices and equipment and for extensibility. Structural separation of data and application layers. Low-code development functions that allow flexible creation of applications for specific use cases.
Open APIs	Open RESTful APIs that integrate data between participants. Accommodates a variety of legacy systems as well as allowing third-party innovations. These APIs allow for easy integration in web applications. The specifications of these APIs should be freely available.
Secure and Safe	Where technical, governance and cybersecurity elements meet accepted data security frameworks, assurance schemes and safety and reliability standards for handling personal health and social care information.

3. Data and terminology standards

Health information systems should share a common language (standards, semantics and structure), thus avoiding translational interoperability friction and the need for bridging between systems. Separating the data layer from applications is achieved by putting a semantic-rich common data model that references a common set of ontologies at the center of design for every use case and then selecting and constraining the relevant predefined data elements required for a specific use case across the health and care system. A bottom-up approach, where the bulk of the semantic standards evolve use case by use case in parallel in different ecosystems, will likely fail and inevitably result in many dialects.

Data standards fall into three categories: interoperability standards, clinical data models and clinical terminology standards. (Refer to Figure 2.) Several international standards are backed by the WHO in terms of increasing efficiency, quality and safety, as well as scalability of health systems. Those supported include HL7/FHIR, Integrating Healthcare Enterprise (IHE), openEHR and SNOMED CT. The newly released ISO 13972:2022²⁶ covers clinical information models and specifies logical models of clinical concepts to define and structure clinical information, including enabling information reuse for such things as public health monitoring.

Figure 2: Platform Standards of Health Care



Source: Professor Rachel Dunscombe, Visiting Professor at Imperial College London and UK government strategic advisor



Interoperability and workflow	Clinical model and pervasive data	Supporting clinical terminology
<ul style="list-style-type: none"> ▶ HL7²⁷ provides interoperability standards for exchanging data across systems regardless of how the data is stored, such as records from traditional EPRs. HL7 also includes the FHIR standard offering modern RESTful APIs. ▶ The IHE profiles are used to implement clinical processes and workflows for a particular clinical need or pathway. They are used globally to bring together meaningful clinical process from other standards such as HL7 messages and imaging standards. 	<ul style="list-style-type: none"> ▶ openEHR provides semantic rich community sourced health data models, published under a creative commons license. These common data models are supported by a robust reference model and state-of-the-art software specifications, including a RESTful API and a query language. This allows for rapid, data standards driven, application development where data is safely stored for longevity. ▶ The OMOP common data model allows analysis of data from different observational data bases. Administrative and health data are transformed into a common format with common terminologies, vocabularies and coding schemes to support systematic analyses.²⁸ 	<p>Clinical terminologies provide clinical codes for tests, procedures, diagnoses, and other technical clinical terms.</p> <p>The following allow for the fine grained recording of the bulk of health data:</p> <ul style="list-style-type: none"> ▶ SNOMED CT: Systematized Nomenclature of Human Medicine Clinical Terms. ▶ LOINC: Logical Observation Identifiers Names and Codes ▶ ISO/IEEE 11073: Set of standards for medical and personal health devices

INFOSTRUCTURE: THE ESSENTIAL FOUNDATION FOR NEW MODELS OF CARE

Sharing organized and complete data to generate insights for better health outcomes is the driving force behind joined-up care in ICSs. This demands an information architecture that supports a longitudinal health and care record, shared services between different resources and the easy exchange of structured data across systems.

Although the NHS points ICS decision-makers toward consolidation and enhancement of existing EPR assets,²⁹ an alternative approach warrants consideration.

Open platform systems will produce significant value as a result of seamless data flow across the entire health and care value chain – from primary and community care through to hospital systems. Experiences in European countries, Canada and the United States suggest that ROI flows from improved user experiences and patient satisfaction, reduced workforce burnout, and personalized care with improved quality and health outcomes. Other benefits realized include reduced utilization of hospital beds, reduced wait times and more timely care transitions. Greater efficiency of available resources through sharing, the reduction of duplication and upskilling human resources to deliver a broad range of services rather than relying upon traditional specialty roles also arise. At a population health level, benefit accrues through capturing and analyzing vast flows of data to direct effort and focus on preventative measures and public health services. As a result, social and economic benefit arises through improved quality of life; economic impact in lower utilization and costs; and, at a societal level, benefit through workforce upskilling, local economy renewal, and a harmonized and more sustainable care delivery system.

Health systems need to plan with a long-term view of the future. Beyond immediate need, strategic considerations must revolve around the vision for a modernized health system. Technology

enablement is key to modernization, and the primacy of data liquidity is beyond question. The tools to deliver such liquidity must enhance, not impede, the permissioned sharing of complete data, which gives rise to service model and operations innovations for better health outcomes. ICSs are a perfect example of the need to consider the needs of all information users and help ensure that a sufficiently agile system underpins the model.

Planning wisely means envisioning future scenarios, including innovative models, ready access to quality data and anticipation of future issues. The growth of health data coming from insecure sources, including IoT, wearable and remote networks, brings cyber risk, along with benefits arising from using quantum computing to analyze the data. Quantum security will be required to combat security gaps in the system. In planning for the longer term, where should the investment decision lie? Pay now and avoid adding yet another layer of technical debt, or pay later and add risk to legacy treatment of data? Leveraging the infrastructure described in this paper gives health care systems a potential uplift in anticipating future demand for such things post quantum cryptography.

Integrated shareable care records replete with good-quality data are the backbone for any future health and care system. This is too important to get wrong. In this early stage of transition to ICSs, opportunity exists to weigh alternatives carefully. If information infrastructure is viewed through a different lens, that of open platforms and systemic design, the building blocks of a truly transformational change become clear.

Collaborations that combine health, social and community expertise offer great promise, but could be even better if supported by a frictionless information architecture that ultimately delivers a connected ecosystem.

CONTRIBUTORS



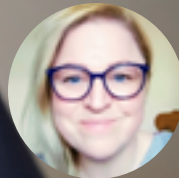
Aloha McBride

EY Global Health Leader
aloha.mcbride@ey.com
linkedin.com/in/alohamcbride



Erik Vermeulen

EY Global Smart Health Solution Leader
and Netherlands Health Consulting Leader
erik.vermeulen@nl.ey.com
linkedin.com/in/erikvermeulen



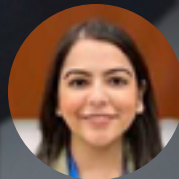
Professor Rachel Dunscombe

Visiting Professor at Imperial College London
and UK government strategic advisor



Dr. Sheryl Coughlin

EY Global Health Senior Analyst



Aishwarya Benjwal

EY Health Sciences and Wellness Analyst

For more information

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ENDNOTES



1. Department of Health & Social Care. "Joining up care for people, places and populations." February 9, 2022.
2. World Health Organization. "Framework on integrated, people-centred health services." Report by the Secretariat, Sixty-Ninth World Health Assembly, April 15, 2016.
3. Berwick, Donald. "What 'patient-centered' should mean: Confessions of an extremist." *Health Affairs* 2009, 28(4) w555-w565.
4. Gusmano, Michael K., Maschke Karen J., and Solomon, Mildred Z. "Patient-centered care, Yes; Patients as consumers, No." *Health Affairs* 2019, 38(3) 368-373.
5. World Health Organization. "Denmark. Country case study on the integrated delivery of long-term care." WHO Regional Office for Europe series on integrated delivery of long-term care. 2019.
6. NHS. "Integrated Care Systems: design framework: June 2021.
7. Hoeksma, Jon. "Major push on EPR 'convergence' and levelling up from the centre." Digitalhealth.net. March 10, 2022.
8. Hoeksma, Jon. "Speculation of national Epic deal with NHS England." Digitalhealth.net. October 7, 2021.
9. Lynn, John. "Speculation of \$10 billion Epic deal with NHS England - Would that help?" Healthcare IT Today October 12, 2021.
10. Melchiorre, Maria G., Papa, Roberta., Quattrini, Sabriina., Lamura, Gionvanni., and Barbabella, Francesco. "Integrated care programs for people with multimorbidity in European countries: eHealth adoption in health systems." BioMed Research International, 2020.
11. Melchiorre, Maria G., Papa, Roberta., Quattrini, Sabriina., Lamura, Gionvanni., and Barbabella, Francesco. "Integrated care programs for people with multimorbidity in European countries: eHealth adoption in health systems." BioMed Research International, 2020.
12. McLoughlin, Ian., Garrety, Karin., Wilson, Rob., Yu, Pin., and Dalley, Andrew. "The Digitalization of Healthcare: Electronic Records and the Disruption of Moral Orders." 2017 Oxford, UK: Oxford University Press.
13. Cresswell, Kathrin M., Worth, Allison., and Sheikh, Aziz. "Integration of a nationally procured electronic health record system into user work practices." *BMC Medical Informatics and Decision Making* 12(15) 2012.
14. Gartner. "Gartner keynote: The future of business is composable." Internet October 19, 2020.
15. OpenEHR International. Industry partners. Internet 2022.
16. Dedalus. "Dedalus Joins openEHR International." Internet May 26, 2022.



17. NHS Digital. Spine. Internet, last updated 2021.
18. Hann, Alistair. "Blog/What is the National Digital Platform Made of?" NES Digital Service. Internet April 2019.
19. Green, Alex. "EMR/EHR development in the Nordics." Signify Research December 2018.
20. International Foundation for Integrated Care. "Developing a new model of information systems and Electronic Health Records in Catalonia." Internet February 16, 2022.
21. Aanestad, Margunn., Grisot, Miria., Hanseth, Ole., and Vassilakopoulou, Polyxeni. "Information infrastructures within European Health Care. Working with the installed base." Springer eBook, 2017.
22. Travkin, Petr. "Data debt: what it is and how to estimate it." Medium.com May 27, 2020.
23. Mitchell, Hannah. "Technical debt catches up to CIOs who launched flawed tech to meet pandemic needs." Beckershospitalreview July 19, 2021.
24. Diaz, Naomi. "Florida health system to spend \$65M on Cerner to Epic transition." Beckershospitalreview May 27, 2022.
25. Hoeksma, Jon. "Major push on EPR 'convergence' and levelling up from the centre." Digitalhealth.net. March 10, 2022.
26. International Organization for Standardization. "ISO 13972:2022. Health informatics – Clinical information models - Characteristics, structures and requirements." February 2022.
27. HL7 International. HL7 Version 3 Product Suite. Website. Available from www.hl7.org/implement/standards/product_brief.cfm?product_id=186
28. Observational Health Data Sciences and Informatics. OMOP Common Data Model. Internet, last updated 2022.
29. Hoeksma, Jon. "Major push on EPR 'convergence' and levelling up from the centre." Digitalhealth.net. March 10, 2022.

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