Briefing May 2019

What can the NHS learn from learning health systems?

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Key messages

The NHS Long Term Plan places digital development at the heart of steps to improve health and care, and to deliver services in a sustainable way. More than merely digitising current ways of working, this requires data to be used to generate evidence that transforms and improves services. A 'learning health system' (LHS) continuously analyses data which is collected as part of routine care to monitor outcomes, identify improvements in care, and implement changes on the basis of evidence.

There is already a lot going on in the NHS which could enable LHSs and more could be done to extend the use of data for learning and improvement. But implementing the LHS concept in the NHS would be a significant challenge to how the NHS currently uses data and supports analytics, requiring a shift in analytic capacity from regulation and performance, to quality improvement and transformation. The balance in priority given to research compared with implementation also needs to change.

This briefing identifies opportunities for local organisations and systems to make better use of health data, and recommends ways that national policy could promote the collaboration and greater use of analytics which underpin the LHS concept. We focus on lessons for the NHS – but many of the same actions could be taken across the wider health and care system.

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The main themes are summarised below.

NHS organisations and health systems can:

- **Assess capacity for analytics and support collaborative approaches to building analytical capacity across an STP or local health system** – for example, by reducing duplication through being transparent about methods, joining up training and development opportunities for the analytics and wider workforce, and considering shared analytical teams
- **Build analytical capability for transformation and improvement**, including how NHS organisations can become more intelligent customers for information and analysis – making use of wider networks and partners, for example, public health teams, academic health science networks, commissioning support units and academic teams
- **Build analytics requirements into local digital plans from the outset.** It would then become possible, from day one, to get information out of electronic health records or shared record platforms and into a form which can be used for improving care. Failure to do this risks analytical requirements being seen as an optional extra to be addressed in future.

National organisations should:

- **Recognise the importance of collaboration and getting clinical engagement** in order for local health care records and digital innovation hubs to support learning health systems
- **Act to increase the value of innovation in clinical careers**, driving long term culture change
- **Address national capacity for analytics**, including developing the skills and capacity of analysts already working in the NHS, as well as developing analytic skills among the clinical and managerial workforce
- **Demonstrate leadership for analytics in the NHS**, through recognising the importance of senior analytics roles and developing national analytics capacity and career pathways, and fostering a culture that expects information to be used to run effective organisations
- **Take a strategic approach to developing NHS data**, including investing in outcomes data collection and patient-reported outcome measures of adequate quality.

Introduction

The NHS Long Term Plan places digital developments at the heart of steps to improve health and care and deliver services in a sustainable way. A huge – but currently underdeveloped – benefit of digitising the delivery of care is using the accumulated data about care activities, resources and outcomes to improve services. Experience from both health care and other industries suggests that to get the benefit of adopting new technology, it is necessary to make use of data to transform services, not just to digitise current ways of working.

This briefing explains the concept of the '**learning health system**' (LHS), in which data and analytics are part of a continuous cycle with implementation and improvement. We consider the context in which analytics is currently undertaken in the NHS, outline the building blocks needed to develop learning health systems, and consider how the approach could be used by local health systems, and at a national level, in the NHS to make the most of health data for improving health care.

The briefing draws on a seminar held at the Nuffield Trust on learning health systems, and on evidence and experience from the UK and internationally (see appendix for further details).

What is a learning health system?

The LHS concept has developed over the last decade, as clinicians have identified new opportunities to use electronic health data to improve care as part of the ongoing delivery of care, rather than as separate research activity.

"The LHS focusses on approaches to capture data from clinical encounters and other health-related events, analyse the data to generate new knowledge, and then apply this knowledge to continuously inform and improve health decision making and practice."

Source: Nwaru BI, Friedman C, Halamka J and others (2017) 'Can learning health systems help organisations deliver personalised care?', ***BMC Med*** **2017 15: 177**

The main features of the LHS cycle (Figure 1) are:

- the 'performance to data' step, capturing what we know about current care and outcomes by analysing data from clinical encounters
- the 'data to knowledge' step, combining local knowledge with evidence from elsewhere, to understand quality of care and how it could be improved
- the 'knowledge to performance' step, turning this knowledge into action, which is undertaken by the learning community.

Arguably, all of these steps are already part of ongoing service improvement or research. But while there is a good deal of overlap with existing initiatives in the NHS, two things make the LHS concept different from either quality improvement or research. One is that the aim is to make use of data in this way on a large scale, and on a continuous basis, and the second is that a series of learning health communities are developed specifically to make improvements happen.

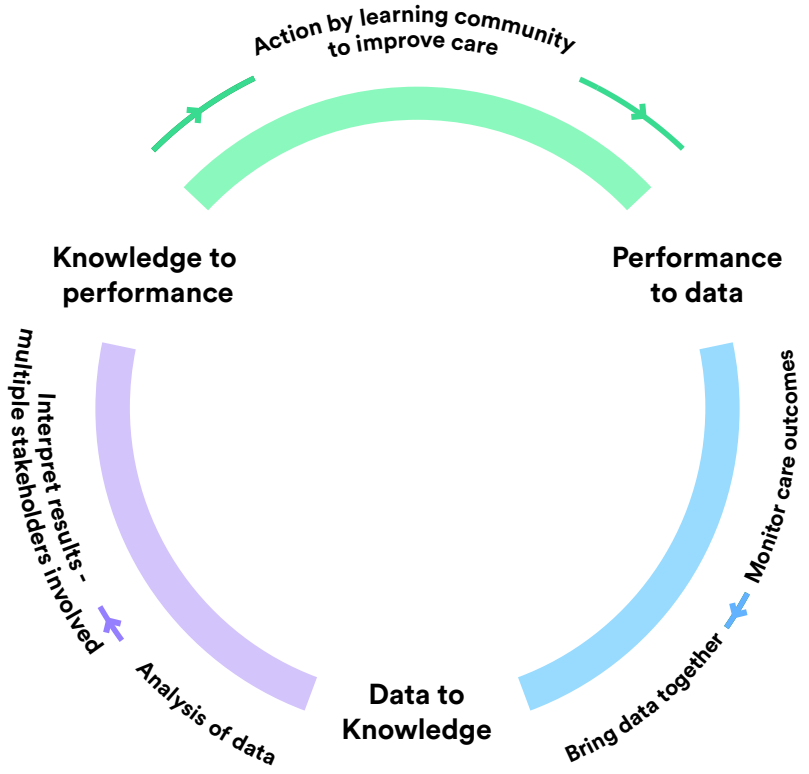

Figure 1: Learning health system cycle

Based on: Friedman CP, Rubin JC, Sullivan KJ. Toward an information infrastructure for global health improvement. Yearbook of Medical Informatics. 26: 16-23, 2017

Learning health communities

A **learning health community** takes on the responsibility for acting on the learning, not just creating new evidence. Proponents of LHSs have identified the key characteristics of learning health communities, which are: inclusivity to all; involving both the whole health care team and the patient; trusted; decentralised; and reciprocal, such that participants creating data also receive access to that data, and the tools to analyse it. The experience of organisations and health systems which have adopted this approach is that **collaboration** is an essential ingredient for a learning community to be effective in **improving care**.

These features of a learning health community can exist in many different contexts and organisational levels. Examples include communities organised around a **clinical specialty** or **treatment**, at a **provider organisation level**, and at a **health system level**.

Although the terminology of the LHS is fairly new in the UK, **some aspects of LHSs and communities** have already emerged here (see Box 1), although these are more focused on the data stage, and less on translating knowledge into action. It is hard to find examples where there is a continuous cycle of improvement driven by information, and where implementing improvements is part of usual ways of working.

A strong theme from the Nuffield Trust seminar was that there is already a lot going on in the NHS which could enable LHSs (as described further in this briefing), and that clinical teams, organisations and health systems could do much more right now to extend the use of data for learning and improvement. But implementing the LHS concept in the NHS would be a significant challenge to how the NHS currently uses data and supports analytics, requiring a shift in analytic capacity from regulation and performance, to quality improvement and transformation.

Box 1: Learning health systems – examples emerging in the NHS

The **RCGP surveillance unit** works with a network of practices across England. The network was originally set up for surveillance of communicable and infectious diseases, but over time has developed a wider programme of research and quality improvement activities, **involving practices as active participants**, not just providers of data. In Scotland, development of a **LHS for asthma** is under way.

Within the acute hospital environment, the Royal Free Hospital has established clinically led multi-professional teams (clinical practice groups, or CPGs) following the **Intermountain** model. Evidence-based pathways are implemented within the electronic health record workflow, to support clinical teams with following the pathway and ensure the right data is collected to monitor outcomes – and drive improvements in care.

A number of health systems have developed shared care records which could support analysis as well as direct care, or enable anonymised data to be used for service improvement and research. **Connected Health Cities** has linked de-identified data from urgent care services across the Yorkshire and Humber region, to monitor patterns of service use and outcomes. This will allow clinicians, commissioners, NHS England and researchers to monitor the impact of interventions to reduce demand on A&E.

Nationally, the development of the National Early Warning Score (NEWS) for identifying patients at risk of deterioration, exhibits several features of LHSs. Physiological **observation data** are increasingly collected digitally, enabling automated alerts for patients with a high or deteriorating score. Monitoring of sepsis, and **suspected sepsis cases**, over time and across hospitals has been implemented. Clinical engagement, supported locally by patient safety collaboratives, has been key to **implementing NEWS** – the network of NEWS champions originally engaged to support the roll-out of NEWS in acute trusts has evolved to form a learning community for improving care for acutely ill patients.

Further use cases of LHSs can be found **here**.

Culture and collaboration

Even though aspects of LHSs have emerged in the NHS, there are clear cultural challenges to developing the LHS model at scale.

Research versus innovation and implementation

One cultural barrier is the higher status attributed to research than to innovation or implementation. Academic research is often competitive, hierarchical and elitist – characteristics which are at odds with the collaborative, open approach required for a learning health community. Clinicians are rewarded in career pathways for undertaking research, but there is not the same requirement or status associated with implementing improvements.

We heard from seminar participants that the experience from implementing learning communities is that clinicians engage because they feel they can make a difference to improving care. In the context of pressurised operational and clinical workloads in the NHS, clinicians can find it hard to spend time on improvement activities that are not valued by the system.

This is a significant issue, because there is a **growing body of research** which shows just how difficult implementing change can be. What's more, the institutions within the NHS are geared towards supporting research, rather than innovation. The UK has a top-down approach to implementing evidence,

for example, evidence-based guidance and approval for new treatments to receive NHS funding is controlled by the National Institute for Health and Care Excellence (NICE).

Lessons for policy and the NHS

There is a need to increase the value of innovation in clinical careers, driving long-term culture change. Potential actions could include:

- Reviewing career 'gateways' to ensure that innovation and improvement projects are given equal value to research. This could build on current revalidation requirements for clinicians to participate in clinical audit and improvement activities
- Giving greater focus to improvement and innovation in clinical excellence/ merit awards
- Expanding programmes that pay for clinical time to work on practical uptake (i.e., effectively aligning National Institute for Health Research (NIHR) and NHS innovation efforts). For example, Innovation Clinical Fellow programmes should match the scale and ambition of Academic Clinical Fellow programmes.

Analytical capacity and capability in the workforce

A shift to a LHS in which clinicians are routinely using data for improvement would require significant change to how NHS information and analysis functions are currently organised. The current reality is that analytics teams are usually managed as corporate functions, with a primary focus on analysis for regulation and performance, rather than quality improvement and transformation.

There are **cultural barriers** between clinical and informatics specialists. Our seminar participants reflected that there is a deeply held view in the NHS that analytical and informatics work is low status, and belongs in the 'back office', rather than being critical for transformation and quality improvement. NHS IT and analytical staff are part of the clerical and administrative workforce rather than members of scientific grades such as lab technicians, limiting their training opportunities, salaries and collaborative opportunities.

In combination, these factors have contributed to a lack of specialist **analytical capacity in the NHS**. So while **analytics methods** already used for research and evaluation of health care could be applied in LHSs in theory, there is scarce capacity to do this in either the NHS or research communities. For LHSs, this is a significant challenge as methods used for robust analysis of large health datasets are not routinely undertaken in the NHS.

There is also a broader challenge to develop and strengthen digital skills in the NHS, including developing informatics skills among clinicians and managers, as well as quality improvement and clinical understanding among analysts. The 'Building the digital ready workforce' programme (see below) recognises and is working to address this challenge.

A major barrier is that the current pay structure in the NHS does not value technical expertise, which means the NHS finds it difficult to compete with other sectors or commercial analytics organisations. Unfortunately, a number of significant national NHS analytics developments are outsourced, contributing to a cycle whereby skills and capacity in the NHS remain underdeveloped relative to third-party organisations.

A further impact of outsourcing is lack of transparency of methods – local organisations can find it difficult to replicate methods used in national tools, reducing opportunities for learning and causing duplication of effort. It is notable that there is no national position with professional responsibility for NHS analytics – the recent integration between NHS England and NHS Improvement has removed key posts such as Chief Analyst. Consequently, there is no-one who can represent best practice analyst standards at the top team in the national organisations and this then sends messages out locally.

Despite this, a number of local health communities have developed solutions in response to these challenges. A huge amount of analytical effort in the NHS is duplicated, with multiple organisations producing routine reporting of the same performance measures. Some areas are tackling this by bringing together capacity across commissioners and providers, where local relationships allow this. Joint working between public health and social care analysts, based in local authorities, and NHS analysts would also strengthen skills and capacity.

The current organisation of analytics support means that there is often competition between analytics teams rather than collaboration. A number of analytics hubs are developing within the NHS family, for example in **academic health science networks**, **commissioning support units** and shared **informatics services**. Hubs could provide the scale to develop and maintain specialist skills, alongside access to integrated datasets. Professional networks for NHS analysts, such as the Association of Professional Healthcare Analysts (see Box 2), are becoming established to address current barriers and provide a stronger voice for NHS analysts, as well as training and development opportunities.

Box 2: Initiatives for building analytical capacity

The **'Building the digital ready workforce'** programme is comprised of a series of workstreams focusing on leadership and culture, professionalisation, the Digital Academy (which provides specialist training to chief information officers and chief clinical information officers), and digital literacy for NHS staff. The programme also funds and supports the Faculty of Clinical Informatics, the professional body for health and social care professionals working in informatics. It is also working on campaigns to attract people with digital skills to the NHS.

The **Skills Framework for the Information Age** (SFIA) is a model for describing and managing competencies for information technology professionals for the 21st century, and is intended to help match the skills of the workforce to the needs of the business. It is not specific to the health sector, but provides a framework to articulate the skills and the level of responsibility needed for organisations using digital in the 21st century.

The **Association of Professional Healthcare Analysts** (APHA) aims to raise the profile of healthcare analysts and provide a professional support network, ultimately achieving professional registration status for its members. The intention is to drive up the quality and applicability of robust analytics as an aid to evidence-based decision making in a modern health and care system. APHA is associated with the **Federation of Informatics Professionals**.

Lessons for policy and the NHS

National bodies should demonstrate leadership for analytics in the NHS, and 'walk the talk' in the way they commission and use analysis. This could include:

- promoting collaboration, learning and transparency by ensuring the methodology and tools developed centrally are published and accessible

- encouraging development of analytics capability in the NHS through ensuring there is effective professional leadership for analytics at senior levels in national NHS organisations, for example though appointing a Chief Analyst role, and through regional analytics roles supporting local service transformation

- developing internal analytical capacity for major analytics projects before outsourcing to third parties – this may require paying more competitive rates for analytical teams, but would come with lots of other benefits

- addressing the growing challenge of pay and reward for analytical and informatics roles, which are currently relatively under-valued within Agenda for Change.

Local NHS organisations and partnerships can also support the development of analytical capability. Actions could include:

- making openness and transparency in analytical methods the default approach, to promote shared learning and improve consistency between organisations

- including an expectation for continuous learning, engaging in professional networking organisations and collaboration within analysts' job descriptions, and providing time for this in jobs

- encouraging the use of MOOCs (massive open online courses), wikis and other knowledge-sharing tools.

Ethical issues and learning health systems

As LHSs have been implemented in the United States, a further set of **ethical concerns** have emerged about how patients are involved in situations where evidence is gathered at the point of usual care, rather than in a research setting.

On the one hand, if it is not clear which treatment is best, clinicians have a duty to monitor the impact of different treatments. This also has the benefit of widening the populations for which evidence is available, as most clinical trials are undertaken for a narrow group of patients. On the other hand, there are **concerns** about patient consent for different treatment options; how patient data is used for purposes beyond their usual care; ensuring that there are mechanisms for patients and communities to be involved; and transparency in the methods and findings from analysis. Research governance frameworks have developed to address these issues in a research context, but they don't currently apply in the same way for usual clinical care.

Pragmatic RCTs provide one route to widen participation in clinical trials, but the LHS can take this much further through routinely randomising treatment at the **point of care**, where evidence about the best treatment is lacking (referred to as 'clinical equipoise'). When there is genuine equipoise between two commonly used treatments, not doing a point of care trial to find out which has a better risk–benefit profile seems unethical. Pragmatic RCTs could enable clinically important questions to be answered quickly, based on studies carried out in routine care settings on a full range of participants.

Lessons for policy and the NHS

Research bodies need to respond to the growing opportunities for research using large routine datasets. Potential actions could include:

- the Health Research Authority (HRA) re-examining guidance on studies designed to answer questions that NICE has identified as important, considering the balance between population benefits and the risks to the individual patients recruited

- NIHR launching a themed call or new programme with accelerated decisions, designed to fund point of care trials to investigate

NICE-identified research recommendations, using routine data, in collaboration with HRA and NHS Digital to ensure rapid approvals from both bodies.

Building the infrastructure

In addition to the cultural factors which provide motivation and enable learning, several building blocks contribute to effective learning health systems which can operate at scale. The NHS is already investing in some of these building blocks, but there are some gaps – and also significant challenges in achieving current aspirations.

Robust data access and governance arrangements

The vast majority of people trust the NHS and most are happy with it using data, even for **secondary uses**. But some people have **concerns** about how their health data is used and who it is shared with. The NHS has struggled to develop governance arrangements which enable information to be used and shared for the benefit of individual patient care and research, while also meeting regulatory requirements and patient expectations. Missteps in the development of shared records have led to a **lack of public trust** in data sharing, and have also contributed to a high level of risk aversion among clinicians and data custodians.

In the context of a LHS which is aiming to link multiple sources of patient-level data, the task of effectively pseudonymising patient data becomes more challenging, because there are more data points about a person which could make them uniquely recognisable, even with no identifiers. Although technical solutions for reducing the risks of unintended disclosure exist as part of privacy enhancing technologies, they are not in widespread use in the NHS.

These challenges are recognised within new initiatives to extend the use of data and analytical methods in health research (see Box 3). Although these programmes differ in their focus and scope, they all include work to develop the governance and public engagement framework for managing and using data beyond direct patient care, as well as the data and technical capability required.

Box 3: Developing the infrastructure for LHSs in the NHS

Health Data Research UK (HDR UK) is a joint investment led by the Medical Research Council, working in partnership with academia, NHS, government, industry and charities. It aims to harness health and biomedical data for discovery research in the UK, and to develop and apply cutting-edge data science approaches in order to address the most pressing health research challenges facing the public.

The **Digital Innovation Hub** programme, which is part of the HDR UK infrastructure, is developing technology and methods to support the use of large data sets and analytical methods for applied health research, evaluation and innovation. The aim is to develop between three and five hubs in regions across the UK to connect health-related data for applied research and innovation, within a single interoperable, trusted and secure governance framework. This will enable accredited researchers, scientists and innovators to work together and safely and securely use data to harness scientific knowledge and emerging technologies at scale, across populations of 3–5 million people.

The NHS in England has established the **Local Health and Care Record** (LHCR) programme, which is intended to build on existing projects and create a set of national standards that all local health and care record initiatives across England will be required to follow. The first wave of LHCRs are in areas with pre-existing shared record programmes, which already have a track record in developing platforms for sharing and accessing data for analysis. It is anticipated that LHCRs will deliver **standardised approaches to the way data is stored**, to enable analysis of data across multiple areas. An important feature of LHCRs is that they involve local authorities and aim to support population health improvement – not just clinical services.

Lessons for policy and the NHS

There has been a lack of clarity about how to meet information governance requirements while also providing various stakeholders with access to linked data. This has created a significant barrier to evaluating the impact of service changes, including **new models of care**. The forthcoming Information Governance Framework should provide the clearer guidance that is needed across the NHS – so there is a consistent approach to data access, and safe havens with sufficient capacity to meet the needs of various stakeholders.

Locally, the strongest message from **health systems** which have successful linked data is that clinical ownership is key to this, along with active programmes for developing public trust.

Platforms for accessing data

The digital health data which a LHS would use is generated on multiple systems. A single hospital trust will have multiple, often dozens, of different clinical systems collecting data for specific purposes. Bringing this data together requires physical infrastructure for storing and processing data, as well as mechanisms for linking data, which may not share common patient identifiers. Providing analysts across multiple organisations with access to such linked data – or combining with **patient generated** data – adds further layers of complexity.

There are different ways in which data linkage and access can be achieved, and importantly for the development of LHSs, the solution used is interdependent with arrangements for data access and governance. For example, some solutions 'pull' selected data from different systems at the time it is needed for clinical care or analysis, while in others, data is routinely 'pushed' into a common data warehouse for storage. The push model generally requires stronger data governance arrangements (because the purposes of data access are less specific) and requires **greater public trust**, but is also necessary for analytical work at scale.

Lessons for policy and the NHS

The considerable investment through HDR UK, Digital Innovation Hubs and LHCRs is welcome and should have long-term impact. However, there is a need to build quickly on what can be done using existing infrastructure. The key to this is likely to be promoting the LHS ethos – of collaboration and iterative development. In particular:

- Infrastructure programmes need to consider the current NHS environment and the need for clinical ownership of data access and analytics – it is not clear that the current models for implementation of LHCRs, for example, will develop this

- There is a need to consider the workforce implications and how LHCRs can develop the capability to make use of linked data

- There is a need to build analytics requirements into local digital plans – so that getting information out of electronic health records and into a form which can be used for improving care is part of the plan from day one, and not seen as an optional extra to be addressed in the future.

High quality data

Electronic health records and the digital capture of data on observations, tests, treatment and outcomes will lead to an exponential increase in the amount of data potentially available for analysis. However, the existence of this data will not automatically translate into useful information and learning unless the data is of sufficiently high quality and in a form which can be readily analysed.

The NHS has a long history of collecting data routinely and using this for research – for example, Hospital Episode Statistics, which provide a structured data set covering hospital activity. Even with this structured data, there are challenges to data quality and completeness, and potential biases in what data is recorded, such that interpreting variations between organisations or trends over time demands careful scrutiny by experienced analysts of potential coding differences.

Primary care services in the UK have used electronic health records for many years, but some of this data is often unstructured free text; there is limited consistency between clinicians in how data is recorded (except in data required for performance payments); practices have limited analytical capacity; and there has not been a widespread culture of sharing data between practices for learning. While there are analytical solutions to these problems, we need to recognise that more data won't automatically translate into learning without incentives or investment to achieve this.

That said, the NHS already has a considerable programme of work to develop data standards (see Box 4).

Maintaining and developing standards is a continuous process – and there are ways to make the most of existing data. Where there is variation in data standards in use, mapping between different sources can enable data to be

analysed, without there being a single data source or standards. For example, this approach has been successfully applied across primary care sources in different countries.

In addition there are important gaps in data collected about patient outcomes. Patient reported outcome measures (PROMs) are widely used in research but are not part of most routine care. There are exceptions such as outcomes for psychological therapy, and joint replacement. There is growing interest in using PROMs at the individual patient level, as part of patient care. This can support shared decision making, inform clinical decisions and enable care to be tailored to individual needs. Routine use and collection of PROMs could play a critical part in enabling services to monitor outcomes, and drive improvements in care.

Box 4: Data standards in health and care

Improving data quality at source is critical, but not sufficient for learning health systems. Linking data across multiple sources requires the ability to know when two items of data are the same – either by using common data standards and codes, or from having a mapping to translate codes between different sources. The NHS data dictionary provides a strong starting point for this, in contrast to social care, where there are currently minimal data standards.

Many of the existing NHS standard dataset definitions need revision, because they are based around care activities and pathways which are changing. For example, care activity which historically has taken place in an outpatient appointment could happen through a virtual or online consultation, through advice provided directly from a specialist to a GP, and be delivered by a range of different clinical professionals, in a range of settings.

Responsibility for the standards for collecting and publishing health and social care data sits with **NHS Digital**. Leadership for standardising records for patient care, including **shared health and care records**, sits with the Professional Record Standards Body (**PRSB**), but implementation of the standards has not always taken place.

Learning health systems depend on high quality data being captured during the **care of the individual patient**, and so improving the implementation of **standards for data recording** and aligning health record standards with data standards will support the development of LHSs.

Lessons for policy and the NHS

To make the most of existing data and enable rapid use of new sources of digital data, the NHS needs to take a strategic approach to developing data. This includes:

- promoting ongoing work on data structures and definitions, and provide clear guidance for local organisations on interpreting and delivering the standard

- build standards into the development of new data collections, for example, through the procurement process

- addressing the current gap in routine collection of outcomes data, and specifically the dearth of PROMs – outcomes data is critical to completing the learning cycle, and enabling comparisons of quality of care.

Concluding remarks

Learning health systems aim to address the challenge of ensuring that the huge growth in digital health and care data can be used to improve care, to shorten the timeframe of improvement projects and ensure these are based on real-world data. There are excellent examples of UK organisations and networks who are moving on this journey already, but we have also identified ways in which national and local organisations could promote and accelerate the development of learning health systems.

A key question for the NHS is whether we have the right incentives in place to enable better use of health data for improvement at scale, both in terms of driving the right culture and developing the infrastructure. Currently there are too few external incentives for clinicians to engage in quality improvement – given the absence of outcomes measurement and the lower status of implementation compared to original research. And at the moment, NHS analytics functions are more focused on regulation and performance than they are on quality improvement and transformation.

An additional challenge, both locally and nationally, is that investment to develop the infrastructure needs to be made by different groups or

organisations from the learning health communities who would benefit. This mirrors the experience of local shared record programmes, which needed individual NHS organisations to invest financially and collaborate, for the benefit of system-wide infrastructure. While organisations are likely to benefit in time, the experience in the UK and elsewhere is that it can take a number of years for this to happen.

The LHS concept should prompt the NHS to look more closely at how we can improve the use of data, and promote collaboration rather than competition. We hope the recommendations in this briefing will provoke NHS organisations and systems to move forward with making better use of data, and also influence the shape of national policy and interventions, to ensure these consider the cultural shift which will be needed for more data to translate into improved care.

Acknowledgements

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Appendix: Seminar and literature review methodology

The seminar, held in January 2019, heard from academics working on LHSs. Professor Charles Friedman, University of Michigan, shared insights from LHSs in the United States, and Professor Jeremy Wyatt, Wessex Institute, discussed the tensions between innovation and evidence in a UK context. Participants included chief clinical information officers, policy makers, data analysts and representatives from academic health science networks and commissioning support units. The seminar discussion addressed the following questions:

- What are the quality improvement benefits to the NHS from developing learning systems?

- What skills, resources and infrastructure would be needed to enable NHS organisations to be true learning systems?

- What are the implications of this for national policy bodies in supporting the development of learning systems, and evaluation and regulatory approaches?

Additional evidence was obtained from a scoping literature review on LHSs. The literature review was based on a PubMed search for papers in English from the last five years, including the terms 'Learning' and 'Healthcare' / 'Health' / 'Health Care' and 'System(s)'. Titles and abstracts were screened to identify relevant papers. Additional references and examples were included where these were mentioned by participants, or from previous or related projects at the Nuffield Trust. The evidence from the literature was used to identify additional themes not covered in detail at the seminar (such as ethical issues), and to provide sources or examples relevant to the themes raised during the seminar discussion.

Seminar participants

Participant	Job title and institution
Dr Minal Bakhai	Lead for Primary Care Digital Transformation Group, NHS England
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Sophie Castle-Clarke	Senior Fellow, Nuffield Trust
Prof Brendan Delaney	Chair in Medical Informatics, Imperial College London
Nigel Edwards	Chief Executive, Nuffield Trust
Prof Charles Friedman	Professor, University of Michigan
Dr Tom Foley	Senior Clinical Lead for Data, NHS Digital
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