THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

The Promise of Population Health Management in England: From Theory to Implementation

Caitlin Main, Madeleine Haig and Panos Kanavos ▪ October 2022

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LSE Consulting
LSE Enterprise Ltd
London School of Economics and Political Science

Houghton Street
London, WC2A 2AE

(T) +44 (0)20 7106 1198
(E) consulting@lse.ac.uk
(W) lse.ac.uk/consultancy

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Disclaimer

The topic of Population Health Management in England highly topical and is constantly evolving, thus a cut-off for sources to be used in this report was introduced. Sources published after September 1st 2022, were not used in the development of this report.

About the authors

Caitlin Main is a Research Associate at the Medical Technology Research Group of LSE Health, London School of Economics (LSE).

Madeleine Haig is a Research Associate at the Medical Technology Research Group of LSE Health, London School of Economics (LSE).

Dr Panos Kanavos is Associate Professor in International Health Policy in the Department of Health Policy, Deputy Director of LSE Health and Program Director of the Medical Technology Research Group (MTRG), London School of Economics (LSE).

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Abbreviations

AAC	Accelerated Access Collaborative
AHSN	Academic Health Science Network
AI	Artificial Intelligence
ARRS	Additional Roles Reimbursement Scheme
CCG	Clinical Commissioning Group
COVID-19	Disease caused by SARS-CoV2
DiiS	Dorset insights and interventions Service
DTAC	Digital Technology Assessment Criteria
EHR	Electronic Health Record
GDPR	General Data Protection Regulation
GP	General Practitioner
HCP	Health Care Professional
IC	Integrated Care
ICS	Integrated Care System (NHS)
IG	Information Governance
JSNA	Joint Strategic Needs Assessment
LHCR	Local Health and Care Record
LSE	London School of Economics
MeSH	Medical Subject Headings
MTRG	Medical Technology Research Group (LSE)
NCD	Non-Communicable Disease
NHS	National Health Service (UK)
NHSd	NHS digital
NHSE/I	NHS England and NHS Improvement
NICE	National Institute for Health & Care Excellence
PCN	Primary Care Network
PH	Population Health
PHM	Population Health Management
QOF	Quality and Outcomes Framework
SDGs	Sustainable Development Goals
STPs	Sustainability and Transformation Partnerships
UK	United Kingdom
WHO	World Health Organisation

EXECUTIVE SUMMARY

I. Background and problem statement

Health care systems are increasingly under pressure to serve ageing populations and tackle the epidemiological shift of increasing non-communicable (chronic) diseases (NCDs)[1]. NCDs, such as diabetes and heart disease, and their associated complications account for 71% of all deaths globally and are one of the leading causes of rising healthcare expenditure[2,3]. The global traditional care model is generally siloed, reactive, and focused on acute care rather than prevention; and is not adapting sufficiently to provide economic and efficient care alongside these significant worldwide changes. Population Health Management (PHM) is an approach that aims to leverage big data capabilities to analyse population needs and provide high-impact care to those who will benefit most, specifically those with chronic diseases.

The NHS in England is currently transitioning towards PHM, as laid out in the NHS Five Year Forward View (2014), the NHS Long Term Plan (2019) and the NHS 2022/23 Priorities (2021). In these policy documents, a number of performance- and infrastructure-based targets were created to support the implementation of PHM. These targets are thought to be particularly ambitious, and, as of yet, no supporting evidence has been published to indicate that NHS England is on the path to success.

II. Objectives and methods

The objectives of this study are to firstly to gain a greater understanding of the nuances of population health (PH) and PHM; and secondly, to understand the current state of PHM implementation in the English context, as well as the enablers, challenges and ways forward. A scoping review, supplemented by six one-hour interviews with key English experts and PHM stakeholders, was used to inform this report.

An analytical framework was developed utilizing PHM's four critical building blocks: infrastructure, insights, interventions and impacts (see Table 1)[4–7] . The authors built on these four critical building blocks and identified the key components for successful PHM through identifying the key objectives of PH and PHM. The framework was used to analyse the state of PHM within the English context.

III. Population health and population health management

PH has been defined as “the health outcomes of a group of individuals, including the distribution of such outcomes within the group”[8]. It has since evolved into a methodology that aims to improve the physical and mental health outcomes of the entire population, as well as reduce health inequalities between members of the population. PH brings together an understanding of population needs through big data, patient engagement and health and care delivery based on three principles, prioritising: outcomes over volume of care, prevention (both primary and secondary) over treatment, and patient-centred care over episodic care[6].

PHM uses data-driven planning and delivery of proactive care to achieve maximum impact and improve PH[9]. It aims to identify local ‘at risk’ cohorts through risk stratification and population segmentation to allow the design and implementation of targeted interventions focussing on the redesign of clinical pathways to improve patient care and support for those with ongoing conditions[9]. PHM can be seen as a continuous cycle of intelligence-led care design. It is one of many tools utilizing data to help guide the planning and delivery of care with maximum impact[10]. Improvements in data analytics, machine learning, and digital technologies can make PHM a reality via effective risk identification and patient population stratification, as well as improving the speed and accuracy of diagnosis and designing personalized treatment plans[11].

IV. NHS policies for the movement towards population health management

Over the best part of a decade, the NHS has been slowly moving from their traditional competitive model with top-down management towards a focus on collaboration and a bottom-up approach. NHS England's 2014 5-year Forward View focused on improving prevention efforts and health services for the population by altering traditional boundaries between primary care, secondary care, and community services[1]. In 2017, PH-focused Sustainable Transformation Partnerships (STPs) were introduced to bring together NHS providers, commissioners, local authorities, and other partners and funders to plan services based on the long-term needs of their local populations[12]. Evolving from STPs, Integrated Care Systems (ICSs) are a move towards improved PHM, allowing for closer collaboration between stakeholders, as well as greater autonomy and responsibility for resources[13]. Additionally, networks of GP practices covering approximately 30,000 to 50,000 patients, called Primary Care Networks (PCNs), have been created[14]. The provision of integrated care will occur around PCN boundaries, and they will have a specific role in addressing the wider determinants of health, as well as the provision of anticipatory and personalised care[14]. The most recent development has been the passing of the Health and Care Act in July 2022. ICSs now have statutory footing and are taking over legal responsibilities previously held by Clinical Commissioning Groups (CCGs). Organisations are also now mandated to join provider collaboratives, which were previously only encouraged.

V. Building blocks of population health management

While PHM is an iterative process that can take many years to show impact and lacks a specific, single globally accepted 'rulebook', several distinct building blocks enable health and care systems to adopt a PHM approach effectively (Table 1)[15]. The first building block is *infrastructure* and relates to integrated data architecture, including digitised health & care providers, effective regulation, sufficient funding and resources, and health and care systems that promote collaboration. The second relates to *insights* and, specifically, the ability to identify patients in need of, and most likely to respond to, intervention. The third building block is *interventions*, addressing single or multiple parts of the patient journey to support one of the four disease management pillars: behavioural change, coaching, nutrition counselling and peer support. The final building block is *impacts*; the ability to regularly monitor interventions, track risk and predict outcomes enables the provision of optimal and value-based solutions as well as risk-sharing among stakeholders.

Table 1. Critical building blocks for the implementation and practice of population health management

Critical building block	Key components
Infrastructure	• Integrated care systems and infrastructure supporting provider collaboration • Digital maturity and data infrastructure • Funding and resources • Regulation • Leadership, culture and relationships
Insights	• Understanding population needs and risk stratification • Redesign of clinical pathways
Interventions	• Patient empowerment and activation • Anticipatory care • Health inequalities • Incentives alignment
Impacts	• Impact analysis • Clinical health improvements and quality of care • Economic efficiency

Source: The authors.

The NHS has set out a clear blueprint for its movement towards PHM, including several ambitious goals relating to digital infrastructure and health inequalities. However, progress towards these goals is difficult to track due to the NHS' siloed nature and bottom-up implementation. A number of gaps in and challenges to PHM implementation are identified, specifically (a) *technical*, including data interoperability, inequality measurements, incentives, collaboration, and limited digital and analytical skills available within the NHS; (b) *mindset*, including proactive vs reactive care and political mindset; (c) *regulatory*, comprising the speed of innovation and unintended consequences of technologies. Additionally, several enablers of PHM have been identified such as (a) communication, both within the system and to the public; (b) the ethos of those working within the NHS (c) digital transformation, including digital infrastructure and innovation; and lastly (d) the unitary system of the NHS allowing shared information and learning between systems.

I. Policy recommendations

England is currently at the beginning of a long journey of transformation in its health care system. Although COVID-19 has created many difficulties for the NHS, it has also acted as a catalyst for the introduction and uptake of new care models, assisting in the transition towards PHM. Due to the size and nature of the NHS, moving the unitary system, consisting of thousands of GP surgeries and hospitals, will take considerable time and effort, and cannot be completed overnight. The following constitute meaningful priorities:

Investment in infrastructure

Improved data infrastructure at both national and ICS levels is needed and should ensure a high degree of data security, provenance, privacy and interoperability. The current conventional method involves data warehousing at the ICS level, but as PH datasets grow, this approach increases privacy and security concerns. By utilizing the latest advancements in digital technology, such as federated data platforms, PH data infrastructure can reliably handle the rapidly growing quantity of information collected securely and efficiently. New technologies (e.g. Machine Learning) will facilitate a greater understanding of population needs, thus promoting the provision of more efficient care. Finally, there are currently not enough data analysts to facilitate data-driven care and enable value to be gained from the significant amount of data the NHS has collected. Moving forward, the NHS may want to consider:

a. Implementing policies to regulate the minimum acceptable privacy and security standards for data collection, storage, and analysis—specifically regarding data aggregation and analysis for PHM. These policies will need continuous monitoring and adaptation in line with rapid technological advancements;
b. Generating peer-reviewed literature around the application of digital innovations, such as federated machine learning and cryptography, for managing PH data;
c. Investing in the future generation of data scientists as well as up-skilling those already working within the NHS; and
d. Increasing investment into machine learning technologies and their potential impact (i.e. their ability to reduce existing health inequalities).

Transparency, communication and understanding

Improvements in transparency, communication and understanding have the potential to improve implementation efforts. With England's bottom-up approach to PHM implementation, ICSs have limited learning from each other. In order to improve efficiency and facilitate a smooth transition towards PHM, 'best practice' learning between ICSs should be stimulated and supported by NHS England. This is already taking shape through the Future NHS platform, allowing those from different ICSs to communicate and discuss issues together. Additionally, consistent research, both within the NHS and by outside organisations, into the impacts of new care models, interventions and digital technologies will facilitate evidence-based decision-making and the creation of a solid evidence base and understanding which can be utilized to push forward the PHM agenda. Lastly, in order to create and maintain support from the public and policy-makers regarding the movement towards PHM, health system leaders must improve transparency and communication surrounding

data sharing policies, as well as what PHM is, its current implementation and its potential to positively impact NHS Moving forward, the NHS may want to consider:

a. Conducting workshops with specific teams (i.e. digital transformation teams) from different ICSs, specifically those at varying levels of PHM maturation, where past and current challenges will be discussed and analysed;
b. Enabling the generation of peer-reviewed literature showcasing the impact of PH interventions and new care models on economic efficiency, patient experience, population outcomes and reductions in health inequalities;
c. Introducing regular communications to and with NHS workers regarding the current changes and their aims, to showcase the potential that moving to this model of service delivery can have on their practice and workload; and
d. Focusing on increasing public awareness and understanding of current and changing data-sharing policies, in terms of their risks and benefits to individual health and to the health of the nation.

<u>Evidence generation, appropriate metrics and relevant skills</u>

Long-term health policy viability is currently limited by the mindset that healthcare is a cost as opposed to an investment. Relevant and appropriate metrics need to be developed in that context. Performance metrics currently used by politicians to display health-system performance may, at times, be acting as disincentives for the improvement of care; for example, the 4-hour accident and emergency wait, which was brought in over 20 years ago is no longer as relevant. These metrics are now pitching different parts of the system against each other in the race to achieve the 'desired' result. Additionally, established policies and practices may need to undergo review and refinement in order to capture essential information in a meaningful way; for example, according to the Quality and Outcomes Framework (QOF) financial incentive program, GPs are paid to contact patients in their community about their health needs. If patients cannot be reached after three attempts, they are put on an exemption list whereby GP practises will not be penalised for no patient response. However, these 'hard to reach' patients are often those that require more support, as they traditionally do not seek support from health or social care as a result of systemic societal issues. Finally, data analysts are now fundamental members of ICSs, however, they often do not have experience working within the health sector and, thus, lack an understanding of the health system and patients at large. Moving forward, the NHS may want to consider:

a. Linking ICS datasets with key economic metrics to facilitate evidence creation of healthy populations' impact on the economy.
b. Examining currently used performance metrics for their relevance to today's health system and replace with alternate system-wide options.
c. Re-working or refining existing policies to suit key health system objectives and PH better.
d. Enabling health sector experience for data analysts working with ICSs to be better equipped to query big datasets and understand health system and patient needs.

1. Introduction

1.1 Background

Health care systems are increasingly under pressure to serve ageing populations and tackle the epidemiological shift of increasing non-communicable (chronic) diseases (NCDs)[2]. NCDs, such as diabetes, heart disease, and chronic obstructive pulmonary disease, and their associated complications account for 71% of all deaths globally and are one of the leading causes of rising healthcare expenditure[2,3]. As a result, NCDs are the subject of intense scrutiny by most healthcare decision-makers and are captured in the Sustainable Development Goals (SDGs)[a].

The rise in NCDs is partly explained by social determinants of health and associated modifiable behaviours such as smoking, excessive sugar intake, and alcohol consumption. Within the United Kingdom (UK), approximately 40% of the adult population have at least one chronic condition[16], the management of which accounts for roughly 70% of total NHS spending[1]. The traditional care model throughout the world is reactive and focused on acute care rather than prevention. This, accompanied by commonplace specialist delivery of healthcare, results in inadequate prevention and an inability to see the holistic needs of patients, resulting in limited support for those with chronic conditions. These diseases place a significant strain on health systems as chronic disease management is complex and requires holistic, patient-centric and – frequently – daily interventions. Digital technologies have been proven to improve health outcomes in various chronic disease areas, including cardiovascular disease and diabetes[17]. Yet, globally, there are few examples of the successful incorporation of such interventions into public healthcare systems[18].

Ageing populations have a profound impact on healthcare costs[19]. This, accompanied by the potential for a decline in the proportion of working-age population, means that systems with pooled resources may be supporting a population with a large older cohort, more susceptible to needing healthcare while contributing proportionally less to the health system's financial resources[6]. This phenomenon coexists with other issues to address, such as wasteful spending on care delivery, deepening health inequalities, staffing shortages, long waiting lists and fragmentation in care delivery, particularly in the context of inadequate integrated care coordination and efforts[20] . These disruptive characteristics all contribute to the likelihood of health systems delivering ineffective and inefficient care[6].

To address these issues, countries need to focus on strategic shifts within their healthcare systems, notably by understanding the needs of patients and the population at large. In the United States, clinical care has been found to only be associated with 20% of patient outcomes, but 88% of the spend[21]. Interventions impacting other determinants of outcomes (e.g., behavioural aspects and social determinants of health) are critical to improving the spend-outcome relationship. Health systems need to review resource allocation and pursue new provision models to achieve closer synergy between supply and demand, including collaborations between providers and other stakeholders. Health systems should also be held accountable for patient and population outcomes, shifting from cost-based payment systems to outcomes-based and, thus, value-based healthcare. Value-based healthcare allows providers to be paid based on patient outcomes in contrast to the number of healthcare services provided; and results in lower costs, better cost control for payers, better patient outcomes and improved patient satisfaction[6,22].

COVID-19 exposed overlooked weaknesses and highlighted key strengths within health systems throughout the world, and has further demonstrated the need for a population health approach and the further use of technology within healthcare provision. Though 2021 saw the largest vaccination campaign in history[23], the pandemic still affected the most vulnerable individuals the hardest—specifically the poor and those with chronic

[a] Sustainable Development Goal (SDG) Target 3.4 aims by 2030, to "reduce by one third premature mortality from NCDs".

conditions—both in terms of financial hardship and an increase in already significant health inequalities[24]. It also stimulated slow moving changes within the health system, with its rapid spread forcing an immediate shift to anticipatory care, as well as the use of digital technologies. For example, despite the availability of telehealth technology for a number of years, COVID acted as a catalyst for its use through the removal of reimbursement barriers previously hindering its widescale use[25].

1.2 Key terms

1.2.1 Population health and public health

Population health (PH) and public health are terms that are often confused. The critical difference between PH and public health is that public health purely focuses on prevention and remaining healthy, whereas PH concentrates on providing high-impact care for populations that will benefit most, be it preventative measures or treatment.

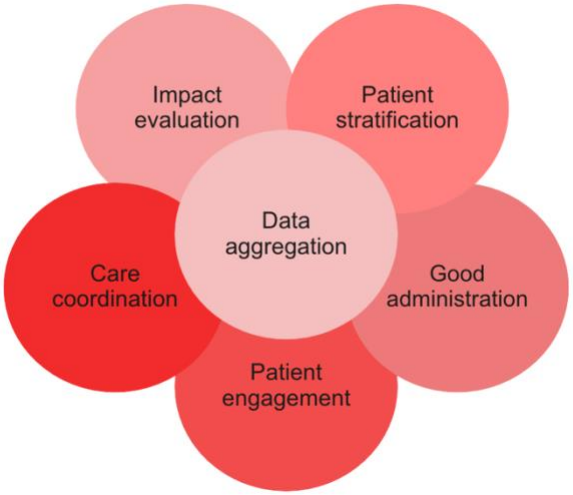
Population health	***Public health***
There is no single definition of PH. It was first coined in 2003, being described as "the health outcomes of a group of individuals, including the distribution of such outcomes within the group" [8]. It has since evolved into a methodology that aims to improve the physical and mental health outcomes of the entire population as well as reduce health inequalities between members of the population. PH brings together an understanding of population needs through big data, patient engagement and health and care delivery based on three principles, prioritising: outcomes over volume of care, prevention (both primary and secondary) over treatment, and patient-centred care over episodic care [6].	The World Health Organisation (WHO) defines public health as "the art and science of preventing disease, prolonging life and promoting health through the organised efforts of society" [70]. Public health efforts aim to target disease prevention through a combination of programmes and policies. Public health aims to ensure that the environment in which people live allows them to remain healthy through a combination of programmes and policies. Some examples of public health interventions include the banning of smoking indoors and immunisation campaigns.

1.2.2 Population health and its key components

The overall aim of PH is to improve the physical and mental health of a population, as well as reduce health inequalities and promote healthy living[10]. PH is increasingly relevant for today's health and care systems and is now seen as a cornerstone of the 'Quintuple aim of healthcare' which focuses on improving the health of the population, enhancing the experience of care, reducing/optimizing the overall costs of care, reducing health and care inequalities and ensuring staff and carer wellbeing[26,27]. The quintuple aim is updated from the 'Triple aim', which aimed to provide efficient, economical and effective care in health systems[28]. The addition of the focus on staff and carer wellbeing is a recognition of increasing demands on staff and increased risk of staff burnout with escalating staff shortages[6].

For PH to function effectively, six components are critical, notably (a) data aggregation; (b) patient stratification, in terms of identifying the needs of different patient groups; (c) care coordination, for all patients within an indication and for patients with multiple conditions; (d) patient engagement, whereby patients are emboldened to take control of their own health; (e) impact evaluation, through a focus on data analytics to showcase benefit of new care models and interventions; and (f) good administration (Figure 1)[6].

Figure 1: Key components of population health

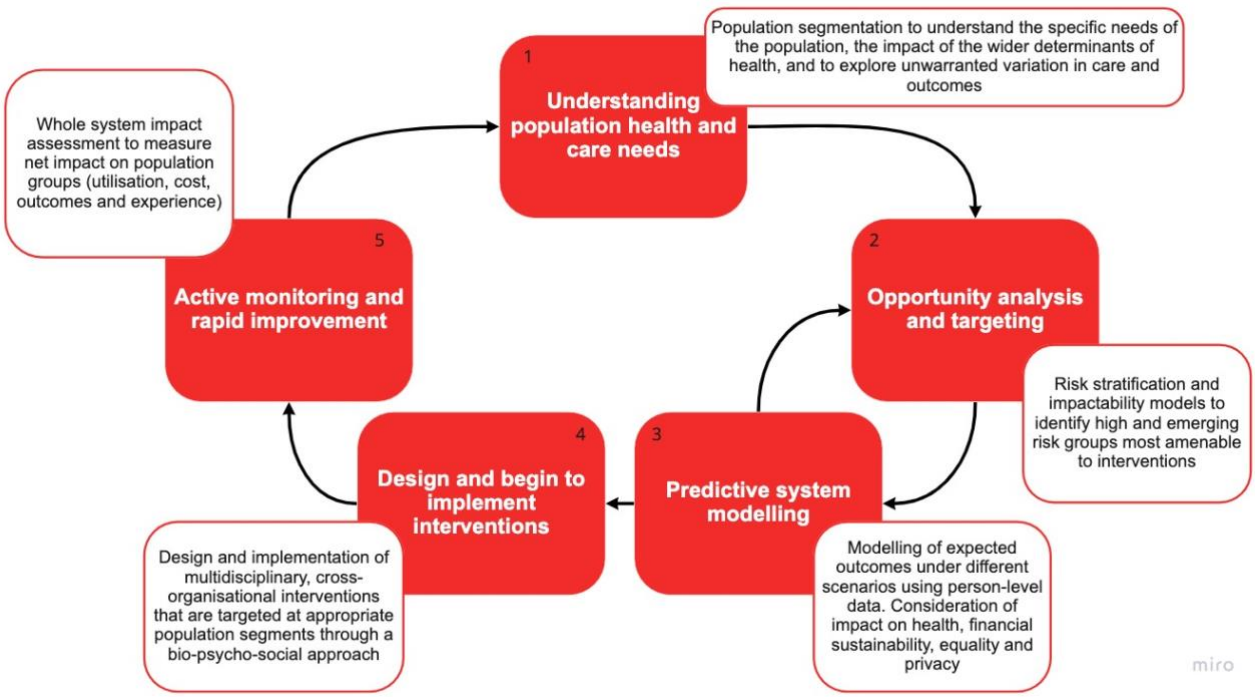


Source: Adapted from Kamphuis et al (2021)[6]

1.2.3 Population health management

Population health management (PHM) uses data-driven planning and delivery of proactive care to achieve maximum impact and improve PH[9]. It aims to identify local 'at risk' cohorts through risk stratification and population segmentation, to allow the design and implementation of targeted interventions focussing on the redesign of clinical pathways to improve patient care and support for those with ongoing conditions[5]. PHM can be seen as a continuous cycle of intelligence-led care design (see Figure 2).

Figure 2: The ongoing learning cycle of intelligence-led care design



Source: Adapted from NHS England and Improvement (2019)[7]

PHM is one of many methodologies utilising data to help guide planning and delivery of care with maximum impact[27]. Improvements in data analytics, machine learning, and digital technologies can make PHM a reality via effective risk identification and patient population stratification, as well as improving the speed and accuracy of diagnosis and designing personalised treatment plans[4]. However, these technologies can only be utilised to their highest potential with rigorous data infrastructure and interoperability standards in place.

While PHM is an iterative process that can take many years to show impact and lacks a specific, single globally accepted 'rulebook', several distinct building blocks enable health and care systems to adopt a PHM approach effectively[4,5]. The first building block is *infrastructure* and relates to integrated data architecture, including digitised health & care providers, as well as health and care systems which promote collaboration. The second is *insights* and, specifically, the ability to identify patients in need of, and most likely to respond to, intervention. The third building block is *interventions*, addressing single or multiple parts of the patient journey to support key health system objectives and/or one of the four disease management pillars: behavioural change, coaching, nutrition counselling and peer support. The final building block is *impacts*, the ability to regularly monitor interventions, track risk and predict outcomes enables the provision of optimal and value-based solutions as well as risk-sharing among stakeholders.

Alongside these building blocks are a set of four key drivers for PHM required to bring together big data, patient engagement, and healthcare delivery[6].

1. **Behavioural change**, from the point of view of both healthcare providers and patients, with a shift in focus from reactive to proactive care and patient activation measures delivered in a tailored manner using an array of analytics, technology and communication tools.
2. **Proactive identification and monitoring of high-risk patients** alongside equitable access to evidence-based medicine, both in terms of prevention and treatment, and the improvement of all individuals' function and wellbeing.
3. **Realignment of funding flows and incentives** to encourage staff to work differently across care settings, underpinned by an appropriate outcomes framework.
4. **Regular monitoring of interventions**, as well as frequent reflection and review by all stakeholders to increase impact and outcomes.

1.3 Objectives and data informing this report

Within England, there is a significant shift in attitudes towards PHM. In the 2019 NHS Long Term Plan and several NHS England policy papers since, a number of performance- and infrastructure-based targets have been created to support the implementation of PHM[29–31]. These targets are ambitious, and, as of yet, no supporting evidence has been published to indicate that NHS England is on the path to success. Consequently, this paper chronicles the gradual shift towards PHM, the challenges it poses and the opportunities it offers the English NHS and its patients. Specifically, the key objectives are: first, to understand the nuances of PH and how PHM can contribute to achieving key health policy objectives of the NHS; and, second, to discuss the current state of PHM implementation in England with careful consideration of enabling factors and challenges, as well as ways of addressing them.

1.3.1 Analytical framework

This report is based on primary and secondary research. A scoping review capturing the period from 2014 to 2022, supplemented by six one-hour semi-structured interviews with key English PHM stakeholders, was used to inform the report's evidence base. Both peer-reviewed and grey literature were included, mainly consisting of governmental, non-governmental and commercial reports. The semi-structured interviews focused on the challenges and potential ways the PHM implementation agenda can be moved forward (see Appendix III. Interview guide for more information).

An analytical framework was developed utilising the four critical building blocks of PHM: infrastructure, insights, interventions and impacts (see Table 1)[4–7]. We built on these four critical success factors through the identification of the key components for successful PHM according to the fundamental objectives of PH and PHM, as displayed in Sections 1.2.2 and 1.2.3. The framework was used to analyse the state of PHM within the English context.

Table 1: Critical building blocks for the implementation and practice of population health management

Critical building block	Key components
Infrastructure	• Integrated care systems and infrastructure supporting provider collaboration • Digital maturity and data infrastructure • Funding and resources • Regulation • Leadership, culture and relationships
Insights	• Understanding population needs and risk stratification • Redesign of clinical pathways
Interventions	• Patient empowerment and activation • Anticipatory care • Health inequalities • Incentives alignment
Impacts	• Impact analysis • Clinical health improvements and quality of care • Economic efficiency

Source: The authors.

The infrastructure building block includes key components of (a) integrated care systems, systems introduced in recent NHS reforms for collaboration; (b) digital maturity and data infrastructure (e.g. data interoperability and digital systems); (c) funding and resources, funding specifically aimed at the implementation of PHM e.g. improving data infrastructure and analytical capabilities, as well as new methods of funding from NHS commissioners; (d) regulation (e.g. efficient regulation and evaluation of digital technologies); and (e) strong leadership, culture and relationships enabling changes within the system. The insights building block includes (a) understanding population need and risk stratification; (b) redesign of clinical pathways, i.e. transformation of service delivery to improve quality of care. Interventions include (a) patient empowerment and activation, i.e. interventions currently used within the NHS to empower patients with their healthcare; (b) anticipatory care, the interventions in place maintaining health rather than treating sickness; (c) health inequalities, interventions specifically targeting a reduction in socioeconomic health inequalities; (d) incentives alignment, such as provider payment incentives. Impacts include (a) impact analysis, i.e. the analysis of the effects of implemented interventions; (b) clinical health improvements and quality of care; (c) economic efficiency, such as funding saved from PHM efforts.

Section 2 explores PHM in England with regards to infrastructure, insights, interventions, and impacts. Section 3 discusses challenges and enabling factors for England in implementing PHM; finally, Section 4 draws the main conclusions and explores policy options.

2. The current state of population health management in England

2.1 Key developments relating to population health and population health management in England

Over the last decade, England has strongly prioritised both digitisation and patient-centred integrated care. After a failed attempt at top-down digitisation of NHS England through the National Programme for IT, the NHS has adopted a cautious approach to digitisation with recent emphasis on the digitisation of secondary care and data sharing[32,33]. Since the COVID-19 pandemic, England, like other countries, has rapidly scaled up the use of technology and digital ways of working at all levels of health care provision. The pandemic has further highlighted the importance of joined-up care and PHM, which is primarily delivered in England through Integrated Care Systems (ICSs).

Figure 3 demonstrates the volume and variety of public body stakeholders with a role in achieving PHM in England, holding various roles such as commissioning care, supporting the health and care system and safeguarding patient interests. In order for the successful implementation and practice of PHM, stakeholders of different proximities and responsibilities towards patients must successfully collaborate. The first layer (inner layer) indicates the range of providers with direct access to patients. The second and third layers include national and local organisations. Lastly, the fourth layer is focused on regulation and safeguarding with four dimensions. The dimensions indicate the four areas of government with a direct role in health, which largely oversee national and local organisations involved in PHM, and are responsible for creating and passing bills to assist in its implementation. They consist of the Secretary of State, who is responsible for the Department of Health and Social Care, as well as Parliament and other government departments and initiatives.

2.1.1 Policies supporting population health management

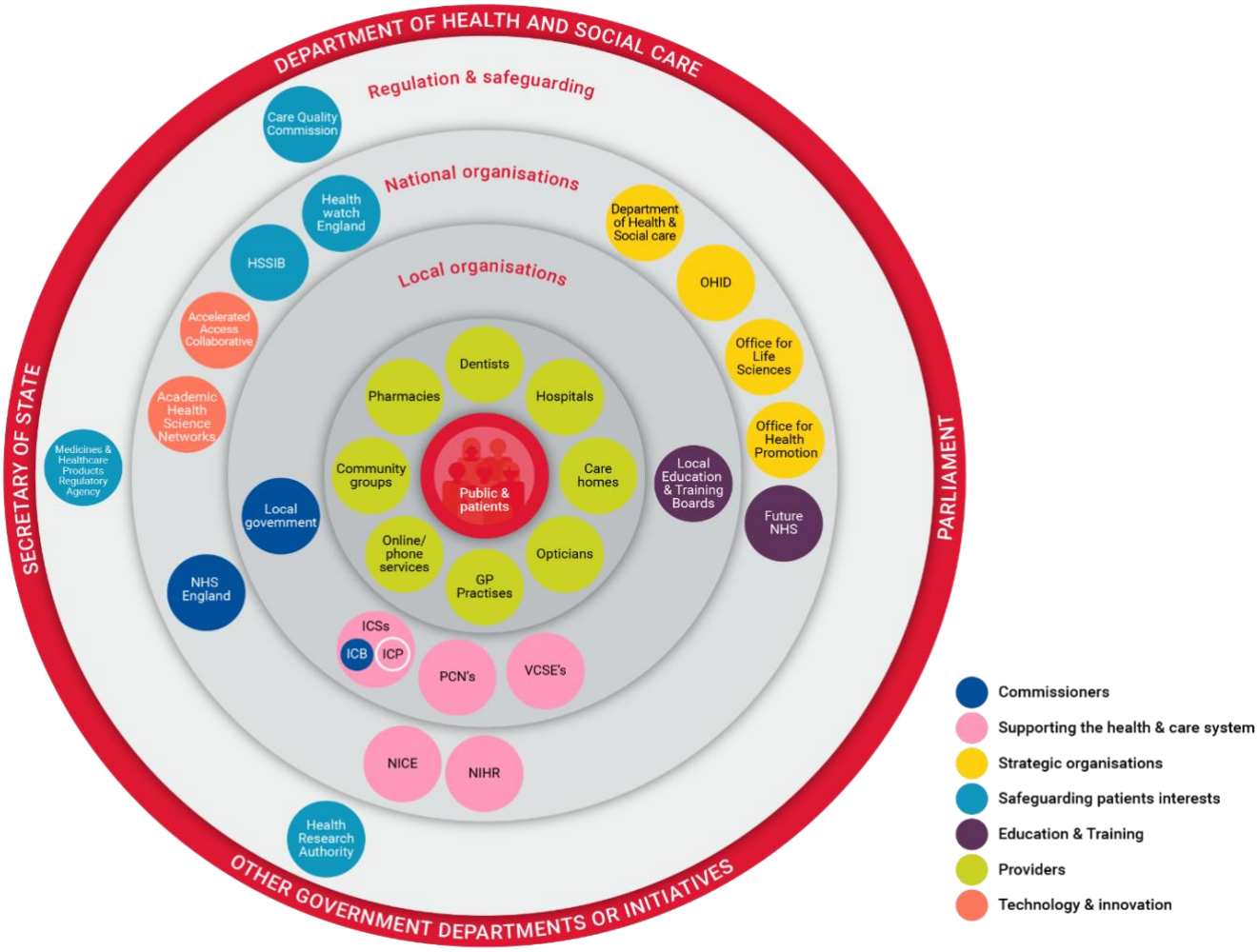
NHS England's 2014 5-year Forward View focused on improving prevention efforts and health services for the population by altering traditional boundaries between primary care, secondary care, and community services[1]. In 2017, PH-focused Sustainable Transformation Partnerships (STPs) were introduced to bring together NHS providers, commissioners, local authorities, and other partners and funders to plan services based on the long-term needs of their local populations[12]. Evolving from STPs, ICSs are a move towards improved PHM, allowing for closer collaboration between stakeholders, as well as greater autonomy and responsibility for resources[13]. The 2019 NHS England Long Term Plan set out an aim to have all parts of England served by an ICS, with systems to support PHM by 2021[13]. Additionally, networks of General Practitioner (GP) practices covering approximately 30,000 to 50,000 patients, called Primary Care Networks (PCNs), have been created[14]. The provision of integrated care will occur around PCN boundaries, and they will have a specific role in addressing the wider determinants of health, as well as the provision of anticipatory and personalised care[14].

The NHS 2022/23 Priorities and Operational Planning Guidance was released in December 2021, with one of its main priorities being to persevere with developing the PHM approach within the NHS[30] . The guidance asks ICSs to develop robust plans to reflect the deliverables set out in the Long Term Plan (2019) ; such as inequality reductions, prevention and personalised care. Systems were also asked to create costed three-year digital investment plans, focussing on cyber-security, electronic patient records and digital inclusion. NHS England will provide capital to support the implementation of these plans, focussing on systems of the lowest maturity[30].

In July 2022, the Health and Care Bill passed through parliament and received Royal Assent. The key features of the Act relating to PHM are ICSs being given statutory footing and legal responsibilities. With statutory footing, ICSs now have formal powers and are taking on the commissioning role of CCGs[34] . Collaboration is also no longer encouraged; instead, providers and organisations are now mandated to join provider

collaboratives. This legislation is the most recent in a long line of initiatives moving the NHS away from its competitive model and top-down management, towards collaboration and bottom-up implementation.

Figure 3: Population health stakeholders in England



***Source**: The authors, enhanced from the Department of Health (2013)*[71]

Abbreviations: *VCSE: Voluntary, Community & Social Enterprises. ICSs: Integrated Care Systems. ICBs: Integrated Care Boards. ICPs: Integrated Care Partnerships. PCNs: Primary Care Networks. NHSE/I: NHS England and Improvement. NICE: National Institute for Health and Care Excellence. NIHR: National Institute of Health Research. OHID: Office for Health Improvement and Disparities (a successor of Public Health England). HSSIB: Healthcare Services Safety Investigation Branch.*

Note: The organisations listed in this figure are not an exhaustive list of all relevant organisations in the English NHS architecture, but represent a comprehensive list to the extent possible. CCGs are no longer commissioners according to the Health and Care Act (2022), passing their commissioning powers to ICBs within ICSs. NHS England and NHS Improvement have also officially merged in the act, with the overarching body named NHS England. Additionally, as of November 2021, it was announced that NHS Digital (NHSd), NHSX and Health Education England would be merged and incorporated into NHS England by April 2023, therefore they are not listed.

2.1.1 Policies supporting the use of digital technologies

Over the last decade, digital health policies have focused on establishing and revising standards and frameworks to guide the design, procurement, and introduction of digital systems in health and social care. In 2013, NHS Digital (NHSd) was established to provide organisation and leadership in England around information and data[35]. By 2019, NHSX was responsible for driving England's system transformation and digital policy[36]. Over the last five years, these central bodies have set standards and guidance around security, information governance, interoperability, IT procurement, and evidence standards for digital health applications to help improve interoperability and accessibility between systems, which is essential for population-based health approaches.

The 2019 NHS Long Term Plan laid plans for digitally-enabled care to "go mainstream" throughout the NHS[29]. Other progress in digitisation has been made with e-referrals, e-prescriptions, online triaging, virtual consultations, and online appointment booking expansion across England[29]. However, some geographic divides still exist[37]. The Long Term Plan (2019) also highlighted the need to digitally enable patients and carers to access their care records and make use of technology to self-manage their chronic conditions, such as cardiovascular disease[29]. In June 2022, 'A plan for digital health and care' policy report was released, which outlined NHS England's investments and plans to digitise, connect and transform the health system, with precise goals and associated timeframes laid out (as seen in Box 2)[31].

2.2 Infrastructure

Infrastructure refers to the basic building blocks that must be in place for PHM to succeed[9].

2.2.1 Integrated care systems and infrastructure supporting provider collaboration

The English NHS has been slowly transitioning from the traditionally competitive model of healthcare provision to a collaborative model with the introduction of STPs and now ICSs. This collaborative model is essential in enabling holistic care of patients and utilising the strengths of different providers and organisations.

ICSs started as informal partnerships between NHS providers, commissioners and local authorities, specifically social care, for a specific region, each covering approximately 1 to 3 million individuals[38]. Following the enactment of the Health and Care Act (2022), each ICS now consists of an Integrated Care Board (ICB), the new statutory body responsible for NHS budgets and accountable to NHS England, and an Integrated Care Partnership (ICP), which brings together partners to care for the needs of their population[34]. ICSs take collective responsibility for managing resources and are seen as the main mechanism for PHM realisation through the provision of patient-centric care and population data generation[15]. ICSs are generally discussed at a system, place, neighbourhood or person level, with each level having specific partnership and delivery structures (Table 2) and completing different PHM activities to improve the health of the population (Table 3)[13].

Table 2: Partnership and delivery structures within integrated care system levels

Geographical footprint of ICS level	Partnership and delivery structures		
	Name	**Role**	**Participating organisations**
System – population between 1-2 million	**Provider collaboratives**[39]	Develop clearly defined plans and programmes of care delivery using insights from partners, people, communities and data	At least two NHS trusts (eg. acute, mental health, specialist) and other provider organisations
Place – population between 250 – 500,000	**Health and wellbeing boards**	Responsible for producing joint strategic needs assessment (JSNA) and health and wellbeing strategies for their local population	Formal committees of local authorities consisting of NHS, Healthwatch, local authorities and other membership
	Place-based partnerships[40]	Responsible for the 'heavy lifting' of integration	Collaborative arrangements including ICB members, local authorities, VCSE organisations, NHS trusts, Healthwatch, general practise and local community itself
Neighbourhood - population between 30-50,000	**Primary care networks**	To work at scale and provide a wide range of services at the neighbourhood level	General practise, community pharmacy, dentistry, opticians, mental health, social care and voluntary services

Source: Adapted from The King's Fund (2022)[20].

ICS design and implementation is up to each system working within a broad national framework, with national NHS bodies taking a permissive, hands-off approach[13]. NHS England believe that decisions should be made on the principle of subsidiarity[b] with individual ICSs determining what makes the most sense for them according to their local needs. However, all ICSs have four common strategic purposes[30]:

- Improving PH and healthcare
- Tackling unequal outcomes and access
- Enhancing productivity and value for money
- Helping the NHS to support broader social and economic development

In theory, ICSs have the opportunity to provide improved joined-up care to patients with chronic conditions and comorbidities, however it will take time for the organisations involved and their associated leadership to become comfortable and efficient with new collaborative networks and partnerships. The Health and Care Act (2022) is believed to be a step in the right direction as the previous legislative framework was still promoting competition between providers and was thus hampering the collaborative efforts. Politicians and leaders will need to be patient to allow these new systems time to adapt and showcase results of collaborative working. National and regional NHS bodies are working towards finding the optimal balance between providing sufficient guidance to support ICSs in their journey, and being too prescriptive, with unrealistic asks and expectations[20].

[b] *Principle of subsidiarity: the notion that decisions should be made as close to the local community as possible*

Box 1 displays the positive impact that data linkage and collaborative working can have on cohorts in need within the population.

Box 1: Reduction of unnecessary 999 calls in Braunstone

Who: The population of the Braunstone consists of 15,700 people and was found to produce approximately 4,600 999 calls per year. Research showed that Braunstone generates the highest amount of emergency calls in Leicester, Leicestershire and Rutland.

How: Braunstone Blues was set up and consists of a team of individuals from emergency service providers, local authorities and health services. An agreement to share information on repeat callers was created.

Why: Individuals who repeatedly use emergency services are likely to be facing similar difficulties which could be supported with social care or mental health support, thus freeing up emergency services to respond to emergencies.

Impacts: Through understanding which households repeatedly contact 999, specific interventions can be designed in order to support them. Communities are educated on who to contact for different needs and GPs are able to refer patients to organisations able to provide specific support.

Contribution to PH: A particular cohort requiring additional support was identified in a geographic area. This example showcases the integration and collaboration between healthcare and community services in order to provide more personalised, efficient care to those who need it. The joining of data between different providers allowed a greater understanding of the needs of that population.

Source: Leicestershire Fire and Rescue (2018).

2.2.2 Digital maturity and data infrastructure

Digital maturity refers to the capabilities of an organisation in the implementation of digital processes and strategies, which is primarily based on the strength of data infrastructure. Data infrastructure is seen as the cornerstone of PHM implementation, because in order for health systems to generate a deeper understanding of the population and determine the optimal way to deliver high-impact care, they must have significant data collection and sharing capabilities between different providers and systems. Inter-system data sharing, known as data interoperability[c], should occur between different parts of the health sector, as well as the voluntary and social sectors. Major requirements for the use of 'big data' are data interoperability, as well as patient and clinician trust in the regulation, standards and governance in place to support data security[15]. Not only is data interoperability vital for data analytics, but it is also essential for increased staff productivity and collaboration within ICSs[41]. Shared data sets are currently being created at ICS level, with mature data sets including patient-level data linked across different care settings (as displayed in Box 3).

The NHS itself holds a substantial amount of data, including the longitudinal medical records of approximately 65 million people, which has incredible potential for improving care through PHM. However, several factors are limiting its use. First, there are still some trusts without electronic health records[d] (EHRs) in place[31]. Second, there is a disconnect in health record data between primary, secondary and tertiary care. Third, patients have been historically misled, thus there is noticeable patient mistrust and discomfort surrounding data sharing.

[c] *Data interoperability:* data held in different locations and formats able to be used together.
[d] Electronic health record: digitised patient longitudinal care record

The NHS has been struggling with IT for several years and has ended up with systems that do not 'talk' to each other[1]. There is now a system-wide push for interoperability and EHRs, as seen throughout NHS policy documents. The Five Year Forward View indicates a need for all patient records to be electronic and aims for the implementation of ICSs to be interoperable by default[1]. Additionally, Local Health and Care Records (LHCRs)[e] are beginning to be implemented throughout the country, aiming to be present in every ICS by 2024, as seen in Box 2[29]. However, there is a significant challenge including social care data as 45% of social care providers still do not have any form of digital care records[31]. Box 2 showcases digital infrastructure milestones being maintained and changing over time through key NHS England policy documents. In the box we see milestones increasing over time with a goal of 60% adult registration in 2023 to 75% in 2024. This indicates that the NHS is making positive strides towards their goals.

Box 2: Digital infrastructure milestones set out by the NHS in England

Milestones for digital infrastructure

NHS Long Term Plan (2019)

- By summer 2021, there will be 100% compliance with mandated cyber security protection across all NHS organisations.
- By 2021/22, systems will be present to support PHM in every ICS throughout England.
- By 2024, all secondary care providers' clinical and operational processes (acute, community and mental health providers) will be digitised. Data will be captured, stored and transmitted. LHCRs will be present in every ICS throughout the country.

NHS 2022/23 Priorities and Guidance (2021)

- By April 2022, suppliers to comply with NHS interoperability standards.
- By March 2023, local authorities with social service capabilities to be connected to LHCRs.
- By March 2023, UK to reach 60% adult registration for the NHS app.

A plan for digital health and social care (2022)

- By 2023, every ICS to have implemented a PH and planning data platform
- By 2024, all constituent organisations of an ICS connected to an LHCR. All individuals, their approved care givers and relevant staff in their care team will have the ability to view and contribute to the record.
- By March 2024, NHS app will be the front door for personalised care, with 75% of adults registered.
- By 2025, 100% of NHS trusts to have an electronic patient record system.

Sources: NHS England (2019)[29], NHS England and Improvement (2021)[30] and Department of Health & Social Care (2022)[31]

NHSd and NHSX (now incorporated into NHS England, as seen in Figure 3), were responsible for improvements in interoperability throughout the system. NHSd launched an Interoperability Toolkit to support interoperability within local communities and between health and social care organisations; while NHSX created nationally recognised interoperability standards for products coming to market[42]. This signifies the importance the NHS places on interoperability both within the NHS and those providers and organisations with which the NHS collaborates. Improved interoperability will allow clinicians to have a complete view of the patient, patients to become more engaged with their own health, and data entered by people or generated by devices to be shared within the health and care systems[41]. Box 3 displays a current example of how specific data infrastructure in place in Dorset ICS enables PHM methodologies.

[e] Local health and care record: a longitudinal care record to be able to be used between both the health and social care sector, with different professionals having different kinds of access to information according to information governance agreements.

Box 3: Dorset Interventions and Insights Service (DiiS)

What: The DiiS is a collaborative service delivering live, linked health and social care data across Dorset. It incorporates 19 PCN's, 77 GP Practises, and covers a registered population of 810,000 people. Patient level and linkable data is incorporated from: social care (including care homes, public health, drugs and alcohol etc), acute care (including diagnostics, referrals to treatment, ambulance transfers etc), mental health (including referrals, interventions etc), primary and community care (including appointments, blood markers, minor injury units, NHS 111 etc) and wider determinants (including demographics, education, housing etc).

How: The data is depersonalised at a population level, but also allows health care professionals (HCPs) to access personalised data of their patients in order to provide effective care to those who require it. 3 years ago, DiiS started with a dataset only including limited secondary data from national systems. Since then, they have been able to incorporate data from social, primary, acute, mental health and the wider determinants. The incorporation of additional datasets has been found to create momentum to build DiiS as organisations are able to see the value that it can create. Front-end tools are co-developed with clinicians in order to be fit for purpose.

Impacts: The data is used at a depersonalised level to conduct analyses to allow decision makers to identify impacts of implemented changes, facilitating an intelligence-led design and identification of patient cohorts most likely to respond to an intervention. It is also used at HCP level to improve interventions for specific patients and allow collaborative working between sectors and organisations.

Contribution to PH: DiiS is a mature dataset and can be seen as a 'best practise' example, although it is still maturing. PHM requires linking data between different health and care providers in order to gain a holistic understanding of patients, help plan care provision and create new models of care.

Source: Primary data collection, October 2021.

2.2.3 Funding and resources

The government has made many funding commitments to assist with PHM implementation. £2 billion has been made available to support and ensure all NHS trusts have EHRs in place[31]. Additionally, £250 million will be allocated in 2022/2023 to support the digitalisation of ICSs[30] , with an additional £150 million to explicitly support digital infrastructure in social care; this will include connectivity foundations, cyber security and digital skills[31]. Commitments to the order of £58 million have been made to help expand community services, such as mental health and employment support, and improve physical healthcare[43].

Several commitments have also been made to support different aspects of the technology lifecycle within the PHM space. UK Research and Innovation released the 'Industrial Strategy Challenge Fund', which pledged an overall £181 million to support and deliver cutting edge healthcare within the UK. Some awards are more specific in their focus[44], such as the digital health partnership award, through NHSX, which targets digital health technologies explicitly focused on managing long-term conditions[45]. This award aims to assist NHS organisations in implementing proven technologies that are transforming care.

2.2.4 Regulation

Due to the importance of digital technologies for PHM, regulation is essential in creating a safe and innovative environment for these technologies to flourish. There are many kinds of technologies within 'health technology' with different risk levels and functionalities; thus, they must meet different regulation criteria. This risk stratification and the fast-moving nature of technology innovation make it extremely hard for regulatory bodies to keep up. Within the regulatory landscape, there are several organisations involved (as displayed in Figure 3), including the Medicines and Healthcare Products Regulatory Agency (MHRA), as well as organisations

which recommend how technologies should be evaluated at different levels of maturity, such as the National Institute of Health and Care Excellence (NICE). Additionally, the General Data Protection Regulation (GDPR) regulates how health and care data is stored, collected, analysed, and shared.

Two main frameworks, created to complement each other, exist in England to help inform NHS commissioners considering purchasing technologies and products with a digital underpinning. The NICE evidence standards framework helps commissioners identify what good evidence of therapeutic benefit and economic impact look like for digital products; and the Digital Technology Assessment Criteria (DTAC) created by NHSX focuses on the minimum baseline of standards for commissioned technologies to meet[46,47].

2.2.5 Leadership, culture and relationships

An essential requirement for the successful implementation of a new methodology of care is leadership with an aligned mission, vision and understanding of the steps that need to be taken[4]. In the case of the implementation of PHM, it is being driven both in the local level through ICSs, each of which are at different stages of maturity and have different foci for their population, and at the national level by NHS England with the overarching aim to support and lift all ICSs to mature PHM enabled systems. One of the key roles in leadership is to enable and empower staff to collectively improve care and outcomes, which can be achieved through a continuous cycle of engagement to co-design strategy that members of the system believe in and will make an active effort to implement. Building and maintaining strong relationships between different organisations within ICSs is also essential in successful collaborative working and enabling patients to move throughout the system easily with holistic care.

2.3 Insights

Insights refer to the opportunities that can be gathered from data in improving quality, efficiency and equity of care through improved decision-making[9]. PH analytical techniques are underpinned by well-established methodologies; examples of techniques include (but are not limited to) risk stratification and population segmentation, opportunity analysis, impactability assessments and health equality/equity impact assessments[48].

2.3.1 Understanding population needs and risk stratification

Joint Strategic Needs Assessments (JSNA) are used to understand the health and wellbeing of a population at the system, place and neighbourhood level, and identify gaps in care[49]. Within the new ICS arrangements they are predominantly completed by place-based partnerships to help strategically plan for the local area (discussed in Table 2). They allow priorities to be set in order to improve outcomes and reduce inequalities; and require several different types of data such as demographic, prevalence and incidence, risk factors and patient user data[50]. Completing local JSNAs allow greater flexibility in responding to health challenges due to variations in health between different geographies. Once population needs are determined, risk stratification can be completed, a process that systematically divides a population into different strata based on specific outcomes to determine who is most at risk. Risk stratification is used to prioritise needs and predictive analytics is used to determine the possible future impact of rising risks identified in the JSNA. This allows the health system to turn strategic priorities into tactical plans to provide efficient and effective care to those who will benefit most[51].

Each ICS is responsible for the analysis and stratification of its own population, and NHSd has a PH team that collects, analyses and interprets general population data to inform policy decisions[52]. ICSs throughout the country are starting to develop analytical capabilities within their systems; for example, Dorset ICS set up a cross-organisation team specifically to develop PHM analytical capabilities to use on their dataset shown in Box 3[9]. However, the maturity of analytical capabilities and data sets vary significantly throughout the country (Primary data collection, August 2021).

Types of insight generation and analysis generally depend on the ICS level, as seen in Table 3. For example, economic modelling and actuarial projections[f] are completed at the system level to determine how population needs are changing and how to mitigate health and financial risk across care settings[53].

Table 3: Population health and analytics examples for the different levels of integrated care systems

ICS Level	PH efforts	Example of analytics	Example of decision informed through analytics
System	ICS strategy and effective management of resources	Economic modelling and actuarial projections to determine changes in PH and care needs.	What is the most efficient way to allocate resources to different providers?
Place	Redesign of local services and the joining of different sectors	Costed segmentation to identify high and rising risk individuals. Benchmarking and variation between providers and patient cohorts.	What is the cause of variation between different areas of the ICS? How can we mitigate this variation?
Neighbourhood	Develop multidisciplinary teams and deliver anticipatory care	Risk stratification and impact ability of different population segments.	What cohort can we make the most significant impact on in X amount of time?
Person	Encourage personal health engagement	Care pathway analysis, redesign of personal care pathways and personalized care	What is the most efficient way to design care for this individual?

Source: Adapted from Future NHS [53].

Strong data analytic capabilities allow systems to understand current and future healthcare costs and utilisation of different cohorts at a population level. This further enables an understanding of the critical risk factors fuelling these costs as well as those patients at the greatest risk of deterioration[5]. The information gathered can then be used for health system planning in order to contribute to the "quintuple aim" [27].

2.3.2 Redesign of clinical pathways

Clinical redesign is the transformation of services to improve the quality of care, driven by the patient and carer perspective. This is typically completed through the analysis of care delays, unnecessary steps in the provision of care and opportunities for error, to then rebuild the process from the ground up in a more efficient and effective manner. Redesigning these processes across traditional boundaries of care, with differing organisational priorities and collaborations/partnerships between local modalities is not an easy task and will require constant evaluation to enable alterations and improvements over time.

Data enables this introduction and provision of evidence-based 'best practice' care[29]. As set out in the Five Year Forward View, 50 vanguards testing one of five different PH approaches or operational models have been created and are acting as blueprints for the evolving NHS[1]. Additionally, between 2013 and 2015, 25 'integrated care pioneer sites' were selected to test whole system integrated models intending to increase the efficiency, effectiveness and quality of care for patients[54]

[f] *Actuarial projections: behaviour predictions based purely on statistical methods.*

2.4 Interventions

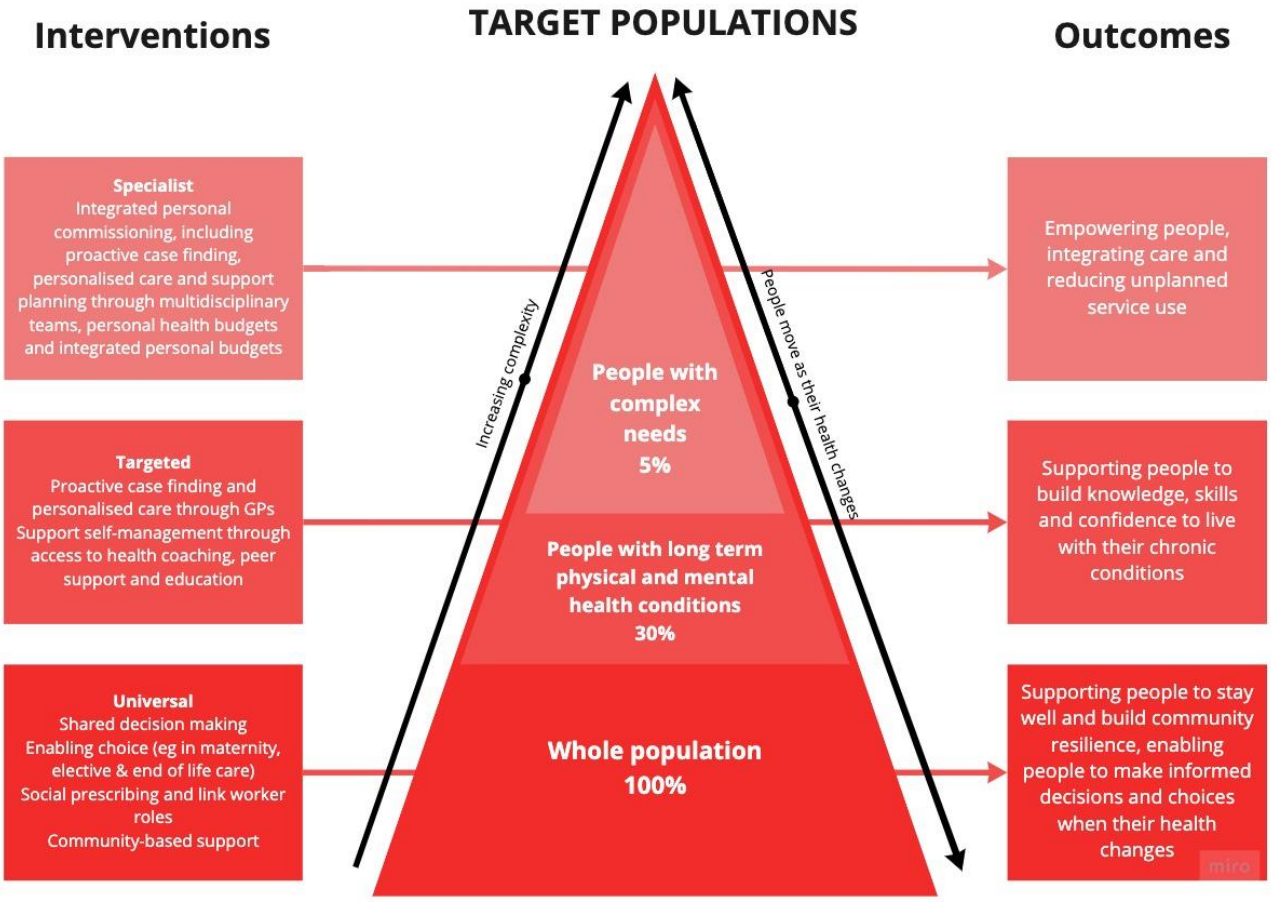
Interventions refer to care models aiming to reduce inequalities and improve the quality and efficiency of care through the movement towards proactive, patient-centric care[9].

2.4.1 Patient-centric care and patient empowerment

Patient-centric care is a key feature of PHM and aims to move patients from historically passive recipients of care to being active in their own health. In 2019, NHS England published the Universal Personalised Care report, setting out how NHS Long Term Plan commitments for personalised care, i.e. reaching 2.5 million people by 2023/24, will be delivered. The report aims to give individuals a greater choice over their health and care through the implementation of 6 key principles: (a) personalised care and support planning; (b) supported self-management; (c) shared decision-making; (d) enabling choice; (e) social prescribing[g] and community-based support; and (f) personal health budgets and integrated personal budgets (see Appendix IV. Key principles of personalised care)[54,55]. Additionally, the report laid out a population approach to personalised care, as shown in Figure 4. NHS England is also aiming to work with a number of stakeholders to set robust quality standards and methods for implementing these principles.

[g] Social prescribing: when health professionals refer patients to support within the community to improve overall health and wellbeing.

Figure 4: A population approach to personalised care



Source: Adapted from NHS England's Universal Personalised Care report (2019)[54].

2.4.2 Anticipatory care

The Long Term Plan (2019) laid out specific aims to reduce smoking, obesity, alcohol abuse and air pollution. To achieve these goals, the NHS Accelerated Access Collaborative (AAC), a collaboration between several organisations with the aim of streamlining new technology adoption in the NHS, has received £140 million of funding for the support of promising artificial intelligence (AI) technologies[56].

Moreover, the NHS is increasing support for patients to manage their own health, including prevention of diabetes, heart and respiratory conditions, and others[29]. These support efforts focus on improving primary prevention[h] of avoidable diseases, such as lung cancer and diabetes, through campaigns to reduce smoking and obesity, as well as secondary prevention[i] with early detection and symptom reduction. Early detection is being improved in a number of hospitals and primary care through the use of algorithms in electronic patient systems. For example, an algorithm called QCancer works out the risk of a patient developing cancer in the next ten years based on individual risk factors (Primary data collection, August 2021). However, implementing anticipatory methods and insight generation comes with several challenges, such as changes in resource use and ethical issues (discussed in depth in Section 3.2.3).

[h] Primary prevention: aims to prevent disease before it can occur.
[i] Secondary prevention: aims to reduce the impact of disease/ailment that has already occurred.

2.4.3 Health inequalities

Health inequalities are a substantial issue in England, and their reduction is a crucial aim of PHM (as shown in Section 1.2.2). The majority of individuals with long-term conditions are from lower socioeconomic backgrounds and generally spend a more significant proportion of their lifetime in poor health than those from wealthy areas[54]. Health inequalities result from a multifaceted mix of societal and environmental factors and thus require a joined place-based approach within local areas, utilising the efforts of multidisciplinary teams available to the local area[57]. The NHS Long Term Plan (2019) set ambitious goals for the next five years that focus on inequalities, as seen in Box 4.

Box 4. Health equality milestones set out in the NHS Long Term Plan (2019)

Milestones for health equality

- By 2021, 280,000 individuals living with severe mental health disorders will have their physical needs met through health checks.
- By 2023/24, there will be an additional 110,000 individuals receiving health checks.
- By 2024, 75% of women from the most disadvantaged groups will receive continuity of care from a midwife during pregnancy, labour, and the post-natal period.

Source: NHS England (2019)[29]

The NHS has linked funding for ICSs to the delivery of plans and measurable goals for reducing local inequalities within the next 5 to 10 years[29]. Additionally, a higher proportion of funding is targeted toward areas with considerable health disparities[29]. The “CORE20PLUS5” approach has also been created by NHS England and NHS Improvement for tackling inequalities at the national and system level[58]. This approach focuses on three core components: 20% of the population in the lowest deprivation category with an additional focus on local inequalities determined at an ICS level, and five key clinical areas of focus determined in the NHS Long Term Plan.

Future NHS, a platform designed to empower individuals within the NHS to codevelop and work together, has also created a "menu of evidence-based interventions for addressing health inequalities". These interventions generally focus on addressing risk factors (i.e. smoking), the wider determinants of health, and variations in access and outcomes for individuals with chronic conditions. Examples from the “menu of evidence-based interventions” include focussing on early intervention for mental health conditions, and improving digital health literacy for those from deprived and excluded communities with a greater risk of poorer health outcomes.

2.4.4 Incentives alignment

The NHS Long Term Plan (2019) indicates the implementation of payment reforms for ICSs to move away from activity-based to population-based funding, i.e. a capitated[j] value-based approach (NHS financial environment described in Appendix I. Supplementary information on the English NHS) . This aims to remove the link between activity and payment, thus aligning payment and incentives around population needs rather than around organisational objectives[4,59]. Its link to population needs aims to reduce inequalities, support equal access to care and enable the provision of anticipatory care; however, specific details of 'population-based funding' is limited. For now, volume-related payments will be retained; nonetheless, some incentives are in place for improvements in quality (such as the Quality and Outcomes Framework for GPs) with more in the process of formation[29].

[j] *Capitated budgets: paying provider(s) a lump sum of money regularly per patient to cover all care*

2.5 Impacts

Impacts refer to understanding the effects of PH-based interventions on the population in order to continuously improve care.

2.5.1 Impact analysis

Interventions need to be continually monitored to remain effective as the population evolves[9]. Whole system impact assessments must be completed to measure the net impacts (i.e. cost, utilisation, outcomes etc.) of interventions on population groups which, in turn, lead to rapid improvements in care, as seen in [52]. Moreover, key indicators and outcomes must be defined and used to measure the value[k] and success of the intervention.

2.5.2 Clinical health improvements and quality of care

There are several examples where the NHS has shown that the introduction of collaborative efforts and appropriate data usage has assisted in the improvement of clinical health outcomes. For example, through a collaboration between GPs, hospital specialists, and public health specialists, Leeds ICS diagnosed liver disease earlier, leading to improved outcomes and the slowing of disease progression[61]. Public health specialists used data to identify areas within the city that had a high prevalence of obesity and/or alcohol consumption and thus would correspondingly have a high rate of liver disease. GPs and hospital specialists then worked together to provide diagnostic tests to these individuals and provide liver disease clinics in their communities, thus allowing early treatment. Although there are a few examples from the NHS, there is limited peer-reviewed literature looking at clinical improvements due to the recent focus and implementation of PHM methodologies. The few studies have not found robust evidence and look purely at the effects of integrated care, which do not encompass all aspects of PHM[60–62].

2.5.3 Economic efficiency

The assumption with the implementation of ICSs and PH methods, such as data-driven care, is that costs of care will be driven down with increases in efficiency within the system. Several examples from the NHS have shown PHM methods resulting in cost savings; for example, the Camden clinical commissioning group (CCG) created multidisciplinary teams and focussed on patient-centric care for frail patients[64]. This intervention led to savings in emergency admissions of approximately £25,770 per month in 2014. However, similar to clinical improvements, little peer-reviewed literature has been completed looking at changes in economic efficiency with PHM, with limited evidence of cost-effectiveness found with ICS implementation[61].

Box 5 displays the four key building blocks working together in practice to form PHM methodology.

[k] *Value: measurement of outcomes vs the cost of obtaining those outcomes*

Box 5: Using data to direct the Dorset primary care network workforce during COVID

Problem: The Vale PCN in Dorset recognised that overall health is a result of economic, social and environmental factors. Social prescribing is a method set out in the Long Term Plan where health professionals refer patients to support in the community, such as community groups and charities. It has the potential to address and support individuals holistically for what matters most to them. It was determined that 30% of clinical appointments were related to non-clinical needs. During the COVID-19 pandemic, The Vale looked at their team of social prescribers and how they could work together with key partners to provide a proactive approach to these individuals.

Infrastructure: Dorset ICS has a mature dataset which encompasses several data sources. These include social care data (i.e. care homes, social prescribing, adult services etc), primary and community care, acute care, mental health (i.e. referrals, interventions etc) and the wider determinants of health.

Insights: A multidisciplinary team of clinicians, social prescribers, self-management coaches discussed and reviewed cases. Using the Dorset Integrated Dataset and COVID-19 Insights report they ran searches for people with significant risk factors such as social vulnerability, mental health and long-term health conditions.

Interventions: Interventions were designed specifically for different groups. Those at low risk were texted out information regarding relevant support groups, helplines and websites. Those with significant COVID-19 risk were contacted by frailty advanced Nurse Practitioners to identify any unmet clinical need(s). Lastly, those with social vulnerability and low COVID risk were contacted by social prescribers to discuss support needs.

Impacts: From a cohort of 94 individuals contacted, 75% received a social prescribing intervention with a recorded outcome. These individuals had not approached any services themselves and were struggling with the weight of lockdown.

Relevance to PH: Identification of individuals requiring additional support through linked datasets and data analytics. The use of interdisciplinary teams at a primary care level enables the health system to provide proactive and holistic care which isn't necessarily clinical in nature.

Source: Primary data collection, October 2021.

3. Gaps, challenges and opportunities

3.1 Population health management in England: from rhetoric to reality

Section 3 outlines the blueprint and current effort of the English PHM approach aiming to tackle the three "widening gaps" of health and wellbeing, care and quality, and funding and efficiency[1]. The NHS has laid out ambitious goals in the NHS Long Term Plan (2019) and policy reports since, such as every ICS in England having systems to support PHM by 2021/22. However, there is no clarity on what "systems to support PHM" constitutes as in reality. System PHM capabilities are typically measured on a maturity scale, thus it is unclear if this goal relates to systems possessing *any* PHM capabilities or systems reaching the highest level of maturity. Moreover, specific goals were made relating to inequalities, patient engagement and digital infrastructure (as seen in Box 2 and Box 4). Although the NHS aims to be completely transparent, there is limited data available surrounding PHM implementation and progress towards these goals is difficult to track due to their ambiguous nature, as well as bottom-up implementation and the siloed nature of the NHS.

The literature analysis and key NHS stakeholder interviews have indicated several gaps and challenges to PHM implementation. These tend to relate to technical, mindset-related and regulation challenges. Additionally, a number of enablers of PHM have been identified such as communication, ethos, digital transformation and the NHS as a sole provider of health services.

3.2 Challenges to the implementation of population health management methodologies and ways forward

3.2.1 Technical challenges

Access to good quality, linked data. PHM relies unequivocally on data, as seen as the first step of the PHM cycle (Figure 2) to understand population needs. High-quality data must be able to be captured, stored, and distributed for actionable insights of the population to be generated and quality care be delivered to those who need it. Ideally, for PHM to be successful and to understand patient group complexities, the health system requires combined mental, community, acute trust (including waiting lists) and primary care data (Primary data collection, September 2021). There are a number of significant barriers the NHS is facing in using data to its highest potential. In order to collect high-quality data, systems need to know what they want to measure, and thus the type of data that will be able to provide valuable insights. Currently, many hospitals cannot collect types of data that would assist them with assessing risk due to the electronic systems they are using (Primary data collection, August 2021). An interviewee attested to the significant opportunity we have, "GP data in this country is probably the richest source you'll find anywhere in the world on which to do population health" (Primary data collection, August 2021).

"GP data in this country is probably the richest source you'll find anywhere in the world on which to do population health"

GP records have a large amount of comprehensive and longitudinal data; however, a great deal is still in paper format and versions that are digitised are not interoperable with hospital systems. This severely limits HCPs in gaining a holistic understanding of their patients and prevents health systems from determining from where demand stems (Primary data collection, August 2021). There has been considerable movement towards linking data sets at the system level; however, there is still a long way to go as systems are at different maturity levels and are linking their data locally, as shown with the Dorset interventions and insights Service (Box 3) (Primary data collection, September 2021).

Measurement of inequalities. While one of the critical aims of PHM is to reduce inequalities, there are significant challenges in understanding who exactly the systems are trying to look for, measuring the inequalities themselves and completing impact assessments of implemented interventions. Most health systems are not adequately set up to be measuring inequalities. Equally, available metrics may take time to show intervention impacts. For example, one of the main indicators used to measure health inequalities is differences in life expectancy, which takes a significant time to be realised. Recently, there has been a considerable political and system push to address inequalities. Health technology impact on inequalities is now being introduced as a critical component in technology evaluation for local adoption and reimbursement (Primary data collection, August 2021). This should positively affect inequality reduction as it will push industry to incorporate health inequality metrics throughout technological development. Additionally, to improve, vision and purpose must be aligned with key metrics that are realistic and allow the NHS to accurately address where there might be inequalities and connect interventions to outcomes (Primary data collection, August 2021).

Incentives. A further issue relates to the nature of incentives provided to HCPs. For example, the Quality and Outcomes Framework (QOF) is a performance management financial incentive system for GPs throughout England. It aims to improve GPs quality of care through a points-based system, which then converts points into monetary incentives for the GP surgery. However, when it was designed, it was decided that 5% of the population was exemptible due to difficulties in reachability (Primary data collection, August 2021). The issue with exempting this 5% is that they are, by definition, a cohort that requires more support (Primary data collection, September 2021). An expert involved with QOF creation emphasized this issue, “We should have gone entirely the other way, we should have said, "We will pay you double for that last 5% compared to the first 95%.”” (Primary data collection, September 2021).

“We should have gone entirely the other way, we should have said, "We will pay you double for that last 5% compared to the first 95%.”

Directors of Public Health are working with systems to proactively approach individuals to understand the reasons behind not responding, whether it be cultural differences or timings offered by the NHS not lining up with their schedules (Primary data collection, September 2021). Once reasons are identified, the health system can co-develop a solution with their community, ensuring the development of services that meet individuals’ needs instead of “expecting everyone to go through the same standardized pathway” (Primary data collection, September 2021).

Collaboration. England’s health and social care systems are entirely separate systems and are funded in different ways. One major challenge for collaboration between the two sectors is that healthcare is nationally funded and free at the point of use, while social care is means-tested[l] and locally funded (Primary data collection, August 2021). The political question of means-testing overshadows the main problem within social care: how can the system provide care most effectively? This question resurfaces issues on data sets and interoperability, where systems are not collecting enough or the correct type of data and, thus, cost drivers cannot be determined nor can supply be matched with demand. An expert expressed, “If people think you can use social care data to identify predicted events, they're wrong because the threshold is so high, people are probably in dire straits by the time they're actually noticed by social care” (Primary data collection, September 2021).

“If people think you can use social care data to identify predicted events, they're wrong because the threshold is so high, people are probably in dire straits by the time they're actually noticed by social care”

[l] Means testing is a financial assessment that determines whether the council will provide financial assistance towards your care. Generally, the council will only pay for your care if your savings are below £23,250.

Means-testing results in social care missing a significant proportion of the population in need, thus resulting in inaccurate data and an inability to predict future costs. Therefore, in order to gain access to social care data and proactively understand health declines, some systems are starting to utilise primary care capabilities to collect 'social care data', such as the ability to walk to the shop or put on socks, thus enabling the health system to intervene earlier and improve patient experience and outcomes (Primary data collection, September 2021). Integrated data sets with both social and health data, called LHCR's, are beginning to be created throughout the country; however, they are not yet across every geography and are at different stages of maturity (Primary data collection, August 2021).

Another difficulty with collaboration is the complexity of the health system, not only with navigating the number of different stakeholders involved in PHM (as shown in Figure 3) but also with the variations in approaches between different geographies and ICSs. Although bottom-up approaches have generally been more successful in the NHS than top-down approaches, there are still several challenges with the bottom-up approach and locally derived solutions[63]. While different PHM approaches of ICSs result in personalised solutions to specific population needs, the varied approaches also cause difficulties for collaboration, because national organisations within the voluntary and social sectors must ascertain the different methods of collaboration in different geographies. Additionally, bottom-up implementation means that work is being done in siloes throughout the country, with limited learning from each other (Primary data collection, August 2021). However, this problem is starting to be amended with the Future NHS and the Health Foundation[m] looking to enable 'best practice' learning between ICSs (Primary data collection, August 2021). For example, a central repository was created on GitHub[n] for analytics teams to exchange code and discuss approaches. 'Best practice' learning of analytic teams will help streamline systems and increase efficiency by reducing different teams making the same mistakes.

Digital and analytical skills. Data-driven care relies significantly on data scientists to provide HCPs with the analysis they need to improve care and outcomes. The NHS has vast amounts of data which is useless without those who can make sense and produce value from it. Currently, there is limited investment and a meagre number of data analysts within systems to interpret this data[64]. The NHS needs to invest in data analysts and up-skill them, not only in terms of analytical skills but also to enable a greater understanding of the health system at large and the human side to the information and issues they see in the data. Moreover, clinicians need to gain digital skills in order for them to successfully use and understand technologies that can improve both their own day-to-day lives as well as the lives of their patients.

3.2.2 Mindset-related challenges

Proactive vs reactive care. Patient care and patient attitudes are still generally focussed on reactive over proactive care. Historically, prevention has not been prioritised in the same way that treatment has, due to benefits materialising at a much later stage and resource limitations forcing a focus on the immediate issues on hand. However, the NHS is starting to focus more on preventing major chronic diseases such as chronic obstructive pulmonary disease and diabetes, with changes in funding models from activity-based to population-based [29]. This change in funding should incentivise providers to have an increased focus on prevention because payments will be linked to population outcomes rather than treatments provided. However, in order to move towards population-based payment models and understand the cost drivers within the population, systems need fully costed segmentation models, which are not yet feasible with the limited data collection and sharing (Primary data collection, September 2021).

[m] The Health Foundation: an independent charity committed to improving the health of individuals in the UK.
[n] GitHub: a website which hosts open source projects (freely available code for redistribution and modification).

Additionally, those in charge of the provision of care need to have aligned mindsets and goals with the overarching NHS bodies to support the paradigm shift from the focus of illness to wellness (Primary data collection, August 2021). The paradigm shift from is also essential for the public, as one interviewee can attest, "we have this mentality of drink and be happy, and the NHS will pick up the pieces" (Primary data collection, October 2021). In order for the NHS to be successful in improving the population's health, citizens must be engaged with maintaining their own health.

"We have this mentality of drink and be happy, and the NHS will pick up the pieces"

Patient mistrust of data sharing. Patient mistrust is a result of inadequate communication from the NHS about data sharing programmes in terms of who data is shared with, when it will be shared, how to opt-out of the program, and, particularly, the benefits data sharing can create for patients and society alike (Primary data collection, August 2021). Patients within the England have historically been misled about the sharing of their data and not been given full transparency on its use (Primary data collection, August 2021). NHS England has been the subject of multiple outrages from the public due to assumed patient consent for data sharing, starting when patient consent of data sharing was assumed with 'care.data'[o] in 2013 and more recently in 2021 when NHSd announced a new data-sharing program[65]. Both instances led to public outrage and the initiatives were scrapped or deferred. The NHS must improve their transparency and communication for trust to be remade. Specifically, data sharing policies must be communicated to the public a substantial amount of time before changes are made, so the public does not feel blindsided.

Political mindset. One major challenge with health policies is that the effects take several years to be seen, which generally does not align with political agendas. As a result of tight budgets, there is pressure to disinvest in projects before long-term benefits have materialised[66]. To stay in power, government actors tend to provide evidence that they have impacted specific short-term goals, relying on a few performance metrics which are inadequate measures of health system performance, such as waiting lists or the 4-hour wait at accident and emergency (A&E) (Primary data collection, September 2021). These specific types of metrics are thought to be disincentives rather than incentives for improving care, and generate "inter-system bashing" (Primary data collection, September 2021). For example, the 4-hour wait at A&E are specific to one department within secondary care and are not an accurate measurement of hospital performance. Effects of PHM will not be instantaneous; thus, politicians must be willing to put their effort into laying down the groundwork for PHM to succeed, specifically investing in solid infrastructure. This can be aided by increased peer-reviewed literature and communication indicating the impacts of PH interventions on population outcomes (i.e. health inequalities), economic efficiency and patient experience (Primary data collection, August 2021). Lastly, there is a mindset of healthcare being a cost rather than an investment "It's really weird that at treasury level we see education as an investment and we see healthcare as a cost, because keeping a population well and healthy actually drives wealth in your community" (Primary data collection, August 2021).

"It's really weird that at treasury level we see education as an investment and we see healthcare as a cost, because keeping a population well and healthy actually drives wealth in your community"

Workload pressures. One of the main challenges identified by HCPs is their current workload pressures due to staff shortages and the pandemic (Primary data collection, September 2021). The workload pressures tend to disincentivise HCPs and systems from engaging with PHM due to the belief that it will add more work to their already busy workload (Primary data collection, September 2021). In order to overcome this challenge,

[o] Care.data was a programme which aimed to extract primary care data, anonymise it and make it available to researchers, planners and managers of the NHS, as well as academic institutions and commercial organisations.

their mindset must be altered to not only believe that PHM is the 'right thing to do' for patients, but also to increase the system's sustainability and improve workload efficiency. This can be achieved by showcasing examples of successful movements towards PHM and the positive impact it has had on HCPs (Primary data collection, September 2021). Decreases in workload pressures are also being supported by the Additional Roles Reimbursement Scheme (ARRS), which assists PCNs in hiring and reimbursing the cost of additional roles for multidisciplinary support, such as social prescribers[p] and clinical coordinators in general practice (Primary data collection, September 2021). Furthermore, with the implementation of digital technologies throughout the system, systems should ensure that the technologies being implemented have been co-created with HCPs and can be seamlessly integrated into their workflows, ultimately improving their performance, efficiency and daily lives.

3.2.3 Regulation challenges

Speed of innovation. Technology is constantly improving, and new digital health technologies are being released at a tremendous pace. One of the significant barriers to the wide-scale implementation of digital health products is the speed at which we can evaluate new technologies to promptly realise their benefits within the health system (Primary data collection, August 2021). Rapid evaluations of technologies are on the advocacy agenda. For example, the Academic Health Science Network is currently creating a key set of metrics that can be used to evaluate a number of different types of technologies covering different clinical areas, which should improve the efficiency of regulation (Primary data collection, August 2021).

Unintended consequences of technologies. With the increased use of technology throughout the health system, such as the use of population insights and risk stratification, comes ethical issues and issues relating to their impact on future resource use (Primary data collection, August 2021). For example, an algorithm currently available called QCancer, predicts individuals' risk of cancer in 10 years. The implementation of algorithms similar to this results in increased resource use for high-risk individuals through increases in testing (Primary data collection, August 2021). One interviewee put this issue into perspective, "Ethically, if you identify people who could be at risk of cancer and are unable to provide services to them, then what's the point of it?" (Primary data collection, August 2021).

"Ethically, if you identify people who could be at risk of cancer and are unable to provide services to them, then what's the point of it?"

With the implementation of risk-stratification and anticipatory care interventions, health systems must think extensively about their impact and have adequate funding to support resource use changes (Primary data collection, August 2021).

3.3 Enablers in PHM implementation

Communication. Communication is arguably the critical enabler of PHM. Effective communication from the public, to the public and within the health and care system is imperative. Several issues regarding patient mistrust could have been alleviated if the NHS had clearly communicated what was going to be changing and the importance of data sharing to benefit society and individual health. The NHS must also support patients and citizens in communicating what actually matters to them, "at the moment, I think population health

"At the moment, I think population health management is primarily driven by medicine and technology, not by patients and citizens"

[p] Social prescriber: a health professional that connects people with non-medical support in the community, such as charities and community groups, in order to improve their health and wellbeing.

management is primarily driven by medicine and technology, not by patients and citizens" (Primary data collection, October 2021).

The NHS must ensure that patients are involved in the design and implementation of new interventions. Additionally, in order for the public to support and champion PHM, the communication of the impacts of implemented PHM methods is essential.

Communication and coordination across PHM stakeholders are essential to the success of PHM. Establishing lateral links between the health system and other governmental departments, as well as public-private partnerships, increase the health system's readiness and its ability not only to collaborate but also to move the implementation agenda forward.

Unitary system. All individuals within England are cared for by 'one system', compared to countries such as the United States or Germany, in which the population is covered by many insurance companies with limited data sharing between them. The significant size and variability within the NHS enables it to be a hotbed of innovation. An interviewee remains positive on the NHS' abilities, "the fact that we are the NHS, even though that brings challenges, it also brings massive enablers that we absolutely can do this." (Primary data collection, September 2021).

"The fact that we are the NHS, even though that brings challenges, it also brings massive enablers that we absolutely can do this."

As seen throughout the report, although there is a potential for the NHS to create system-wide integrated datasets and thus allow the analysis of data at population levels, there is still a significant way to go, as moving the substantial number of health care providers will take a considerable amount of time and cannot be completed overnight.

Ethos. The NHS was founded on a key set of principles, such as the provision of services based on need rather than the ability to pay and placing the patient at the centre of every decision[67]. These principles and the ethos of HCPs and civil servants to help people and improve the lives of others are significant enablers in the implementation of PHM (Primary Data Collection, September 2021). The movement towards PHM has been described as a "social movement" because individuals working within the health and care system are pushing towards using PHM methods and capabilities as they genuinely believe the approach will improve people's lives and allow better provision of care (Primary data collection, September 2021). In order for this ethos to be leveraged, the impact of PHM must be consistently communicated to HCPs and civil servants.

Digital transformation. PHM not only requires data collection and sharing supporting the integration of care, but its aims are also supported through digital innovation. Without the digital transformation of the NHS and their focus on utilising digital potential, PHM would not be achievable. The NHS is currently working towards an interoperable, inclusive system which can be utilised to its highest potential by an up-skilled workforce with a deep understanding of how to utilise digital infrastructure to significantly improve care and patient outcomes. Moreover, specific technologies are essential for successful data-driven care, for example, without Machine Learning, we would be unable to stratify populations and complete risk assessments efficiently. Additionally, technologies such as remote monitoring are transforming care for patients with chronic conditions, allowing more efficient care and improved patient outcomes.

4. Policy recommendations

England is currently at the beginning of a long journey of transformation in its health care system. Although COVID-19 has created many difficulties for the NHS, it has also acted as a catalyst for the introduction and uptake of new care models, assisting in the movement towards PHM. The NHS has worked hard to create the blueprint for a more proactive, patient-centered, and data-driven health system, moving towards the complex notion of PHM. However, there are also several gaps and challenges to its implementation, specifically technical, mindset and regulatory challenges. Due to the size and nature of the NHS, moving the unitary system, consisting of thousands of GP surgeries and hospitals, will take considerable time and effort, and cannot be completed overnight. The following constitute meaningful priorities:

4.1 Investment in infrastructure

Improved data infrastructure at both national and ICS levels is needed and should ensure a high degree of data security, provenance, privacy and interoperability. The current conventional method involves data warehousing at the ICS level, but as PH data sets grow, this approach increases privacy and security concerns. By utilizing the latest advancements in digital technology, such as federated data platforms, PH data infrastructure can reliably handle the rapidly growing quantity of information collected securely and efficiently. New technologies (e.g. Machine Learning) will facilitate a greater understanding of population needs, thus promoting the provision of more efficient care. Finally, there are currently not enough data scientists to facilitate data-driven care and enable value to be gained from the significant amount of data the NHS has collected. Moving forward, there NHS may want to consider:

a. Implementing policies to regulate the minimum acceptable privacy and security standards for data collection, storage, and analysis—specifically regarding data aggregation and analysis for PHM. These policies will need continuous monitoring and adaptation in line with rapid technological advancements;
b. Generating peer-reviewed literature around the application of digital innovations, such as federated machine learning and cryptography, for managing PH data;
c. Investing in the future generation of data scientists as well as up-skilling those already working within the NHS; and
d. Increasing investment into machine learning technologies and their potential impact (i.e. their ability to reduce existing health inequalities).

4.2 Transparency, communication and understanding

Improvements in transparency, communication and understanding have the potential to improve implementation efforts. With England's bottom-up approach to PHM implementation, ICSs have limited learning from each other. In order to improve efficiency and facilitate a smooth transition towards PHM, 'best practice' learning between ICSs should be stimulated and supported by NHS England. This is already taking shape through the Future NHS platform, allowing those from different ICSs to communicate and discuss issues together. Additionally, consistent research, both within the NHS and by outside organisations and researchers, into the impacts of new care models, interventions and digital technologies will facilitate evidence-based decision-making and the creation of a strong evidence base and understanding which can be utilized to push forward the PHM agenda. Lastly, in order to create and maintain support from the public and policy-makers regarding the movement towards PHM, health system leaders must improve transparency and communication surrounding data sharing policies, as well as what PHM is, its current implementation and its potential to positively impact NHS. Moving forward, the NHS may want to consider:

a. Conducting workshops with specific teams (i.e. digital transformation teams) from different ICSs, specifically those at varying levels of PHM maturation, where past and current challenges will be discussed and analysed;

b. Enabling the generation of peer-reviewed literature showcasing the impact of PH interventions and new care models on economic efficiency, patient experience, population outcomes and reductions in health inequalities;
c. Introducing regular communications to and with NHS workers regarding the current changes and their aims, to showcase the potential that moving to this model of service delivery can have on their practice and workload; and
d. Focusing on increasing public awareness and understanding of current and changing data-sharing policies, in terms of their risks and benefits to individual health and to the health of the nation.

4.3 Evidence generation, appropriate metrics and relevant skills

Long-term health policy viability is currently limited by the mindset of healthcare as a cost opposed to an investment. Relevant and appropriate metrics need to be developed in that context. Metrics currently used by politicians to display health-system performance may, at times, be acting as disincentives for the improvement of care; for example, the 4-hour A&E wait, which was brought in over 20 years ago, is no longer currently as relevant. These metrics are now pitching different parts of the system against each other in the race to achieve the 'desired' result. Additionally, established policies and practices may need to undergo review and refinement in order to capture essential information in a meaningful way; for example, according to the QOF financial incentive program, GPs are paid to contact patients in their community about their health needs. If patients cannot be reached after three attempts, they are put on an exemption list whereby GP practises will not be penalised for no patient response. However, these 'hard to reach' patients are often those that require more support, as they traditionally do not seek support from health or social care as a result of systemic societal issues. Finally, data analysts are now fundamental members of ICSs, however, they often do not have experience working within the health sector and, thus, lack an understanding of the health system and patients at large. Moving forward, the NHS may want to consider:

a. Linking ICS datasets with key economic metrics to facilitate evidence creation of the impact that healthy populations can have on the economy;
b. Examining currently used performance metrics for their relevance to today's health system and replace with alternate system-wide options;
c. Re-working or refining existing policies (e.g. identification of hard-to-reach patients through the QOF) to better suit key health system objectives and PH; and
d. Enabling health sector experience for data analysts working with ICSs, to be better equipped to query big datasets, as well as understand health system and patient needs.

Bibliography

1. NHS England. Five Year Forward View [Internet]. 2014 [cited 2021 Jul 26]. Available from: https://www.england.nhs.uk/publication/nhs-five-year-forward-view/

2. WHO. Assessing national capacity for the prevention and control of noncommunicable diseases: report of the 2019 global survey. Geneva: World Health Organisation. 2020;

3. WHO. Noncommunicable diseases - Factsheet [Internet]. 2021 [cited 2021 Nov 8]. Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

4. Deloitte. The transition to integrated care Population health management in England. Deloitte Centre for Health Solutions [Internet]. 2019 [cited 2021 Aug 21]; Available from: https://www2.deloitte.com/uk/en/pages/public-sector/articles/population-health-management.html

5. Future NHS. Population Health Management Academy: PHM Maturity Matrix Sept 2020. 2020 [cited 2021 Aug 21]; Available from: https://future.nhs.uk/populationhealth/grouphome

6. Kamphuis B, Gill J, Vogelzang M, Haig M, Kanavos P. The Role of Virtual Health Care and the Pharmaceutical Sector in Improving Population Health [Internet]. 2021 [cited 2021 Jul 26]. Available from: https://doi.org/10.21953/4vxz-8553

7. NHS England and Improvement. Population Health Management [Internet]. 2019 [cited 2021 Aug 21]. Available from: https://www.adph.org.uk/wp-content/uploads/2019/02/NHS-England-Presentation.pdf

8. Kindig D, Stoddart G. What Is Population Health? Am J Public Health [Internet]. 2003 Oct 10 [cited 2021 Aug 12];93(3):380–3. Available from: http://ajph.aphapublications.org/

9. Future NHS. Population Health Management Academy [Internet]. [cited 2021 Aug 24]. Available from: https://future.nhs.uk/populationhealth/grouphome

10. Buck D, Baylis A, Dougall D, Robertson R. A vision for population health: towards a healthier future. [Internet]. KING'S FUND; 2018 [cited 2021 Aug 18]. Available from: https://www.kingsfund.org.uk/sites/default/files/2018-11/A%20vision%20for%20population%20health%20online%20version.pdf

11. Deloitte. The transition to integrated care Population health management in England. 2019.

12. The King's Fund. Sustainability and transformation plans (STPs) explained [Internet]. 2019 [cited 2021 Aug 18]. Available from: https://www.kingsfund.org.uk/topics/integrated-care/sustainability-transformation-plans-explained

13. Charles A. Integrated care systems explained [Internet]. 2021 [cited 2021 Aug 8]. Available from: https://www.kingsfund.org.uk/publications/integrated-care-systems-explained

14. Baird B, Beech J. Primary care networks explained [Internet]. The King's Fund. 2020 [cited 2021 Aug 14]. Available from: https://www.kingsfund.org.uk/publications/primary-care-networks-explained

15. Taylor K. The transition to integrated care: why population health management is critical to the future sustainability of health and social care [Internet]. Thoughts from the Centre | Deloitte UK. 2019 [cited 2021 Aug 18]. Available from: https://blogs.deloitte.co.uk/health/2019/03/the-transition-to-integrated-care-why-population-health-management-is-critical-to-the-future-sustain.html

16. People with long-term health conditions [Internet]. Office for National Statistics. 2019 [cited 2022 Aug 31]. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/adhocs/11478peoplewithlongtermhealthconditionsukjanuarytodecember2019

17. Murray E, Hekler EB, Andersson G, Collins LM, Doherty A, Hollis C, et al. Evaluating Digital Health Interventions: Key Questions and Approaches. Am J Prev Med. 2016 Nov 1;51(5):843–51.

18. Desveaux L., Soobiah C, Bhatia S, Shaw J. Identifying and Overcoming Policy-Level Barriers to the Implementation of Digital Health Innovation in Ontario: Qualitative Study. Health Serv Res. 2020 Aug;55(S1):112–3.

19. Dieleman JL, Squires E, Bui AL, Campbell M, Chapin A, Hamavid H, et al. Factors Associated With Increases in US Health Care Spending, 1996-2013. JAMA [Internet]. 2017 Nov 7 [cited 2021 Aug 12];318(17):1668–78. Available from: https://jamanetwork.com/journals/jama/fullarticle/2661579

20. The King's Fund. Are ICSs getting off to the right start? [Internet]. 2022 Jul [cited 2022 Aug 25]. Available from: https://www.kingsfund.org.uk/blog/2022/07/are-ics-getting-right-start

21. Hood CM, Gennuso KP, Swain GR, Catlin BB. County Health Rankings: Relationships Between Determinant Factors and Health Outcomes. Am J Prev Med [Internet]. 2016 Feb 1 [cited 2021 Aug 30];50(2):129–35. Available from: http://www.ajpmonline.org/article/S0749379715005140/fulltext

22. NEJM Catalyst. What Is Value-Based Healthcare? New England Journal of Medicine, Catalyst [Internet]. 2017 [cited 2021 Aug 12]; Available from: https://catalyst.nejm.org/doi/full/10.1056/CAT.17.0558

23. Lancet T. Access to COVID-19 vaccines: looking beyond COVAX. Lancet [Internet]. 2021 Mar 13 [cited 2021 Nov 5];397(10278):941. Available from: /pmc/articles/PMC7952094/

24. Hacker KA, Briss P, Richardson L, Wright J, Peterson R. COVID-19 and Chronic Disease: The Impact Now and in the Future. Prev Chronic Dis. 2021;18:1–6.

25. McElroy JA, Day TM, Becevic M. The Influence of Telehealth for Better Health Across Communities. Prev Chronic Dis [Internet]. 2020 [cited 2021 Sep 21];17. Available from: /pmc/articles/PMC7380287/

26. Steenkamer B, Drewes H, Putters K, Oers H van, Baan C. Reorganizing and integrating public health, health care, social care and wider public services: a theory-based framework for collaborative adaptive health networks to achieve the triple aim: https://doi.org/101177/1355819620907359 [Internet]. 2020 Mar 16 [cited 2021 Jul 26];25(3):187–201. Available from: https://journals.sagepub.com/doi/10.1177/1355819620907359

27. Yong C, Smith S. Population Health Management Flatpack: A guide to starting Population Health Management [Internet]. 2018 [cited 2021 Aug 5]. Available from: https://future.nhs.uk/

28. Berwick DM, Nolan TW, Whittington J. The triple aim: Care, health, and cost. Health Aff. 2008 May;27(3):759–69.

29. NHS England. The NHS Long Term Plan [Internet]. 2019 [cited 2021 Aug 10]. Available from: www.longtermplan.nhs.uk

30. NHS England and NHS Improvement. 2022/23 priorities and operational planning guidance [Internet]. 2021 Dec [cited 2022 Jan 15]. Available from: https://www.england.nhs.uk/wp-content/uploads/2022/02/20211223-B1160-2022-23-priorities-and-operational-planning-guidance-v3.2.pdf

31. Department of Health & Social Care. A plan for digital health and social care [Internet]. 2022 Jun [cited 2022 Aug 30]. Available from: https://www.gov.uk/government/publications/a-plan-for-digital-health-and-social-care/a-plan-for-digital-health-and-social-care

32. Justinia T. The UK's National Programme for IT: Why was it dismantled?: http://dx.doi.org/101177/0951484816662492 [Internet]. 2016 Nov 16 [cited 2021 Aug 14];30(1):2–9. Available from: https://journals.sagepub.com/doi/10.1177/0951484816662492

33. Department of Health & Social Care. Making IT work: harnessing the power of health information technology to improve care in England - GOV.UK [Internet]. 2016 [cited 2021 Aug 14]. Available from: https://www.gov.uk/government/publications/using-information-technology-to-improve-the-nhs/making-it-work-harnessing-the-power-of-health-information-technology-to-improve-care-in-england

34. The King's Fund. The Health and Care Act: six key questions [Internet]. 2022 [cited 2022 Aug 24]. Available from: https://www.kingsfund.org.uk/publications/health-and-care-act-key-questions

35. About NHS Digital [Internet]. NHS Digital. [cited 2021 Feb 3]. Available from: https://digital.nhs.uk/about-nhs-digital

36. Digital transformation [Internet]. NHS England. [cited 2021 Feb 8]. Available from: https://www.england.nhs.uk/digitaltechnology/

37. Asthana S, Jones R, Sheaff R. Why does the NHS struggle to adopt eHealth innovations? A review of macro, meso and micro factors. BMC Health Serv Res [Internet]. 2019 Dec 21 [cited 2021 Aug 14];19(1). Available from: https://pubmed.ncbi.nlm.nih.gov/31864370/

38. Alderwick H, Dunn P, Gardner T, Mays N, Dixon J. Will a new NHS structure in England help recovery from the pandemic? BMJ [Internet]. 2021 [cited 2021 Aug 6];372:248. Available from: http://dx.doi.org/10.1136/bmj.n248http://www.bmj.com/

39. NHS England. Working together at scale: guidance on provider collaboratives ICS implementation guidance. 2021.

40. NHS England and NHS Improvement. Thriving places: Guidance on the development of placebased partnerships as part of statutory integrated care systems. 2021.

41. BMA. Technology, infrastructure and data supporting NHS staff [Internet]. 2020 [cited 2021 Aug 5]. Available from: https://www.bma.org.uk/media/2080/bma-vision-for-nhs-it-report-april-2019.pdf

42. NHS Digital. Interoperability Toolkit [Internet]. 2020 [cited 2021 Aug 5]. Available from: https://digital.nhs.uk/services/interoperability-toolkit

43. Department of Health & Social Care. Integration and Innovation: working together to improve health and social care for all. 2021 [cited 2021 Aug 3]; Available from: www.gov.uk/official-documents.

44. UK Research and Innovation, Innovate UK, Department for Business Energy & Industrial Strategy. Industrial Strategy Challenge Fund: for research and innovation [Internet]. 2019 [cited 2022 Feb 9]. Available from: https://www.gov.uk/government/collections/industrial-strategy-challenge-fund-joint-research-and-innovation

45. NHSX. Digital Health Partnership Award [Internet]. [cited 2022 Feb 9]. Available from: https://www.nhsx.nhs.uk/key-tools-and-info/digital-health-partnership-award/

46. NHSX. Digital Technology Assessment Criteria (DTAC) [Internet]. [cited 2021 Aug 23]. Available from: https://www.nhsx.nhs.uk/key-tools-and-info/digital-technology-assessment-criteria-dtac/

47. NICE. Evidence standards framework for digital health technologies. [cited 2022 Jan 17]; Available from: https://www.nice.org.uk/about/what-we-do/our-programmes/evidence-standards-framework-for-digital-health-technologies

48. Health Economics Unit NHS. Population health analytics service [Internet]. [cited 2022 Aug 30]. Available from: https://healtheconomicsunit.nhs.uk/what-we-do/population-health-analytics-service/

49. Public Health England. Mental Health and Wellbeing JSNA [Internet]. 2020 [cited 2021 Aug 24]. Available from: https://fingertips.phe.org.uk/profile-group/mental-health/profile/mh-jsna

50. Department of Health. Statutory Guidance on Joint Strategic Needs Assessments and Joint Health and Wellbeing Strategies. 2013 [cited 2022 Feb 9]; Available from: www.nationalarchives.gov.uk/doc/open-government-licence/

51. NHS England. Using case finding and risk stratification: A key service component for personalised care and support planning. 2015 [cited 2021 Aug 9]; Available from: https://www.england.nhs.uk/wp-content/uploads/2015/01/2015-01-20-CFRS-v0.14-FINAL.pdf

52. NHS Digital. Population health team [Internet]. [cited 2022 Aug 30]. Available from: https://digital.nhs.uk/data-and-information/data-insights-and-statistics/population-health-team

53. Beddows D. Population Health Management Academy: Actuarial Projections for PHM Strategic Planning [Internet]. [cited 2021 Aug 15]. Available from: https://future.nhs.uk/system/login?nextURL=%2Fconnect%2Eti%2Fpopulationhealth%2Fgrouphome

54. Sanderson J, Kay N, Watts R. Universal Personalised Care: Implementing the Comprehensive Model [Internet]. 2019 [cited 2021 Aug 19]. Available from: https://www.england.nhs.uk/wp-content/uploads/2019/01/universal-personalised-care.pdf

55. McShane M, Kirkham K. Making it personal – population health management and the NHS. Journal of Integrated Care. 2020;28(3):243–52.

56. NHS England. NHS Accelerated Access Collaborative » What innovations do we support? [Internet]. [cited 2021 Aug 16]. Available from: https://www.england.nhs.uk/aac/what-we-do/what-innovations-do-we-support/

57. Public Health England. Place-based approaches for reducing health inequalities: main report - GOV.UK [Internet]. 2021 Aug [cited 2021 Aug 19]. Available from: https://www.gov.uk/government/publications/health-inequalities-place-based-approaches-to-reduce-inequalities/place-based-approaches-for-reducing-health-inequalities-main-report

58. Buck A, Lewis T. NHS England and tackling inequalities [Internet]. 2021 [cited 2022 Feb 15]. Available from: https://www.kingsfund.org.uk/blog/2021/12/nhs-england-and-tackling-inequalities

59. Behrendt M, Bains D, Warriner K. Primary and secondary care integration in delivery of value-based health-care systems. Br J Hosp Med [Internet]. 2018 Jun 12 [cited 2021 Aug 23];79(6):312–5. Available from: https://www.magonlinelibrary.com/doi/abs/10.12968/hmed.2018.79.6.312

60. Keeble E, Bardsley M, Durand MA, Hoomans T, Mays N. Area level impacts on emergency hospital admissions of the integrated care and support pioneer programme in England: Difference-in-differences analysis. BMJ Open. 2019;9(8).

61. Looman WM, Huijsman R, Fabbricotti IN. The (cost-)effectiveness of preventive, integrated care for community-dwelling frail older people: A systematic review. Health Soc Care Community [Internet]. 2019 Jan 1 [cited 2021 Aug 24];27(1):1–30. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/hsc.12571

62. Liu D, Pace ML, Goddard M, Jacobs R, Wittenberg R, Mason A. Investigating the relationship between social care supply and healthcare utilization by older people in England. Health Economics (United Kingdom). 2021;30(1):36–54.

63. The King's Fund. It's time to end top-down reform of the NHS [Internet]. 2014 [cited 2021 Aug 29]. Available from: https://www.kingsfund.org.uk/press/press-releases/time-end-top-down-reform-nhs

64. Culkin S, Panesar S. Data saves lives: building and up skilling the NHS analytics community [Internet]. 2021 [cited 2022 Sep 28]. Available from: https://transform.england.nhs.uk/blogs/data-saves-lives-building-and-skilling-nhs-analytics-community/

65. Mundasad S. NHS data-sharing project scrapped - BBC News [Internet]. 2016 [cited 2021 Aug 30]. Available from: https://www.bbc.co.uk/news/health-36723486

66. Cheetham M, Visram S, Rushmer R, Greig G, Gibson E, Khazaeli B, et al. 'It is not a quick fix' structural and contextual issues that affect implementation of integrated health and well-being services: a qualitative study from North East England. Public Health. 2017;152:99–107.

67. Department of Health & Social Care. The NHS Constitution for England [Internet]. 2021 [cited 2021 Sep 21]. Available from: https://www.gov.uk/government/publications/the-nhs-constitution-for-england/the-nhs-constitution-for-england

68. Wachter R, Hafner K. Making IT work: harnessing the power of health information technology to improve care in England [Internet]. 2016 [cited 2022 Apr 22]. Available from: https://www.gov.uk/government/publications/using-

information-technology-to-improve-the-nhs/making-it-work-harnessing-the-power-of-health-information-technology-to-improve-care-in-england

69. Tatarek-Gintowt R. Fair Shares - a guide to NHS allocations [Internet]. 2020 [cited 2021 Aug 14]. Available from: https://www.england.nhs.uk/wp-content/uploads/2020/02/nhs-allocations-infographics-feb-2020.pdf

70. Huang WY, Wong SH, Gao Y. Public Health. Encyclopedia of Quality of Life and Well-Being Research [Internet]. 2014 [cited 2022 Aug 30];5208–11. Available from: https://link.springer.com/referenceworkentry/10.1007/978-94-007-0753-5_2321

71. Department of Health. Helping people live better for longer. 2013;

72. Leicestershire Fire and Rescue. Braunstone Blues [Internet]. 2018 [cited 2022 Feb 9]. Available from: https://leics-fire.gov.uk/wp-content/uploads/2018/07/news-release_braunstone-blues-to-leave-legacy-june-2018.pdf

Appendix I. Supplementary information on the English NHS

Type	Tax-payer financed health system (>80% of funding from public sources)
Coverage	Universal access to health care that is mostly free at the point of delivery
Competition	Limited competition between providers in public system
Decentralised	Health care financing and service organisation is devolved within UK and decision-making fairly decentralised

Funding and resources

Traditional funders

UK residents pay taxes which entitles them to receive free-at-the-point-of-service health care from the NHS. NHS services cover all aspects of prevention, management, treatment, and rehabilitation as set forward by NICE. NICE is a national public body that reviews evidence for new interventions and provides guidance on health care improvements, thus all devices used to support, manage, or treat illness need to be approved for use through NICE.

Private insurers are an alternative type of traditional funder. Private health care is widely available in the UK but remains a relatively small market. Major private healthcare providers leverage shorter waiting times and innovative technologies not available through NICE to attract their customer base.

Non-traditional funders

Occasionally, the national government sets funds aside for initiatives within the NHS that is funding beyond what is normally allocated. For example, in 2016, the UK Treasury provided £4.2 billion for NHS digitisation [68]. Additionally, national allocations of ring-fenced funding has been provided to help establish STPs and PCNs [14].

Financial flows and funding environment

Currently, funding for standard care and services was allocated to CCGs by NHSE/I based on a formula that considers geographic distribution, local health needs and health equity, and the type of services commissioned by the CCG [69]. However, per the NHS Long Term Plan [29], the NHS intends to reform its payment system from a majority activity-based reimbursement scheme to something that is population-based.

Appendix II. Additional Information for Methods

Data Collection

This paper draws on a mixture of primary and secondary research to understand and explore the concept and implementation of PHM in England.

Secondary data collection

A scoping literature review of peer-reviewed and grey literature was completed to comprehensively search the literature and 'map' PH efforts within England regarding the key components of the four critical building blocks, as shown in Table 1. The majority of the literature identified within the review was grey literature due to the recent implementation and focus on PHM.

The review was conducted using Joanna Briggs Institute reviewer's manual. Databases Medline and Scopus were searched for peer-reviewed literature using a search strategy influenced by the PICO table; the search strategy included all terms present in the 'search strategy' column (Appendix Table 1). Literature was searched from 2014 to 2022, when PHM was first introduced strategically in the NHS Five Year Forward View, and studies were included if their main focus was the implementation or effects of PHM in England. Screening was completed within the systematic review software Rayyan. A two-step process was used for the identification of relevant studies. Firstly, titles and abstracts were screened for relevance, followed by the full text of studies that passed the previous step (Appendix Figure 1).

Grey literature was searched through Google using the same key terms as used in the peer-review search. Sources were only identified from the first ten pages, and additional sources were identified through reference list screening. Sources were included if from governmental bodies (e.g. NHS England), non-governmental organizations (such as The Nuffield Trust and The King's Fund) and commercial entities (e.g. Deloitte). The same time frame was used as peer-reviewed literature.

Primary data collection

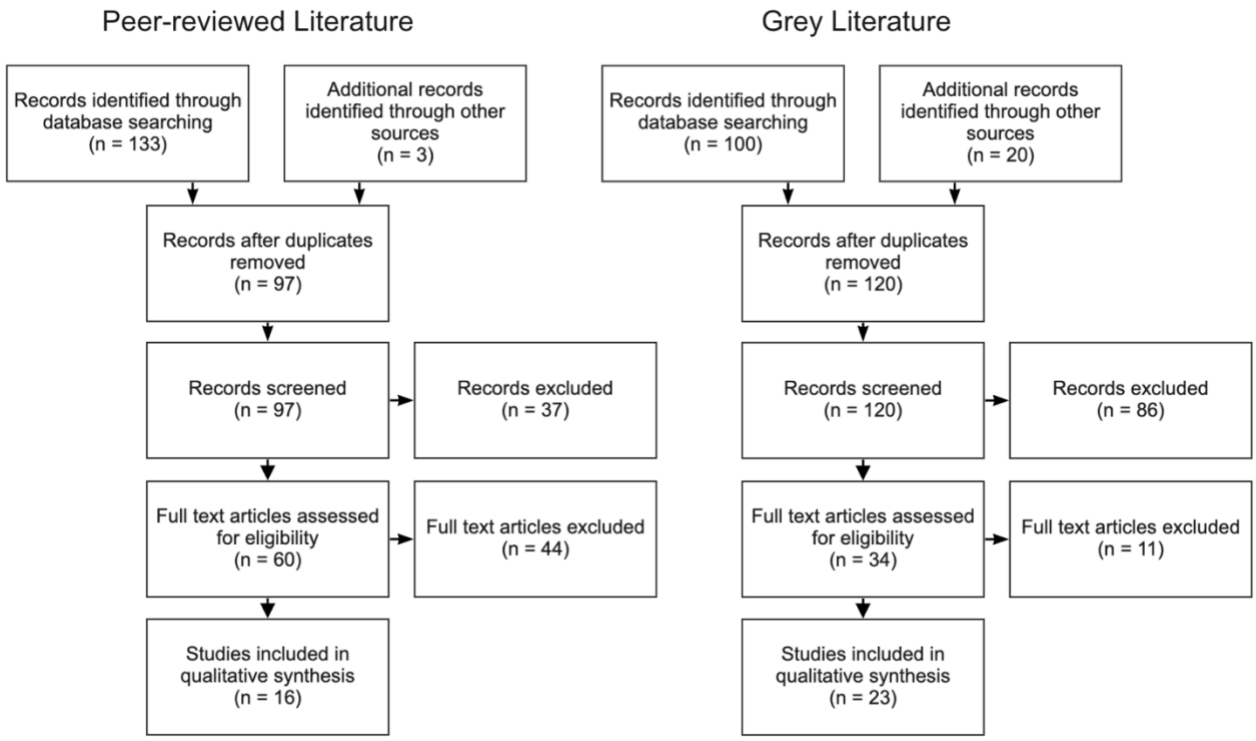
A series of semi-structured interviews were completed with several stakeholders of the English health system; these included a clinician, senior managers and individuals in strategic positions within the NHS, as well as an advisor to the NHS on digital technologies. These stakeholders were selected based on their insight on whether the NHS was delivering on claims and goals set out in government white papers and having insight on the issues on the ground with implementation. The primary focus of the interviews was to gain an understanding of the key challenges, as well as opportunities in the implementation of PHM, particularly concerning the key components of the critical building blocks of PHM (Table 1). Specific questions were asked relating to the challenges of implementing the digital infrastructure needed for PHM, as well as what the NHS is doing specifically to reduce inequalities, what the technical barriers are and how the mindset of the system can shift (see Appendix III. Interview guide for complete guide). Interviews were transcribed, and a thematic analysis was completed to identify key themes, as identified in section 3.

Appendix Table 1: PICO Table for Scoping Review

PICO Elements	Keywords	Search Terms	Search Strategy
Population	England	England	England AND NHS
Intervention	Population health management implementation in the NHS	Population health	Population health OR Population health management OR Integrated care
Comparison	N/A	N/A	N/A
Outcome	Implementation	Implementation	implementation

Source: The authors.

Appendix Figure 1: PRISMA flow diagram of scoping review search



Source: The authors.

Appendix III. Interview guide

- Q: Why population health? What do you think is so important about population health & why has there been such a large focus on it recently?
- Q: What do you think are the biggest challenges and opportunities for population health management?
- Q: What do you think are key healthcare priorities that we could test the paradigm of population health on?

Culture & Mindset

- *Background*: Population health management requires a completely different mindset than what is currently observed in the NHS. It has a large emphasis on preventative care, the movement from episodic care to patient centric and increased patient engagement in their own health. This change in mindset & culture is seen as a significant challenge in the implementation of PHM.
- Q: How do you think this change in mindset can be achieved?
- *Background*: Collaboration between multidisciplinary teams is extremely important for the success of integrated care systems. We've seen that collaboration between providers & teams is very system specific and relies a lot on strong working relationships between groups & individuals.
- Q: How is the NHS going about assisting with increasing collaboration & how can we overcome the barriers to collaboration?

Data & Interoperability

- *Background*: Population health management requires different care providers ideally having access to patient information and data to provide integrated care across large population groups.
- Q: The NHS has struggled with data interoperability in the past, do you think we are on a good path to data interoperability between health, social care & voluntary sector?
- Q: Is there anything more/different you think can be done to improve data collection and interoperability?

Health & Care Bill (July, 2021)

- *Background*: As you are aware, in July 2021 a new health & care bill was put forward to Parliament, which proposed changing the current voluntary integrated care systems to being statutory.
- Q: Do you think this change will have a large impact on the success of Integrated Care Systems? If so, what is this impact likely to be?
- Q: Additionally, it was proposed that ICSs will be required to promote integration, reduce inequalities in health outcomes & between patients and 'promote innovation in the provision of health services'. How do you think these aims should be measured?

Inequalities

- *Background*: Within all the government white papers throughout the past few years, two key focus areas relate to (a) reducing inequalities and (b) increasing preventative measures. But it's difficult to see what is actually changing in order to reach these goals.
- Q: In your view, what is changing with regards to inequality reduction and prevention?
- Q: How do you think progress should be measured?
- Q: Due to the broad nature of inequalities, are there any aspects of inequalities that population health management could maybe target first?

Health Economics & Digital health

- Q: Do you see NICE/NHSd/NHSe making necessary changes to their regulation/assessment/appraisal pathway(s) to support the implementation of digital health interventions, as well as the rapid pace of innovation? And is there anything more that you think could (or should) be done?
- Q: Do you see scientific & governmental infrastructure adequately enabling digital health innovation?
    - E.g. the digital health partnership award & industry strategy challenge fund
- Q: In the 2021-2026 NICE Strategy, they are aiming to place a stronger focus on prevention & the reduction of health inequalities in the guidelines. Do you think this will have a large impact on contributing to population health management?
- Q: How do you think the digital transformation can help patients become pro-active about their health? Do practitioners need additional incentives in this context?

Appendix IV. Key principles of personalised care

Appendix Table 2 displays the 6 key principles of personalised care laid out in the personalised care plan by NHS England [54]. The plan also includes goals for each principle by 2023/24 and their maximum potential scale.

Appendix Table 2: Key principles of personalised care

Key Principles of Personalised Care	Principle overview
Personalised care and support planning	People have proactive, personalised conversations focussing on what matters to them. Includes both clinical needs and their wider health and wellbeing.
Supported self-management	Increasing the knowledge, skills and confidence (patient activation) of patients in managing their own health and care. Systematic implementation of interventions such as health coaching, self-management education and peer support.
Shared decision-making	Individuals are supported in order to (a) understand the range of support and treatments, as well as the risks and benefits and consequences associated with them; (b) make a decision on their preferred course of action based on their personal preference and evidence-based information.
Enabling choice	Enables the choice of provider and services to meet the patient's needs. Additionally, an alternative provider is available if the patient is not able to access certain services within national waiting time standards.
Social prescribing and community-based support	Enables local agencies to refer people to a 'link-worker' and connect them to community based support based on what the individual has identified is important to them via shared decision making, and personalist care and support planning.
Personal health budgets and Integrated personal budgets	An amount of money put towards an individual's health and care needs, planned and agreed between the individual and their local CCG. Personal health budgets may lead to integrated personal budgets if individuals have both health and care needs. This uses available money to better meet the individual needs of a patient.

Source: [54]