

# A mixed-methods process evaluation of an integrated care system's population health management system to reduce health inequalities in COVID-19 vaccination uptake

Georgia Watson and Cassie Moore

*Department of Public Health, London Boroughs of Camden and Islington, London, UK*

Fiona Aspinall

*Department of Applied Health Research, University College London, London, UK*

Andrew Hutchings

*London School of Hygiene and Tropical Medicine, London, UK, and*

Rosalind Raine and Jessica Sheringham

*Department of Applied Health Research, University College London, London, UK*

## Abstract

**Purpose** – Many countries have a renewed focus on health inequalities since COVID-19. In England, integrated care systems (ICSs), formed in 2022 to promote integration, are required to reduce health inequalities. Integration is supported by population health management (PHM) which links data across health and care organisations to inform service delivery. It is not well-understood how PHM can help ICSs reduce health inequalities. This paper describes development of a programme theory to advance this understanding.

**Design/methodology/approach** – This study was conducted as a mixed-methods process evaluation in a local ICS using PHM. The study used Framework to analyse interviews with health and care professionals about a PHM tool, the COVID-19 vaccination uptake Dashboard. Quantitative data on staff Dashboard usage were analysed descriptively. To develop a wider programme theory, local findings were discussed with national PHM stakeholders.

**Findings** – ICS staff used PHM in heterogeneous ways to influence programme delivery and reduce inequalities in vaccine uptake. PHM data was most influential where it highlighted action was needed for “targetable” populations. PHM is more likely to influence decisions on reducing inequalities where data are trusted and valued, data platforms are underpinned by positive inter-organisational relationships and where the health inequality is a shared priority.

**Originality/value** – The COVID-19 pandemic accelerated a shift toward use of digital health platforms and integrated working across ICSs. This paper used an evaluation of integrated data to reduce inequalities in COVID-19 vaccine delivery to propose a novel programme theory for how integrated data can support ICS staff to tackle health inequalities.

**Keywords** Integrated care systems, Population health management, Health inequalities

**Paper type** Research paper



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## Introduction

In many countries, health policy has moved towards greater structural integration between different organisations that plan, commission and deliver health and care (NHS England, 2019). In England, for example, the [Health and Care Act \(2022\)](#) formalised partnership working through the creation of Integrated Care Systems (ICSs). ICSs are geographical partnerships comprising hospital, mental health and community trust healthcare providers; primary care providers; clinical commissioning groups and local government organisations, which have a lead role for public health ([Health and Care Act, 2022](#)). They have a remit for reducing health inequalities ([Alderwick \*et al.\*, 2022](#)). However, there has been a lack of clarity about how this should be achieved. Early ICS plans for reducing health inequalities had variable and vague conceptualisations of health inequalities, with little precise information about which groups or health outcomes were affected ([Olivera \*et al.\*, 2022](#)). More recent plans demonstrated clearer conceptualisation of inequalities but still little detail on how ICSs will affect the wider determinants of health ([Goddard, 2023](#)).

The English Health and Care Act recognises the need for sharing patient information across organisations as a key mechanism to support integration and population health management. All areas are required to use joined-up data by 2025 to support their planning ([Department of Health and Social Care, 2021a](#)). Population Health Management (PHM) is an emerging approach that seeks to facilitate the application of data in practice to improve the health of a defined population ([Steenkamer \*et al.\*, 2017](#)). It has been used for several years internationally, particularly in the USA. It is particularly relevant to an integrated care context because it involves linking and analysing health and social care data from different organisations to understand the health of a local population, predict what local people will need in the future, and to inform decisions on the design and delivery of services. In England, PHM is expected to be important in enabling ICSs to reduce health inequalities (NHS England, 2023), and it features in many ICS plans ([Goddard, 2023](#)).

There is a paucity of evidence, however, about how PHM can help ICSs to reduce health inequalities. There are two main reasons for this. First, there are well documented challenges to sharing the data required to understand population need across organisations. As a result of this, efforts have been focussed on how to share data and achieve data linkage, and not on how staff can use PHM. However, it has been recognised that staff usage is key ([Ingram \*et al.\*, 2022](#); [McShane and Kirkham, 2020](#)). Secondly, the goal of reducing inequalities in health or health care appears to be absent from international models, definitions and theories about PHM. In [Steenkamer \*et al.\*'s \(2017\)](#) international scoping review to define PHM, for example, reducing inequalities or inequities in health or healthcare is not mentioned ([Steenkamer \*et al.\*, 2017](#)).

There is a need to clarify PHM's role in reducing health inequalities in order to explain and to enhance the utility of PHM for this purpose. This clarification can help ICSs to take full advantage of PHM, which is variably understood at present. To address this gap, we propose a first iteration of a programme theory about how and when PHM can help ICSs to reduce health inequalities. Programme theories set out causal pathways linking interventions to anticipated outcomes, which can be useful to guide future evaluation and implementation ([Baraitser \*et al.\*, 2015](#)). In developing this programme theory, we seek to generate debate and advance the capacity for further research into the role of PHM systems in reducing inequalities in health care.

## Methods

We conducted a process evaluation using a mixed-methods approach. We combined a team of research practitioners and senior stakeholders embedded within a local and regional health and care system with university researchers. The evaluation was conducted in two

overlapping phases. The first phase focussed on a specific local PHM tool designed to reduce inequities in COVID-19 vaccination delivery and comprised qualitative interviews and quantitative analysis of staff usage of the tool. The second phase sought to explore the transferability of findings from the case study context through a workshop with participants drawn from PHM programmes across England.

The objectives and the methods (described more fully in the protocol) are summarised below, indicating where and why methods diverged from what was planned in the protocol (Watson *et al.*, 2022).

#### *Phase 1 – mixed methods evaluation of PHM usage in the context of reducing inequities in COVID-19 vaccine delivery*

The national COVID-19 vaccine programme required all health and care systems to work rapidly to mobilise vaccine delivery mechanisms, and collaboratively monitor and ensure high uptake across their regional population (Table 1). North Central London Integrated Care System (NCL) developed the COVID-19 Vaccination Dashboard in December 2020 to help promote uptake and reduce inequities in delivery of the COVID-19 vaccine (Watson *et al.*, 2022). We selected this Dashboard as the evaluation’s focus because NCL was keen to understand whether and how PHM helped them reduce inequities in vaccine delivery and thus reduce health inequalities. There is good evidence that vaccine delivery protects against COVID-19 acquisition, and against severe disease, hospitalisations and mortality in those who do contract it (Dagan *et al.*, 2021). Therefore, it is credible to propose that reducing inequities in COVID-19 vaccination delivery could reduce inequalities in both healthcare use and health outcomes. Figure 1 gives an illustration of the Dashboard, with more information on its construction and design in the protocol (Watson *et al.*, 2022).

#### *Qualitative data collection and analysis*

Our objective was to describe how (or whether) staff across organisations used evidence of inequities in uptake available in NCL’s COVID-19 Vaccination Dashboard to shape delivery or care.

Interviews were conducted with health and care staff across NCL who used the COVID-19 Vaccination Dashboard, either directly or indirectly via an intermediary. Potential participants were initially identified through NCL’s PHM programme leads’ recommendations of staff that would be expected to use the Vaccination Dashboard in their role. Then, a snowball approach was taken with those who agreed to take part supplemented with additional advertising through a local GP news bulletin and COVID-19-related working groups.

All interviewees gave written consent to take part. Four members of the evaluation team conducted interviews. Normalisation Process Theory (NPT) was used as a sensitising framework to structure a topic guide to capture staff perceptions and experiences of the Dashboard (Murray *et al.*, 2010). After piloting, three versions of the topic guide were produced for use with different participants based on whether they used the tool directly or indirectly, and whether they had access to personal identifiable data. Interviews were conducted on MS Teams, recorded and transcribed. Additionally, interviewers made brief notes about their interviews, capturing their impressions in “pen portraits”.

Transcripts and pen portraits from interviews were analysed alongside contextual documentation comprising correspondence from NCL about the dashboard, and personal emails from participants about the Dashboard shared with interviewers. These data were analysed using the Framework method (Gale *et al.*, 2013). We used an initial coding framework based on the four constructs of NPT which was adapted inductively in response to the data (May and Finch, 2009) (Supplementary Table S1). Two members of the team

**Table 1.**  
The COVID-19  
vaccination  
programme – the UK  
policy context

Date	Policy event
8 December 2020	COVID-19 vaccine rollout began
17 December 2020	Scientific Advisory Group for Emergencies (SAGE, 2021) <ul style="list-style-type: none"> <li>• Reports evidence of ethnic inequalities in uptake of other national vaccine programmes, and variations by ethnicity in readiness to take up the offer of a COVID-19 vaccine; recommends specific strategies to minimise the risk of lower uptake in minority ethnic populations</li> </ul>
30 December 2020	Government's Joint Committee on Vaccination and Immunisation (JCVI, 2020) <ul style="list-style-type: none"> <li>• Announced the order for vaccination rollout, with clear prioritisation given by age to prevent mortality</li> <li>• First phase comprised four cohorts in order <ol style="list-style-type: none"> <li>1. Elderly care home residents and their carers, followed by</li> <li>2. Over 80 years and frontline health and social care workers</li> <li>3. Aged 75 and over</li> <li>4. Aged 70 and over plus clinically extremely vulnerable individuals.</li> </ol> </li> </ul> JCVI also recommended “flexibility in vaccine deployment at a local level” to mitigate health inequalities in access to healthcare and ethnicity
13 January 2021	UK Vaccines Delivery Plan (Department Of Health And Social Care, 2021b) sets out that NHS England (devolved locally) working with Public Health England will provide vaccinations in <ul style="list-style-type: none"> <li>• Vaccine centres (large venues – accessed by a national booking system)</li> <li>• Hospital hubs</li> <li>• Local services (e.g. general practices and pharmacies)</li> </ul>
15 February 2021	Deadline for the first four cohorts to have been offered a first vaccine dose
February–April 2021	Eligibility for first vaccine dose widened to the following cohorts, in order <ul style="list-style-type: none"> <li>• Over 65 years</li> <li>• Aged 16–64 at high risk of serious illness or death from COVID-19 because of underlying health conditions</li> <li>• Over 50 years</li> </ul>
April 2021	Eligibility for first vaccine dose widened to: 40–49 years and 30–39 years
June 2021	Eligibility for first vaccine dose widened to: 18 years and over
<b>Source(s):</b> Department of Health and Social Care (2021b), Joint Committee on Vaccination and Immunisation (2020), Scientific Advisory Group for Emergencies (2021)	

conducted coding on all transcripts (GW, CM). The wider evaluation team read key transcripts and advised on coding refinements and descriptive analysis.

### Quantitative methods

*Objective:* To describe staff usage of NCL’s COVID-19 Vaccination Dashboard, including differences over time and by organisation.

*Data:* CM sought anonymised staff usage data already stored within NCL’s PHM system from the time of its launch in December 2020 until November 2021. NCL analysts extracted data on all staff registered to access the Dashboard from NCL’s PHM platform. Multiple iterations of the dataset were produced by CM in partnership with the NCL analysts, for example, to correct organisation names, to assign Dashboard users to consistent organisational categories, to assign each user to the correct user access category (i.e. that took into account their rights to view individual- or population-level data) and to clarify how “activity” recorded in the PHM system’s metadata corresponded to users’ views of, and actions on, the Dashboard.

*Analysis:* Data were cleaned in Excel and imported to Stata 15 for analysis (StataCorp, 2017). Local and national policy documentation were used to identify key time points in the vaccination programme and in the development of the Dashboard (Table 1). We sought to

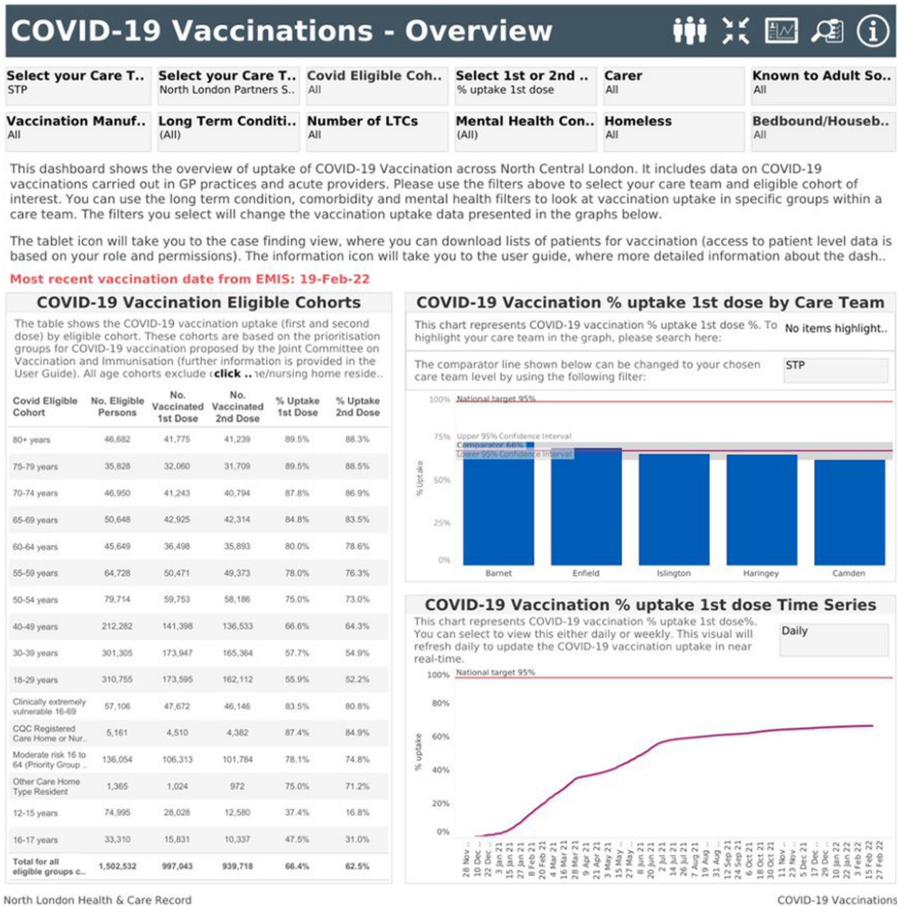


Figure 1. Screenshot from NCL's population health management system's COVID-19 vaccination uptake dashboard, 2021

North London Health & Care Record  
 Source(s): North London Partners

describe usage by presenting the numbers of staff using the Dashboard as a proportion of those given access (i.e. those eligible to use it). This was not possible because data were missing for many staff that been granted access to the Dashboard but had not used it. In addition, it became clear that staff were given access to the Dashboard at different time points, and some would have lost access during the lifetime of the Dashboard (e.g. because of leaving the organisation) but date of granting or losing access for each user was not captured in the system. The variables constructed for the analysis are described in [Supplementary Table S2](#).

*Phase 2 – development of programme theory through mixed-methods synthesis and interpretation*

An initial programme theory was developed through reviewing the analysis of both the quantitative and qualitative components of the case study evaluation and through discussing findings with NCL staff and stakeholders between December 2021 and June 2022.

A workshop was held in June 2022 with individuals working in PHM nationally and internationally to extend the programme theory for how integrated health and care systems could use PHM to reduce health inequalities. Initial discussions with the NHS England PHM development programme, national and international experts (n = 10) identified leaders in PHM using different approaches in different contexts. It also provided examples of how integrated systems were seeking to use PHM to inform individual patient care, service delivery and inter-organisational commissioning. Workshop participants (n = 50) were identified and invited through several routes including the NHS England PHM development programme, regional research networks and national public health networks. The workshop was held simultaneously in person and on Zoom and recorded, with Sli.do software used to capture participant comments and questions (Sli.Do, 2022). The recording of stakeholder discussions and poll results were used in conjunction with the local evaluation findings to develop a generalised programme theory.

## Results

### *Phase 1 sample*

Interviews were conducted with 19 health and care professionals across a range of organisations in the ICS involved in the planning or delivery of the COVID-19 vaccination programme. Participants represented a range of professional groups working in primary care, acute trusts, public health teams and the Clinical Commissioning Group (CCG) across all five boroughs in NCL (Table 2). The final quantitative dataset is summarised in Table 3.

### *Phases 1 and 2: programme theory*

A model of the programme theory is illustrated in Figure 2. It is structured under the headings of context, mechanisms and outcomes, with arrows showing the directional relationships between these constructs. The themes and supporting evidence are described in detail below.

	n	
Role	Analyst	5
	Strategic (e.g. Director, Consultant in Public Health)	12
	Commissioning	2
Organisation type	Clinical (incl. GPs)	3
	Clinical Commissioning Group	3
	Primary care	6
	Local authority	10
	Hospital	1

**Note(s):** The sum of all categories is greater than 19 because some participants fulfilled more than one role or worked across organisations

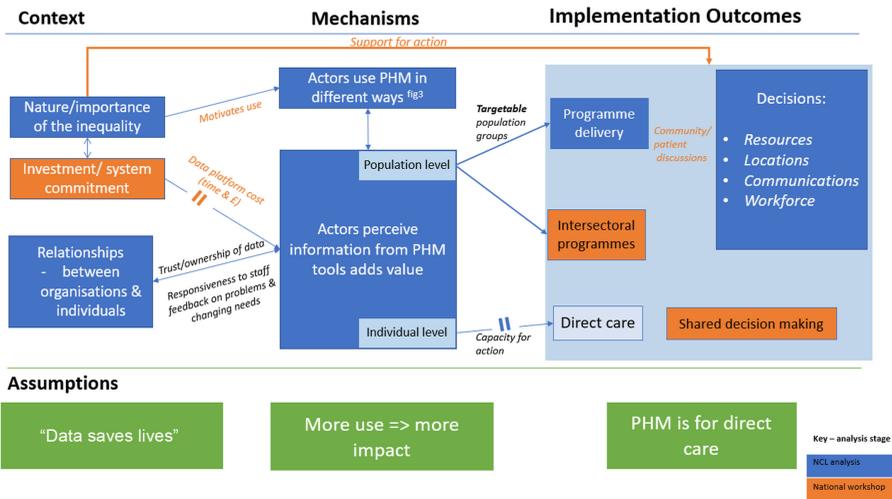
**Source(s):** Interview participant data

**Table 2.**  
Interviewee  
characteristics (n = 19)

Variable	n
Users (individuals with accounts that accessed the Dashboard)	289
Organisation category (within NCL only)	6
Events (i.e. logins, page views, downloads)	12,198

**Source(s):** North London Partners COVID-19 Dashboard user data

**Table 3.**  
PHM staff usage  
analytics over the  
lifetime of the tool  
(December 2020–  
November 2021)



**Figure 2.** Model of a programme theory proposing how actors in a supportive context may be enabled to use PHM to address health inequalities across an integrated care system, and how such usage may result in decisions to reduce health inequalities

**Note(s):** The assumptions that initially underpinned the way in which PHM would work are shown in green, with elements of the programme theory developed from analysis of NCL case study data in blue, and iterations from wider stakeholder input from the national workshop in orange

**Source(s):** Figure created by JS and GW

*Context*

There were three contextual conditions which actors identified as important for the success of PHM: the importance ascribed to the health inequality in question, the importance of investment and commitment to data sharing and the role of underlying personal and organisational relationships.

*Importance of the inequality.* In the interviews and documentation analysed within NCL, the overwhelming importance of the COVID-19 vaccination programme was clear. There was local recognition of inequalities in the risk of and from COVID-19, particularly by ethnicity. A tangible example of this support was the ICS’ financial and strategic commitment to deviate from “one size fits all” provision of vaccinations in a small number of high-volume clinic settings to commissioning multiple “pop-up” and mobile vaccination sites.

*“The vaccination programme is probably the single most important thing I will ever do in terms of the country and recovery of the country. You can’t just go, ‘Oh well, never mind, we’ve got 90% of people, it’s fine’. You have to think, ‘Right. OK. We’ve got to go the extra mile to sort this out.’”*

Participant 11, Director, Endorser

*Investment/system commitment.* Stakeholders in the workshop commented that linkage of data and thus development of PHM tools was further progressed in NCL compared to other regions. NCL’s data linkage had required several years of development before the production of analytical tools for health system usage was possible. Several actors also noted difficulty in obtaining the commitment and investment needed to take action in response to the findings arising from the PHM tool. In particular, there was a tension between spending more initially on approaches to achieve equity in delivery or outcomes versus the health care systems’ efficiency goals.

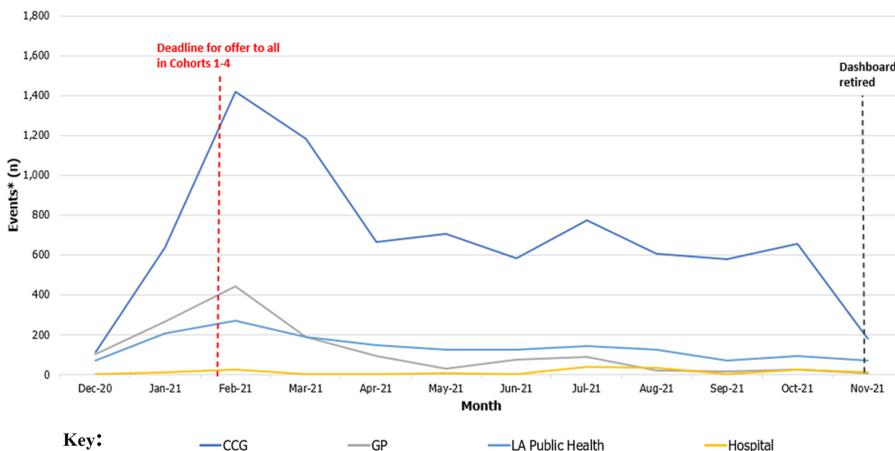
*Personal and organisational relationships.* There was evidence from our interviews that using the Dashboard facilitated better inter-organisational communication and collaboration. PHM was described as an enabler of ICS formation and the Dashboard was a practical example of this. At the time of the case study, ICSs were being established throughout England. This meant that staff were experiencing the dissolution of previous organisations and were forming new networks. This was also occurring during lockdowns when meeting in person was difficult. At this time, therefore, there was a particular receptivity to mechanisms that could bring people together. Users described that key factors leading to system working were that the data were the same for all users (excepting role-based access to personal identifiable data), that the data were accessible to all health and care providers in NCL and that the data were local and therefore users trusted the information provided by the Dashboard. The tension between national strategic direction and local decisions guided by local data was a clear theme in dissemination discussions, and representatives from PHM systems within and beyond NCL echoed the value of local insight and ownership.

*“The fact that we share a sort of underlying dataset and a way of accessing it is really helpful and I think going forward that’ll really help us in terms of perhaps working more across the system and helping each other.”*

Participant 36, Senior Public Health Analyst, Deployer

*Mechanisms by which PHM may be implemented*

*Actors use PHM in different ways.* Analysis of staff usage of the Dashboard in NCL showed that the number of users and intensity of Dashboard use both peaked in February 2021 at the time of national programme deadlines for offering the vaccine to all in the first cohorts. Whilst the number of GP users dropped considerably after mid-February, the number of CCG users remained consistent (between 25–35 users) up to late October 2021 (Figure 3).



**Note(s):** CCG = clinical commissioning group – NHS predecessor organisations to ICS, responsible for planning the vaccine programme; CSU = commissioning support unit, responsible for data analysis to support CCGs; GP federation = organisations of GPs; LA public health = public health staff in local authorities

An event refers to each time a user performs an action, e.g., a log-in, downloading a resource, clicking on a visualisation, navigating to a new page

**Source(s):** Figure created by CM, AH and JS

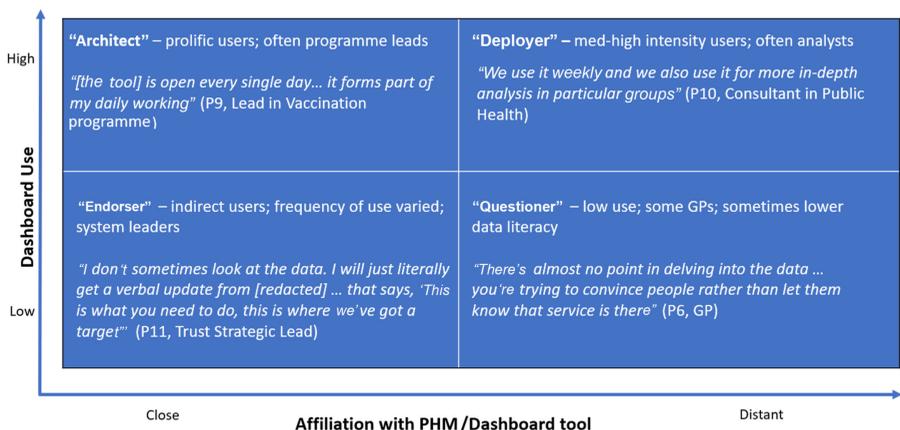
**Figure 3.**  
Dashboard use by  
staff group

Interviews with users indicated that the quantity of digital interactions with the tool did not always equate with engagement with the Dashboard. Many participants reported sharing information onwards to other stakeholders in the form of reports and verbal updates. Participants' descriptions of their engagement with the tool and its data enabled them to be categorised into four user types: architects, endorsers, deployers and questioners (Figure 4).

A user's affiliation with the PHM programme or involvement in the Dashboard design was correlated with their user type and usage profile. We characterised many of the tool's most prolific users as "architects", often programme leads who were involved in designing the Dashboard. "Deployers" also had consistently high usage. They were typically analysts or other professionals used to working with data. In contrast to architects, deployers were not closely affiliated with the Dashboard. We identified a group of indirect users, "endorsers". Endorsers may not have accessed the Dashboard directly at all but used the outputs to inform decisions. They were often system leaders and likely to emphasise the strategic importance of the tool even if they did not access it personally. The group with the lowest use – "questioners" – was distant from the design of the tool and often less comfortable working with data. Questioners were often clinical staff, or others similarly distant from the strategic development of the Dashboard. Some participants described lack of training and inconsistent or impersonal communications about the tool as barriers to their usage.

Local stakeholders were unsurprised by the findings, as many of the decisions about vaccine delivery strategy were made by system leads in collaboration with local providers. Many frontline clinicians were more involved in the physical delivery of vaccines than strategic planning, and therefore less likely to use the Dashboard to refine their approach. They considered the user typology and feedback a useful demonstration of the need for tools like the Dashboard to be tailored and specific, and the fact that a smaller pool of "super-users" may be more effective than generalised use for some population health programmes.

*Actors perceive information from PHM tools adds value.* The value of the PHM platforms rested not just in the data that were available, but in the interpretation or presentation of such data. It was broadly reported that the novel elements of the Dashboard were one of the most important features supporting users to translate insight into action, namely that the Dashboard provided access to information which was otherwise unavailable including demographic data such as language spoken, small geographies and granular ethnicity information; and health information such as learning disability, mental health and long-term condition status. Access to this information enabled users to identify sub-groups of residents to support.



**Figure 4.**  
Types of PHM user identified from interview data with typical quotes

**Source(s):** Figure created by GW, JS and CM

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*“Having the first language spoken, it was quite useful to see which cultural groups you need to target, rather than just ethnicity, which is something that I’ve not really seen in other datasets”*

Participant 42, Public Health Analyst, Deployer

Participants also reported that being able to benchmark and compare uptake across sites and providers was helpful and important.

*“It also enables us to . . . layer that information . . . you want to look at your, maybe younger housebound population, we can very quickly overlay those two things and see the impact.”*

Participant 9, Lead in Vaccination Programme, Architect

There were also examples of where difficulties in obtaining data limited the platform’s usefulness; some found the interface difficult to use and were at times unable to find the information they needed. Some participants still found the tool valuable because the PHM team made multiple changes to the Dashboard in response to identified limitations or when the context changed. For others, these challenges posed a barrier to usage, demonstrating the varied needs of users from interpretative analytical tools such as the Dashboard, and the need for better communications and training on the use of the tool.

*“It’s actually pretty hard to navigate as well. It’s not very intuitive . . . I can’t get the link, I can’t work out where it is, I don’t have the time to do it.”*

Participant 6, GP, Questioner

Some users also described their own limited capacity to act on information gleaned from the dashboard, suggesting additional opportunities for organisational integration.

*Implementation outcomes:* Translation of insight into actions or decisions to reduce inequalities.

Most interview participants reporting that the information in the Dashboard helped them to recognise inequities in the vaccine programme. Through this recognition, they could take actions to make a significant difference to inequalities in vaccine programme delivery which resulted in reducing inequalities in vaccine uptake.

### *Programme delivery*

Participants described multiple strategies to increase awareness or readiness to accept existing vaccination opportunities, including communication strategies, for example investing in translating leaflets and videos into languages spoken by populations with lower uptake; targeting communication campaigns via WhatsApp and social media; ensuring that campaigns used images reflecting the ethnic groups they were aiming to reach; workforce strategies, using staff reflective of communities and utilising trusted community voices to deliver vaccination information and reaching out to communities via door-knocking; working closely with faith or community leaders to share accurate information including about uptake.

*“We’ve got that information and we’ve got it at a fairly granular level to allow us to then effectively target those communities or engagement events. So we’ve done a lot of engagement events on social media and stuff like that – again, those have been targeted at audiences that we know are hesitant using languages that we know they can speak.”*

Participant 36, Senior Public Health Analyst, Deployer

Participants also described physical changes made to the location of vaccine delivery units and reported that these changes may not have been made without the evidence provided by the Dashboard, as the more mobile and flexible delivery model was more resource-intensive than centralised vaccination centres. For example, the Dashboard’s capacity to display maps

showing areas with very low uptake was used in the business case for, and design of route of, vaccine buses which were deployed in areas of low uptake. Additionally, NCL commissioned ‘pop-up’ vaccination events, for example arranging vaccination drives at sports stadiums aimed at young people, at universities aimed at students or employing vaccine link workers.

*“[We] use it to set the groups who need to have vaccine link workers for so for example, identify the need to have a Polish speaking vaccine community worker.”*

Participant 10, Consultant in Public Health, Deployer

Participants ascribed value to the Dashboard providing “targetable” information, namely that which enables the user to reach a specific population group in a tangible way for example via an identified location. Participants highlighted that targeting, in turn, was enabled by the dashboard’s ability to layer and combine characteristics, such as ethnicity and language spoken, enabling an intersectional and granular approach. Finally, the short duration between initiating an action and seeking a change in the data gave them confidence in both the data and their approaches.

*“We saw low uptake in White Other populations, and our first vaccine bus after doing specific door knocking in those communities, we had our highest number of vaccines administered in the White Other populations that are Romanian, Bulgarian, and Turkish. And, again, the same in our Caribbean population, again low uptake targeted with door knocking, targeting community leaders and that was our second highest uptake from our vaccine buses.”*

Participant 1, Public Health Analyst, Deployer

Many participants described that the Dashboard provided strategic intelligence which helped them formulate the question of how to reach groups with low uptake. In NCL, users reported *ad hoc* engagement with local community groups and leaders on a case-by-case basis to determine the best mechanisms to improve uptake. Stakeholders indicated that some PHM localities are prospectively building community engagement into their programmes in a more structured way.

*“... gives you the data to then be able to have proper discussions with people who do know those populations.”*

Participant 27, Lead in Vaccine Programme, Deployer

In contrast, there were parts of the ICS where participants did not feel they had the support to understand the reasons behind low uptake or the capacity to respond to it. This acted as a disincentive to looking at the data in PHM tools:

*“I think unpicking the reasons why people are not coming is also difficult to do and time-consuming... at some points we just didn’t have capacity to set up a popup or run out or going to speak at local community centres or religious venues... So there’s almost no point in delving into the data.”*

Participant 6, GP, Questioner

### *Intersectoral programmes and direct care*

From our local evaluation we learnt little about how PHM could be used for direct care. Some of the evidence suggested the COVID-19 Vaccination Dashboard had minimal impact on direct clinical care, in part because general practice staff that were not providers of vaccinations and were therefore less able to respond to indicators of low uptake, but also because PHM may not have reached its potential in primary care. In the workshop, however, several stakeholders discussed the potential for PHM to influence direct clinical care, and particularly how data could be used to support shared decision making and the potential to differentially benefit disadvantaged patients.

With respect to intersectoral care, workshop participants also gave examples of how data from PHM has been used to decide on the commissioning of new programmes or influence

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referral pathways to address health inequalities. For example, they described a programme whereby patients with conditions exacerbated by cold weather that had high emergency department attendances were referred to receive energy efficient home improvements (Anon, 2016).

## Discussion

This mixed-methods local case study, combined with stakeholder insights, illustrated ways in which PHM can help local health and care systems to work together to identify and reduce health inequalities. It has highlighted the importance of a conducive system context, both for generating joined-up data across organisations and for acting upon inequalities revealed by such data. The finding also suggested that using linked data that is locally owned could help foster a sense of collective system identity, and thus facilitate joint working to reduce inequalities. We have used these findings to propose a programme theory for how and when PHM could help ICSs seeking to reduce health inequalities which can be tested and refined through implementation and evaluation.

### *Strengths and limitations*

This study's main strength lay in its blended team of embedded and external researchers. The internal position of the embedded researchers, who had substantive roles in the health and care system, made the study possible. They were able to obtain interviews with participants through their networks and were permitted to access data on PHM staff usage. Their contextual knowledge of participants, familiarity with the local and regional policy context and with PHM also strengthened the interpretation of data. Experienced external researchers were able to navigate research ethics and governance procedures and enhanced the rigour of the data collection and analysis and transferability of the findings.

The case study analysis was based on Normalisation Process Theory, which focuses on the work actors do together to make sense of and embed innovations (May and Finch, 2009). In developing the programme theory we have gone beyond 'the work' involved in adopting and embedding an innovation and therefore diverged from NPT in our structure of reporting our findings. However, constructs of NPT emerged through analysis and in elements of the programme theory. For example, the construct of coherence was central to NCL staff's receptivity to PHM in the particular context of COVID-19 vaccinations, and prompted discussion with stakeholders on where coherence might be lacking in other contexts and its implications for PHM's adoption. In addition, coding to the construct of collective action helped to surface some unexpected ways in which actors used the dashboards and collaborated based on the findings, for example direct users summarising findings for indirect users.

There are three major limitations of this study. First, the evaluation of PHM centred on one region. The national stakeholder workshop, however, helped to understand what themes might be transferable to other geographical areas. Second, we were limited in the quality of the quantitative data we were able to obtain on staff system usage in the mixed-methods case study, which significantly constrained the analysis we were able to conduct. However, the qualitative findings also indicated that quantitative measures of direct usage would not have captured the powerful indirect ways in which the PHM could influence decisions. Third, many staff contacted did not respond to invitations to participate, and several of those who gave a reason for declining to participate cited insufficient experience of the Dashboard. There is therefore a risk that our findings do not fully capture where and why PHM may not be used. Nevertheless, some of those who were interviewed were forthcoming about what deterred them from using it.

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*Comparisons with other literature*

As Stein *et al.* identified, the COVID-19 pandemic highlighted the fragmentation in health and care systems and the impact of this on exacerbating inequalities (Stein *et al.*, 2020). They noted barriers in accessing system-wide data as a challenge to integrated responses to health and care challenges post-COVID-19. Our study suggests that where system-wide datasets are present and there is readiness to implement change, PHM can help integrated systems in addressing health inequalities.

There have been comparable approaches used to those described in this study to increase vaccine uptake overall and to address inequalities in uptake, such as tailoring communication messages (Halvorsrud *et al.*, 2022). In common with our study, Halvorsrud *et al.* (2022) also found other London areas were open to recognising inequities arising from service provision and to support more costly forms of programme delivery. While many areas across London commonly targeted population groups by ethnicity, it was rarer for local areas to target inequalities by language spoken, and there were no examples of targeting geographical areas. Our data suggested it was the distinct integrated data provided through PHM that enabled North Central London to target these population groups.

*Applications in real-world settings*

We have drawn from the specific features of the COVID-19 vaccination programme to speculate on the conditions necessary for PHM to help ICS to reduce health inequalities. While technical conditions, that is, generating accessible shared data are necessary, they alone are not sufficient. National and local prioritisation of the inequality are also needed. In the case of the COVID-19 Vaccination Dashboard, the priority of the programme and national policy on eligible cohorts facilitated its adoption and NCL's focus on horizontal equity. Furthermore, the vaccination programme had a strong evidence base and yielded swift, measurable change, which may have made it a particularly good candidate for PHM.

This study highlights some tensions which could hamper ICS efforts to exploit the potential of PHM to help them reduce health inequalities in other circumstances. One major tension relates to how PHM is conceived, and the resulting permissions attached to its use. PHM in other contexts, mainly the US, has focused on its use for direct care of individual patients (Steenkamer *et al.*, 2017). Indeed, the one PHM model we identified in the literature has drawn on individual behaviour change theories rather than theories of structural or social determinants of health (Scheck McAlearney, 2002). The information governance surrounding data linkage in the UK is interpreted differently across different areas, but in many cases is interpreted to cover data linkage for the purposes of informing direct health care (North Central London Integrated Care System, 2022; NHS England Transformation Directorate, 2021).

Another major tension relates to the ability of ICSs to reallocate budgets in response to information on inequalities from PHM systems (Goddard, 2023). National policy in England is now focused on health care inequalities (NHS England, 2022). This may narrow the focus of ICSs to seeking to address inequalities in access to health care, and thus limiting intersectoral contributions to reducing health inequalities through addressing wider determinants of health. The Hewitt review describes the narrow scope of health inequalities policy, and advocates for the role of ICSs as agents of improvement for wider determinants of health. In her independent review of ICSs, Hewitt also notably recommends a shift in funding towards upstream preventative services and a greater facilitation of data sharing, including ICS performance data (Hewitt, 2023).

*Implications for research and practice*

We conclude from the evidence obtained in this study that PHM can aid integrated health and care systems in reducing health inequalities by providing trusted data on populations that

could benefit from intervention. PHM can be effective, however, only where there is organisational support for reducing inequalities. The programme theory developed from this evidence suggests that the focus of PHM should go beyond the data infrastructure to facilitate actors' use of PHM tools in practice. In addition, by providing clear evidence of inequalities, PHM may be a useful tool for integrated care systems to reconcile efficiency priorities with goals for addressing inequality within local areas at intersectoral, population and individual levels.

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(The Appendix follows overleaf)

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Theme	Sub-theme code	Sub-theme
Understanding (NPT coherence domain)	A1	Personal/professional background or attitude/experience (re: data/technology etc.)
	A2	Perspective/understanding about what HeI is
	A3	Perspective/understanding about what HeI is for
Motivation and individual usage	B1	Usage: motivating factors
	B2	Usage: inhibiting factors
	B3	Communication about the tool
	B4	Usage over time
	B5	Purpose of usage
	B6	Integration into daily work
	B7	Observations about whether/how colleagues use the tool
Tool design	C1	Ways in which tool works well/evidence of utility
	C2	Ways in which tool doesn't work well/evidence of problems
	C3	Helpfulness of changes to tool (a specific change or practice of iterative design)
Tool impact	C4	Communication about changes to tool
	C5	Improvements to tool suggested
	D1	Impacts of the tool on activity: strategic planning
	D2	Impacts of the tool on activity: knowledge/monitoring
	D3	Impacts of the tool on activity: direct patient care
	D4	Impacts of the tool on activity: population-level interventions
	D5	Impacts of the tool on activity: personal working habits
	D6	Impacts of the tool: identifying and responding to inequity
	D7	Impact of the tool on personal behaviour/ways of working
	D8	Impact of the tool on system working
D9	Impact of the tool outside the NCL system	
Comparisons to systems	D10	Reasons for tool's lack of impact
	D11	Comparing impact to other areas
	E1	Comparison to other tools/platforms specific to covid vacc (Foundry, PHE, LG Inform etc.)
System view	E2	Comparison to EMIS/clinical systems
	E3	Unique qualities of HealthIntent (explicit comparison to other tools)
	F1	Benefits of a system view: population level for benchmarking etc
HealthIntent	F2	Benefits of a system view: patient level, data from multiple providers
	G1	Usage/referral to other HeI tools
	G2	Comparison to other HeI tools

**Table S1.**  
Coding framework for  
the qualitative analysis  
of NCL staff interviews

**Note(s):** HealthIntent (HeI) is the name of North Central London's Population Management System  
**Source(s):** Authors

**Table S2.**  
Variables constructed  
for quantitative  
analysis of staff  
usage data

Variable	Description
User	Dashboard users' NHS email addresses were used to identify distinct users. These were anonymised before being shared with CM
Organisation	Each user was assigned an organisation, based on their email address
Organisation category	Each Organisation was assigned to one of 7 Categories (Clinical Commissioning Group; Commissioning support unit; GP Federation; GP Practice; Hospital; LA Public Health; NHS England and NHS Improvement). Users from categories outside of NCL were removed from the dataset for this study
User access	Users have access to different Workbooks (i.e. versions of the dashboard) based on their role and the level of data granularity they are permitted to see. A User can be assigned to multiple User Groups
Event	An event refers to each time a user performs an action, e.g. a log-in, downloading a resource, clicking on a visualisation, navigating to a new page
Dashboard "page"	The 30 different tabs the user can access on the Dashboard were grouped into the following categories; Case Finding; Data Quality; Equalities; Meta data; Overall Uptake
<b>Source(s):</b> Authors	

**Corresponding author**

Cassie Moore can be contacted at: [cassie.moore@camden.gov.uk](mailto:cassie.moore@camden.gov.uk)

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