IMPERIAL COLLEGE HEALTH PARTNERS

Implementation of Remote Patient Monitoring Programmes in NW London

An Evaluation

October 2022

IMPERIAL COLLEGE HEALTH PARTNERS

Contents

About Imperial College Health Partners

Imperial College Health Partners (ICHP) is a partnership organisation bringing together NHS providers of healthcare services, the Integrated Care System (ICS) and leading universities across North West London.

We are also the designated Academic Health Science Network (AHSN) for North West London (NWL). We were created by the NHS to support complex change across the health and care sector – innovating and collaborating for a healthier population.

ICHP is part of the NHS family, and our success is the success of our partners. At the same time, we are sufficiently removed from the daily pressures of the health and care system enabling us to provide a fresh perspective, headspace and a bridge into other sectors and industries.

We are therefore uniquely placed to understand the challenges within the NHS, its structures, processes, policies, and culture and help solve complex problems. Our team of diverse and committed experts have the tools, networks, and skills to quickly understand and tackle these challenges.

We are motivated by our values of creating high quality impact, asking the difficult questions and bringing together the right people to solve a challenge. We are determined to deliver the highest quality of service to help our clients deliver more effective and efficient health and care to their populations.

Definitions & Abbreviations

ICS	Integrated Care System	RPM	Remote Patient Monitoring
LTC	Long Term Condition	EHR	Electronic Health Record
NWL	North West London	VW	Virtual Ward
WSIC	Whole Systems Integrated Care		

Remote Patient Monitoring:
Remote patient monitoring refers to a channel of interaction or method of care between clinician and patient in which the patient is monitored outside of a conventional clinical setting. This may include the use of digital technologies to enable this tracking. Remote monitoring can take several forms: Self-care, in which the patient monitors themselves and only they see their data. Remote Monitoring with clinical input, with ad hoc nurse support and intervention only when necessary and Specialist Remote Monitoring, which requires clinicians with specialist skills and produces data that requires a specialist condition to review.

IMPERIAL COLLEGE HEALTH PARTNERS

Executive Summary

The Covid pandemic has accelerated the need for remote monitoring programmes as a method for reducing face to face GP appointments, hospital admissions and increasing the provision of care in the home. Imperial College Health Partners (ICHP) were asked to conduct an Implementation Evaluation to review progress to date on remote monitoring work taking place across the sector. This included an overarching look at lessons that could be learnt across the evaluation of seven clinical workstreams: Blood Pressure, Type 2 diabetes, COVID, Serious Mental Illness, Care Homes, Heart Failure and Chronic Obstructive Pulmonary Disease (COPD).

The aim of this evaluation was to summarise progress to date on activity and outcome, review the implementation process, identify the challenges experienced by those programmes and develop recommendations based on those challenges.

This evaluation took two parts:

1. Quantitative data was used to look at the scale and spread of adoption of the programmes
2. Qualitative data was used to look at the factors which positively or negatively influenced the adoption of RPM

The main findings:

- Despite challenging circumstances and a sub-optimal implementation environment (a time of unpresented demand and change), meaningful implementation occurred.
- This is considered (direct causation cannot be established) to have significantly contributed to the estimated circa. £2M (non-cash releasing) benefits of the clinical pathways (COPD, Heart Failure and Diabetes) demonstrated in the 21/22 Regional scaling Programme Benefit Management Register.
- Despite this, adoption and use were found to be highly inconstant across patient cohorts, clinical teams, and geographies.
- Numerous barriers to spread and adopt were identified using the NASSS (non-adoption, abandonment, scale-up, spread, sustainability) framework[1].
  Key messages included:
  - Need to consider RPM for multimorbidity/whole person rather than one condition
  - Define the problem before progressing with a solution. Respond to demand, not push unwanted “solutions”
  - Solutions must “plug in and play” with existing EHR. Significant customisation or bespoke solutions add significant resource and risk to implementation.
  - Realising the benefits of the investment (financial and non-financial) require investment in the people concerned – comprehensive change management programmes where patients/ public, staff and leadership are brought into the journey are a key success factor
- Recommendations to address these barriers in future implementations were set out against a Theories of Change model.
- Some specific remedial actions for the current NWL programme are also recommended.

1 -Greenhalgh T, Wherton J, Papoutsi C, Lynch J, Hughes G, Hinder S, Fahy N, Procter R, Shaw S. Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies. Journal of Medical Internet Research. 2017 Nov 1;19(11):e8775

Aims and Objectives

- Summarise progress to date on activity and outcomes
- Review implementation process
- Provide gap analysis and recommendations
- Understand lessons learned

Background

It was established that RPM would function as a key enabler for an agreed common framework for the monitoring of LTCs, as part of a multi-specialty approach spanning primary, community, and acute care. This included the integration of appropriate escalation/de-escalation pathways, monitoring within primary care, facilitation of early supported discharge, and safety-netting through the tracking of rising risk.

During 21/22, NWL ICS continued/ initiated the implementation of the following seven RPM programmes, with four different technology providers:

Programme	Technology provider
Blood Pressure (BP)	Accurx
Type 2 diabetes (T2D)	HUMA
COVID	HUMA
Serious Mental Illness (SMI)	InHealthcare
Care Homes	InHealthcare
Heart Failure (HF)	Luscii
Chronic Obstructive Pulmonary Disease (COPD)	Luscii

See Appendix 1 for summary of each programme

Context

COVID-19 - Whilst the Covid pandemic has accelerated the need for remote monitoring programmes, it was also a time of unpresented demand and change within the NHS meaning whilst the tension for change was greater than ever, the environment for implementation, evaluation and scaling changes could be considered sub-optimal.

ICS Formation – The programme was managed by an ICS in the process of formation. Staff, governance, and systems were transitioning from the previous CCG system during the implementation evaluated.

Methodology

We conducted Formative Process/ Implementation Evaluation of the RPM programmes in NWL in 2021/22.

The following were requested to support the evaluation:

- Activity data
- Outcomes and experience data
- Programme Documentation

This evaluation was conducted using secondary quantitative data (generated by the technology providers) to look at the scale and spread of adoption of the programmes and primary qualitative data (interviews with those involved in the programmes) to look at the factors which positively or negatively influenced the adoption of RPM. Due to the challenges of conducting a retrospective evaluation in a time of high system pressures/ demand, the two

data collection exercises were conducted asynchronously and as such there was no opportunity for the two parts to inform each other.

We collected a primary dataset of six interviews (seven participants) with the NWL RPM implementation leads, in addition to one submitted written summary. The below framework (Fig.1) was used as the prompt in a conversational interview in which the participants were invited to tell the story of the RPM programme in their own words and reflect on the multiple interacting influences on it. Interviews were audiotaped and transcribed with consent.

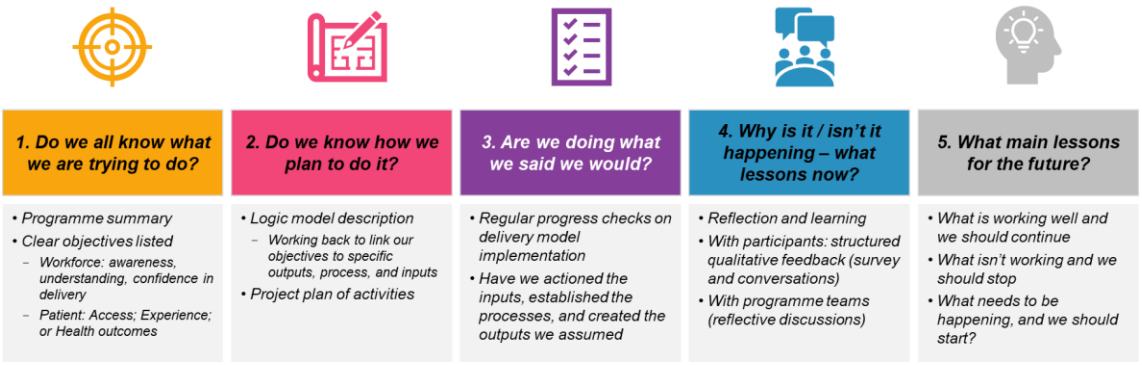


Figure 1. Implementation Evaluation Framework

Analysis

Quantitative

The secondary quantitative data was supplied directly by the RPM technology providers. However, due to the absence of an agreed data collection or evaluation approach during the programmes, the data provided was through a pragmatic "what was available" approach. Due to information governance barriers the primary data sets were not available to us and the data supplied has been summarised and presented rather than analysed.

Qualitative - The NASSS Framework

Throughout, the NWL RPM programmes have been assessed using the NASSS (non-adoption, abandonment, scale-up, spread, sustainability) Framework, as shown in Fig.2 below.

Using the NASSS domains (Appendix 1) as a sensitising framework, we undertook a thematic analysis of the interviews.

The NASSS framework[1] has been developed to study unfolding health technology programmes and identify the emergent uncertainties and complexities that can impact their progression. The NASSS framework has proved useful in understanding how and why a technology-enabled quality improvement intervention generated mixed outcomes. Findings through the NASSS framework can add insights at the overall health system level and identify interplay between the various contributory factors at different levels within the system.

In the framework, complexity is considered in seven domains, covering the major elements which can affect the success or failure of a technology-supported innovation, including internal factors, the wider system and potential for sustainability over time. Complexity in any domain is considered a significant barrier to the adoption of innovations. The different sub-

domains can be applied eclectically to generate a nuanced narrative that surfaces different kinds of complexity in the unfolding programme.

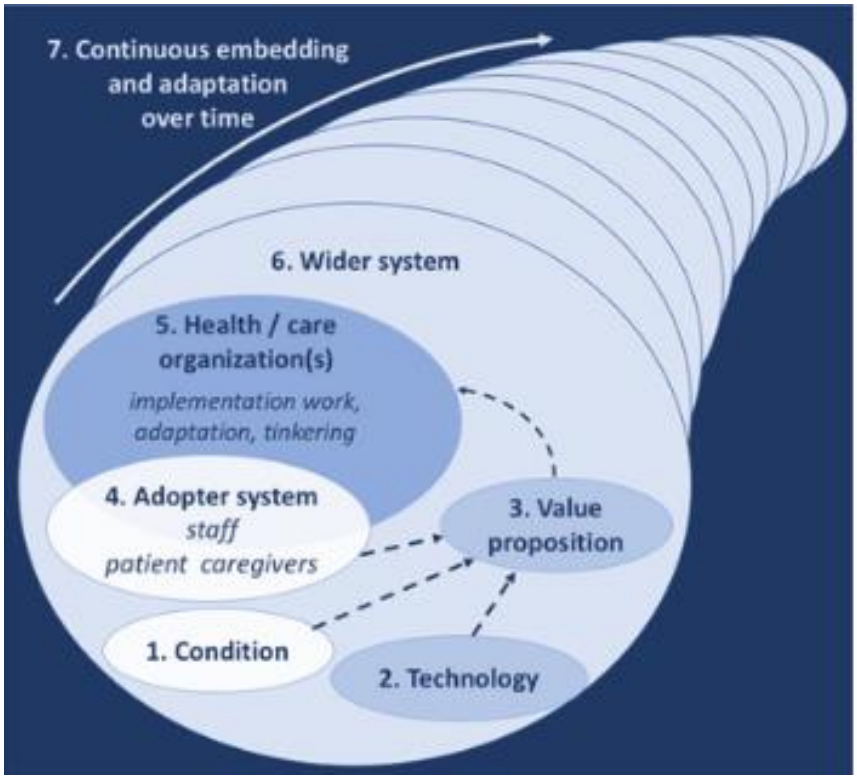


Figure 2. The NASSS framework. Image adapted from Greenhalgh et al (2017)

Results - Quantitative Data

Diabetes RPM App – Huma

182 Patients registered with the App between June 2021 and March 2022, of which 90% logged data as per figure 3, and table 1 below. 18 (9.9%) of the registered used logged no activity.

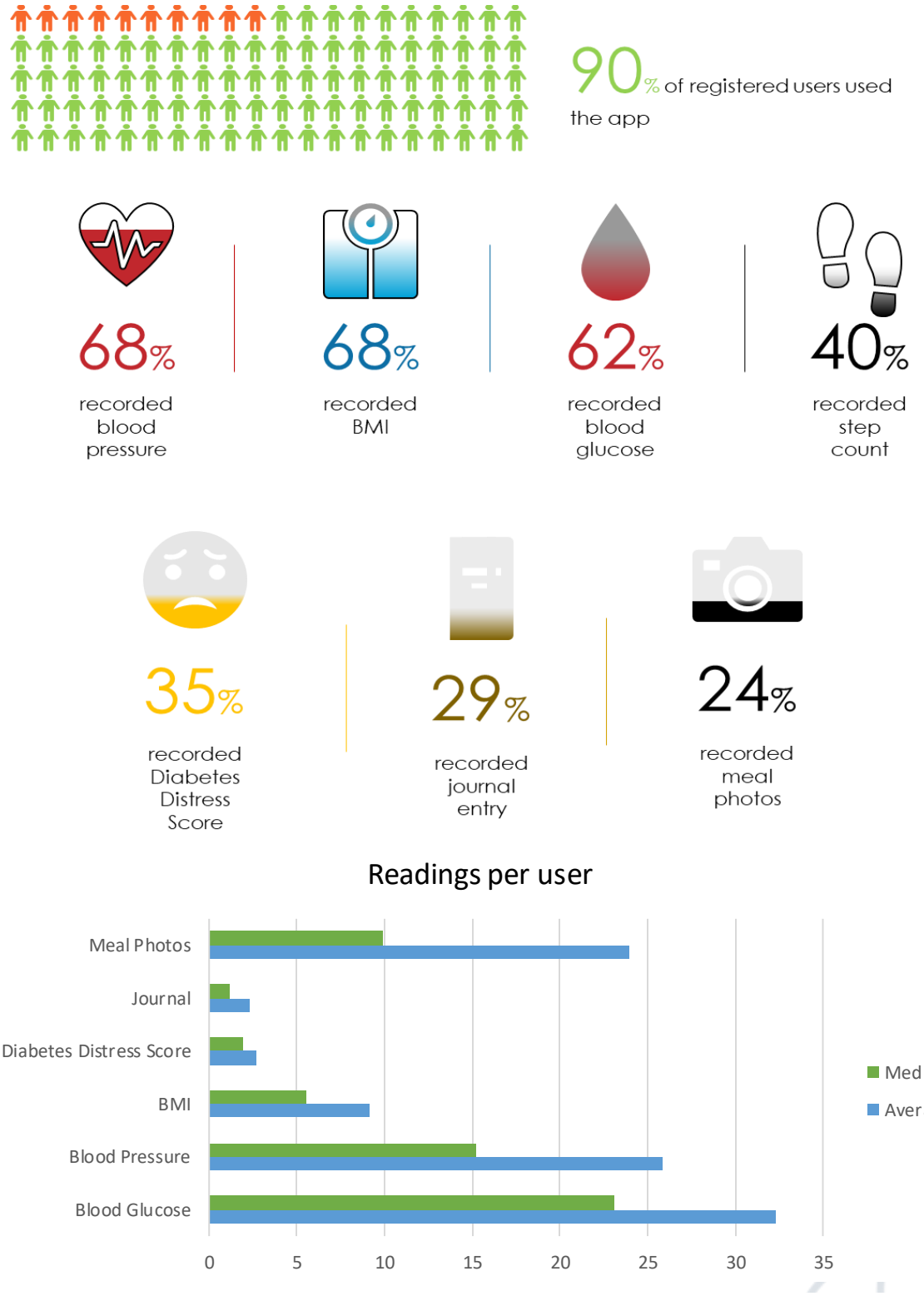


Figure 3. Data Visualisation Summary of Huma Diabetes Data

Table 1. Use of each Diabetes app module/ metric

Module/ Metric	Blood Glucose	Blood Pressure	BMI	Diabetes Distress Score	Journal	Meal Photos	Step Count
Total Users	112 (62%)	123 (68%)	123 (68%)	64 (35%)	53 (29%)	43 (24%)	73 (40%)
Total readings	3624	3181	1130	174	121	1029	57956
Average per user	32.4	25.9	9.2	2.7	2.3	23.9	793.9
Median	23.1	15.2	5.5	1.9	1.2	9.9	609
Max	184	145	75	11	36	269	3022
Min	1	1	1	1	1	1	1

The majority of users were in their fifth and sixth decades, as show in Fig.4.

3	4	2.2%
4	24	13.2%
5	47	25.8%
6	49	26.9%
7	24	13.2%
8	6	3.3%
9	1	0.5%
Unknown	27	14.8%

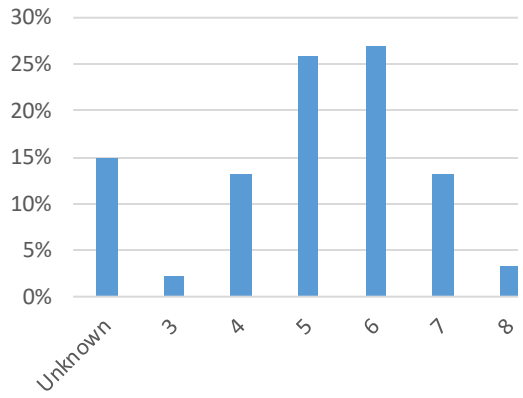


Figure 4. Age by decade of Diabetes App users

90% did not record their gender

30 NHS staff were registered as users. This equates to 0.16 patients to each staff user.

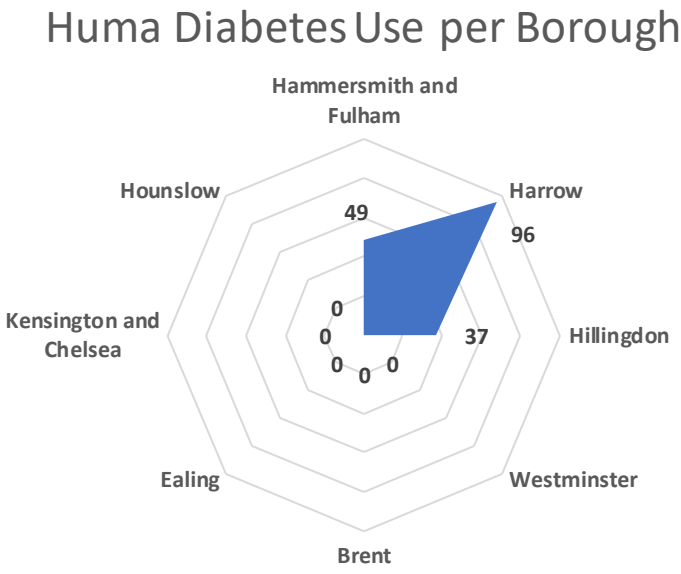


Figure 5. Huma Diabetes Spread of Adoption across NWL Boroughs

COVID RPM App – Huma

2054 Patients registered with the App between June 2021 and March 2022, of which 90% logged data as per figure 6 and table 2 below. 213 (10.4%) of the registered used logged no activity.

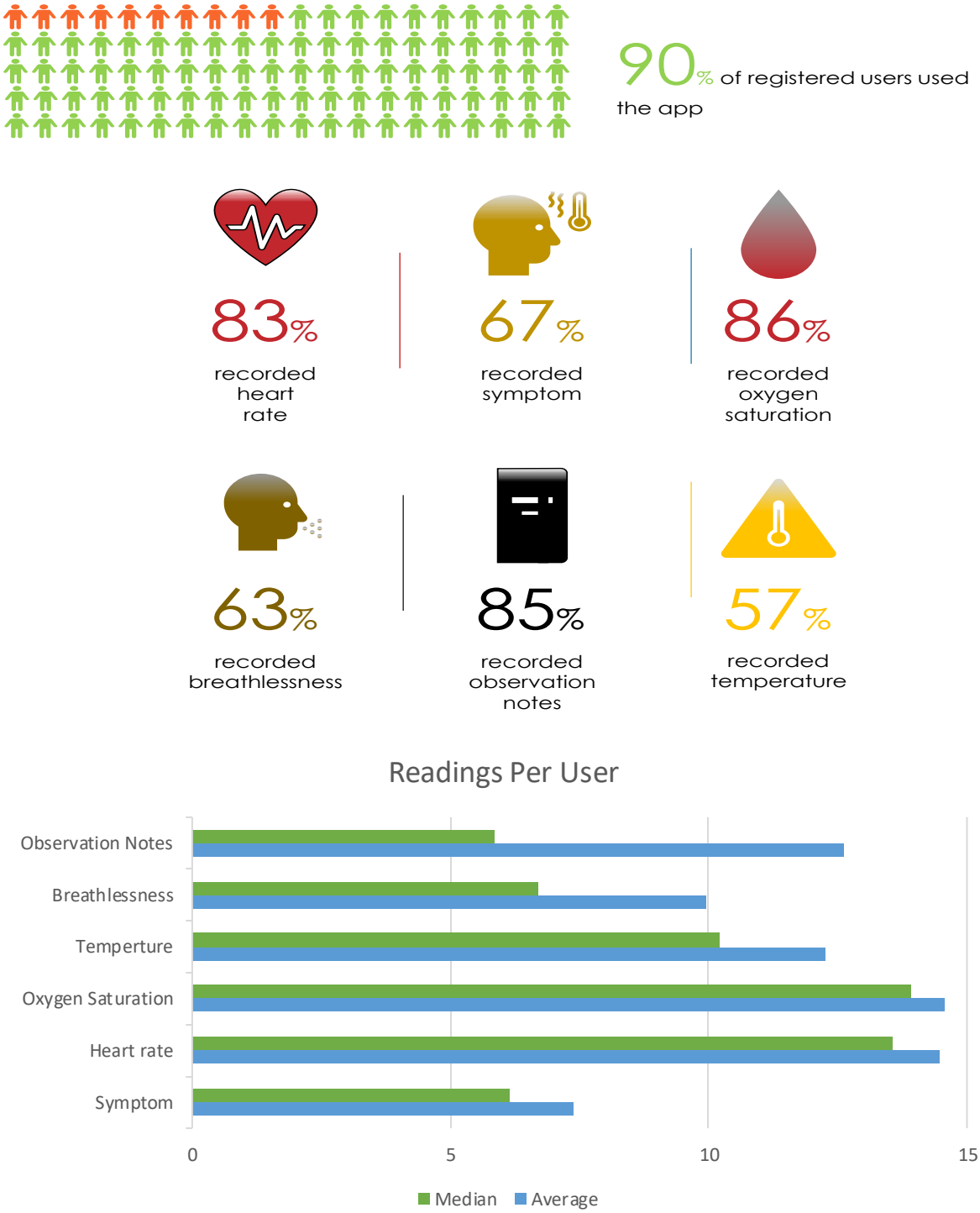


Figure 6. Data Visualisation Summary of Huma COVID Data

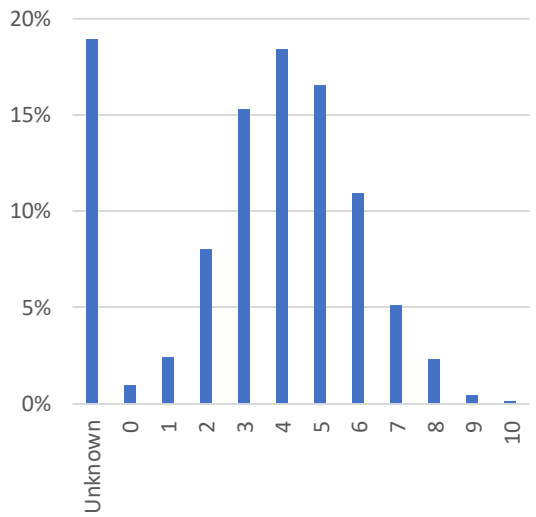
Table 2. Use of each COVID app module/ metric

Metric	Symptom	Heart rate	Oxygen Saturation	Temperature	Breathlessness	Observation Notes
Users	1365 (67%)	1706 (83%)	1773 (86%)	1172 (57%)	1301 (63%)	1741 (85%)
Total readings	10078	24683	25854	14379	12950	21964
Average	7.4	14.5	14.6	12.3	10.0	12.6
Median	6.1	13.6	13.9	10.2	6.7	5.9
Max	80	182	183	183	187	61
Min	1 (12%)	1 (5%)	1 (5%)	1 (7%)	1 (11%)	1 (7%)

The majority of users were in their fifth and sixth decades, as show in Fig.7.

Figure 7. Age by decade of COVID users

Unknown	389	18.9%
0	21	1.0%
1	51	2.5%
2	165	8.0%
3	314	15.3%
4	378	18.4%
5	341	16.6%
6	226	11.0%
7	105	5.1%
8	49	2.4%
9	10	0.5%
10	3	0.1%



95% did not record their gender

121 NHS staff were registered as users. This equates to 0.06 patients to each staff user.

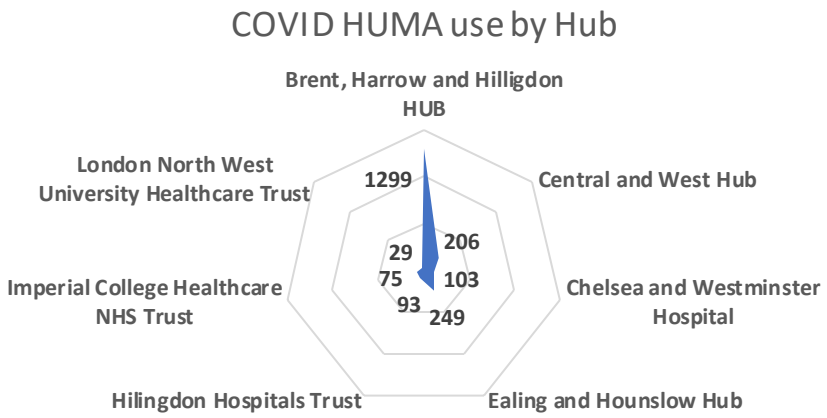


Figure 8. Huma COVID Spread of Adoption across NWL Hubs

Heart Failure Program - Luscii

233 Patients registered between June 2021 and March 2022, of which 84% logged data as per figure 9 and table 3 below. 37 (16%) of the used logged no activity

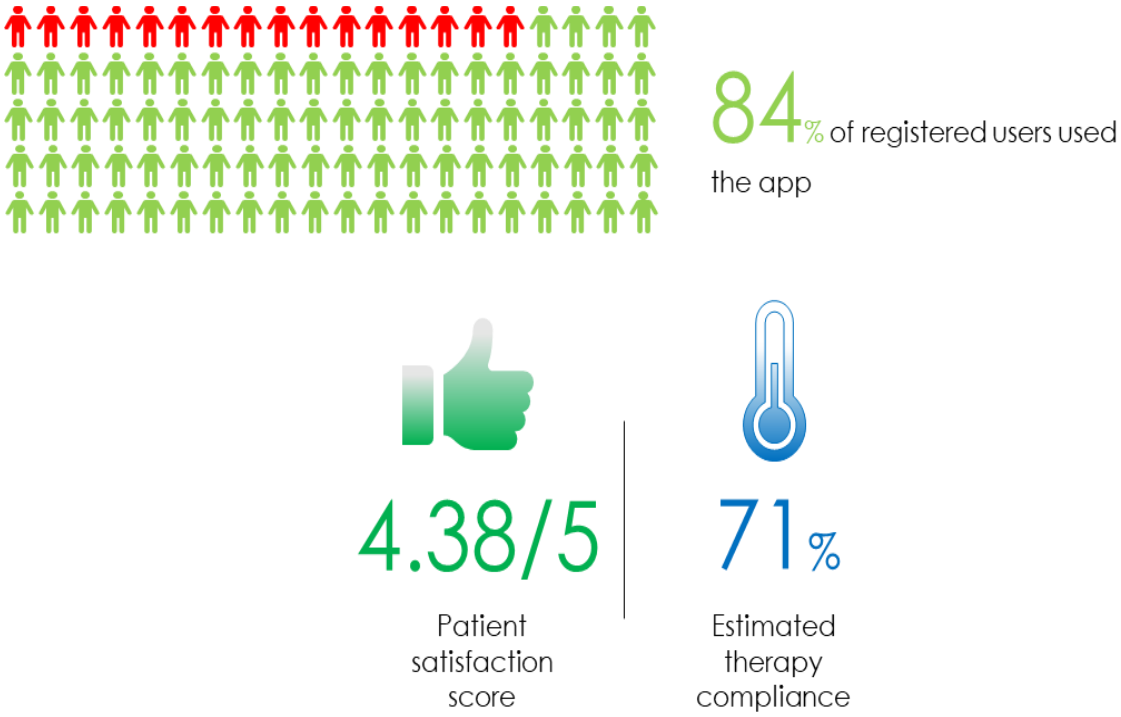


Figure 9. Data Visualisation Summary of Luscii HF Data

Table 3. Use of Luscii Heat Failure Program

Users	233
Registered but no activity	37 (16%)
Total readings	41490
Average per user	211.7
Patient Satisfaction	4.38/5
Female: Male	66(28%):167 (72%)
Total alerts	7123
Alerts based on measurement	5301 (74%)
Total number of remarks made	926
Estimated therapy compliance	71%

COPD Program - Luscii

35 Patients registered between June 2021 and March 2022, of which 29% logged data as per figure 10 and table 4 below. 25 (71%) of the used logged no activity.

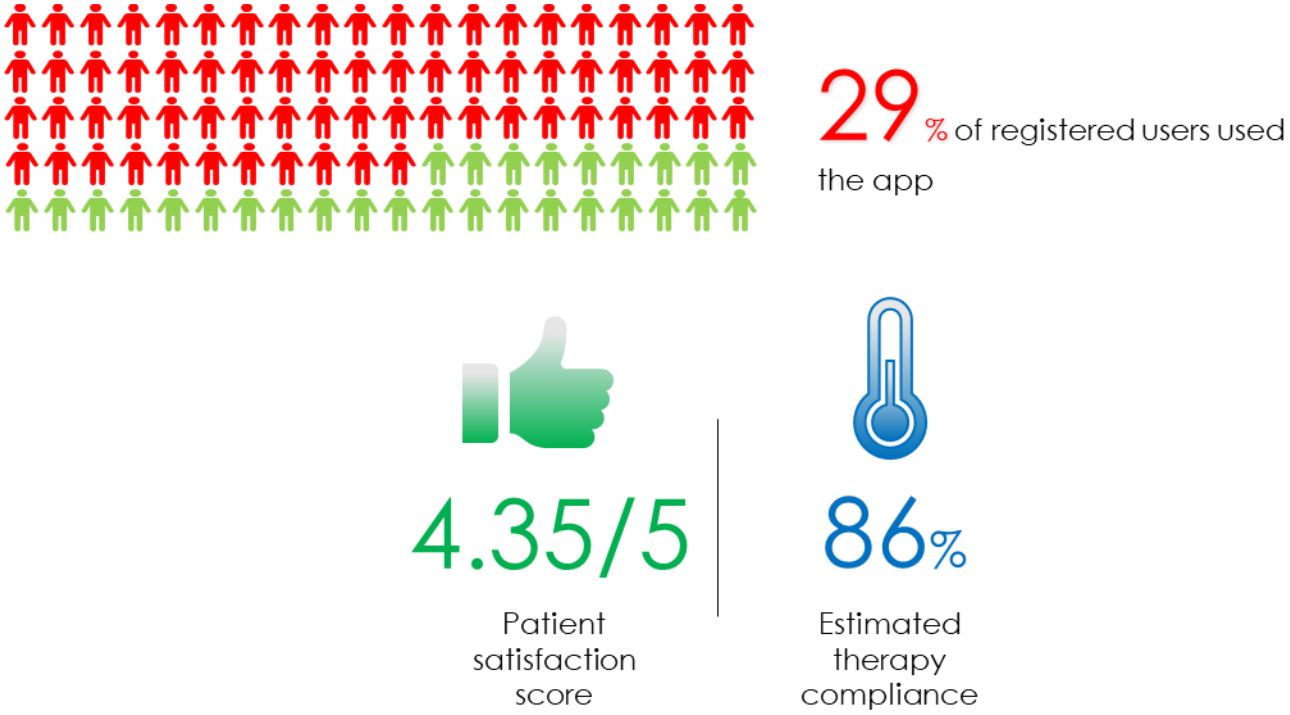


Figure 10. Data Visualisation Summary of Luscii COPD Data

Table 4. Use of Luscii COPD Program

Users	35
Registered but no activity	25 (71%)
Total readings	4887
Average per user	70.6
Patient Satisfaction	4.35/5
Female: Male	18(51%):17 (49%)
Total alerts	405
Alerts based on measurement	315 (78%)
Total number of remarks made	**73**
Estimated therapy compliance	**86%**

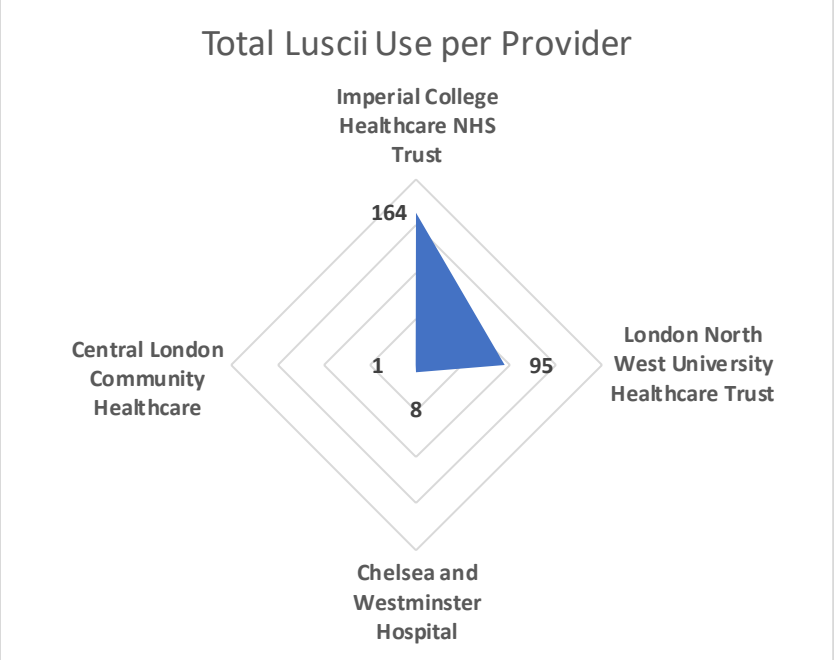


Figure 11. Total Luscii Spread of Adoption across NWL Trusts

No Data was provided for the following LTCS/ providers;

- Serious Mental Illness (SMI) – InHealthcare
- Care Homes – InHealthcare
- Blood Pressure (BP) - Accurx

Results - Qualitative Data

The analysis identified interacting complexities in the seven NWL RPM programs. These are presented under the NASSS domains below.

Domain 1: The Condition

The complexity of the conditions addressed with Remote monitoring were not directly evaluated by this work but have been accorded varying degrees of complexity in other studies dependant on the specific setting and cohorts.

Themes adding to complexity and therefore barriers which hindered adoption;

- Lack of clear inclusion/ exclusion criteria for patient suitable for RPM pathways.
- Cross organisational/ pathways inconsistencies on patient eligibility
  i.e. different providers using different criteria for same condition or same provider using inconsistent criteria across different conditions
- Clinicians and admin uncertainty around pathways
  i.e. admin staff unaware of services existence when asked questions by patients
- Ambiguous target cohorts
  i.e. Virtual ward/ admission avoidance vs. Early Support Discharge vs. Post discharge support)
- All the pathways were single condition pathways meaning that some patients with co-morbidities (significant numbers given the cohorts) were confronted with multiple remote

monitoring tools/platforms/ measurement requests. Conversely, they may have only had one of their LTCs catered for by an RPM solution, whilst still using traditional pathways for others. Coding issues (i.e. being unable to code patients as on multiple RPM pathways) made identification of these patients challenging.

Domain 2: The Technology

Themes adding to complexity and therefore barriers which hindered adoption;

2A. Material Features

- Multiple EHR platforms, each requiring their own solutions/ custom builds
- Lack of shared records/ access to shared records
- Lack of RPM solutions integration into existing EHR
  i.e. *clinicians having to manually enter information from one system to another*
- Equipment not being fit for purpose
  i.e. wrong sizes, not fit for clinical needs

2C. Knowledge

- Significant requirements for initial training and ongoing support with using the technology for both staff and in particular patients. However, this was not pre-emptively resourced and often created an additional workload for clinicians.

Data

- No strategy built into plans (for data collection/ reporting/ evaluation)
- Infrastructure for the collection of data and the mechanism for reporting was lacking or not put in place at all.

Domain 3: The Value Proposition

Themes adding to complexity and therefore barriers which hindered adoption;

3A. Supply side value

Although not directly evaluated with this work, the level of engagement required by the programmes and the ongoing need for direct engagement with the clinicians using the technology (generally not resourced and therefore not possible to meet the demand for) was a consistent theme and significant business/ resourcing risk for the supplier.

3B. Demand Side Value

Whilst the following clear overarching objective and value of the RPM was understood

"Utilising the best technologies available to enable personalised clinical support to be delivered virtually to people in the setting of their own home including care homes", NHSE

There was:

- Often no detail/ understanding of the specific objectives/ outcomes for pathways.
- Limited alignment on objectives between those funding and commissioning the programmes and those delivering care.
- A perceived focus on activity and scale over patient/ staff experience and outcomes.

- A feeling some products were "pushed from the centre" and did not solve problems. "Just gadgets!". This reduced time to care and therefore worsened both patient and clinician experience.

Domain 4: The Adopter system

4A. Staff

- There were varying degrees of staff input/ co-production opportunities into pathway/ tech solution implementation.
  If high, this is likely to address barriers and have a positive impact on engagement and adoption.
  If low (seen as imposed change/ pushed solutions), this results in a negative impact on engagement and adoption.
- Significant ongoing clinician engagement seen as key to engagement and adoption.
  Clinical Champions and meetings needed at all levels of systems.
  Clinician attendance at meetings should not be seen as indicative of buy in.
- Importance around coding needs constant messaging and re-enforcement.
  Adequate clinician time to enable pathways is vital.
  i.*e. Trusted clinician interaction seen as vital to patient sign up/ buy in.*
  Often equipment needs fitting by a clinician, not patient, carer, or admin staff.

  "Do not assume admin staff and tech can do all the work"

- Getting engagement right first-time is key. It is tough to regain trust/ re-engage after an initial poor experience.

4B. Patients

The acceptability of remote monitoring to patients were not directly assessed by this work but have been accorded varying degrees of complexity in other studies dependant on the setting and cohorts.

A clear theme which hindered adoption was that of too many readings/ same readings repeatedly asked for.
In a single pathway or lack of alignment/integration across conditions/ pathways (RPM or traditional).

Domain 5: The Organisation

5A. Capacity to innovate

- Too much change / innovation at the same time was identified as a barrier to adoption of RPM during this period.
- Protected time for staff to engage/ support/ deliver was seen as vital to successful adoption.
  - *The ideal being identified as backfilled roles for people to focus on implementation.*
  - *The creation of some "headroom" was seen as a minimum requirement for success.*
  - *Engagement with the RPM programmes in addition to business as usual was seen as actively detrimental to successful adoption.*

5B. Readiness for change

Themes adding to complexity and therefore barriers which hindered adoption;

- The pandemic provided the tension for change from the traditional model of care, but the perception of limitations in the fit of the new pathways/ solutions was identified as a barrier to adoption.
- Pathways were often perceived as designed to meet the funding/ activity requirement, as opposed to the needs and problems of the patients and clinicians.

5C. Ease of adoption and funding decisions

The absence of a benefits management/ evaluation strategy for the programmes from their outsets meant evidence of efficacy and justification of ongoing funding is challenging to provide.

5D. Implications for Teams

Adoption of an RPM solution which is embedded in a pathway as a solution was far less complex than those where it was a bolt onto an existing pathway/ programme.

i.*e. funding for an RPM app obtained mid-programme implementation becomes a distraction/ additional unplanned work.*

5E. Work needed to implement change

Themes adding to complexity and therefore barriers which hindered adoption;

- Trying to design, pilot, study/ evaluate and scale at same time, rather than iteratively. This leads lack of clarity/ focus on priorities (somethings competing).
- Project teams, clinical leads/ champions joining implementation and planning processes too late to have meaningful influence or make changes that could address barriers to successful adoption.

Themes which aided adoption.

- Delivery teams (Project Teams, Clinical Champions, and tech provider) out on the ground with clinicians.
- Funded and dedicated project support.
  It was noted that externals (consultancies, pharma, tech PMO) add resource, but can lack insight into NHS delivery and processes.

Domain 6: The wider context

6A: Political and policy context

Themes adding to complexity and therefore barriers which hindered adoption;

- Lack of alignment across providers.
  Described as often doing own thing and at different stages.
- Lack of alignment across the RPM programmes.
  Tended to be developed in silos. It was perceived that this was partly driven by funding requirements.

Themes which aided adoption.

- Regional Clinical Reference Groups (where in place) played a vital role in system and cross provider alignment.

- Alignment was not always possible. But shared learning and resources should always be cross provider, regionally and nationally.
  Covid VW described as exemplar.

6B: Regulatory or legal hurdles

Information governance processes consistently identified as unclear, not timely, tackled too late or were overlooked in planning.

6C: Professional bodies

Local clinical champions appear key to persuading their peers that a technology-supported service is effective, safe, and "normal" (i.e., professionally appropriate).

6D: Public

Significant ongoing public engagement is required to make the case for the implementation and utilisation of RPM in healthcare.

Domain 7: Embedding and adaptation over time

7A. How much scope is there for adapting and co-evolving the technology and the service over time?

- Providing clinicians some flexibility in approach to delivery enabled successful adoption
  So they can make it work for their clinics and patients or they are unlikely to engage with RPM.

7B. How resilient is the organisation to handling critical events and adapting to unforeseen eventualities?

Themes adding to complexity and therefore barriers which hindered adoption;

- No clear governance structure built into plans
  Both internal to projects and external
- No clear reporting structures
  Often duplicate lines of reporting
- No consistent reporting documents
  Different for each audience/ reporting line
- Lack of clear purpose
  "Everyone wanted to know everything, but why?"
- Lack of tailored project documents and therefore governance
  Bid or national docs often used lieu of NWL/ programme docs
- Lack of clear roles/ responsibilities/ accountability
- COVID removed a lot of layers, but also checks and balances
- Too long before course corrections/ re-direction occurred (or need for this even raised)
  Due to lack of governance/ mitigations

Recommendations

Recommendations and Change Theory

One of the key lessons learned in the evaluation was realising the benefits of the investment (financial and non-financial) require investment in the people concerned – comprehensive change management programmes where patients/ public, staff and leadership are brought

into the journey are a key success factor, therefore the recommendations are set out against Change Theory. Specifically Lewin's Change Management Model[1], Roger's Adoption Curve[2] and Kotter Change Model[3].

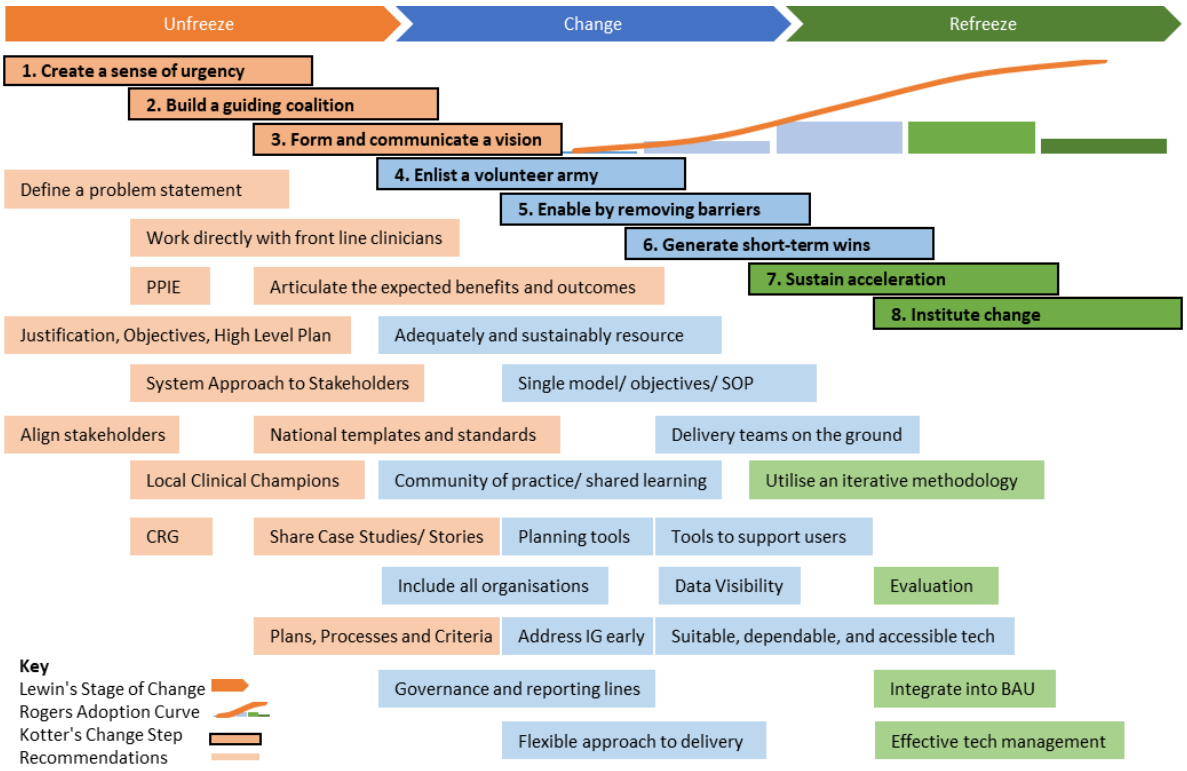


Figure 12 – Recommendations Mapped Against Change Theory

Table 5. Recommendations and relevant Change Theory Stage

Lewins Stage of Change	Rogers Adoption Group	Kotter Change Step	Recommendations
Unfreeze	Pre	Create	**Define the problem** before progressing with a solution *Respond to demand, not push unwanted "solutions"* Use a local **Project initiation process** - *Justification, objectives, and high-level delivery plan (what are we doing and why)* Identify where programme **aligns with local and national priorities**
Unfreeze	Pre	Build	Work directly with **front line clinicians and patients/ public** to co-create +/- iterate **System approach to stakeholder management and reporting** *Remove duplication and mixed messaging*

			Engage existing **Clinical Reference Groups** and recruit local **clinical champions** *Key to persuading their peers*
Unfreeze	Pre	Form	**Articulate the expected benefits and outcomes** for the local population and staff Where possible start from **National documents/ standards/ best practices** *Tailored to local population and system needs* **Create and share stories/ case studies** *Stories are often more effective than statistics* **High level Programme Plan** *Form plan, processes and criteria for programme*
Change	Pioneers	Enlist	**Adequately and sustainably resource** the programme team, clinicians, administrators and technical staff Set up a **cross organisational steering group** to maintain visibility of processes *Include senior sponsors and clinical leaders* Create **community of practice/ shared learning** mechanisms **Establish single line of reporting and reporting template**
Change	Early adopters	Enable	Design and share **single model, objectives and SOP** *Include and define a level of acceptable variation. Needs to be adaptable for every local setting* **Resource planning tools** – *staffing, technology, equipment, estimated recruitment per population/ clinical episode* Create **IG SOP, templates, and process map**
Change	Early majority	Generate	Site **Delivery teams out with front line users** *Project Teams, Clinical Champions, and tech provider* Create **guides/ tools to support users** *Patients, careers and clinicians* Ensure **technologies and equipment are suitable, dependable, and accessible** Regularly **collect, assess and share data** to continuously evaluate and improve *Pre-defined from a data and benefits strategy*
Refreeze	Late majority	Sustain	Work through stages of **development and implementation iteratively** • *Utilise an established methodology* • *Use (if appropriate) minimal viable product, piloting, and QI to ensure continuous improvement* • *Do not proceed to activity driven product roll out/ scaling approach until indicated*

Refreeze	Final few	Institute	**Evaluation** to drive ongoing business case *Workstream included from outset of programme* BAU **asset management approach** to technology and equipment Integrate and sustainably resource programme into BAU delivery

Areas for further Evaluation/ Research

- Demand side value – further understanding of patient and clinician needs from RPM technology to optimise adoption
- What is the optimal pathway to achieve digital transformation in the NHS?

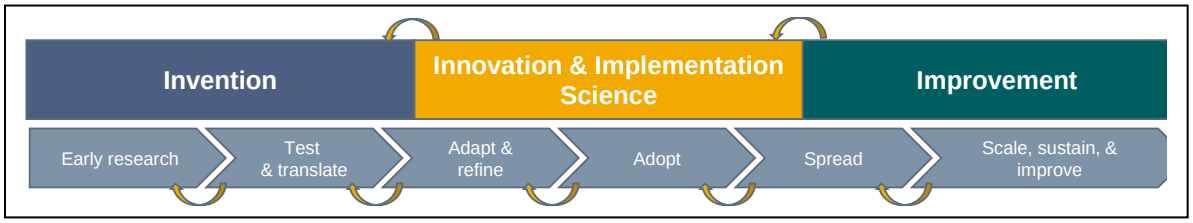


Figure 13 – High Level Conceptional Model: Clinical Innovation Journey

NWL Gap Analysis and Recommendations

The above recommendation set out the lessons learned that be carried forward to any future RPM/ technology implementations. Below are the recommendations at the time of evaluation which would specifically aid the existing and future programmes in NWL.

- Clear articulation of vision, and expected benefits and outcomes for NWL population, system, and workforce
- Single NWL delivery model. Including a defined level of acceptable variation
- Create community of practice/ shared learning mechanisms
- Create and share stories/ case studies from work to-date
- Create IG SOP, templates, and process map
- Asset management approach to technology and equipment
- Systematically address complexity/ barriers to implementation. A Learning Health System and/ or Quality Improvement approach is recommended

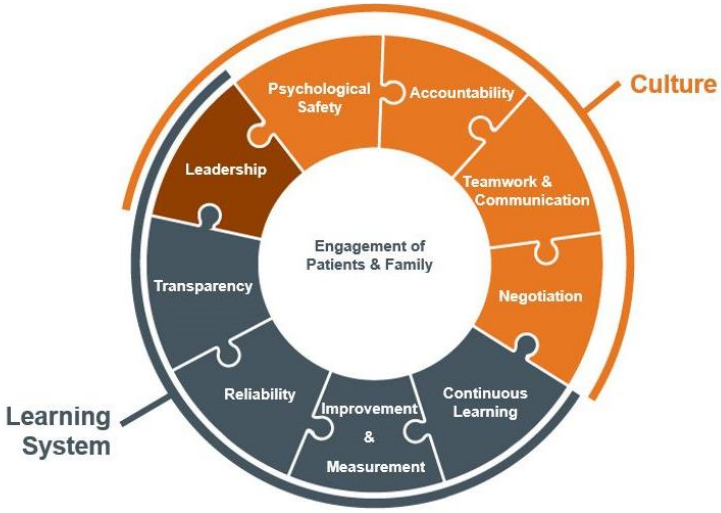


Figure 14 – Institute for Healthcare Improvement, Framework for Safe, Reliable and Effective Care

1- Lewin, K., 1951. Field theory in social science: selected theoretical papers (Edited by Dorwin Cartwright.).

2- Rogers, Everett (16 August 2003). Diffusion of Innovations, 5th Edition. Simon and Schuster. ISBN 978-0-7432-5823-4.

3- Kotter, J.P., 2012. Leading change. Harvard business press.

Appendices

Appendix 1: Summary of Programmes

Blood Pressure – Accurx
UCLP risk stratified hypertension searches used to identify suitable patients. Accurx SMS then used to invite patients to sign up for the programme. Patients receive a home blood pressure monitor and submit readings via Accurx SMS. The readings are automatically added to the patients record and reviewed by a named clinician. Accurx can be used to direct patents to external materials or arrange consultations.

Type 2 diabetes (T2D) - Huma
The objectives of the programme, Fresh Start, were to provide consistently high quality, accessible and cost-effective care for high-risk patients with Type-2 Diabetes at scale, improve clinician access to patient information without increasing the data burden and increase patient engagement and involvement in their own health.
In order to do this a combination of remote patient monitoring, group video consultations and digital education was provided in a 12-week programme. The remote monitoring service (a patient iPhone and Android app) was provided by Huma alongside a blood pressure cuff, blood glucometer, strips and lances and digital scales. The clinician was able to see the data recorded in the application in a dashboard.

COVID - Huma
This workstream includes two Covid response services, Covid@Home and Covid Virtual Ward. The nomenclature for these services varied from their inception. Covid@Home refers to the primary care-based service, which used oximetry to monitor and identify 'silent hypoxia' and rapid patient deterioration at home in lower acuity patients who had tested

positive for Covid-19 and met the clinical parameters of the service. The programme was delivered through Covid Hot Hubs and directly by GP practices. Patients were provided with a pulse oximeter and monitored over a 14-day period. The patient could record their data via the Huma application or by paper, with regular phone calls to record this information.

The Covid Virtual Ward service is secondary-care led for higher acuity patients and provides early supported hospital discharge for patients with a primary diagnosis of Covid-19, who are referred from ED or have an improving clinical trajectory. The service is led by a consultant and the patient receives proactive daily monitoring calls, a pulse oximeter and uses either the Huma application or paper to self-monitor at home over a 14-day period. A phone support line is also available during service hours and some medication is provided.

Serious Mental Illness (SMI) – InHealthcare
An app to support healthcare staff undertaking physical health checks was developed but not implemented during the evaluation period.

Care Homes - InHealthcare
This programme was delayed by the conflicting priorities of the Coronavirus vaccine roll-out programme and ongoing Coronavirus testing programme. The NWL team have developed a plan moving forward.

During the delay, work has been undertaken to lay the groundwork for future implementation setting up lines of communication and engagement. They will then aim to roll-out remote monitoring in 42 care homes in both nursing and residential care homes before scaling. The work will be undertaken by a digital integration and change management team, who will support all care home digitisation activities. This will be a different approach to the implementation of remote monitoring in care homes in other areas of London.

Heart Failure - Luscii
AstraZeneca worked in partnership with the Discover-NOW Hub, Imperial College Healthcare Trust and primary care leaders to improve the heart failure pathway. The co-design team included a mix of clinicians, both cardiologists and GPs. It was this team working alongside AstraZeneca that established opportunities for improvement, including the possibility of using remote monitoring, and identified the funding required. The intervention used remote monitoring technology to optimise medication for patients with heart failure, avoiding unscheduled appointments of hospital visits and allowing the management of more patients. Patients used the Luscii application, an AI powered application with an intelligent alert system to monitor vital sign readings, including heart rate, blood pressure and weight. Clinicians had access to a clinical dashboard to monitor and alert them to abnormal values or trends. Patients could also access educational materials via the application. While there had been some delays due to Brexit and the pandemic, which held up the delivery of equipment, at the time of this evaluation patients have begun to be onboarded and initial data returned.

Chronic Obstructive Pulmonary Disease (COPD) - Luscii
Supporting discharge of patients (within 48 hours of admission) from acute settings to complete their recovery at home, under digitally enabled observation from an interdisciplinary team working across primary and secondary care. Referrals for assessment were accepted from hospital-based respiratory nurse specialists, inpatient doctors, and consultants. Remote monitoring put in place reduced the need for face-to-face reviews but recorded changes in symptoms using current health tech and pulse oximetry. This also encouraged patient-led care and self-reporting of symptoms when patients can be remote

monitored. Regular daily review (twice daily if being remote monitored) for 7-10 days. Patients were referred back to acute care if they deteriorated (increase in NEWS2), or back to their GP if they stabilised.

Appendix 2: NASSS Framework

Domain	Question	Simple	Complicated	Complex
Domain 1: The condition or illness	1A. What is the nature of the condition or illness?	Well-characterized, well-understood, predictable	Not fully characterized, understood, or predictable	Poorly characterized, poorly understood, unpredictable, or high risk
Domain 1: The condition or illness	1B. What are the relevant sociocultural factors and comorbidities?	Unlikely to affect care significantly	Must be factored into care plan and service model	Pose significant challenges to care planning and service provision
Domain 2: The technology	2A. What are the key features of the technology?	Off-the-shelf or already installed, freestanding, dependable	Not yet developed or fully interoperable; not 100% dependable	Requires close embedding in complex technical systems; significant dependability issues
Domain 2: The technology	2B. What kind of knowledge does the technology bring into play?	Directly and transparently measures [changes in] the condition	Partially and indirectly measures [changes in] the condition	Link between data generated and [changes in] the condition is currently unpredictable or contested
Domain 2: The technology	2C. What knowledge and/or support is required to use the technology?	None or a simple set of instructions	Detailed instruction and training needed, perhaps with ongoing helpdesk support	Effective use of technology requires advanced training and/or support to adjust to new identity or organizational role
Domain 2: The technology	2D. What is the technology supply model?	Generic, “plug and play,” or COTS solutions requiring minimal customization; easily substitutable if supplier withdraws	COTS solutions requiring significant customization or bespoke solutions; substitution difficult if supplier withdraws	Solutions requiring significant organizational reconfiguration or medium- to large scale-bespoke solutions; highly vulnerable to supplier withdrawal
Domain 2: The technology	2E. Who owns the intellectual property	Clear definition of rights to intellectual property with no	Unconfirmed but there is a shared understanding,	Unclear; risk to developers and adopters

	generated from the technology?	current ongoing issues	discussions ongoing	
Domain 3: The value proposition	3A. What is the developer's business case for the technology (supply-side value)?	Clear business case with strong chance of return on investment	Business case underdeveloped; potential risk to investors	Business case implausible; significant risk to investors
Domain 3: The value proposition	3B. What is its desirability, efficacy, safety, and cost effectiveness (demand-side value)?	Technology is desirable for patients, effective, safe, and cost effective	Technology's desirability, efficacy, safety, or cost effectiveness is unknown or contested	Significant possibility that technology is undesirable, unsafe, ineffective, or unaffordable
Domain 4: The adopter system	4A. What changes in staff roles, practices, and identities are implied?	None	Existing staff must learn new skills and/or new staff be appointed	Threat to professional identity, values, or scope of practice; risk of job loss
Domain 4: The adopter system	4B. What is expected of the patient (and/or immediate caregiver)—and is this achievable by, and acceptable to, them?	Nothing	Routine tasks, e.g. log on, enter data, converse	Complex tasks, e.g. initiate changes in therapy, make judgments, organize
Domain 4: The adopter system	4C. What is assumed about the extended network of lay caregivers?	None	Assumes a caregiver will be available when needed	Assumes a network of caregivers with ability to coordinate their input
Domain 5: The organization	5A. What is the organization's capacity to innovate?	Well-led organization with slack resources and good managerial relations; risk taking encouraged	Limited slack resources; suboptimal leadership and managerial relations; risk taking not encouraged	Severe resource pressures (e.g. frozen posts); weak leadership and managerial relations; risk taking may be punished
Domain 5: The organization	5B. How ready is the organization for this technology-supported change?	High tension for change, good innovation-system fit, widespread support	Little tension for change; moderate innovation-system fit; some powerful opponents	No tension for change; poor innovation-system fit; many opponents, some with wrecking power
Domain 5: The organization	5C. How easy will the adoption and funding decision be?	Single organization with sufficient resources; anticipated cost savings; no new	Multiple organizations with partnership relationship; cost-benefit balance favourable or	Multiple organizations with no formal links and/or conflicting agendas; funding depends on cost

		infrastructure or recurrent costs required	neutral; new infrastructure (e.g., staff roles, training, kit) can mostly be found from repurposing	savings across system; costs and benefits unclear; new infrastructure conflicts with existing; significant budget implications
Domain 5: The organization	5D. What changes will be needed in team interactions and routines?	No new team routines or care pathways needed	New team routines or care pathways that align readily with established ones	New team routines or care pathways that conflict with established ones
Domain 5: The organization	5E. What work is involved in implementation and who will do it?	Established shared vision; few simple tasks, uncontested and easily monitored	Some work needed to build shared vision, engage staff, enact new practices, and monitor impact	Significant work needed to build shared vision, engage staff, enact new practices, and monitor impact
Domain 6: The wider context	6A: Political and policy context	Current or potential policy push	Financial and regulatory requirements being negotiated nationally	Political opposition
Domain 6: The wider context	6B: Regulatory or legal hurdles (e.g. medical devices)	None or easily surmountable	Few, may be overcome	Many, no easy way through
Domain 6: The wider context	6C: Professional bodies	Positive or open to discussion	Some resistance, not yet committed	Opposed
Domain 6: The wider context	6D: Citizens / lay public	Positive or open to discussion	Some resistance, not yet committed	Opposed
Domain 7: Embedding and adaptation over time	7A. How much scope is there for adapting and coevolving the technology and the service over time?	Strong scope for adapting and embedding the technology as local need or context changes	Potential for adapting and coevolving the technology and service is limited or uncertain	Significant barriers to further adaptation and/or coevolution of the technology or service
Domain 7: Embedding and adaptation over time	7B. How resilient is the organization to handling critical events and adapting to unforeseen eventualities?	Sense making, collective reflection, and adaptive action are ongoing and encouraged	Sense making, collective reflection, and adaptive action are difficult and viewed as low priority	Sense making, collective reflection, and adaptive action are discouraged in a rigid, inflexible implementation model

Appendix 3: Previous Assessment of NASS Domains in NWL RPM Programmes