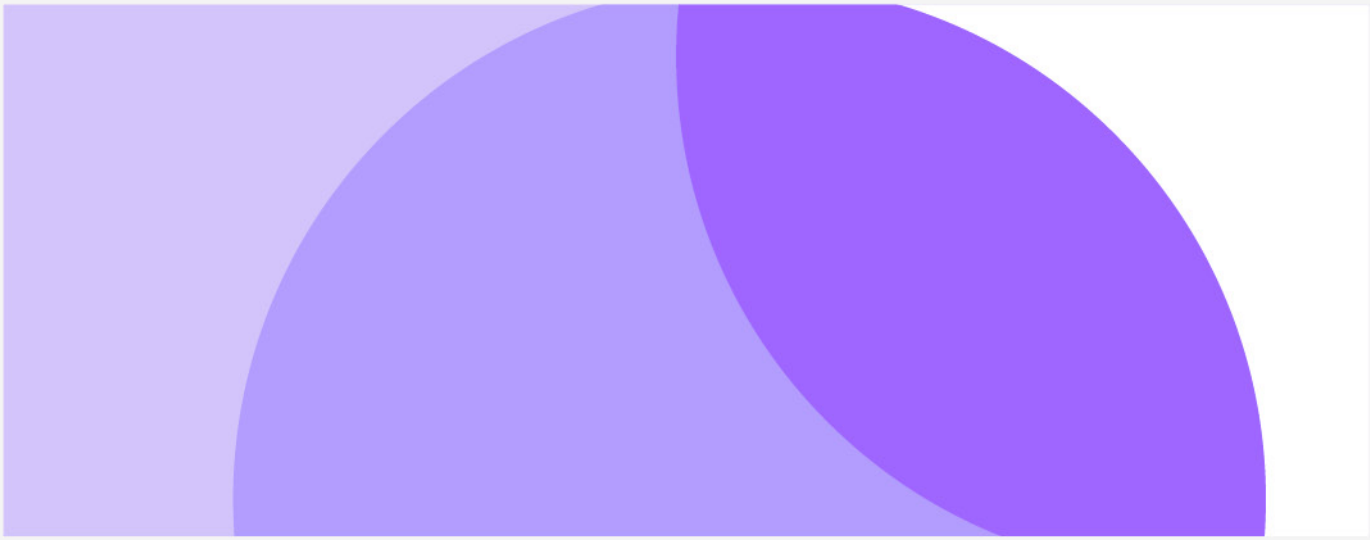

Evaluation of the Care City Wave 2 test bed

Final report

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Executive summary

The Care City test bed

The Care City test bed is one of the NHS Wave 2 test bed sites for digital innovations. It was established to test market-ready innovations in new ways to address local priorities and needs and use them to create opportunities for developing care support staff. Ongoing evaluation of the test bed would provide learning about the extent to which the innovations engage service users, improve their outcomes and alleviate some of the capacity challenges of the wider health and care systems.

Six digital innovations were implemented within East London, which together recruited some 650 users between June 2019 and August 2020. These innovations were organised into three clusters that reflected the different care settings and workforce involved. Two were implemented in domiciliary care, three in primary care and one in an acute hospital cardiac rehabilitation service.

The scope of this report

This is the final evaluation report of the test bed, which brings together all the findings. In addition, more focused outputs are being produced for particular audiences.

This was an independent evaluation using a mixed-methods approach, combining qualitative findings from Care City, service users, staff and innovators with quantitative analysis of uptake, outcomes, resource use and cost.

However, the original scope of the evaluation had to be reduced following the start of the Covid-19 pandemic. The reprioritising of services and staff in response to the pandemic affected the implementation of the test bed. It made comparisons with patients receiving usual care outside of the test bed difficult by altering the context in which services operate. It also reduced the number of interviews we were able to do as well as having an impact on the availability of data and the volume of survey responses.

Summary of findings

Workforce roles within domiciliary care and primary care were enhanced in a variety of ways, with staff developing a range of skills that were more diffuse than anticipated. For example,

domiciliary carers and other agency staff reported developing confidence in dealing with general practitioners (GPs) and primary care teams, and primary care staff reported greater understanding of and confidence in using digital health applications. Feedback from staff involved in the test bed indicated that people in these roles felt empowered to have more options to offer patients.

Recruitment to each innovation varied substantially, from 39 to 369 patients. While some innovations met their target numbers of users, others had to widen their recruitment criteria and approach. For example, with the Liva health coaching app, the original plan to recruit people with newly diagnosed type 2 diabetes was relaxed to include anyone diagnosed with this within seven years.

Uptake also varied by innovation, from 25% to 52% of those offered, with some potential users coming up against language barriers and others finding the innovation not relevant to them, lacking confidence with the technology or just not having time. Some could not access the necessary technology or lacked the digital skills to use it. Across all three of the primary care innovations there was a notable influence of age, with those who used the technology being significantly younger.

Some of these factors influencing uptake were also barriers to access and it was valuable for the test bed to be able to work with the innovators to overcome some of these through further developing their product or providing extra support: for example, with app-based programmes being translated into other languages.

Factors that influence uptake and access, alongside the prevalence of the relevant health condition, had an impact on the costs of implementation. Costs were also influenced by the way the innovations were implemented: for example, which staff were involved with implementation, and the impacts on other services within the pathway of the users and patients.

We observed no positive or negative clinical impact of the innovations on patients, but the robustness of this finding was affected by the short duration of the test bed and the low numbers of patients who had follow-up measurements. However, feedback from users and patients who used the innovations was generally positive, with several reporting clinical benefits.

Implementing the innovations required more time and resources than many expected: for example, to enrol patients, train and support staff and redesign pathways. Also, there was a recognition of the importance of flexible and active engagement across the system, particularly where changing pathways had wider impacts, such as between domiciliary care agencies and GPs.

Summary of key messages

The ambitions of the Care City test bed, addressing both the implementation of innovations and workforce development in health and social care, provide a rich opportunity for learning. There are several key messages following from our findings to inform scaling up and national policy. These are described in more detail in the next chapter.

Lessons for local teams implementing innovations

- Plan sufficient time and resources to engage with the right people early on in the process.
    - Involve people from across the care pathway to help drive processes around service need rather than the technology.
- Understand the motivations and expectations of partners early on.
- Confirm the role of the innovation in the care pathway.
    - Consider whether the innovation is offering a new service or an adjunct, as well as the impact on wider services.
- Start co-design early on and ensure it is ongoing throughout implementation.
    - This is a valuable process involving partners (particularly service users and frontline staff) through which feedback on the implementation can be gathered and challenges identified.
- Develop a dedicated project team with innovation expertise.
    - Having a team with project management expertise for support throughout the implementation process is crucial to connect partners.
- Maintain engagement with innovators throughout implementation.
- Consider the impact of an evaluation on the implementation.
    - The evaluation can add to the workload of implementation teams, who already have limited time and capacity, and the focus on recruitment targets can disrupt implementation.
- Collect and analyse data to monitor the progress of implementation and whether the technology is reaching the people it is intended to benefit most.

Lessons for scaling up across systems

- Be clear about what evidence has been provided for the innovation in the context within which it is being scaled up, and mitigate for any lack of evidence.
- Consider the influence of local demographics on successful implementation.
- Understand the factors that influence patient uptake of an innovation.
- Build working relationships between partners and implementation sites.
- Ensure there are sufficient resources and capacity from innovators and project support for roll-out.
    - Consider the funding and resource input required to implement innovations in order to ensure sustainability and delivery capacity within the services.
- Understand the information governance requirements.
    - During the set-up of the innovations, gaining information governance approvals is a critical component. Sufficient time and expertise must be allocated to this.
- Carefully design the training for implementation teams.
    - Consider the time and resources available, staff characteristics and the context of the care pathway.
- Recognise that there is no ‘one size fits all’ approach and therefore implementation should be adapted to each site as appropriate.
- Prepare for an extended length of time to embed innovations.
- Consider the pros and cons of clustering innovations.
    - The clustering of innovations can help to create a shared vision. However, clustering in a combinatorial manner can also risk leading to delays.

Lessons for innovators

- Engage with partners early on in the process to set and clarify goals.
- Engage early and continuously with implementation sites.
- Maintain information flows between innovators and the implementation team to facilitate engagement and motivation – such as providing feedback relating to uptake.
- Ensure there are sufficient resources and capacity for roll-out.
- Be open and flexible to adaptations to the innovation in order to better suit the implementation pathway.

Recommendations for national policy

- Consider the implications of centrally designed programmes.
    - Imposed objectives or timescales can lead to challenges with implementation.
- Consider the resources, funding and support required to roll out innovations more widely.
- Look to provide both high- and low-tech solutions that are inclusive to all groups in a population.
- Consider workforce development in the implementation of innovations. This can help to accelerate the implementation and generate novel insights.
- Consider how the implementation of existing technology in new ways within the NHS can improve wider adoption.
    - This could include generating evidence when implementing innovations in new settings or with new patient cohorts.
- Consider the disruption to current pathways or system-wide change that might be required in order to achieve the full benefits of an innovation.
- Consider the impact of the Covid-19 pandemic on health and social care services and the local service context when implementing digital innovations.
    - While the pandemic has undoubtedly led to opportunities, more research on its impact is needed.

1 Key messages

The ambitions of the Care City test bed, addressing both the implementation of innovations and workforce development in health and social care, provide a rich opportunity for learning. There are several key messages to inform the scaling up of innovations and national policy.

Lessons for local teams implementing innovations

Plan sufficient time and resources to engage with the right people early on in the process.

- Early engagement with implementation teams and sites, particularly the right clinical expertise, middle management and service users, is important to develop a clear implementation pathway and identify risks. This increases the chances of decisions about the processes and whether an innovation is appropriate being driven by service needs rather than the technology.
- Implementation teams should have the ability to test the technology to ensure that the technology is appropriate for users. For example, in the cardiac rehabilitation cluster the team were able to recommend changes to the content and delivery of the app prior to implementation.
- Engagement should include the identification of potential challenges and risks, and should be realistic about what can be achieved and what sort of solution can be provided.
- Not only is it important to have clinical and service user involvement early on (during the development phase) but this involvement must also be continued throughout to support implementation. For example, the involvement of clinicians in the co-design sessions was pivotal in identifying any implementation issues as they arose and in co-developing solutions – such as the need for further training of frontline staff in the digital prescribing cluster.

Understand the motivations and expectations of partners early on.

- To build and manage relationships it is important to set out partners' roles early. This includes their responsibilities in developing the pathway, implementation and problem solving, as well as clarity around their commitments, expectations and motivations.

- Creating a shared vision across all stakeholders is important and should be sustained throughout. The focus of the test bed on workforce roles and the distinct cluster settings were beneficial for creating a shared narrative between partners.

Confirm the role of the innovation in the care pathway.

- Consider whether the innovation is providing an alternative service or an adjunct to an existing service, taking into account local priorities and service aims, and the importance of clinician input.
- Consider how the innovation might disrupt or impact care pathways (and workforce capacity) further down the line. For example, when implementing Whzan, high National Early Warning Scores (NEWS) required escalation to the GP, which can add to their workload, as well as that of the carers.

Start co-design early on and ensure it is ongoing throughout implementation.

- Partners valued the process of co-design for gathering feedback on the implementation and identifying practical changes. The sessions led to new insights for all partners who attended, and resulted in changes to patient cohorts, care or implementation pathways, or an adaptation to the technology itself – a continuous 'quality improvement' approach.
- Funding and time for co-design should be provided during bid development. Stakeholder mapping and bringing partners together are important for identifying a shared view of the problem and actions to be taken. Developing a logic model can provide an opportunity to do this, but the utility of such a model may be more limited when the implementation is highly complex. However, co-design during bid development poses its own challenges given that time and funding are often limited and bids are often not successful.
- The purpose of co-design and the commitment required from partners should be outlined early on.
- It is important to recognise the value of more 'informal co-design' (i.e. spending time on the ground in different settings and 'going where the people are' – the places where patients, service users and healthcare professionals are).

Develop a dedicated project team with innovation expertise.

- Universally, implementation teams recognised the value of having an organisation such as Care City to support them with the set-up and implementation phases, to drive the process, to provide feedback, reassurance and practical support and to monitor progress.

- Partners were positive about the supportive role provided by Care City – particularly their project management expertise, bringing together partners and managing relationships.
- Care City played a pivotal role across all clusters in bringing implementation teams and innovators together and providing the link and project management between partners to help the implementation progress more smoothly.

Maintain engagement with innovators throughout implementation.

- Ensure that technological issues that arise during implementation can be resolved with minimal impact on the implementation teams or pathway by engaging innovators. For example, in the digital prescribing cluster, technological issues relating to accessing one of the apps were resolved quickly by the innovator. Similarly, in the cardiac rehabilitation cluster, the implementation team valued the responsiveness of the innovator and how it enabled them to develop the app so it was appropriate for their patient population.

Consider the impact of an evaluation on the implementation.

- The evaluation added to the workload of the implementation teams, who already had limited time and capacity. For example, in the digital prescribing cluster, the consent process and data collection were reported by implementation staff to pose an administrative burden that was more than expected.
- The focus on achieving recruitment targets disrupted implementation pathways and hampered the embedding of innovations. For example, retrospective recruitment strategies in the digital prescribing cluster required significant time from implementation teams, possibly hindering staff engagement.

Collect and analyse data to monitor the progress of implementation and whether the technology is reaching the people it is intended to benefit most.

- When embedding a new innovation, it is important to collect data on how well it is meeting its original aims, whether there are problems with access or reasons why it might not be used. This could then lead to changes in the process or schemes to improve uptake within target populations.
- Coupled with this is the value of collecting data on outcomes to see whether the new technology within the local setting is leading to its intended advantages and that serious unintended consequences are not being missed. To measure outcomes effectively it is important to recruit sufficient numbers of patients and allow enough time to follow them up.

- It is therefore important to address the relevant information governance issues early, particularly if needing to link data gathered by the technology with that collected by the service.

Lessons for scaling up across systems

Be clear about what evidence has been provided for the innovation in the context within which it is being scaled up, and mitigate for any lack of evidence.

- Quantitative evidence needs to be scrutinised carefully to check robustness and context.
- Where the evidence is not substantial then a formative approach to scaling up may be appropriate, with regular monitoring of data and feedback of results.

Consider the influence of local demographics on successful implementation.

- Care is needed in selecting the cohort of patients likely to benefit, taking account of local priorities such as local incentive schemes and service configuration. For example, diabetes was considered a priority in the local area due to the local incentive scheme relating to the completion of the care processes.
- Language barriers can be a significant issue as many of the innovations are available in English only.
- Cultural barriers can also exist for patients around sharing diagnoses.
- Digital literacy such as smartphone familiarity among users and also the workforce can impact on the uptake of the innovations.
- Digital exclusion: the access that individuals might have to technology or the internet, and the availability of data to use the innovations, can also be a significant barrier to uptake.

Understand the factors that influence patient uptake of an innovation.

- The influence of being referred by a ‘trusted’ individual on patient uptake of an innovation, their motivation to use it and engagement with it should not be underestimated. For example, in the digital prescribing cluster, face-to-face clinician referrals proved to be an important factor for uptake and engagement. This was also seen in the domiciliary care cluster, with the importance of care agency managers liaising with users and families.
- Innovations seeking to augment current service pathways must consider people’s motivations to use a particular service and explore ways for addressing them. For example, identifying what motivates people to take up cardiac rehabilitation will aid in

understanding whether people are more likely to use the technology. Those who opt to do the traditional face-to-face cardiac rehabilitation programme value the opportunity to share their journey with people with the same lived experience.

- Where digital literacy and exclusion are more pronounced, particularly among older people, it is important to maintain access to traditional modes of care delivery.

Build working relationships between partners and implementation sites.

- Creating a unified vision of success with the full implementation team is important to facilitate engagement. For example, the relationships that Care City built with the practices in the digital prescribing cluster and being a presence within the practices were crucial for staff engagement.
- Implementation staff reported the importance of having a leader or champion to drive the innovation within each site.

Ensure there are sufficient resources and capacity from innovators and project support for roll-out:

- The time and resources required from innovators and implementation sites proved to be more than was originally expected and intended (as reported by some implementation teams across all clusters).
- Project support (such as project management, bringing partners together, driving the implementation) is likely to be needed for roll-out, even if the innovations have been tested. For example, the majority of implementation staff in the digital prescribing cluster reported that some support would be needed from an organisation like Care City if the innovations were to be rolled out more widely, particularly in the set-up phase and to support the implementation.
- Consideration should be given to how partnership working within clusters outside a test bed set-up would work such as who would be best placed to take on the role of linking organisations and facilitating engagement, as this role was largely taken on by Care City.
- Consideration should be given to the funding and resource input required to deliver/implement innovations in order to ensure sustainability within the services – for example in the expert carers cluster, given how under-resourced domiciliary care is and the necessity to implement the checks as an ‘add-on’ rather than part of routine service. This was also the case in the digital prescribing cluster: practices did not have the workforce capacity to implement the innovations, which meant that Care City had to take on this role.

Understand the information governance requirements.

- During the set-up phase, gaining information governance approvals was a critical component. Sufficient time and expertise should be allocated pre-implementation (particularly for local and national information governance sign-off) and throughout the implementation.

Carefully design the training for implementation teams.

- Time and resources available for training may be limited at implementation sites. Therefore, there should be some consideration of whether to adapt existing training material and sessions to get the most out of them in a shorter timeframe. It is essential to emphasise to implementation teams the importance of having sufficient time to devote to training.
- Parts of the standard training should be delivered within the context of the care pathway – this was particularly important in the domiciliary care cluster for carers to understand the implementation pathway.
- Implementation staff should understand the technology, its functionality, capabilities and limitations. For example, in the digital prescribing cluster there was early feedback from implementation teams that more understanding of the functionality of the apps was needed in order to support patients. Allowing staff to use the apps themselves can help with understanding and confidence.
- Adequate training is crucial for implementation teams to feel confident in prescribing or using digital innovations. A lack of confidence can act as a barrier to staff engagement.

Recognise that there is no 'one size fits all' approach and therefore implementation should be adapted to each site as appropriate.

- The implementation process will not be identical across all sites. It will need to be adapted according to the different organisational structures of the sites in order to be successful (e.g. workforce structure, capacity and staff roles).
- Implementation teams should be involved in adapting the implementation process and resolving issues to the specificity of their own setting. For the domiciliary care cluster, implementation was most successful where care agencies demonstrated strong organisational leadership, adapted innovations and developed care pathways unique to the specificity of their own setting and existing care delivery routines – for example, they developed solutions to increase recruitment and facilitate implementation such as packaging contacts as 'health and wellbeing' checks.

Prepare for an extended length of time to embed innovations.

- Embedding new innovations within services can take time to see the full potential of an innovation. The timescale imposed by the test bed programme is not necessarily long enough for the innovation to be embedded and services to be evaluated.

Consider the pros and cons of clustering innovations.

- The clustering of innovations around workforce roles helped to create a shared vision between partners, provided an opportunity for shared learning and was beneficial for managing relationships between partners.
- However, the clustering of innovations in a combinatorial manner can lead to delays when there is interdependence between innovators in an implementation pathway; if one innovation is not successfully adopted, this can impact another. This was particularly evident in the set-up phase of the test bed when trying to get several innovations up and running together.
- When clustering innovations for implementation, consideration should be given to whether implementation sites have the workforce capacity and resources to take on several innovations at one time. This was evident in the digital prescribing cluster; some implementation sites reported that trying to implement several innovations at one time was overwhelming.

Lessons for innovators

Engage with partners early on in the process to set and clarify goals.

- Engage early to understand the key performance indicators, to agree what success looks like, to identify the potential barriers and to determine the time and resources required.
- Forecast time commitments to be involved in this early phase of work and cost them into grant applications. Across the test bed, some innovators had committed more time than expected, whereas others had spent less time.
- Spend time with service users, patients and health care professionals early on to understand the service needs and identify how the innovation might improve a particular service and/or provide a solution to a particular service need.

Engage early and continuously with implementation sites.

- Engage with implementation staff at all levels – organisational leaders and frontline staff (clinical and non-clinical) – to demonstrate the importance and case for the innovation. Implementation teams are more likely to engage with an innovation if they trust the innovation and innovation team.
- This was evident across the test bed clusters; the credibility of the innovations and the trust between the sites and the innovators were important for implementation staff to be reassured that they were providing the best care possible.

Maintain information flows between innovators and the implementation team.

- A regular communication channel between innovation and implementation teams can facilitate engagement and motivation. For example, the Healthy.io dashboard was circulated to implementation teams regularly and was beneficial to keeping staff informed and engaged.
- This is also important to solve any challenges with the technology early on.
- Data sharing between innovators and sites is also important to allow the implementation to be as efficient as possible and for care to be aligned – for example, patient feedback relating to use of the Liva Healthcare programme included that closer alignment and sharing of data between their GP practice and the innovator would be beneficial.

Ensure there are sufficient resources and capacity for roll-out.

- As noted above, the time and resources required from innovators have proved to be more than was originally expected – clarity around responsibilities, commitments and expectations should be discussed early on (pre-implementation).
- Innovators should be prepared to consider adaptations to the innovation in order to better suit the implementation pathway, should this be needed – as was seen for the adaptation of Dip.io for domiciliary care.
- Consideration should be given to the impact of scaling up on innovator resources and on the service provided.

Be open and flexible to adaptations to the innovation in order to better suit the implementation pathway.

- The process of implementing and spreading innovations often requires innovators to make changes or adaptations to their product or process in order to respond to users' needs or adapt to new settings, pathways or situations. Being flexible and open to

adaptations can enable innovators to spread to new markets or users, or improve their innovation or support offer. This was seen in the adaptation of Dip.io for domiciliary care and in the changes made to TickerFit as a result of co-design.

- The test bed project highlights the value that can arise from tailoring innovations or the process of implementation to better support patients and staff, or respond to new situations (such as the Covid-19 pandemic). But, it may also require trade-offs, in order to maintain fidelity to the model or existing evidence base.[1] Other considerations also apply, for example the capacity of the organisation to respond to requests (which may be more challenging for a smaller company).

Recommendations for national policy

Consider the implications of centrally designed programmes.

- The purpose of the test bed, to provide evidence for innovations, can introduce barriers to successful adoption, which should be accounted for in future programmes.
- Promoting innovation through programmes that are designed centrally can result in greater challenges with implementation, due to imposed timescales or objectives. For instance, programmes and bid processes that focus on implementing innovations can divert attention away from specific clinical needs or problems.
- Also, timescales are often not long enough to fully evaluate new services and pathways.

Consider the resources, funding and support required to roll out innovations more widely.

- Take into account the scale of effort invested by innovators into the programme or pilot – including how scaling up might impact on their resources – and consider what further support might be beneficial for successful adoption.

Look to provide both high- and low-tech solutions that are inclusive to all groups in a population.

- Consider the impact of digital exclusion and digital literacy when addressing a particular service need or problem. Not all individuals will have access to a smartphone, computer or the internet. This is crucial to prevent increasing inequalities in access to healthcare.

Consider workforce development in the implementation of innovations.

- The focus on workforce development has provided novel insights in relation to workforce roles, and facilitators and barriers to upskilling in different healthcare settings.

- Workforce development was demonstrated in two of the settings. The range of skills developed was more diffuse than anticipated, including knowledge, digital skills, confidence and empowerment, as well as an openness to using digital innovations.
- Clarity on whose role will change in order to adopt and implement innovations can help to accelerate progress.
- However, there is a need to recognise that different stakeholders will have different aims and motivations that are not just focused around workforce development.

Consider how the implementation of existing technology in new ways within the NHS can improve wider adoption.

- The Care City test bed findings may provide useful learning for other NHS sites, particularly other adopting organisations that may prefer evidence of NHS implementation. For example, the test bed was the first time TickerFit was used in an NHS cardiac rehabilitation setting.
- The test bed may provide useful learning for implementing already tested and evidenced technology with new cohorts or to test new ways of implementation. For example, the test bed was the first time Liva Healthcare was used with people living with type 2 diabetes in the NHS.

Consider the disruption to current pathways or system-wide change that might be required in order to achieve the full benefits of an innovation.

- For example, while Whzan is implemented by carers, the care escalation process requires action from primary care.
- The ability to embed data transfers between apps and patient clinical records could benefit routine practice where they record app usage and test results.

Consider the impact of the Covid-19 pandemic on health and social care services and the local service context when implementing digital innovations. While this has undoubtedly led to opportunities, more research on the impact is needed.

- The pandemic has resulted in unprecedented changes to the way that health and social care services are delivered. Priorities have shifted, ways of working and resources have changed, and in many cases there has been a rapid adoption of digital technology.
- For example, primary care priorities have shifted and have undergone a rapid digital transformation with an increase in the use of remote health services.

- Within the domiciliary care cluster, providers are facing even greater financial pressures and staff shortages, which have heavily affected their ability to deliver all services. However, the improved communication between care agencies and primary and community care services provides future opportunities for more collaborative working.
- There has also been a change in patients' behaviour and attitudes – many patients have been less likely to agree to attend services and are therefore looking for alternatives such as digital options.
- Digital exclusion and digital literacy were huge barriers to the use of digital innovations in the test bed programme. The digital transformation of services facilitated by the Covid-19 pandemic is likely to only accentuate these barriers and promote further inequalities. When implementing digital technologies, consideration must be given to those unable to access digital innovations.

2 Background

The Test Bed Programme (national perspective)

The NHS Test Bed Programme was designed to bring together NHS organisations and commercial providers of digital technologies. These partnerships test new ways of delivering care, with the potential of improving patient experience and outcomes. Wave 1 of the programme ran for two years, starting in January 2016, and a second wave of test bed sites was announced in 2018. There have been seven Wave 2 sites in all: three funded by NHS England, focusing on the self-management of diabetes, and the other four funded directly by the Department of Health and Social Care (DHSC). One of the DHSC-funded sites is run by Care City, which is the focus of this report.

Care City

Care City was established as a joint venture between North East London NHS Foundation Trust (NELFT) and the London Borough of Barking and Dagenham, with the purpose of improving health and social care within one of the most deprived areas of London. As a Community Interest Company, it aims to help local people have a healthier, happier old age through research, innovation and education. As already noted, it is running one of the four DHSC-funded test beds in Wave 2 of the national Test Bed Programme, receiving funding of just under £1.4 million. Care City is the only test bed site to have received funding in both Waves 1 and 2 of the programme.

Care City and its delivery partners carry out projects that seek to:

- improve patients' confidence, health outcomes and ability to self-manage
- increase staff skills and workforce productivity
- remodel areas of the workforce and service pathways across East London
- scale these models to adoption partners, backed by training and investment.

The technology that Care City chose for the test bed were digital applications intended to improve outcomes and experiences for individuals with long-term conditions. These were also chosen because they had the potential to meet Care City's aim of enhancing the skills of support staff.

The Care City test bed programme

The Care City Wave 2 test bed planned to implement a total of eight innovations, intended to meet the needs of people with long-term conditions in East London. These were clustered around three specific staff roles to support implementation:

- domiciliary carers
- healthcare assistants
- hospital administrators.

A selection of local care agencies, GP practices and one acute hospital trust agreed to act as test bed 'sites' for implementation. Of the eight innovations, six were able to proceed to testing (see Table 1).

Table 1: Innovations that proceeded to testing

Cluster	Proposed technologies
Cluster 1: Domiciliary care	Domiciliary carers using digital diagnostics and data to spot deterioration in patients and better manage medication, using: • Whzan Digital Health – digital measurement of vital signs • Healthy.io – digital urine analysis (Dip.io, now Minuteful 10).
Cluster 2: Digital prescribing	Healthcare assistants in primary care prescribing digital applications and supporting people to benefit from them to prevent deterioration of long-term conditions, using: • Sleepio – proven digital medicine for sleeplessness • Liva Healthcare – a digital platform connecting patients and health professionals to drive behaviour change for people recently diagnosed with type 2 diabetes • Healthy.io – a home-based albumin to creatinine ratio (ACR) urine test (now Minuteful Kidney).
Cluster 3: Cardiac rehabilitation	Hospital administrators using digital pathway tools to support patients to change their lives, using: • TickerFit – digital programmes of education and exercise for cardiac rehabilitation.

Evaluation terms of reference

Care City invited the Nuffield Trust to be its evaluation partner for the Wave 2 test bed, for which we adopted a mixed-methods approach to assess both process and service outcomes. The scope of the evaluation is outlined in Box 1.

Box 1: Evaluation scope

Scope of the process evaluation
• The process that sites went through to design their programme. • Whether interventions were delivered in line with the proposed plans. • Whether the partnership of implementing sites, innovators and Care City worked as intended, and why. • What changes had to be made during implementation to ensure effective delivery of the intervention, and why. • The barriers and facilitators to effective delivery and uptake of the new technology, as well as how barriers were overcome. • Any unintended consequences that needed to be managed and how this was done. • Whether the interventions are likely to be scalable, and why.
Scope of the outcomes evaluation
• Uptake and sustained use of implemented innovations, and the relationship to patient characteristics. • The measurable impact over the time of the study on resources and health outcomes. • The qualitative impact on patient experience and satisfaction – including the acceptability of the innovations. • The experiences of staff of working with the innovations and their broader role. • The likely longer-term outcomes and costs of each innovation pathway compared with usual care, where possible.

The evaluation was formative – the Nuffield Trust team shared information throughout the course of the project to monitor how well the aims were being met and to inform decisions about whether changes were needed to meet those aims.

The evaluation did not cover:

- quantitative analysis of workforce metrics, such as productivity, turnover and retention rates, except where it was relevant for measuring costs
- measures of overall job satisfaction pre and post innovation implementation
- analysis of the effectiveness of each innovation beyond the context of each cluster.

The evaluation approach was informed by some of the learning from Wave 1. For example, the approach involved qualitative evaluation from the outset; there was an investigation of digital exclusion; and individual patient-level data were used to track patients' use of healthcare resources and their outcomes, with a view to comparing them to matched controls not participating in the test bed.

The test bed was initially scheduled to run for 18 months from October 2018 to March 2020, but it was extended to September 2020 to accommodate delays in implementation.

Context of the test bed

National context

The Care City team were confident that their approach to the test bed sat well within the national policy drive to embed digital innovations into health and care practice, supported also by the growing ability and willingness of frontline health and care staff to use digital innovations.

A number of well-established national programmes were instrumental in developing the test bed narrative and these have continued to influence activity as the programme has progressed. They include NHS Vanguards (although focused on care homes rather than domiciliary care), national programmes such as the National Diabetes Prevention Programme and the Diabetes Prevention Service, and more recently, initiatives such as Health Education England's work on developing GP assistant roles. Emerging results from these programmes have fed into the Care City test bed programme.

Care City also referred to key policies, such as the NHS Long Term Plan and the GP Contract Framework, which emphasise the importance of and provide funding for social prescribers. The test bed has been an opportunity to translate these policies into practice and generate new learning on the integration of digital elements into various roles.

It is important to recognise that the test bed has operated under the existing national pressures within the system and staff culture. For example, in domiciliary care, the systemic funding issues and the complex nature of social care provision in private homes have hindered engagement with clinical staff. Without doubt, however, the biggest challenge for the test bed has been the Covid-19 pandemic, which has resulted in widespread changes to the national policy context and priorities since March 2020.

Local context

As the innovation partner to the local health and care system, Care City had existing relationships with system networks and this would ensure the programme sat within local priorities and be sustainable in the future. This has involved working closely with Barking and Dagenham, Havering and Redbridge (BHR) Clinical Commissioning Groups on a number of proposals around 'digital innovation to enhance support roles'. Care City also solicited feedback from local stakeholder organisations such as Skills for Care East London, Barking and Dagenham Healthwatch, and the Executive Group for East London Health and Care Partnerships. As the test bed has progressed, Barking and Dagenham council has been particularly engaged around the domiciliary care cluster, and has drawn on the programme's learning to develop an online platform to support 'expert carers' in domiciliary care at Barking and Dagenham College.

As part of its role as a Community Interest Company, Care City has set up a Community Board to facilitate its work with the community, and especially with services that may be under-supported.

The London Borough of Barking and Dagenham, as one of the most deprived areas of London, poses unique challenges for the test bed. Barking and Dagenham was ranked the 11th most deprived area in England in the 2015 Index of Multiple Deprivation[2] and has the second highest unemployment rate (6.1%) of all the London boroughs. It is an ethnically diverse area; as of 2019, 47% of Barking and Dagenham's population were White, 23% were Black and 23% were Asian.[3] It is estimated that its diversity will increase over the coming years as the younger, more ethnically diverse population ages. The population is also relatively young, with a median age of 32 compared with 35 for London as a whole and nearly 40 for England.[3] The local context is important when implementing digital technologies in health and social care, particularly when considering issues around digital exclusion, digital literacy and other potential cultural and language barriers.

The Covid-19 pandemic

On 31 January 2020, the UK recorded its first confirmed case of Covid-19 and, by 11 March 2020, the World Health Organization had declared Covid-19 as a pandemic. Two weeks later, the UK government declared strict lockdown and social distancing measures. The pandemic has had a huge impact on health and social care services in the UK, with services undergoing fundamental changes in relation to: how care is paid for and delivered; NHS capacity and staffing; access to services; and health system governance and decision making. There has also been a notable reorganisation of services to manage Covid-19 patients. This undoubtedly had an impact on the progress of the test bed. This report will outline the impact that the Covid-19 pandemic has had on the implementation of the innovations across domiciliary care, primary care and cardiac rehabilitation settings, as well as its impact on the evaluation of the test bed.

3 Methods

The evaluation comprised both qualitative and quantitative elements, as described below.

Qualitative methods

The qualitative evaluation that informs this report was divided into three phases – pre-implementation, implementation and post-implementation – to capture how views, processes and outcomes change over time.

Phase 1: Pre-implementation

We conducted rapid scoping reviews to identify:

- literature relating to the introduction of innovations in health care, including principles of staff and patient engagement, to inform the process of implementation
- literature associated with each of the innovations, including existing evaluations and randomised controlled trials – this helped us to inform implementation, develop appropriate outcome measures and compare our findings with those from other contexts
- evidence underpinning programme design for each cluster – for example, for the domiciliary care cluster, we considered evidence regarding how domiciliary carers have been upskilled elsewhere.

The review also included national policy documents about NHS England's Test Bed Programme and internal Care City documents such as implementation plans, protocols and training guides.

We were involved in planning and implementation from the beginning, attending cluster meetings that brought together the different partners, information governance sessions covering the test bed as a whole and the evaluation, and ad-hoc meetings with implementation sites and innovators.

We also led 'logic model' sessions for each cluster, which helped City Care and partners to agree on the rationale, stakeholders, output and outcome measures and gave an opportunity for conversations about appropriate patient cohorts and pathway design.

We observed, as either participants or non-participants, 16 training, engagement and co-design sessions with implementing sites. We were particularly interested in how the purpose and intended outcomes of the innovations, cluster and test bed were described; in staff reactions; and in any questions or concerns raised.

We also conducted 26 interviews with the Care City team, lead implementers at sites and innovators (examples of interview topic guides are shown in Appendix 2). These explored:

- understanding of the purpose of the cluster and the role of Care City
- interpretations of the problem being solved through implementing the innovation, including any benefits and drawbacks relative to usual care, any anticipated barriers or challenges, and mitigation strategies
- understanding of how the innovation fits into the cluster approach
- expectations of participating in the test bed in terms of resources and what they will need to contribute, any anticipated risks or barriers and what they hope to gain from being part of the test bed.

Phase 2: Implementation

Within the implementation phase of the evaluation, we conducted 18 interviews with frontline staff (e.g. healthcare professionals and domiciliary carers) supporting the implementation and 15 interviews with service users. Interviews with staff focused on:

- their view of the innovation (the value proposition) and the pathway
- site characteristics (e.g. readiness to adopt the innovation)
- their confidence in recommending and supporting the use of the innovation
- the impact of the innovation on their role and satisfaction
- the perceived impact of the innovation on patients
- their views on scale and spread.

Interviews with service users focused on their engagement and satisfaction with the innovations. We conducted surveys with service users to collect information relating to referral, engagement, satisfaction and perceived outcomes. We also conducted surveys with frontline staff to examine their view of the innovations, their confidence in recommending and supporting the use of the innovations, the impact of the innovations on their role and satisfaction, and the perceived impact on patients.

We conducted 11 observations to understand how patients were supported to use the innovations, for which we developed an observation framework to collect field notes.

Phase 3: Post-implementation

We completed 30 post-implementation interviews with lead implementers, Care City staff, clinical leads and innovators, to:

- understand how the test bed progressed in comparison with pre-implementation expectations
- gain their reflections on the programme
- learn lessons for the transferability of the innovations and pathways across the NHS.

Analysis

We recorded and transcribed all interviews, and removed patient-identifiable information to ensure anonymity/confidentiality. We coded the interviews using NVivo software (version 12). We conducted a thematic analysis to explore and identify key themes. We developed the coding framework deductively based on the scope and aims of the evaluation and guided by the non-adoption, abandonment, scale-up, spread and sustainability (NASSS) framework[4] – developed to explain individual and organisational challenges to the adoption and sustained use of technological innovations in health and care. We used the NASSS framework to identify possible areas of complexity in implementing technology. NASSS consists of seven domains: the illness or condition, the technology, the value proposition, the individuals intended to adopt the technology, the organisation(s), the wider system, and embedding and adaptation over time. We grouped the data into themes according to these domains.

For each of the phases, we triangulated the data collected across the qualitative methods to test the validity of the findings through the convergence of information.

Quantitative methods

Overview

The quantitative evaluation examined:

- uptake and sustained use of the implemented innovations, and the relationship to patient characteristics
- the measurable impact over the time of the study on resources and health outcomes
- the likely longer-term outcomes and costs of each innovation pathway compared with usual care, where possible.

The methods used for costing are described in the next section.

The primary aim of the analysis was to investigate the process and effectiveness of each innovation within the context of the test bed, rather than provide evidence as to whether or not each innovation works for those who engage with it. That has been covered more rigorously in

other studies and trials. For the digital prescribing innovations, evaluation of outcomes was carried out on an 'intention-to-treat' basis, which accounts for variable uptake and people dropping out. So, rather than evaluate the impact on an individual, we investigated the impact on the population and those serving the population.

For each innovation we collected data at an individual person level. Where possible, this comprised routine data recorded in existing systems and data gathered from the apps or innovators themselves. Linkage between routine data and the technology was not always possible due to insufficient common information against which to make a link, or complications with information governance. For some innovations we specified extra bespoke fields that would enhance the routine data collections. For Whzan we developed an entirely new data collection tool, as established routine data sources did not exist within the care agencies.

Whzan

Because the care agencies involved in the Whzan innovation did not collect routine data, we developed a data sheet for them to fill in to record, for each of their clients, the results of their Whzan tests. These records included the six individual components that made up their National Early Warning Score, version 2 (NEWS2): systolic blood pressure, heart rate, oxygen saturation, respiration rate, temperature and level of consciousness. For each entry, there was also the option to indicate whether the results had been escalated to health care services, such as the GP, 111 or 999. Lastly, the data sheet also captured service users' age, gender and ethnicity.

The time period for the evaluation was relatively short, so we were not able to measure long-term impact. We focused on monitoring the use of the Whzan kits and the frequency of resulting NEWS2 scores, in particular the numbers high enough for escalation to the GP. We also investigated issues that either facilitated or hindered effective data collection across the agencies. For instance, the completeness of demographic information on funded users that agencies held was partly dependent on case notes that they received from the local authority or clinical commissioning group. However, for self-funded clients, there was no obligation for them to share their medical history when they first registered with the agency.

Liva

To evaluate the Liva app, we analysed patient-level primary care data on all individuals within the test bed practices who were eligible for health coaching as well as data that Liva Healthcare

collected from the app itself. The primary care data consisted of patient characteristics, relevant comorbidities and prescriptions, as well as related clinical measurements such as control of blood sugar levels (HbA1c) and body mass index (BMI). These were obtained for the patient before, during and after implementation. To enhance the data, a bespoke template was embedded within the participating GP practices' EMIS system. This template allowed the recording of information about an individual's access to the appropriate technology, alongside decisions they made about taking part.

The data from Liva Healthcare included information that individuals recorded in the app, indicating their level of engagement, including step counts, contacts with the health coach and registrations against goals. Liva Healthcare also recorded whether individuals completed or dropped out of the nine-month programme.

We analysed uptake by patient characteristics as well as features of individuals who either declined or were considered unsuitable for the app. We analysed differences between patient groups with combinations of univariate and multivariate tests, as appropriate.

For outcomes, we analysed the changes in HbA1c and BMI at six, nine and twelve months. In practice, since follow-up visits did not occur exactly at these intervals, we chose follow-up periods of 4.5 to 7.5 months, 7.5 to 10.5 months and 10.5 to 13.5 months respectively. If more than one measurement was taken in those periods, we chose that which was taken closest to the mid-point of the period. This also enabled us to make best use of the amount of follow-up data we had.

Because we were not able to link data between the Liva app and GP records, we only analysed outcomes on an intention-to-treat basis, drawing our cases from all those who were referred to the programme. We compared changes among these cases with control patients drawn from all practices across Barking and Dagenham who were not using Liva as part of the test bed. Because numbers of cases with follow-up visits were low, we did not run a case–control matching, but used the control group to predict outcomes according to patient characteristics and applied these predictions to the cases. We derived the predictions from linear regression models, with separate models applied to each period of follow-up. The different variables used in these models are shown in Appendix 3.

Sleepio

As with Liva, to evaluate the Sleepio app we had access to individual patient records from local GP systems alongside data that Sleepio collected on engagement with the app. The app data

also included self-reported measurements of users' quality and quantity of sleep. The GP data and the data from Sleepio were not linked because the Sleepio app did not gather information that would enable this to be done accurately.

We developed a similar data template to the one used for Liva exclusively for the test bed practices, to record consultations about Sleepio, including questions about access to technology.

As with Liva, we analysed uptake and the features of individuals who declined to use the app. We also analysed impact on the prescribing of hypnotic drugs and of specific anti-histamines used for sleep disorders, matching individuals who were referred for Sleepio to controls drawn from practices in Barking and Dagenham who were not part of the test bed for Sleepio. As with Liva, this was done on an intention-to-treat basis. Each case was matched to two controls: the different matching variables were age, gender, ethnicity and previous use of hypnotics or promethazine in the previous twelve months. Chosen outcomes were at least one prescription for at least one of the specific drugs between one and six months after referral and, again, between one and nine months after referral. We analysed the differences between the two matched groups using logistic regression, with each set of case and controls treated as repeated measures.

TickerFit

For the evaluation of the TickerFit app (an online rehabilitation programme), we linked routine data collected by the implementing hospital trust to data from the TickerFit app. The trust data included an individual's demographics, relevant clinical measurements and comorbidities as well their use of rehabilitation services. The data collected by TickerFit included an individual's engagement with the app.

The National Audit of Cardiac Rehabilitation (NACR) provided us with data on the use of rehabilitation services both nationally and within the local area. This helped to provide a context against which to assess the particular needs of the local area and any differences in the way rehabilitation services are used.

We analysed uptake by comparing the characteristics of patients who downloaded TickerFit with those who were offered the app but did not download it. We also compared changes in BMI before and after rehabilitation for these groups. There were insufficient numbers of patients with follow-up records for formal case–control matching.

Costs, budget and measurable impact

In this report we address the following questions:

1. How much did it cost to deliver the innovations, and how did this vary across the test bed sites?
2. How much would it cost to scale the innovations up (or deliver them elsewhere)?

Data collection

Care City staff collected data from the implementation sites on the resources used to deliver innovations, as part of financial monitoring arrangements. This information was recorded as time spent on an activity related to the test bed (e.g. catch-up calls, delivering care) and detailed the individuals involved and what role each held in relation to the activity. Care City and the innovators provided information on the cost of the innovations themselves and the necessary kits. These costs are those relating to the test bed, and may not reflect costs in other contexts where different commercial arrangements may be in place.

Analysis

We coded implementation data based on:

- what phase of the implementation the activity was related to, i.e. set-up, onboarding, care delivery or implementation support
- whether each activity would be required outside of the test bed context if rolling out the particular pathway
- whether the activity was carried out by Care City or a staff member at the implementation site.

The level of detail varied between sites, and although we made every effort to ensure data were consistent, there was variation between sites in how test bed related activities were described. Where the intended pathway was altered due to resource restrictions (e.g. Care City onboarding patients in the digital prescribing cluster), we added an additional scenario. The activity carried out by Care City that would have ordinarily been done in another role was recoded and costed according to the customary staff member's rate, in the case of the above example the healthcare assistant (HCA) rate. We undertook descriptive analysis by assessing how the cost

of different phases of the implementation varied across sites and by innovation, and related this to other findings (for example, challenges with implementation in some sites).

We estimated the unit costs of the innovations based on the costs within the test bed and the number of patients benefiting.

We also estimated the costs of the innovations if scaled. We used the implementation data from sites in conjunction with data on the size of the patient cohort and uptake to estimate unit costs relevant for each innovation, including an overall estimate of cost per eligible patient. Due to the small number of patients enrolled in TickerFit, we were not able to produce these estimates for this innovation.

Estimates from the test bed are considered in the context of findings from previous economic evaluations, where available.

Ethical issues

In line with Health Research Authority (HRA) guidance, the test bed evaluation was classified as a service evaluation rather than research and therefore did not require research ethics committee or HRA approval. Given that participants were not randomised, the test bed did not change care from accepted standards for any of the service users involved; and findings are context-specific to understand issues of scale and spread.

We followed the informed consent process for all participants; participant information sheets provided details of the project, and service users were required to provide consent to ensure that participation was informed and voluntary. The research team is experienced and appropriately trained in conducting service evaluations.

Data management and information governance

Throughout the conduct of the project, we followed guidelines for data security, confidentiality and information governance. Data were stored/handled and transferred securely in accordance with the Data Protection Act (2018) and the General Data Protection Regulation (2018) to uphold confidentiality. Further information relating to Nuffield Trust privacy guidance can be found here: www.nuffieldtrust.org.uk/resource/privacy-notice.

Influence of the Covid-19 pandemic on the evaluation

The Covid-19 pandemic had a notable impact on the qualitative and quantitative evaluation of the Care City test bed programme.

The pandemic posed several challenges for the qualitative evaluation by reducing the availability of implementation staff for qualitative interviews and surveys due to redeployment, staff shortages, increased pressures on health and social care services and shifting priorities. This in turn impacted on the timing and volume of qualitative data collection. To minimise the impact of the Covid-19 pandemic, some data were collected earlier than originally planned while other data collection was delayed, and some data collection was no longer deemed feasible. Implementation teams acted as ‘gatekeepers’ to service users and the number of surveys and interviews was less than originally planned due to difficulties and delays in contacting service users. These challenges manifested across the test bed clusters to a greater or lesser extent.

For the quantitative evaluation it became increasingly difficult to collect data across all settings as the staff required for data transfer were not available. When data arrived they were delayed, which precluded our ability to use the data formatively and to act on data quality issues sooner. Where the implementation required patients to receive follow-up appointments, many did not take place, which meant we had less information than planned on how the innovations affected patient outcomes.

Further description of the impact that the Covid-19 pandemic had on the implementation of the innovations is outlined in the cluster-specific chapters of this report.

4 Key findings related to the test bed set-up

This chapter of the report outlines the key findings related to the set-up of the test bed. It is informed by the qualitative findings derived from the pre-implementation interviews.

Test bed aims and design

The bid to NHS England was focused towards workforce development and healthy ageing, in order to align with local objectives and ensure stakeholders across the local health system were involved. A stakeholder panel selected the innovations and made the decision to cluster these around three distinct workforce roles. The two main aims of the test bed, shared across the clusters, were to develop learning around:

1. **The real-world testing of combinatorial innovations**. It was hoped that by implementing market-ready innovations in combination, the test bed would provide learning that could be shared locally and nationally. This ambition was especially reflected by the Care City programme team, as well as among innovators. The choice to test the innovations in clusters followed encouragement from NHS England to 'test' market-ready technologies as 'combinatorial innovations' around 'disease-based' pathways. NHS England defines combinatorial innovations as 'new combinations of products… to work in combination with other products in the partnership, as well as innovations in service delivery; producing better outcomes for patients at the same or lower cost'[5].

2. **The upskilling of workforce roles**. This was considered essential to the delivery of health and social care for people with long-term conditions in North East London. This upskilled workforce would contribute to better experiences and outcomes for service users. This would, in turn, alleviate pressures on the local health and care system. Stakeholders at all levels across the three clusters reflected that this was a priority. The fact that Care City shaped its clusters according to the three distinct workforce roles (i.e. by which members of the health and care workforce would be best placed to implement the innovations) represented a novel approach to combinatorial design.

Stakeholders at different levels prioritised different aims for the test bed. For example, those stakeholders closest to the front line tended to focus on cluster-specific aims and potential benefits of the specific technologies for service users and the system, including:

- **Improved outcomes for service users.** Experience and outcomes for service users were closely linked with improved access to digital innovations. It was hoped the technologies provided would help patients manage their long-term conditions. This aim was especially reflected by stakeholders closest to the front line, such as implementation and clinical leads.
- **Improved system outcomes.** Many respondents hoped that in the long term, the chosen innovations would become embedded into local and national care pathways and contribute to alleviating the systemic pressures in the NHS and social care. Providing more care in the community would reduce the burden on hospitals and ultimately provide care and cost efficiencies. As such, willingness from local commissioners to identify and adopt new care pathways developed by Care City was suggested as a key indicator of success.

Learning from Wave 1

Care City is the only Wave 2 site to have also been a Wave 1 site, which facilitated the planning, design and implementation of the test bed:

- Care City built in capacity to manage the time-consuming activities associated with the real-world testing of innovations, such as information governance and preparing for unintended outcomes.
- The testing of a large number of innovations was intended to ensure that even if some innovations did not proceed to testing, as had happened in Wave 1, there would still be a viable number to learn from.
- The team also sought to communicate with partners from the earliest stages of bid design to promote a more collaborative design.
- Care City reported that its Wave 1 test bed lacked a coherent narrative, which led to implementation “challenges”. Wave 2 was therefore designed with a clear narrative around workforce development, particularly for those staff who are well placed to support the implementation of innovations.

Innovators and innovations

The process of choosing innovators began with a long list of 50 innovators who had attended the Innovate UK and NHS England marketplace days. Eighteen were identified for interview with

Care City staff and representatives from the local health and care system, according to their ability to 'identify, treat and manage'. A final eight innovators/innovations were chosen to take part in the test bed. The Care City team reported that recruiting innovators into the programme had followed a rigorous process that would allow a fruitful collaboration for the test bed and in the future.

The innovations were assigned to clusters based around different care settings and workforce roles, to create a coherent narrative for the test bed, to demonstrate the potential of digital innovations to enhance the roles of support staff, and to meet the requirements of the test bed programme (i.e. for different innovations to work in combination). A number of factors helped shape the clusters around three workforce roles, namely their relevance to the local community, the influence of existing technology, the evidence base and the distinctiveness of the chosen settings.

Three innovations were selected for a domiciliary care setting for care workers, three innovations were chosen for a primary care setting focused around health care assistant roles and two innovations were aimed at hospital administrators in secondary care (cardiac rehabilitation) settings. Five of the innovations proceeded to testing and one of the remaining innovators tested two interventions within two different clusters, making a total of six innovations. Their key features are outlined in Table 2. For those that did not proceed to testing, the reasons are outlined in the next section.

Table 2: Features of the innovations that were tested

Innovation	**Description of innovation (key features)**
	Domiciliary care
Whzan	• The Whzan kit measures a person's vital signs (temperature, blood pressure, blood oxygen, pulse, respiration rate and level of consciousness) using instruments connected via Bluetooth to a tablet – to calculate a National Early Warning Score (NEWS) score. • The NEWS score, first developed in 2012, was superseded by the NEWS2 score in 2017. The NEWS2 score produced includes a number between 0 and 10, and a traffic-light rating (0–3 = green, 4–5 = amber and 6–7 = red) to facilitate interpretation and convey urgency to clinical services.

Innovation	Description of innovation (key features)
Dip.io (now Minuteful 10)	• Healthy.io manufactures three smartphone-based urinalysis tests. The Dip.io test includes a urine pot, a 10-parameter dipstick and a colour board and requires a smartphone and internet access to function. The product has been designed to enable patients to test their urine at home, with the results reviewed by a healthcare professional for diagnosis. • The technology consists of a test kit and a mobile app containing image recognition software. It can be installed on Android and iOS smartphones. • Dip.io tests for ketones, leukocytes, nitrites, glucose, protein, blood, specific gravity, bilirubin, urobilinogen and pH – markers that span pathologies from urinary tract infections to ketosis, kidney disease, pregnancy ill-health and bladder cancer. • Results are integrated into electronic patient records for review using a secure web-based portal. • For this project, the product was adapted for use by a personal carer rather than an individual patient, i.e. enabling the carer to use their smartphone as a point-of-care testing device.
	Digital prescribing (primary care)
Liva Healthcare	• The Liva app is a digital behaviour change programme consisting of one-to-one personal coaching, group-based interventions, tailored health plans, goal tracking and self-monitoring. • The app can be placed on a smartphone, tablet or computer. • The patient is paired with a health coach with whom they have an initial live video consultation to establish a relationship and collectively set achievable health and lifestyle goals. The patient tracks progress against these goals. They are also encouraged to submit photographs of their meals, and record activity and clinical test results. The health coach supports the patient to manage and reach their goals based on the information.

Innovation	Description of innovation (key features)
	• The patient is given access to educational resources and personalised coaching via the platform and a forum, where they can interact with other users and join groups.
Healthy.io ACR test (now Minuteful Kidney)	• The albumin to creatinine ratio (ACR) test is a smartphone-based diagnostic test for home use by the patient and results are automatically filed in the patient's electronic patient record (held by their GP or other clinician). • The technology consists of an ACR test kit and a mobile app containing image recognition software. • The app can be installed on Android and iOS smartphones and guides the patient through each step of the testing process using video, audio and text guidance.
Sleepio	• Sleepio is an evidence-based digital programme that delivers fully automated cognitive behavioural therapy for insomnia. • It is delivered through a web-based platform or supporting iOS app and consists of six 15- to 20-minute sessions. • The content of sessions is based on cognitive (e.g. cognitive restructuring.) and behavioural (e.g. sleep restriction therapy and relaxation) techniques to help improve sleep. • Treatment is personalised from responses to a sleep questionnaire and daily sleep diaries that track progress and help determine a sleep schedule. • Users have access to an online library of light-sleep help guides and to an online forum that hosts regular 'live chats' with clinical psychologists and provides peer-to-peer support.
	Cardiac rehabilitation
TickerFit	• TickerFit is digital technology that enables health professionals to prescribe a customised programme of exercise and education for patients via a web platform, which can be viewed by patients on a mobile app.

Innovation	Description of innovation (key features)
	• It is described by the innovator as a 'tool to leverage' the relationship between the healthcare professional and the patient, rather than as a replacement for face-to-face contact. • It can be used in any setting that operates cardiac rehabilitation services.

Innovations that did not proceed to testing

Three of the innovations did not proceed to testing:

- **Echo** is a mobile app that sends in-app medication reminders to a patient's personal mobile, and gives them directions on dosages of each of their medications. It was planned to be implemented in the domiciliary care cluster. However, it is being evaluated separately outside the test bed, as a more suitable use was found with informal carers, which fitted better with the app's design and functioning.
- **Our Mobile Health (OMH)** provides a library of apps that have been through their review process and was to be evaluated in the digital prescribing cluster. However, OMH did not proceed to testing, in part due to the fact that the company lost its contract with EMIS, and therefore could not help make apps in the test bed more accessible to primary care staff.
- **DrDoctor** is a technology that supports healthcare organisations to manage appointments, which did not proceed to testing in the cardiac rehabilitation cluster. One of the main reasons was that the trust using the technology was implementing a new clinical informatics platform that was not compatible with DrDoctor, and which had parallel functionality.

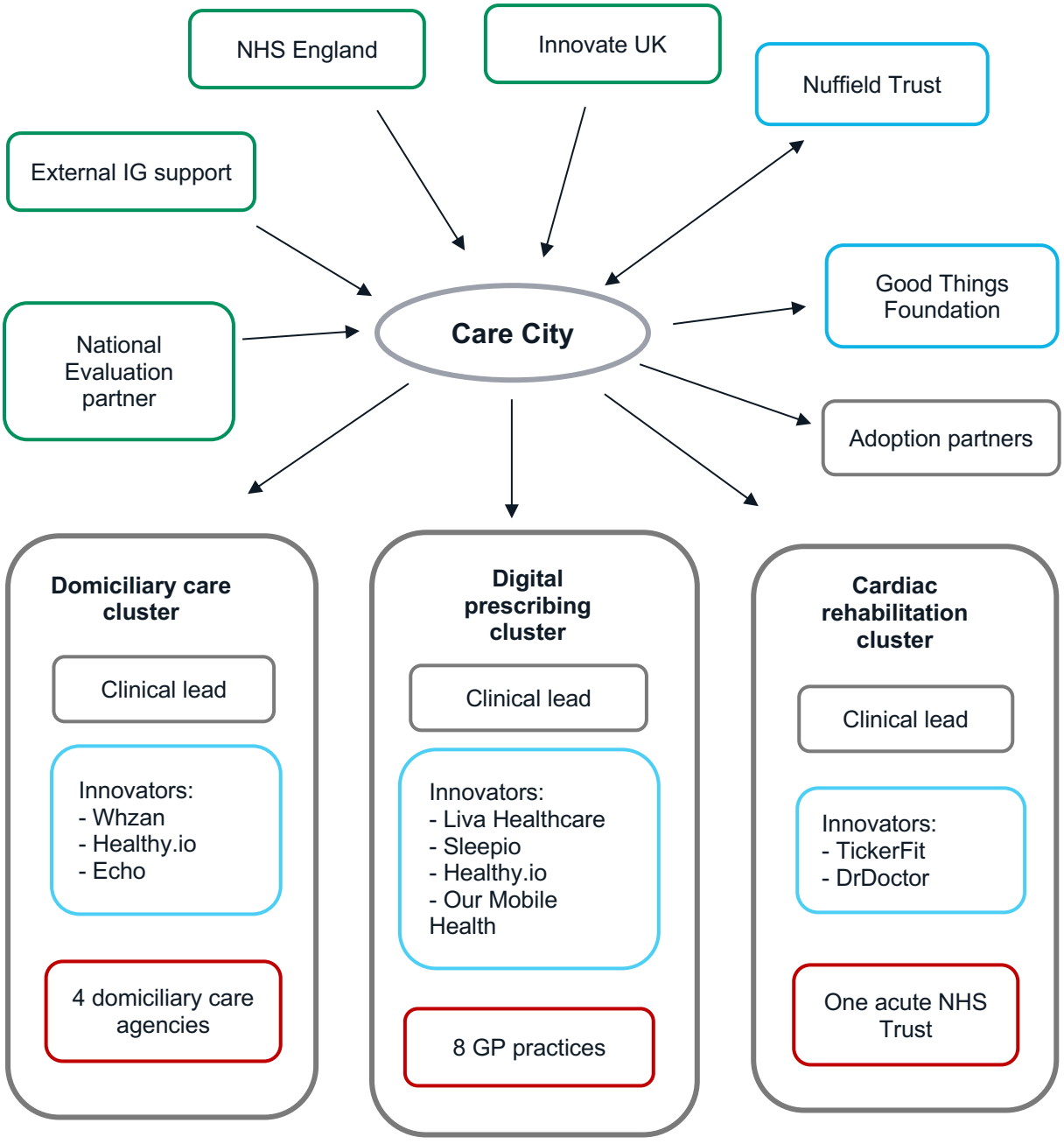
Partners/stakeholders

With technologies implemented across three clusters covering primary, secondary and social care, the test bed involved a large number of partners and external organisations to liaise with. The complexity of the test bed in terms of partners involved is illustrated in Figure 1. Partner/stakeholder roles included:

- **'Innovators'**. Each technology company had staff representatives who were involved in the planning, design and delivery of the test bed.

- **‘Clinical leads’**. Each cluster was assigned a clinical lead by Care City to provide clinical expertise and advice, and champion innovations. This was a role mandated by NHS England, but Care City and the clinical leads themselves shaped the responsibilities.
- **‘Co-design partners’**. The Good Things Foundation, an organisation that aims to improve digital exclusion through community development work, helped to engage panels of patients and staff in shaping the design, planning and implementation of the technologies. Co-design was an NHS England requirement of the bid.
- **‘Lead implementers’ and frontline staff**. Each site was asked to assign one person to lead the integration of the technology within their organisation, and decide internally which frontline staff would deliver the intervention.
- **‘Adoption partners’**. These were organisations that would be part of the scale and spread work beyond the test bed, a role designed by Care City in recognition that involving adopters from the outset can accelerate spread.
- In setting up the test bed, Care City also fostered a number of relationships with system networks to ensure the bid would sit within local priorities, including the Barking and Dagenham, Havering and Redbridge Clinical Commissioning Groups, Skills for Care East London, Barking and Dagenham Healthwatch, and the Executive Group for East London Health and Care Partnerships.

Figure 1: Test bed partners and other stakeholders



Engaging with partners

Managing the relationships with partners/stakeholders and fostering a common vision was challenging and complex in both the set-up and implementation phases. Pre-existing links with organisations was an important factor in facilitating engagement with sites.

The test bed development was generally seen to have been a well-focused, inviting process for innovators and the implementation sites. Sites with well-established links to North East London were chosen as obvious candidates for the test bed, in particular the acute trust and some of the GP practices. Identifying local home care agencies proved more difficult, reflecting a sense that these were less linked to the geography of the area.

Partners had varied levels of input into the test bed development and reflected different understandings of varying partners' level of involvement: some suggested there could have been, from the outset, greater engagement with innovators, frontline staff and patients. This would have helped in the selecting of innovations for the local setting and patient cohort, and it would have helped to develop a clearer implementation pathway and mitigate some of the risks of adapting market-ready innovations to a new setting. For example, in the cardiac rehabilitation cluster, cardiac rehabilitation nurses are key but were not involved in the test bed development.

Partners' motivations

Given the complexity of the test bed and the number of partners involved, it is important to recognise the variation in partners' motivations, and their alignment with each other and the test bed aims.

Joining the test bed was reported as an 'obvious choice' for most partners, but their motivations varied. Most implementation sites reported that they were drawn to the test bed because they had been approached by various technology companies in the past; had previously tried to start a project with an innovator; or had seen local peers engaging in digital projects – and thus they were interested in exploring options to introduce technology into their clinical practice and better understand how it could impact their patients and users. Some implementation sites viewed themselves as 'innovators' with technology and were keen to pilot any new ideas that complemented their current activities and income streams, and some were attracted by the upskilling narrative and opportunities to create career pathways through technology, citing staff retention as a challenge.

Innovators similarly reported being extremely motivated to join the test bed. They were particularly keen to develop evidence around a small trial that could be replicated across the NHS. The opportunity for spread was a key motivator among almost all innovators. Innovators also reported being keen to learn from the test bed (and similar opportunities) to improve the functionality of their innovations – for example, to see how to work better with users and the healthcare community or to determine the best use of the technology. Some innovators knew they wanted to test the technology in a particular patient population (e.g. diabetic patients) where they had less evidence and wanted to build a reputation in the UK. Others mentioned how they were keen to be seen as part of a project supported by Innovate UK and NHS England.

Information governance

Information governance (IG) proved to be a critical component of the test bed set-up. Stakeholders including Care City and innovation teams alike reported the process to be challenging across the three clusters. Stakeholders described the process of achieving IG sign-off as being more onerous than expected and one of the most time-consuming aspects of set-up, which led to delays in starting the implementation. The IG challenge seemed to be accentuated by the number of partners involved with the test bed, recent changes to the General Data Protection Regulation and more stringent IG guidelines that had been introduced.

NHS England commissioned a private company to advise on and assist with IG for the first few months of the test bed. Some innovators were satisfied with the support they provided. However, from an evaluation perspective, IG was particularly complex with individual-level data requested from multiple sources, some to be linked, as well as patient contact details for interviews. With many parties involved, advice was not always consistent, leading to more time being spent on IG than was necessary.

Implications for setting up innovation test beds and roll-out

There are a number of recommendations that can be made for the set-up phase of implementation projects:

Create a shared vision across all stakeholders. Success in introducing new technologies into health and social care settings can be aided by the co-production of a shared vision of the aims of the project, which must be maintained throughout. While a cluster-level understanding of implementation sites was seen as critical for implementation success, understanding the wider

programme aims could also be beneficial. This supports the learning from Wave 1 that a clear narrative is crucial.

Engage with the right people early on in the process. It is important to engage early on with partners, including frontline staff, people with the right clinical expertise and service users. This helps to develop a clear implementation pathway and to identify risks. It also enables decisions to be made about whether an innovation is appropriate and improves the chances of implementation being driven by service needs rather than the technology. For example, the role of the clinical lead in the digital prescribing cluster was pivotal in the development of the implementation pathway and setting the patient cohorts. However, in the cardiac rehabilitation cluster, the cardiac rehabilitation team was not recognised soon enough as needing to lead the implementation. It should be acknowledged, however, that it can be difficult to ensure that all of the relevant partners have been engaged with before the implementation pathway has been defined.

Make efforts to understand the motivations and expectations of partners. There was notable variation in the motivations and expectations of implementation sites and innovators within the test bed. It is important to achieve clarity early on regarding partners' expectations and goals, to determine whether they are aligned with the test bed purpose and aims. Similarly, the early setting of partner roles and responsibilities (and expectations) in developing the pathway, in implementation and in problem solving is key.

Allow sufficient time and expertise for information governance processes. To avoid lengthy delays, sufficient time, resources and expertise must be dedicated to resolving IG issues early on and throughout the implementation.

Be realistic about what can be achieved and the potential challenges. It is important to consider the potential risks and challenges early on, and to be realistic about what sort of solution can be provided. For example, the Care City team recognised from the outset that the systemic funding issues and complex nature of social care provision in private homes were likely to impact clinical engagement.

Consider the impact of programme requirements on the test bed design. Future national test bed programmes should consider the impact of certain requirements on the design and delivery of the test bed. For example, the national Test Bed Programme selected a list of innovations as solutions and asked bidders to find matching problems in their local areas.

5 Implementation in practice: overview

Originally there were eight innovations across the three clusters. Over the first year of the project, two innovations did not progress to testing and one is being evaluated separately outside the test bed (reasons for this are outlined in the previous chapter of this report). Moreover, one of the remaining innovators tested two interventions within two different clusters, making a total of six innovations within the test bed. Figure 2 provides an overview of the set-up and implementation timeline. Table 3 outlines the six innovations and the implementation sites.

Figure 2: Timeline of set-up and implementation

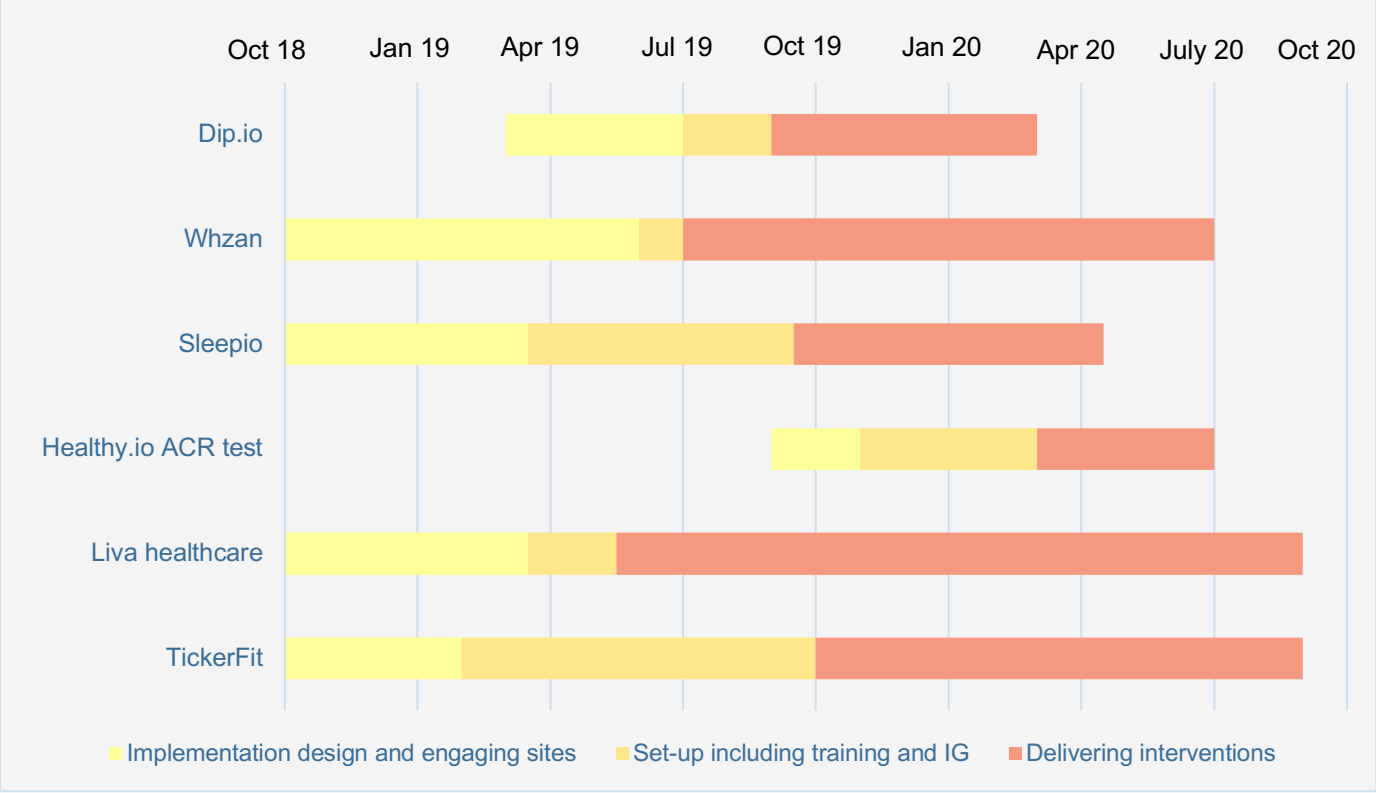


Table 3: Implementation sites for the six innovations in the test bed

Cluster	Innovation	Implementing organisations
Domiciliary care cluster	Whzan	Four domiciliary care agencies (originally five, but one did not proceed to testing)
	Dip.io (now Minuteful 10)	Three of the four care agencies implementing Whzan intended to implement Dip.io (in combination with Whzan)
Digital prescribing cluster	Liva Healthcare	Four* GP practices in Barking and Dagenham
	Sleepio	Five GP practices in Barking and Dagenham
	Healthy.io ACR test (now Minuteful Kidney)	Three GP practices in Barking and Dagenham
Cardiac rehabilitation cluster	TickerFit	Cardiology and cardiac rehabilitation services at a large London NHS trust

*Originally five, but two practices merged during the implementation phase.

The technologies have all been tried and tested elsewhere, some backed by robust clinical trials. The test bed aimed to take tested digital technologies and to apply these in a novel way in order to address local priorities and needs, and with the intention of supporting and transforming support staff roles. Combined with the importance of local context for implementation, pathway design was a core component.

6 Domiciliary care cluster – implementation and outcomes

Aims of the cluster

The aim of the domiciliary care cluster was to help domiciliary care users – in particular those with high-frequency hospital use – to manage their long-term conditions through regular 'health and wellbeing checks', as well as when there was cause for concern. The chosen innovations were also intended to upskill domiciliary care workers into 'expert carer' roles by giving them the tools to contact the most appropriate health professionals as and when needed, and increase confidence among both care workers and their service users.

Three innovations were selected for use in domiciliary care agencies: Whzan, Healthy.io's Dip.io test (now known as Minuteful 10) and Echo, of which Whzan and Dip.io were implemented to be used in combination. Echo is now being evaluated separately by Care City outside the scope of the test bed. The key implementation plans for the two innovations in the domiciliary care cluster are outlined later in this chapter.

The national and local social care context

The social care sector in England has been under significant pressure for many years, with concerns around how it is funded, the pay and conditions of its undervalued workforce, and the sustainability of its provider market, to name but a few.[6] In England, no established career pathway and associated pay progression scale exists for social care roles, which means the sector often loses out to better-paid roles in the NHS.[7]

Recruiting – and retaining – staff is especially challenging in domiciliary care, due to additional pressures such as travel times.[8] Furthermore, research on the domiciliary care workforce and the development of enhanced roles finds that carers are often not supported enough to meet their (new) responsibilities with sufficient training, support and remuneration.[9] Interviewees also reflected on the additional difficulties of innovating and providing remote monitoring in domiciliary care when local authorities are increasingly "very restricted on their budgets" (innovator).

As such, Care City is working with Barking and Dagenham Local Authority and other partners in response to these pressures by:

- supporting the recommissioning of domiciliary care in Barking and Dagenham, to explore the level of pay for domiciliary carers in the borough and to look at options for raising it to the level of the London Living Wage – this includes building on the model of 'expert carers' developed in the test bed
- working with Barking and Dagenham College on the development of an online platform to enhance the skills of domiciliary care workers
- in the wider Barking and Dagenham, Havering and Redbridge area, working in partnership with Skills for Care to develop and trial a nursing associate role for residential and domiciliary care settings.

Use of National Early Warning Scores as a measure of clinical deterioration in service users

The predictive value of National Early Warning Scores (NEWS) as a sign of deterioration has been relatively well supported in its growing use outside of hospitals;[10] and recent studies have evaluated the distribution of NEWS2 scores in community settings and care homes:

- A study of NEWS2 scores for attendances in the community reviewed 31,063 records from a leading community services provider and found that a large majority (72%) of attendances presented with a NEWS2 score of between 0 and 2.[11] Studies have concluded that it is relatively uncommon to observe high NEWS2 scores outside of hospital settings.
- A recent study recorded the distribution of 19,604 NEWS2 scores for 2,424 older adults in care home settings, and found that only 12% of calculated scores were above 5, with the median NEWS2 score being 2.[12] The study notes that no similar literature currently exists in domiciliary care.

Whzan

The Whzan kit was originally designed for monitoring people in care homes and nursing homes and service users with long-term conditions living at home in the community. It has the advantage of avoiding 'human error' in calculating a NEWS2 score. The main reported aims of Whzan for its use within the domiciliary care pathway are listed in Table 4, as described by the implementation team at the onset of the project.

Table 4: Perceived aims and benefits of Whzan within the domiciliary care pathway

Aim	Quote
Provide early detection of health problems and intervention	"Sometimes we go to clients, they are unwell but instead of calling an ambulance we can actually do their blood pressure and all that at home and if we think they need anything [we can] call a GP or an ambulance." (Implementation lead)
Provide clinical information to improve communication with health professionals and facilitate escalations of care from social care to the most appropriate health services, thereby avoiding unnecessary admission to hospital	"Whzan is bridging that gap between the care workers and the hospitals in that we can perform [tests] and provide the results that they would normally have to go and do." (Implementation lead) "Whzan is basically presenting the outcome of these tests in a language that GPs and health professionals understand in terms of the form of NEWS score." (Implementation lead)
Empower care workers through more responsibility and confidence in communicating with the healthcare sector and their service users	"I just think it helps to have a bit more responsibility and it takes the pressure off." (Implementation team)
Provide service users and their families with more confidence about their health, "proactively" "preventatively" seeking out problems, and provide them with a more "comfortable" option for having routine monitoring tests done	"[Service users] like to feel kind of nurtured, so I think it's quite a nice thing for them to feel and like I said I think it's really going to cut down on people's anxieties… sometimes just having those tests and knowing that someone's looking at them would make someone feel more well if that makes sense." (Implementation lead)
System benefits at scale due to growing demand and the drive to increase the number of people in receipt of domiciliary care	"[The health checks are] to ease up the pressure on the NHS, which is already crumbling a bit, and people are staying at home for longer…, they're getting older,

Aim	Quote
	people don't want to be going into care homes from our point of view so for us it makes us keep them at home." (Implementation lead)
Avoid home visits from GPs, district nurses and other community healthcare professionals	"We take the pressure off hospitals, GPs and the district nurses a little bit." (Implementation team)

Prior use of Whzan

The effectiveness of Whzan is drawn from small-scale studies using before-and-after designs:

- In care home settings, one study of 10 sets of records found reductions in GP visits (-25%), emergency ambulance use (-22%), Accident & Emergency (A&E) attendance (-71%) and emergency admissions (-33%).[13]
- Another small-scale evaluation, which compared data across eight care homes as part of the Well Connected Care Homes project, found a reduction in hospital bed days used by care home occupants after the introduction of digital health monitoring.[14] An associated qualitative study highlighted the perceived potential of using Whzan among care home staff, when supported with context-specific training and implementation support.[15]
- Partly as a result of increased need due to the Covid-19 pandemic, Whzan systems are being rapidly rolled out into care homes and nursing homes across the country, with 600 new systems being ordered in 2020 (personal communication, August 2020).
- There is limited literature to date that evaluates the impact of Whzan in domiciliary care settings.

Dip.io

Dip.io was originally developed to enable service users to undertake urinalysis at home using the Dip.io kit and associated smartphone app, which uses computer vision technology to enable clinical-grade interpretation of dipstick results. Urinalysis is a key diagnostic test in many care pathways, including those for maternity, renal and urological conditions, and the product was designed to enable timely access to diagnostic testing by reducing barriers to patients associated with multiple clinic visits or waiting for appointments.

Within the domiciliary care pathway, Dip.io was adapted for use to enable carers to use the kit with the smartphone app for multiple service users, rather than for use among service users themselves. As part of the pathway, this approach was intended to be used in conjunction with Whzan to provide carers with a better report of service user's vital signs, which could then be shared with health professionals such as the GP.

In its regular use, interviewees reflected on the opportunity the Dip.io kit presents to avoid unnecessary visits to the GP:

> *If an individual goes to the pharmacy and they can buy a Dip.io test, go home, take their own urine test and take that sample or the test results back to the chemist and if it meets the expectations… the chemist can issue antibiotics… they're circumventing the necessity to wait to go to a GP to get the antibiotics.* (Innovator)

Similar benefits were expected in social care settings*:* "If you can use that in a care home setting, again you're going to be able to circumvent or rather cut down the time of having to get the doctor in" (innovator).

The published research on Dip.io in the United States (US) focuses on the clinical evidence base around accuracy, and reports 99% usability rates in Food and Drug Administration (FDA) clinical trials covering 500 patients across varying demographics.[16] Leddy and colleagues[17] showed that the Dip.io kit was able to increase proteinuria screening rates in previously untested hypertensive populations (sample size N=999) in the US. In this case, 98% of 69 people surveyed found the test 'easy' or 'very easy' to use. UK-based research has also looked at the acceptability and experiences of the Dip.io test among professionals and patients.[18] It is now deployed in Boots pharmacies in the UK for use among the general population with uncomplicated cases for use at home, as well as in several hospital settings in renal and maternal care.

NHS guidance for care home staff indicates that dipstick use is not a reliable indicator of urinary tract infection (UTI) among the over-65s.[19] As a result, Healthy.io was clear that the Dip.io product would not be used for UTI diagnosis within the test bed; rather, the product would only be used alongside Whzan to provide a fuller picture of the service user's vital signs for healthcare professionals.

Service user cohort

Approaches to selecting service users varied across agencies, in part influenced by the make-up of their client base. Overall, agencies focused on individuals with (multiple and complex) long-term conditions with regular hospital use and who struggled to obtain primary care

services, so-called “frequent flyers” (implementation team). A majority of agencies concentrated on elderly clients, although interviewees recognised the potential of using the innovations on “frail, not necessarily older” users (implementation lead). In some cases, service users were also selected because of the distance from their families or other support networks who could ‘keep an eye’ on potential deterioration of health signs.

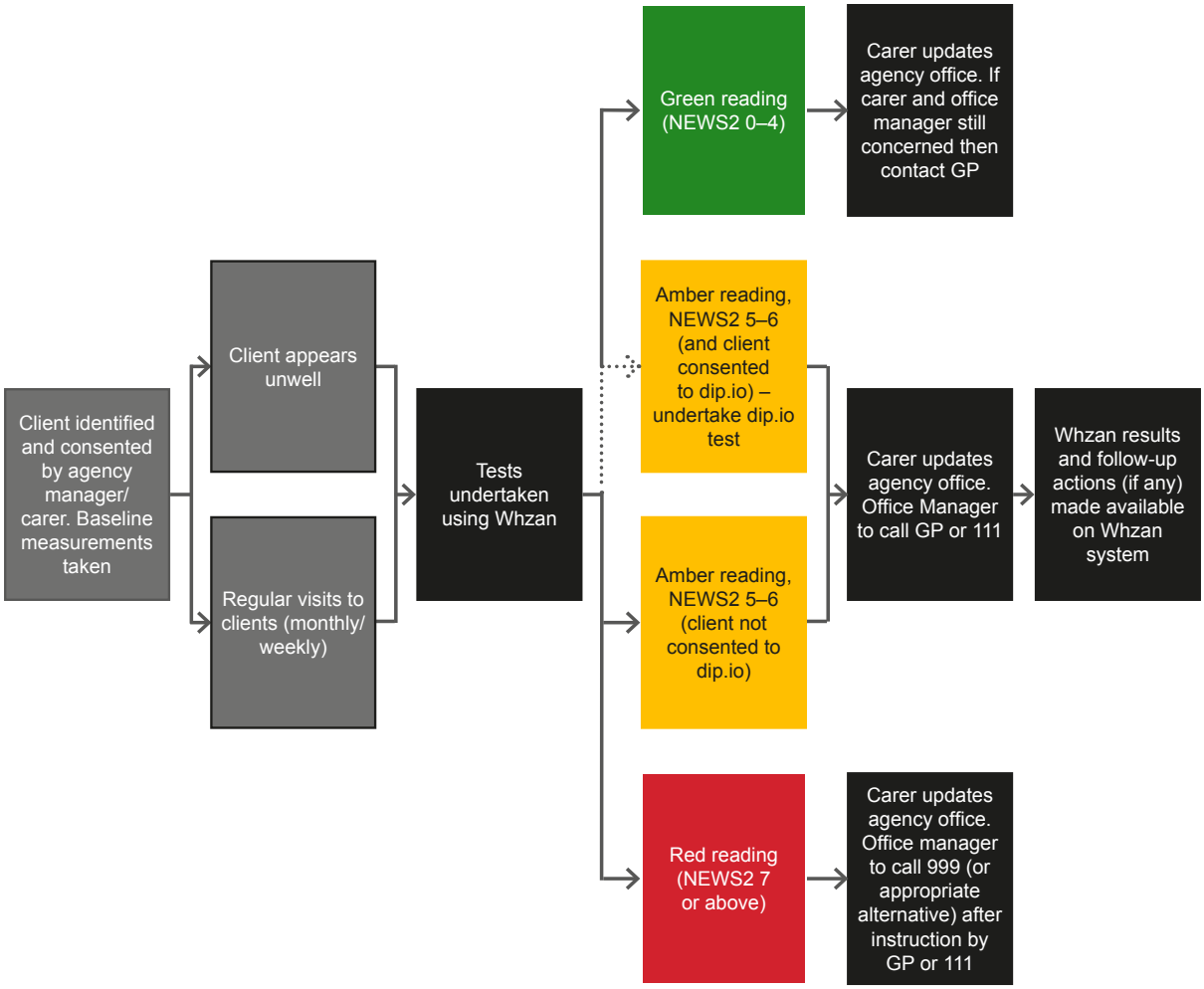
Process of implementation

The Whzan and Dip.io innovations were proposed to service users as an additional offer to the domiciliary care package they were receiving. Typically, carers visit their clients multiple times per week and deliver a mix of personal care and additional household tasks.

The implementation process for each agency is outlined in Figure 3. Implementation involved three roles: agency managers, office staff and carers. Agency managers were usually assigned as lead implementers, with oversight of key implementation activities. Office staff, where used, acted as liaison between carers and health personnel and collected readings for the evaluation team. The ‘expert carers’ were responsible for undertaking the monitoring checks and escalating results where necessary to the appropriate office staff or healthcare personnel. Expert carers reported that undertaking the checks took approximately 15–20 minutes. Service users were able to receive the innovations in two circumstances:

- at regular monitoring checks conducted weekly or monthly specifically for the purpose of collecting NEWS2 scores using the Whzan kits
- when the carer (or otherwise) had cause for concern during visits.

Figure 3: Implementation pathway for Whzan and Dip.io



Implementing sites

A total of four care agencies were 'onboarded' and implemented one or both of the innovations (see Table 5). A fifth agency was originally onboarded and received training; however, it was unable to recruit any service users and as such did not proceed to testing before the test bed came to an end.

Table 5: Sites planned for testing

Site	Site 1	Site 2	Site 3	Site 4	Site 5
Date onboarded	April 2019	May 2019	July 2019	November 2019	November 2019
Date ended	March 2020	March 2020	June 2020	June 2020	N/A

Site	Site 1	Site 2	Site 3	Site 4	Site 5
Whzan planned for implementation	✓	✓	✓	✓	✓
Number of Whzan kits planned for use	4	4	2	3	3
Dip.io planned for implementation?	×	✓	✓	✓	✓
Number of carers trained for Whzan	4	14	5	8	3
Number of carers frequently using Whzan	3	6	2	Unknown	Unknown
Number of carers trained for Dip.io	0	7	5	10	15

**N.B. Site 1 did not implement Dip.io. Site 5 did not proceed to testing due to difficulties in recruiting service users into the test bed.*

There was variation in how agencies (that proceeded to testing) determined their eligible pool of service users. Selection of the service users in Site 1 was not based on particular characteristics; rather, all service users in this site were offered Whzan, in part due to the smaller size of the agency. In the other sites, selecting the service users who were offered Whzan was based on drawing on a range of different customers with varying levels of need; for example, some service users who were offered Whzan were on end-of-life care, which involved a lot of support from community services.

Service users left the pilot for many reasons, although most were because they had passed away, changed home care providers or were moved to residential care (see Table 6).

Table 6: Uptake of Whzan among domiciliary care service users across all sites

Site*	Number of eligible service users for Whzan	Number of service users offered Whzan	Number of service users that consented to take part	Number of service users that left the pilot
Site 1	60	60	17	7
Site 2	19	19	18	2
Site 3	38	38	37	15

Site*	Number of eligible service users for Whzan	Number of service users offered Whzan	Number of service users that consented to take part	Number of service users that left the pilot
Site 4	Unknown	Unknown	Unknown	Unknown
Total	**117**	**117**	**72**	**24**

**N.B. Numbers for Site 5 are not reported as it did not proceed to testing.*

Bringing Dip.io into the domiciliary care pathway

There were delays in the implementation of Dip.io due to queries around how the Dip.io product could best be used with the service user cohort "commonly found within domiciliary care" (Care City team), and due to logistical issues around securing smartphones for staff. Also, despite it being clear from the outset that Dip.io was not to be used to diagnose UTIs in this context, there was still some confusion around this from other stakeholders, such as home care staff. As a result, the innovators and implementation team provided additional clarity around use of the Dip.io test, to complement the NEWS2 score generated by Whzan in order to provide a fuller picture of service users' vital signs.

Unfortunately, a high number of service users receiving Whzan were excluded from the Dip.io cohort due to their health conditions, with many, for instance, being incontinent; and among those who were eligible, there was a relatively low uptake (see Table 10 later in this chapter for reported reasons). In addition, low numbers of Whzan amber readings were recorded (discussed further below), which had a significant impact on the number of occasions in which Dip.io could be used. In one agency, fewer than 10 Dip.io results were produced, with the other two agencies implementing Dip.io recording none. As such, stakeholders agreed that Dip.io's use within the pathway "would not have been effective enough to see any sort of impact or changes within their domiciliary care practice" (Care City team). In March 2020, Healthy.io required the return of the technology it had supplied for another project, and care agencies focused their efforts on implementing Whzan between March and June 2020.

As a result, the evaluation has only been able to consider limited evidence around Dip.io's use within the test bed. The following content focuses primarily on Whzan.

Variation across agencies

There are a number of differences between the agencies: these include size (influencing the proximity of frontline staff to central management, as well as the pool of service users to which the innovations could be offered), organisational routine and service user cohort. A key difference reported by the agencies was in the make-up of their service users, with some having a majority of clients funded by the local authority and clinical commissioning group, while others catered mostly to self-funders. As such, there was variation in the types of services offered by agencies as business as usual, in the duration of services delivered and in the extent to which agencies had prior knowledge of service users' medical history (this differs also between local authority and clinical commissioning group-funded clients).

Implementation pathways varied in terms of:

- the numbers of carers trained and whether office staff were involved in the implementation
- whether checks were included as part of routine care or as a supplement
- the frequency with which checks were undertaken (weekly/fortnightly/monthly)
- escalation procedures, with some making use of rapid response teams
- use or not of the Dip.io kit
- the types of service users recruited into the test bed and decisions as to who would be eligible for testing.

The differences across the agencies, and their varying approaches to implementation, are likely to have affected delivery. For example, some interviewees suggested that self-funded service users were more likely to decline receiving the intervention.

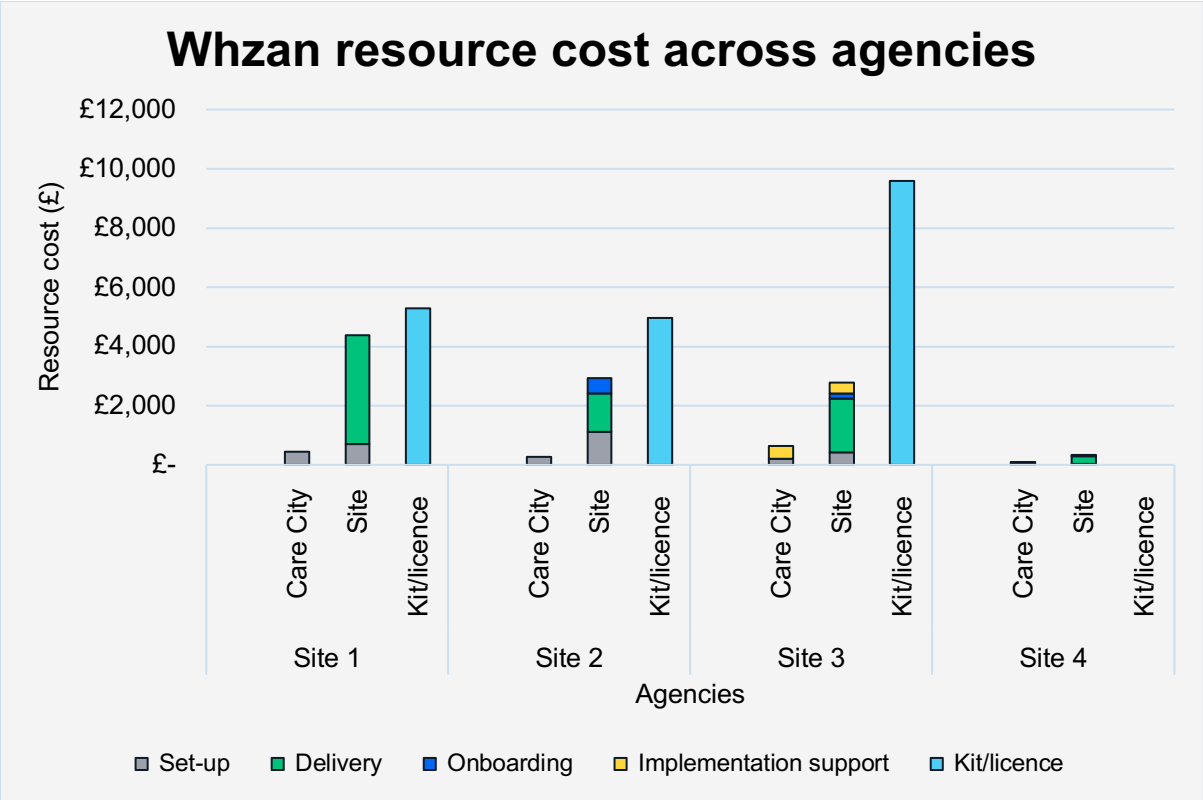
Implementation costs

The costs of implementing the Whzan pathway are summarised in Figure 4. Implementation costs are broken down into those related to set-up, onboarding, delivery and implementation support, and according to whether Care City or agency staff carried out the activity. Figure 4 also indicates kit and licence costs, which include equipment, consumables and the penetration testing required to enable the transfer of data.

The implementation cost differed considerably between sites, from £431 to £4,816. Processes for testing and delivery were not consistent across agencies. For instance, site 1 administered a test on every occasion, and at this site the cost of delivery is over twice that of the next highest

costing agency. Other reasons that may account for the vast cost difference between agencies include the seniority level of staff overseeing implementation, the number of kits used, the number of expert carers delivering the service and the time spent onboarding service users.

Figure 4: Resource cost across agencies



Role of Care City in the pathway

Care City recruited the care agencies into the pilot with support from the clinical lead. Care City provided support to the agencies throughout the course of the project, for instance in the development of Standard Operating Procedures for escalation activities, arranging training for agency staff and facilitating co-design sessions.

Interviewees had very positive feedback about Care City's role in supporting implementation. Respondents valued the organisation's open communication and constant presence on the ground, and as such felt that if they needed anything, they felt "comfortable, confident… that Care City are willing and able to provide it" (implementation lead), especially given their expertise in project management support. Care City's ability to connect with stakeholders across the system and bring people together was seen as a real advantage in the context of domiciliary care where service providers are so fragmented.

The proportion of the costed activity carried out by Care City staff was relatively low in this cluster in comparison with other clusters. The cost of Care City time ranged from £97 to £636

between agencies. These costs were predominately for setting up the pathway, and in site 3 related to extra implementation support throughout the process.

Staff training

Each agency received an initial training session organised by Care City and delivered by the innovators, at which the cluster lead, implementation leads and senior carers were present.

- Whzan training lasts approximately an hour and is delivered by the innovator. It covers how to onboard service users to the central system, the rationale behind a NEWS score and how to take readings. The session is supported by online videos to which agencies have access if a refresher is needed.
- Dip.io training lasts approximately 45 minutes to one hour and, for the purpose of the test bed, is delivered by the innovator. It includes an introduction to Healthy.io and the importance of urine testing across care pathways, how the smartphone technology works, and a demonstration of the innovation and its use within the implementation pathway.
- The Care City cluster lead then walked staff through the escalation protocol, which outlined the appropriate actions to take for each Whzan reading.

The two earlier agencies (Sites 2 and 3) that were implementing both Whzan and Dip.io received training for each innovation separately due to Whzan's earlier start date. It was reflected through interviews and co-design sessions that it would have been beneficial to receive training for both innovations in conjunction, as well as support in understanding the proposed escalation pathway. As a result, training in the two later onboarded agencies (Site 4 and Site 5, the latter not proceeding to testing) was delivered in tandem.

The training received was felt to be simple and self-explanatory, with staff reporting that they "understood straight away" (implementation team) and that they felt confident to use the innovations. Most agencies organised follow-up training during which staff were invited to practise using the kits on each other. Carers reflected feeling supported by their office to use the innovation and felt that the Whzan training they had received was sufficient, although a small number of respondents felt they could have benefited from more Dip.io training.

Staff also appreciated the availability of online video content for both innovations and generally reported feeling confident that they could stay up-to-date with their content and could receive refresher training if needed.

Some lead implementers and carers suggested that training could be improved through a more in-depth explanation of how to interpret the results and the procedures to follow in the event of escalation. As one respondent noted, “doing it in the office and doing it with a person being treated is different” (implementation lead), and as such a more “hands-on” walkthrough of the innovations with tips about possible malfunctions and associated solutions could be helpful.

Impact of the Covid-19 pandemic on domiciliary care

The Covid-19 pandemic had an immediate impact on domiciliary care agencies and their operations, presenting both challenges and opportunities for the domiciliary care providers and the implementation of the innovations (see Table 7).

Table 7: Impact of the Covid-19 pandemic on the domiciliary care cluster

Theme	Description
Challenges	
Stalled operations	In some agencies, operations stopped completely at the beginning of the first national lockdown period in March 2020, with concerns about the sustainability of their business, setting up to work remotely, and acquiring essential Personal Protective Equipment (PPE). Implementation was necessarily impacted and was seen as less of a priority as agencies focused their efforts on putting protocols in place to sustain delivery. However, agencies were keen to resume testing as early as possible once operations stabilised.
Anxiety from carers	Some staff reported being fearful of spreading Covid-19 infection through their use of the kits: “I just need to be careful… that’s the reason I don’t do it anymore” (expert carer).
Anxiety from service users	Lead implementers and carers reported that a number of service users, many of whom were vulnerable and possibly shielding, refused to have carers (especially if these weren’t regular carers) inside their homes, in addition to concerns around technology use and Covid-19 infection.

Theme	Description
Opportunities	
Changing attitudes to technology use in domiciliary care	In wider domiciliary care, stakeholders identified the pandemic as an opportunity to use more technology for remote monitoring: "I think Covid-19 has taught us all lots and lots of things especially in managing patients in community and in primary care as well and it has made a big impact and I think these technologies would actually… Whzan and Healthy.io and all of these if done out in the community would save a lot of people unnecessarily going into hospital or unnecessarily keeping them out of hospital" (implementation team).
Improved relationships between domiciliary care providers and primary care	Many primary care practitioners relied heavily on domiciliary care providers to support vulnerable individuals over the course of the pandemic, which many respondents hoped would continue and could support long-term implementation of the innovations. "Some of the GPs asked us to take video footage, to do the calls from the house when the carers were there on their phones and they would assess the client and that was really exciting with Covid, so in the same way I think this kit could be used as well to enhance because you would have clear up-to-date observations, so they have changed." (Implementation lead)
Technology use to help with Covid-19 detection and monitoring	The Whzan kit includes a thermometer and pulse oximeter, and stakeholders saw the potential to use the kits to monitor key Covid-19 symptoms. Frontline staff hoped that using the kits would help reduce pressure on community healthcare professionals through monitoring.

Implementation team: satisfaction, roles and responsibilities

This section discusses staff outcomes for both central agency staff (implementation leads and office staff) and 'expert' carers responsible for using the monitoring kits.

Central agency staff (implementation leads and office staff)

Although expert carers were originally intended as the beneficiaries of upskilling, experience of implementation suggests this was also the case among agency staff and agency managers.

Lead implementers were essential to ensuring the innovations were successfully adopted through a careful adaptation of the implementation protocol to suit the needs of their individual agencies. Table 8 outlines some examples of creative project management that lead implementers put in place.

Table 8: Creative ways of ensuring successful implementation as introduced by lead implementers

Activity	Aim
Packaging as 'health and wellbeing checks'	Have clear messaging to simplify introducing the kits and their purpose to service users and to increase uptake. "Once I think you've given them a good understanding on the benefits and the technology and the confidence of using it, that message then conveys onto the wider senior carers and the clients to the wider network." (Implementation lead)
Facilitating the onboarding process	The majority of implementation leads accompanied carers on their first visits to demonstrate management buy-in, and ensured family members were present to maximise confidence in the service. "I divided to my staff to help them, and before they go there [alone], myself [and staff] went there and introduced [ourselves]: 'We are in this project and if you're happy to take part in this project' – wherever I went to get their consent they were very happy." (Implementation lead)
Managing issues with the technology and creating ease of communication	To reduce stress on carers in the event of technology malfunctioning, and to help with communicating results, implementation leads used a number of creative solutions to ensure checks were undertaken. These included WhatsApp groups, notebooks to note observations if the tablet malfunctioned and email alerts within the agency.
Supporting the carers to feel empowered and engaged in the project	Implementation leads proposed a number of innovative ways to give carers a sense of pride in their new skills. These included 'Care Champion badges', training certificates and sign-off processes.

Implementation leads described a clear sense of pride from having taken part in the project, as well as the competitive advantage of being able to offer "something [to] customers and clients over and above the other market operators and… something that also the client themselves have appreciated" (implementation lead).

Office staff taking part in the project also benefited from skills development. One implementation lead described the "amazing skill set" developed by participating office administrators, who grew in confidence and became "much more assertive" in speaking to GPs as the project progressed. This would suggest training is also necessary for office staff in new agencies wishing to use this resource as part of their operating protocol.

The front line

Characteristics of frontline staff

Implementation leads chose frontline staff to deliver the innovations who had demonstrated a high level of engagement with their work and had shown their care agency "that they wanted to progress" (implementation lead). Many had long-term experience of working in social care or healthcare roles – some for "over 20 years" (implementation team) – and had previously expressed aspirations to progress further: "This is what I've wanted to do for a long time" (implementation team).

Staff highlighted the specificities of their carer role that appealed to them and made them appropriate candidates to deliver the innovation, such as the "hands-on" nature of their work (implementation team). Many expressed their dedication to their service users and their families, for instance by visiting them in hospital and keeping families up to date with any situation that would occur.

Other attributes that were deemed beneficial to the 'expert carer' role were an ability to manage responsibilities appropriately and navigate stressful situations with calm. Implementation leads were also keen to choose staff who would not overstep the boundaries of their role and the level of care that agencies were regulated to provide.

Upskilling

The upskilling frontline carers was perceived by all stakeholders to be a key objective of implementation, motivated by the desire to change the often-reported image of carers as 'low-skilled' workers. Upskilling was observed in a number of ways, listed in Table 9.

Table 9: Features of upskilling among frontline domiciliary care staff

Skill development	Description/quotes
Increased digital capability and ability to use healthcare tools	Carers described being proud of using technologies and tools that they had previously felt to be out of their reach: "Well I must admit I never thought I'd be able to use a blood pressure machine… I never got it but now it's built my confidence just a little bit more." (Implementation team)
Increased proficiency to understand and interpret health information	Carers reported being able to understand what 'normal' looked like for their service users – something they had not felt able to understand before – and were more confident to look for signs of deterioration: "I think it's given them all a very good… understanding on some of these tests and readings and even some underlying conditions which we know from the GPs that may be a reason why some of the readings are slightly higher than normal. I think it has been a good education piece for us as well." (Implementation lead)
Increased confidence in communicating information to other health and care professionals	Carers felt more assured to contact and communicate with other social care staff as well as a number of healthcare professionals, including GPs, district nurses, paramedics and community treatment teams. "Because they have the ability to use this equipment on their clients, that gave them extra confidence and skills to actually speak to the clinicians and say look, 'I've done this and this was the result'… so that was a big help to the clinicians." (Implementation lead) This confidence was especially relevant to communicating with GPs, who were described as traditionally reticent to receiving information from social care staff: "GPs do feel like I don't know anything, I shouldn't be contacting them, but when I actually show them the readings I've got and the previous knowledge I've got with the client, they do feel like I'm actually calling for a reason, whereas before I was given no background knowledge about the client they…, when you've got the background knowledge you feel like you've got more of a reason to call." (Implementation team)

Skill development	Description/quotes
Increased status of carers among service users and their families	Carers felt that the perception of their role had changed among service users and their families, who had now become "friends". Likewise, service users were more confident in their carers' abilities to deliver high-quality care: "I believe it might give the clients a little bit more confidence in us. I know some of them don't understand what we are doing but [for] the ones that do it gives them a little bit more confidence that we actually know what we are doing." (Implementation team) "When they are using the kits, everybody appreciates them, even family members." (Implementation lead)

As a result of the increased responsibility of their changed roles, carers reported feeling empowered and reflected a sense of pride in relation to their peers, feeling "proud to be one of the first" (implementation team). Alongside a new sense of empowerment, many staff reported either new or strengthened ambitions to progress into other roles and opportunities in the health and care sector, which included more senior social care and social work positions, nursing and undertaking new qualifications such as National Vocational Qualifications (NVQs). Carers hoped that future employers would value their ability to use healthcare equipment and digital technologies.

Barriers to staff undertaking their role

There were some concerns that affected the ability of implementing staff to undertake their expert carer role.

Lack of clarity around escalation protocols. Some staff felt unsure about the appropriate actions to take for higher readings, and, in participating sites, when to use Dip.io in conjunction with Whzan. This may in part be explained by the low number of amber and red NEWS2 scores recorded by the agencies, which meant few carers were frequently exposed to these situations. Scaling-up activities could consider possibilities for refresher training and signposting to escalation protocols to maximise staff confidence around escalation.

Conflict with service user preferences. Expert carers reported that there were some occasions in which escalation protocols conflicted with the service user's wishes, thereby creating a stressful situation in which staff had to balance results with ensuring their "client is the priority" (staff). For example, one carer remembered a situation where a Whzan reading was

returned as red, but they called 111 instead of 999 as the service user was reluctant to go to hospital:

> *This is the type of client [where] I can't say anything because she wouldn't go to hospital… I didn't call the ambulance straightaway, I phoned 111 to get advice… the nurse got the same NEWS score and said straightaway [to] call the ambulance.* (Implementation team)

Technology issues undermining expert carer ability and their relationships with other services. Staff reported situations where healthcare professionals were contacted, according to protocol, due to high NEWS2 readings, but carers and healthcare professionals both felt there was little cause for concern. This led carers to feel that their relationship with other health and care services had been undermined, and made them less confident to use the innovation:

> *The readings are quite sensitive because even by one number going up it just flags up red, and they make it out as if they're quite vulnerable at the point when they're not, they're quite fine… I just think they don't need GP attention.* (Implementation team)

Reflections on the 'expert carer' role

Overall, carers reported an overwhelmingly positive experience of their involvement with the project and were getting the recognition they deserved for their work: "Carers were really excited, they saw it as a wonderful opportunity to upskill them… sometimes they can feel the undervalued part of health and care so this was a great kudos I think as well for people working in homecare" (implementation lead). This supports previous findings that care staff derive satisfaction in their work from skills development, practical autonomy and hands-on work.[20]

While carers felt comfortable with the level of training and support provided by their agencies, respondents were keen to ensure carers did not assume an excessive level of responsibility and were not asked to undertake activities outside of their remit, such as making clinical decisions:

> *Carers are not clinicians and we cannot impose a great responsibility on them because I think it was something that I think was out of their remit as well, they can do the test,… but they can't tell the clients or make decisions.* (Implementation team)

One respondent hoped for a dedicated role in which the 'expert carer' would have protected time to undertake their enhanced health monitoring responsibilities:

> *I see a place for this in specialist roles with your hybrid carer where they've got that physical health care knowledge, they've got supervision in place to support that, and this kit as a tool with them could be I think excellent.* (Implementation lead)

Patient outcomes: uptake, engagement and satisfaction

Patient uptake

Across all agencies, 117 service users were identified as being eligible for Whzan. All eligible users were offered the innovation, of whom 72 consented to participate in the pilot.

Uptake varied significantly across the agencies, with some having almost complete buy-in from the prospective service users, while others struggled to recruit. Interviewees suggested that differences in uptake could be due to variations in the selected service user cohort across agencies, and in the support from agency management around consenting. Overall, implementing teams felt that service users were receptive to using the innovations: “The intake for the actual service that we put out, I think it was very, very high” (implementation lead). In some agencies, service users and their families actively sought to receive the service and “booked an appointment straightaway to speak to the managers” (implementation lead).

Some implementation staff outlined examples of service users with long-term conditions who particularly benefited from the intervention. These included those with high blood pressure, diabetes, chronic respiratory disease such as chronic obstructive pulmonary disease (COPD) or chronic heart disease.

Agency staff outlined a number of reasons why service users had declined to receive one or both of the innovations (see Table 10).

Table 10: Reported reasons for refusal among domiciliary care users

Reason for refusal	Description
Type of service user and services received	Staff suggested that how service users funded their care, and the types of services they received, were likely to impact on whether they would accept the innovation. For example, respondents felt service users were less likely to want the checks if they funded their care privately. This could have implications for how to package the service if it were rolled out at a wider scale.
Clinical appropriateness for the service user cohort	Some service users or their families refused to receive the innovation due to their health conditions. For example, some respondents found it would be difficult to use Whzan on service users with advanced dementia: "Because of the advanced dementia, sometimes for interventions like straightening your arm, trying to check your blood pressure…, it was hard to articulate and reason with her and would cause distress, so that was some of the thinking around that refusal." (Implementation lead) Similarly, many service users were unable to receive Dip.io as they were bedbound or incontinent, and samples could not be taken from a catheter bag: "Most of my clients are double-handed care, which means they're either bedbound or incontinent… I'd understand why they wouldn't want to use it because the urine is passing through catheter bags, so it's quite difficult to get urine from them." (Implementation lead)
Pre-existing support in place	Some service users or their families refused as they already had support from community health teams in place, and wanted to avoid duplication of effort and overlap of input: "They felt that it wouldn't enhance their care in any way and these are people that had end-stage dementia, needing fuller care at home… One felt [that] while it would be a great opportunity, his wife was fully supported with the community health teams and community matron." (Implementation lead)
Service user expectations of care	Some service users declined due to the perceptions they had of the interventions: "Yes [they declined], purely because… they feel like their privacy is being invaded, realistically, if they're bed bound and everything." (Implementation team)

Patient demographics

The demographic characteristics of consented service users are reported here across all sites, rather than numbers from individual sites. This is to avoid the disclosure of small numbers. There were 72 clients across all sites still being tested with Whzan at the time of report writing. Although data were missing for some of the service users (10%), the majority were aged 85 or above (57%). Additionally, a high proportion of the cohort were female (64%), and many of them were of British origin (81%). This broadly fits with the overall British population of Havering (83%), which is above the average for London (45%) and England (80%).[21]

Clinical outcomes

Although four sites were involved in implementing Whzan, we only received data on clinical outcomes from three of the sites. From a total of 377 readings taken, there were 89 invalid or missing NEWS2 scores (see Table 11). Invalid scores were identified because the data indicated a couple of impossible events (for instance, a pulse of 0). Typically, the readings were filled in automatically by the tablet via a Bluetooth connection to the Whzan equipment, but there was also the option to manually enter readings, which could have been the reason for invalid results.

Table 11: Total breakdown of NEWS2 readings and escalation

NEWS2 and escalation	Total
Number of scores ≥5	28
Number of escalations (GP)	24
Number of escalations (111)	< 6
Number of escalations (emergency admissions to hospital)	< 6
Number of valid NEWS2 readings taken	288
Number of invalid/missing NEWS2 scores	89

One reason for the absence of NEWS2 scores in some of the readings was due to difficulties in obtaining a result for some of the tests – if the results were missing, a NEWS2 could not be generated. For example, service users' hands had to be warm before measuring their oxygen

saturation with a finger pulse oximeter, otherwise the equipment would not produce a reading. If warming their hands took too long, the carer could skip this test, but this meant that there was no NEWS2 score attached to the reading.

From the 288 readings with a valid NEWS2 score, 28 readings resulted in scores of 5 or above (9.7% of readings). This is similar to results found in residential care where in one study 12% of scores were greater than or equal to 5.[12] NEWS2 results in community care have also been reported in similar proportions, with 11% of NEWS2 readings being 5 or above.[11]

When looking at the data for some individual service users, agency records showed that escalations to the GP occurred even when the NEWS2 score was not between 5 and 6 (i.e. an 'amber' score, which required GP contact). In these instances, carers were told to escalate regardless of the score given to them by Whzan if they still had significant concerns about the service user. This supports previous literature, which argues that NEWS2 scores are used more as a support for decisions based on judgement, rather than as decision-making tools in themselves.[22]

Our findings show that implementing technology that uses NEWS2 in domiciliary care may increase the workload of GPs. While in the short term, an increase in GP contacts may be expected, this additional workload is unlikely to be too burdensome, particularly as NEWS2 scores of 5 and above are uncommon. Previous literature has also found that the use of NEWS2 does not necessarily increase health care referrals, where supported by clinical expertise and individual judgement around referrals.[23] In addition, NEWS2 scores are intended to spot early deterioration, which, in the longer term, should avoid the need for more serious interventions later on (for example, for attendances at A&E).

It should be noted that one agency did not have escalation outcomes recorded in the data returns for their service users, even though some escalations did take place, so the total number of escalations made to the GP reported here is likely to be an underestimate.

Satisfaction

Respondents reported that service users were very satisfied with the health and wellbeing checks they received, with one client describing the service as a "jolly good idea". Seven of the 10 surveyed service users were likely or extremely likely to recommend the kits to a friend or family member with similar needs, and none were unlikely to recommend them. As one staff member put it: "They're loving it, I don't know a client who is against it… They feel a bit looked after by the care company as well… they feel like [we] care about not just your personal care but your health" (implementation team).

Service users and their carers highlighted having more regular knowledge about their health as the main reason for receiving the service, and reported feeling less worried about their health since regular monitoring had been introduced. One service user suggested the service was helpful, especially given their difficulty in contacting their GP, to “keep a regular check on seeing what was going up and what was going down and why it was doing it”. Receiving the checks regularly, with the same carer, was found to provide reassurance to the service users: “If they know I’m coming that day, it puts their mind at rest” (implementation team). The main benefit of the checks was perceived by service users to be having a tool for reassurance that their health was stable and well managed and to spot deterioration early. There was no expectation that the checks would contribute to improving health.

Costs of scaling up Whzan

A number of factors are likely to affect the costs of scaling up Whzan. We assumed a 25% uptake rate based on the care agency which offered Whzan to all its clients, but a higher uptake would be expected for a frailer client group. The escalation pathway will also be a factor. The time and resources of carers and agencies to follow up on high NEWS2 scores will depend on the approach taken, the responsiveness of the organisations the issue is escalated to and the number of high readings. The organisation of carers' work will also impact on the number of kits required. In the test bed there were an average of 5.5 clients per carer, but this ranged from 2.5 to 14.5. Agencies using Whzan on a higher proportion of patients may be able to implement the innovation at a lower cost per client, because fewer kits and licences would be needed. Table 12 sets out the costs associated with rolling out Whzan.

Table 12: Costs associated with rolling out Whzan

	Estimate	Notes
Eligible clients	People receiving domiciliary care	Clients using Whzan varied between care agencies. In some care agencies, Whzan was only offered to the frailest patients. Uptake was 25% in the agency which offered Whzan to all its patients.
Unit cost of innovation per client receiving the Whzan test	£529	Unit costs include implementation costs and the cost of the Whzan equipment and licence (from the test bed).
Estimate of the number of eligible clients per 1,000 population	10.3 per 1,000 population	The number of domiciliary care users in England is estimated to be 576,600, that is, 10.3 per 1,000 population.
Estimate of the cost to implement across a population of size:		Estimates assume uptake is 25% among home care users.

	Estimate	Notes
1000	£ 1,362	
50,000	£ 68,102	
300,000	£ 408,612	

The costs for implementing the innovation need to be considered within the context of how the innovation impacts on the overall care pathway. Use of Whzan could increase GP contacts and care agencies' escalations to other services, including 111, ambulance services and A&E. The numbers of escalations at the test bed sites were relatively few, and it is unclear whether more escalations took place than would have been the case without Whzan. Further, even if short-term escalations did increase, the longer-term implications are unclear – for example, whether earlier identification and management of clients prevents more serious illness.

We were unable to identify any relevant cost-effectiveness studies of the use of tools or protocols to identify deterioration in care home or home care settings. One earlier implementation study in care homes found a reduction in hospital bed days among care home occupants after the introduction of digital health monitoring.[14] Our study adds to the very limited literature around the use of NEWS2 outside hospital settings, of which the evidence base is still emerging.

It should be noted that the intervention is not designed to improve clinical outcomes, and many of the clients are frail or on end-of-life care pathways. As a result, quantifiable benefits in terms of quality of life are not expected, although clients have fed back positive experiences.

Key implementation findings and reflections

There are a number of reflections and lessons arising from implementation of Whzan and Dip.io within the domiciliary care cluster. The key lessons are discussed below.

Engagement and prioritisation. Stakeholders reported that, across the agencies, implementing the innovations became a priority once they had "seen how easy it is to use the kit and… they're not intimidated by what it is… that's definitely helped them prioritise the implementation of the kits within their workforce" (Care City team).

The nature of domiciliary care. There is little research to date on the use of digital technologies and health monitoring interventions in domiciliary care. The findings of this test bed are therefore likely to make an important contribution to the evidence base on the home care sector. A number of specifics about the sector were highlighted for consideration for scaling-up opportunities:

- The innovations were originally designed for use in different settings (care homes for Whzan and self-use for Dip.io), and staff suggested some adjustments that could facilitate their long-term use for home visits. For example, the Whzan kits were found to be bulky and noticeable, which made them difficult to transport for carers who did not travel to their appointments by car:

  If they got something smaller and more discreet that maybe might fit into a little bag and also the blue seemed to draw attention to it and if you've got people thinking 'oh there's health professionals out there and they might have some medication in the kits',… and making sure we weren't exposing our carers to any other risks. (Implementation lead)

- Regular visits to service users are often limited to 30 minutes, with limited room for manoeuvre in case of delays given the number of clients carers are expected to visit on a shift. The health and wellbeing checks were described as taking 15–20 minutes, and longer where Dip.io was used in addition to Whzan. If used outside of protected time, this could take away from delivering other activities:

  I think perhaps in a care home it may be more suitable where the carers do spend the whole day practically with the client… As opposed to home care where we're literally there for 30 minutes at certain times in the day, it's sometimes difficult… to get the sample that we need. (Implementation lead)

- The domiciliary care sector experiences a high turnover of staff, and many participating agencies lost the carers they had originally trained to take part in the project. As a result, agencies were required to set up additional training to ensure the implementing team had sufficient capacity to operate the innovations: "Initially we had a team trained and ready to deliver this but such is life, people move on and develop into other roles and careers and we've had to retrain our senior carers again and again" (implementation lead).

Resources needed to implement and sustain implementation. Implementing teams committed significant resources, both financially and in terms of time, to ensure the successful set-up and running of the innovations. Many reported that the time spent on the project, especially in the set-up phase, was greater than they had originally anticipated, which led lead implementers to conclude that "a bit more of a hands-on management approach was needed over and above what [was] thought initially" (implementation lead). Examples of activities that

respondents described as time-consuming included getting people to consent to the innovation, communicating with healthcare professionals and supporting carers through training and other activities.

Communication with the healthcare sector. Implementation teams reported difficulties in getting in contact with, and communicating results to, healthcare professionals. This was especially the case when the teams needed to contact GPs "on an urgent basis… It can take two to three hours to get in touch" (implementation lead). As a result, many carers and office staff preferred instead to work around their operating protocol and contact alternative sources, such as 111. However, there were also times when frontline staff felt obliged to follow protocol and follow up abnormal results even where they felt there was little cause for concern, resulting in occasions where they felt the escalation was disproportionate to the service user's need. For instance, one lead implementer reported having to escalate a service user to A&E on a weekend due to high blood pressure because the GP was closed and could not provide adequate support. As such, respondents suggested scaling-up opportunities would benefit from a much greater involvement of healthcare services in the area, including GPs, community teams (e.g. rapid response teams) and matrons. However, agencies were also hopeful that the new opportunities to work closely with healthcare afforded by the Covid-19 pandemic would go some way to improving these relationships.

Challenges in collecting service user information and creating a baseline. Collecting baseline information to assess what could be considered as 'normal' health for service users proved challenging due to the limited access that care agencies had to medical records. The wealth of this information varied according to the type of service user, whether funded by the clinical commissioning group, the local authority or of their own account:

> *[I]f they're coming from social services we get a certain amount of data, if they're a private customer we get more limited data and if they're a client coming through CCG [the clinical commissioning group], NHS we get a different set of data… it's hard sometimes to get a full picture and trying to work out the client's base score, that was one of the biggest challenges… to know the full picture because no system really talks to any other system.* (Implementation lead)

The quantitative data that was collected for the domiciliary care cluster relied solely on data submitted directly from the care agencies. Other avenues were considered in order to understand retrospective information for each service user, but this was not possible due to the mix of clients participating in the pilot and the availability of their health records. Since there was not a common identifier (such as NHS number) that was consistently reported, we explored whether GP records could be linked through fuzzy matching – linking their retrospective health

information based on the client's name, address and postcode. Given the sensitivity of the information that needed to be reported for matching, this was not pursued.

However, using data collected by the agencies had its limitations. There was no consistent way in which the care agency sites recorded information. Date of birth and gender for each service user was clearly documented; however, recording of ethnicity and comorbidities was less clear. There was some evidence that the agencies used Census classifications to categorise these data, though the information on service users' medical history held by the sites was not fully complete or consistently recorded.

7 Digital prescribing cluster – implementation and outcomes

Aims of the cluster

The aims of the digital prescribing cluster were to embed digital innovations in standard care pathways in primary care for people living with diabetes and insomnia, promote digital prescribing for the self-management of diabetes and insomnia, understand the barriers and enablers of digital prescribing, and facilitate the upskilling of GP practice support staff. Four innovations were selected for use in eight general practices in the London Borough of Barking and Dagenham: Sleepio, Liva Healthcare, the Healthy.io ACR test (now known as Minuteful Kidney) and Our Mobile Health, the first three of which proceeded to testing. The implementation plans and key findings for each innovation are outlined in this chapter.

Impact of the Covid-19 pandemic on primary care

The Covid-19 pandemic has had a notable impact on primary care services: many GP practices had to quickly adapt to different ways of offering services to patients to limit the number of face-to-face appointments, there were staff shortages due to illness, self-isolation or caring responsibilities, and some staff were redeployed. Primary care services have undergone a rapid digital transformation. Services have largely shifted to remote means with the adoption of digital consultations. As a result, face-to-face appointments only take place when necessary so that clinical staff can work remotely and patients are not required to attend the practice. Priorities have shifted and resources have been redirected, and therefore the impact on the implementation of the digital innovations within the test bed has been notable.

Sleepio

Sleepio is an automated digital programme delivering cognitive behavioural therapy (CBT) for insomnia. There is a growing evidence base to support the effectiveness of the programme; it has been evaluated in numerous trials and real-world evaluations. Sleepio has been shown to

be safe and effective in improving insomnia symptoms and mental health by reducing symptoms of depression and anxiety.[24,25,26,27,28,29,30,31,32,33,34]

Implementation staff recognised the prevalence of sleep problems in primary care and the benefit of the Sleepio programme in providing an alternative option (to medication) or an extra resource that can be offered to patients to improve quality of care:

> *This is [an] extra resource, online available to us. It does help to improve the rapport with the patient when you are consulting, you know about insomnia so then you can say actually yes we [are] talking about this but you know we have an app here which we could offer you which might be able to help and suddenly the patient thinks… actually my GP or my clinician is actually far more interested, not just dishing out a tablet or something…* (Implementation lead)

However, some implementation staff reported that CBT is rarely prescribed for insomnia in their practices, in favour of sleep hygiene or medication. This is partly due to lack of clinician awareness of the positive evidence for CBT and partly because of a lack of resources to deliver face-to-face CBT to everyone who could benefit. Implementation staff also discussed the challenges around treating sleep problems in primary care: that consultation times are limited for discussing issues around insomnia and sleeplessness, which often occur alongside other physical and/or mental health conditions.

The national and local context

Approximately 8–12% of adults report chronic insomnia and 30–50% experience insomnia symptoms.[35] Evidence shows that CBT is a lastingly effective treatment for persistent insomnia[36] and guidance from the National Institute for Health and Clinical Excellence (NICE)[37] recommends CBT for insomnia as the first line of treatment. However, access to non-pharmacological interventions for insomnia is often limited due to a shortage in the number of qualified staff. This shortfall is likely to be accentuated by the Covid-19 pandemic, which experts expect will increase demand for mental health services. Therefore, an online CBT programme such as Sleepio provides an opportunity to complement or substitute face-to-face therapy.

Sleepio is in use in several pilots across the NHS. It is available to eight million people across London via a partnership with the Good Thinking Foundation and funding from NHS England and local clinical commissioning groups. It has also been used as part of the Improving Access to Psychological Therapies (IAPT) programme; in Greater Manchester, IAPT patients with sleep problems and comorbid anxiety and depression can access Sleepio via a partnership with Self Help Services. Sleepio is also available to 2.3 million people in the Thames Valley, supported by the Buckinghamshire, Oxfordshire and Berkshire West Sustainability and Transformation

Partnership, Oxford AHSN and Innovate UK.[38] Sleepio is also available to 1.3 million NHS staff and 1.5 million social care staff through partnerships with the Department of Health and Social Care, NHS England, NHS Scotland and certain health boards in Wales.

Implementation pathway/process

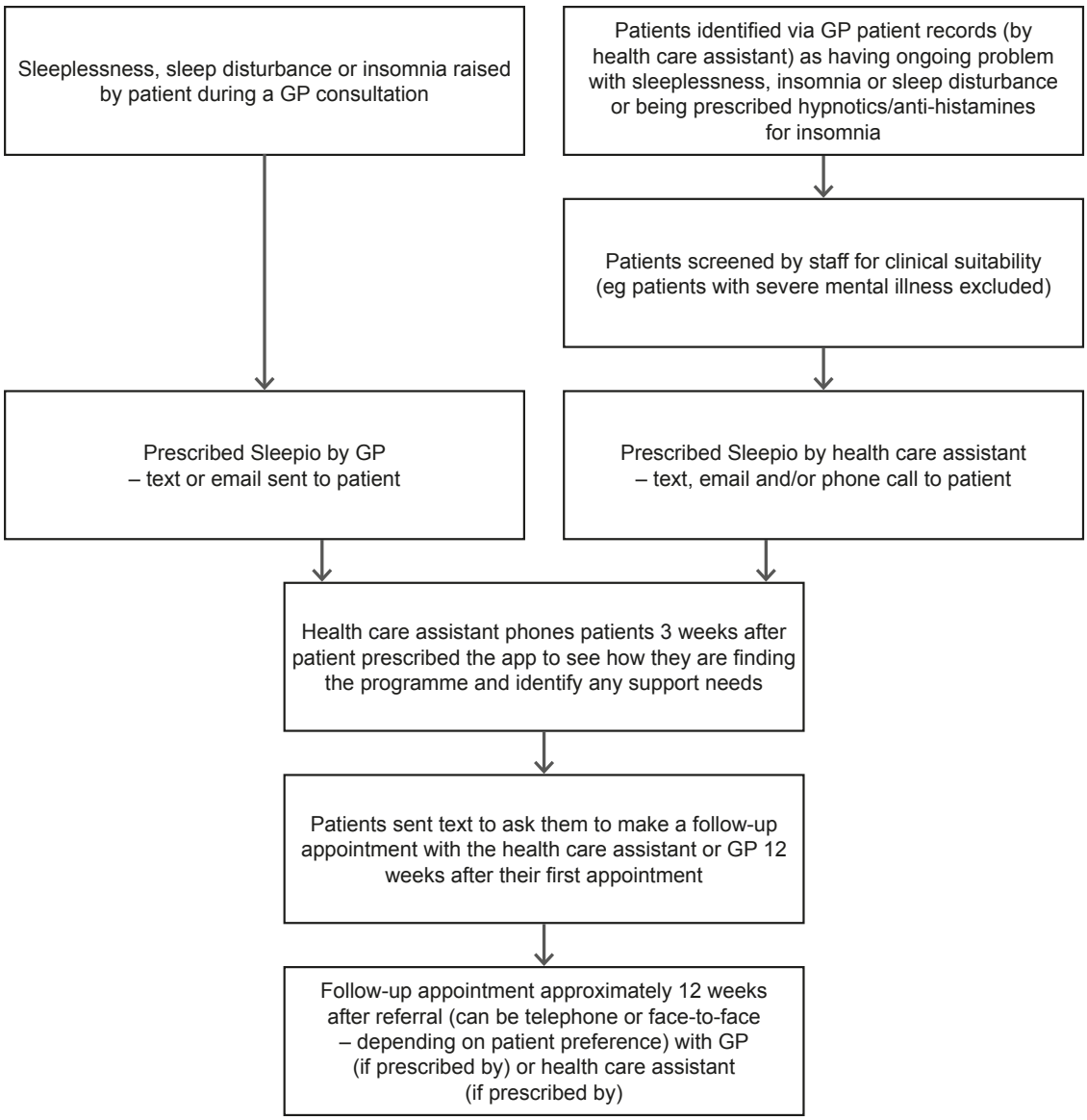
The implementation process (outlined in Figure 5) ran between March 2019 and April 2020, when it was halted across practices due to the Covid-19 pandemic. There were two pathways for patient recruitment:

- Patients who raised sleep issues during a consultation (with their GP or health care professional) were prescribed the programme.
- Patient records were searched to identify patients who had reported sleep difficulties in the past (such as those being prescribed hypnotics or with a current diagnosis of a sleep disorder) who were called by a member of staff (usually a health care assistant) to prescribe the programme.

Patients were required to have access to a smartphone, tablet or computer, and the internet – the full Sleepio programme was available via computer (web browser), while the app (which is considered supplementary to the full programme) could be accessed via smartphone (iOS only). The programme was prescribed using the NHS Apps Library, which is a resource located in the GP practice system. Usage of the apps library across primary care services is relatively low and for some practice staff it was their first time using it.

Patients who were prescribed Sleepio received the link to access the programme. Patients then received a call from the practice roughly three weeks after being prescribed the programme to discuss how they were finding it and identify any support needs. Three weeks was chosen because that is when sleep restriction is introduced within the Sleepio programme, which some users find particularly challenging.[39] Patients were asked to book a follow-up appointment with their GP or health care professional 12 weeks after referral, which was via the telephone or face to face depending on patient preference. Sleepio is usually offered as a stand-alone programme, without any professional healthcare support.

Figure 5: An outline of the implementation pathway



Usually, patients who raise issues with insomnia or sleep disturbance during a consultation might be prescribed sleep hygiene or sedatives. However, there does not appear to be a clear standard pathway for patients with insomnia across primary care services. Patients referred to Sleepio (particularly those recruited retrospectively) might also have been using sedatives and/or sleep hygiene.

Implementation across sites

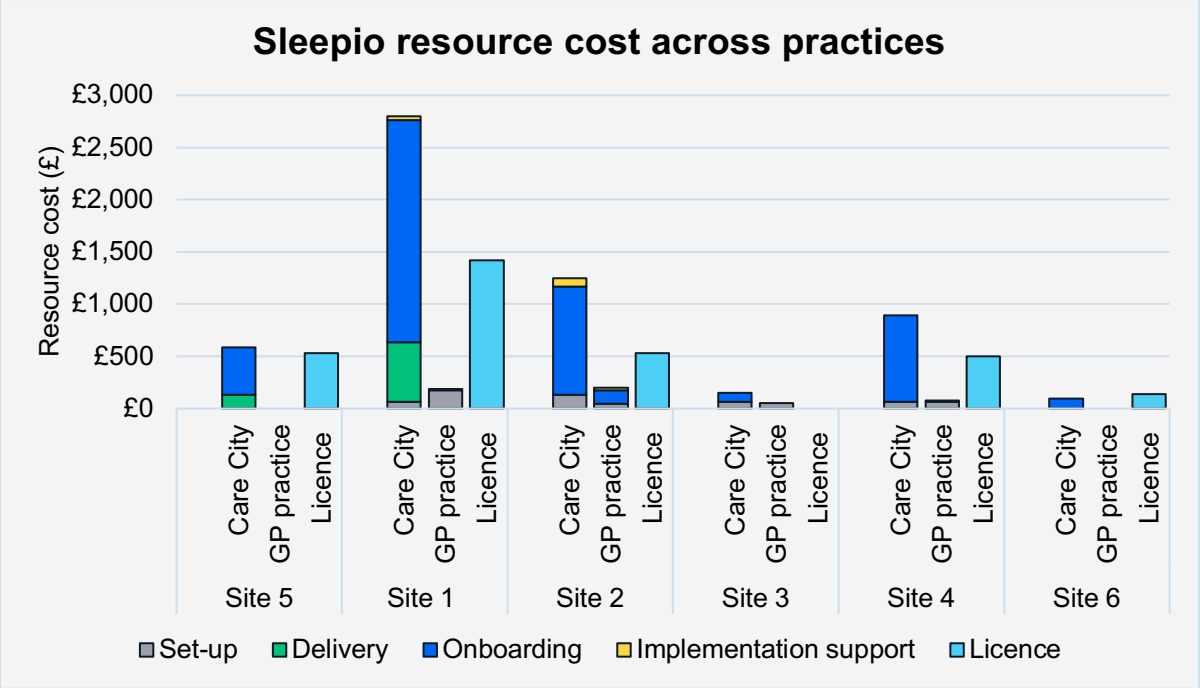
Sleepio was initially implemented in seven practices; however, two practices subsequently disengaged with the implementation after a short period of time. The reasons cited by one implementation site were that patients were not engaging with the programme and/or were finding the programme challenging, staff did not have the time or capacity to support the

implementation and there was a lack of eligible patients. To increase referral rates, three further practices were recruited to the implementation in early 2020.

Implementation costs

The costs of implementing the Sleepio pathway are summarised in Figure 6. Costs are broken down into those related to set-up, onboarding, delivery and implementation support, and according to whether Care City or GP practice staff carried out the activity. Although Sleepio was offered at no cost within the test bed, costs also include the licensing costs that would have been incurred at each site. This is calculated from the unit cost for the innovation, scaled for the size of the test bed and the number of patients successfully recruited.

Figure 6: Resource cost across practices



There was considerable variation in the cost of resources used to implement Sleepio between practices, ranging from £96 to £2,984. The implementation cost at Site 1 was over twice that of the next highest costing site; this practice had a larger eligible patient pool and was more engaged in the test bed. Across most practices, referring patients accounted for the majority of the total cost in each site; this is likely due to the fact that referring patients (particularly retrospective referrals) was relatively time intensive and engaging patients was challenging.

The role of Care City

As demonstrated in the costing data, across the GP practices there was significant variation in the level of staff engagement, staff time spent prescribing Sleepio and time spent making follow-up calls to patients. The Care City team supported the implementation at all of the practices. For those practices where staff engagement was relatively low, the Care City team assumed a much larger role in implementation than had originally been planned; practices received regular support from the Care City team for prescribing the programme and conducting follow-up calls. Care City staff time accounted for 68–100% of the total cost related to implementing Sleepio across practices. The lack of staff engagement in the implementation was a particular challenge and was largely related to workforce capacity, time to support the implementation, the administrative nature of the tasks and some staff also described a lack of engagement from organisational leaders – that the implementation of Sleepio was perhaps not viewed as a priority.

Impact of the Covid-19 pandemic on the implementation

The Covid-19 pandemic had a significant impact on the implementation pathway. Patient recruitment and follow-up calls scheduled to take place at three weeks and 12 weeks post-referral were suspended due to the impact of the pandemic on the priorities, capacity and resources of primary care services. Care City was no longer able to attend the practices to support the implementation and practice staff did not have the capacity. It is difficult to evaluate the impact of this on patient uptake, engagement and outcomes; however, it might well be expected that patients were less likely to use the programme when not receiving the support phone calls from practices.

Training implementation sites

The innovator provided training to participating practices. For the first participating site, training was held within the practice. However, subsequently, a group training session across GP practices was held, for which staff attendance was low. The training covered: the importance of sleep and its association with other health problems; how to manage poor sleep and insomnia; the use of Sleepio elsewhere in clinical practice for the management of insomnia; the evidence base and guidance for clinicians; and how to prescribe Sleepio. Observations of training sessions revealed that clinicians were generally very positive about the innovation and implementation staff reported that the training was sufficient, that they felt confident prescribing the programme and were happy with the level of support provided by the innovator. The main queries from practice staff related to how Sleepio would actually be prescribed via GP patient

records. One implementation lead also reported that the training had been beneficial in informing practice staff of the treatment options for patients with sleep problems.

Implementation team: satisfaction, roles and responsibilities

Implementation staff reported the benefit of having an extra option to offer patients: “I think it’s giving staff members a different option to offer the patient instead of just the regular things that we can give out” (implementation team). Implementation staff reported little role change; approximately 30 minutes to one hour each week for eligibility screening, prescribing and follow-up calls. There were mixed feelings from practice staff regarding their role in the implementation; one staff member described the responsibilities as a challenge as they did not have sufficient time for the additional workload, while another described the responsibilities as a welcome distraction from other work. This perhaps, in part, explains the low level of staff engagement in some of the practices, which required Care City to take on a fairly significant role in the implementation.

Perhaps unsurprisingly, due to the low levels of staff engagement, relatively low attendance of practice staff at the initial training session and the administrative nature of the tasks involved with supporting the implementation, implementation staff did not report the development of skills. However, they did report development in a number of other ways – for most implementation staff this was their first experience of digital prescribing and they reported increased awareness and knowledge around this. This was also confirmed by Care City staff supporting the implementation:

> *They [practice staff] found out about new tips and tricks of how to digitally prescribe or they found out about the app library, which some of them have never used before and they were just excited to see that they could do that and that is a function of their system.* (Care City team)

One implementation team member also described that being part of the test bed had changed the nature of their interactions with patients when discussing sleep problems and their awareness around insomnia and the different treatment options.

Patient outcomes: uptake, engagement and satisfaction

Offering Sleepio

From the lists of eligible patients provided by the GP practices, 163 patients were able to be contacted for using Sleepio. Of these, 105 (64%) expressed an interest in the innovation, and 58 (36%) declined the offer (see Figure 7). There were a number of reasons given for declining, with the most frequently cited being because patients were managing other health conditions.

Some were simply not interested in the offer, and others said that they were no longer experiencing sleep issues.

Of the 105 patients who expressed an interest, 50 went on to register with the programme and provided an initial baseline. This was done using the two-item Sleep Condition Indicator (2-SCI), a brief measure used to screen patients for insomnia.[40] Uptake among the 163 patients who were contacted was therefore 30.7%, which is generally higher when comparing our findings to previous studies using Sleepio.[41,42]

Figure 7: Sleepio – number of patients contacted to number of patients engaged with the programme

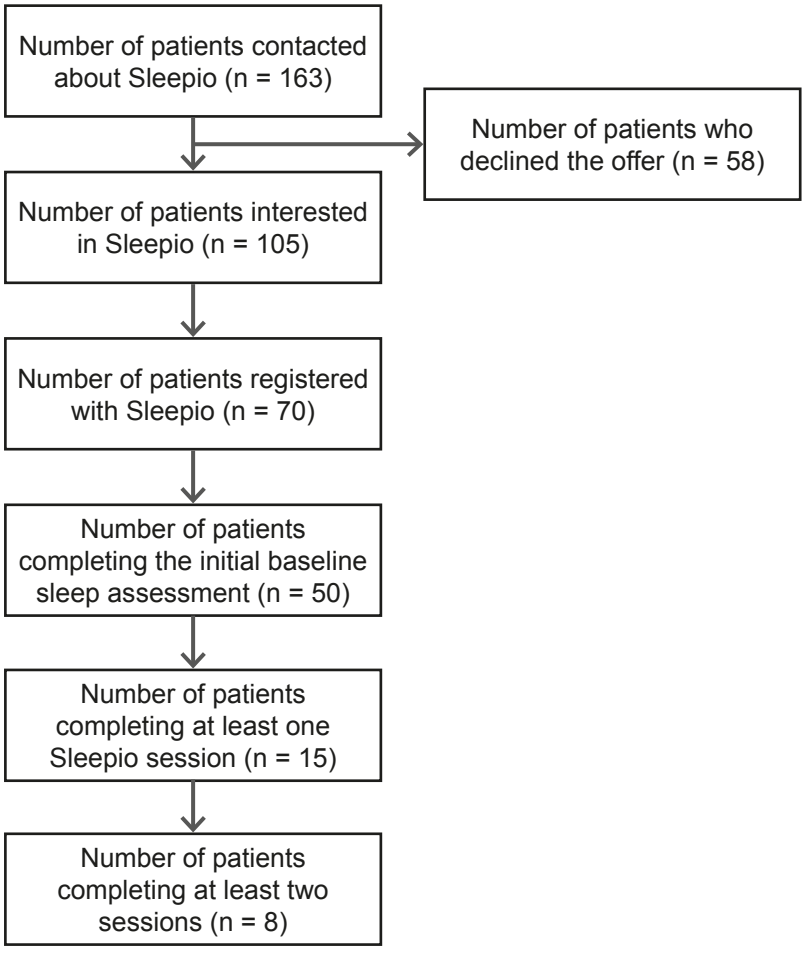


Table 13 shows the characteristics of patients offered Sleepio who were identified through the GP practice systems, compared with those of patients from the same practices who had not been offered Sleepio. The innovation was offered if the patient was successfully contacted, if they were interested and if they had a smartphone or computer (through which they could receive a link to download or access Sleepio).

Table 13: Characteristics of individuals offered and not offered Sleepio

Variable	Category	Number of patients offered Sleepio (%)		Number of patients not offered Sleepio (%)	
Age band	<=39	49	37.1%	237	44.9%
	40–44	13	9.8%	73	13.8%
	45–49	13	9.8%	42	8.0%
	50–54	19	14.4%	43	8.1%
	55–59	17	12.9%	40	7.6%
	60+	21	15.9%	93	17.6%
Mean age (std error)		45.6	*(1.2)*	42.0	*(0.8)*
Gender	Female	82	62.1%	294	55.7%
	Male	50	37.9%	234	44.3%
Ethnicity	Asian	15	11.4%	102	19.3%
	Black	11	8.3%	86	16.3%
	White	67	50.8%	177	33.5%
	Mixed/other	*	-	29	5.5%
	Not stated	*	-	134	25.4%
Comorbidity	Depression	14	10.6%	52	9.8%
	Hypertension	9	6.8%	29	5.5%
	COPD, coronary heart disease, stroke or heart failure	7	5.3%	23	4.4%

N.B. Data on patients who were offered Sleepio include those who were offered and declined it.

**Numbers are suppressed because those in the mixed/other category total between one and five.*

From the GP data, we identified 132 patients who had been offered Sleepio and 528 patients from the same practices who had sleep disorders but with no record of having been offered the app. The mean age of patients offered Sleepio was 45.6, which is significantly higher than the mean age of those not offered it (42.0, p=0.02). More females (n=82) were offered the innovation compared with males (n=50); there were also more females than males who were not offered the innovation, but the difference between these groups was not statistically significant. Half of the group offered Sleepio were reported as having a White ethnicity, but only

33.5% of patients not offered Sleepio were reported as White. Excluding those who had no ethnicity recorded, the proportion of patients offered Sleepio who were White was significantly higher than among those not offered it ($p<0.0001$).

The most common comorbidity alongside a diagnosis of sleeping problems was depression (in about 11% of cases offered Sleepio and 10% of cases not offered it) – a widely reported finding is that disturbed sleep and depression are strongly associated.[43]

Limited information was held on patients who declined the innovation, but of the 22 patients for whom demographic data were available, the group who declined were, on average, older, with a mean age of 55.6 compared with a mean age of 43.5 for the patients who were offered the innovation and accepted the offer. This difference was statistically significant ($p<0.001$). Twenty per cent of female patients were offered Sleepio compared with 12% of males, but this difference was not statistically significant.

Uptake and engagement

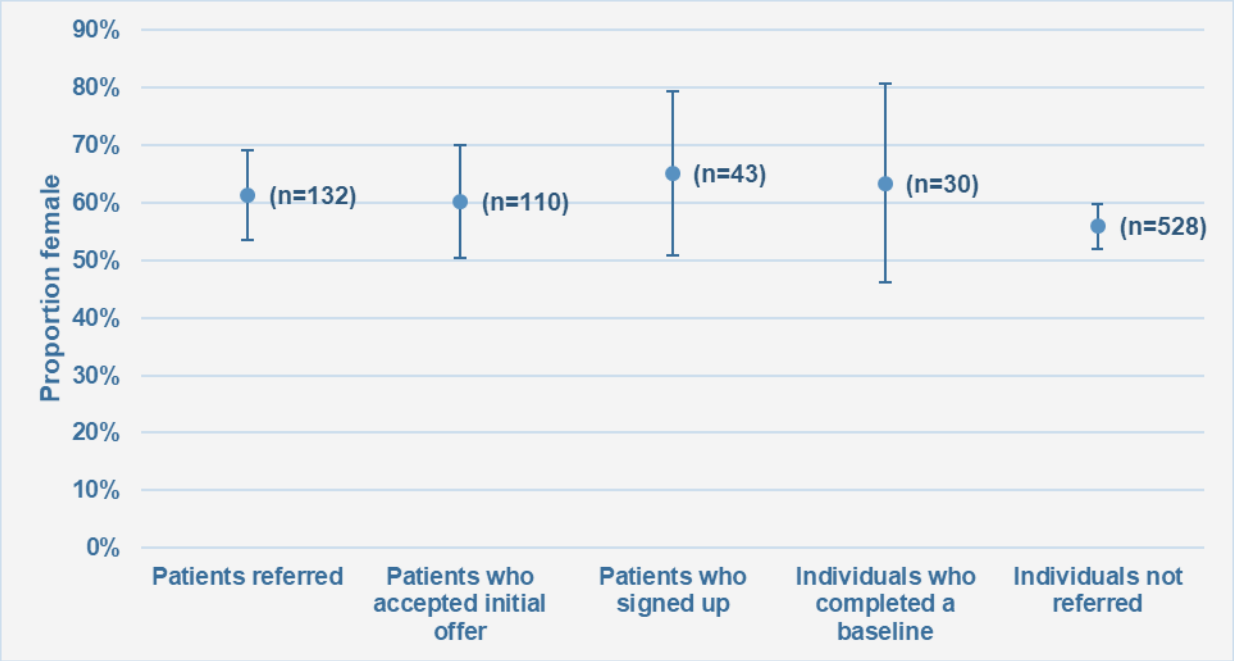
In the first instance, 70 patients who were offered Sleepio signed up to the programme. Of these, 50 completed the initial baseline (see Table 14).

Table 14: Number of patients engaging with Sleepio

	Frequency
Number of sign-ups to Sleepio	70
Number of baselines completed	50
Number of patients who completed session 1	15
Number of patients who completed at least 2 sessions	8

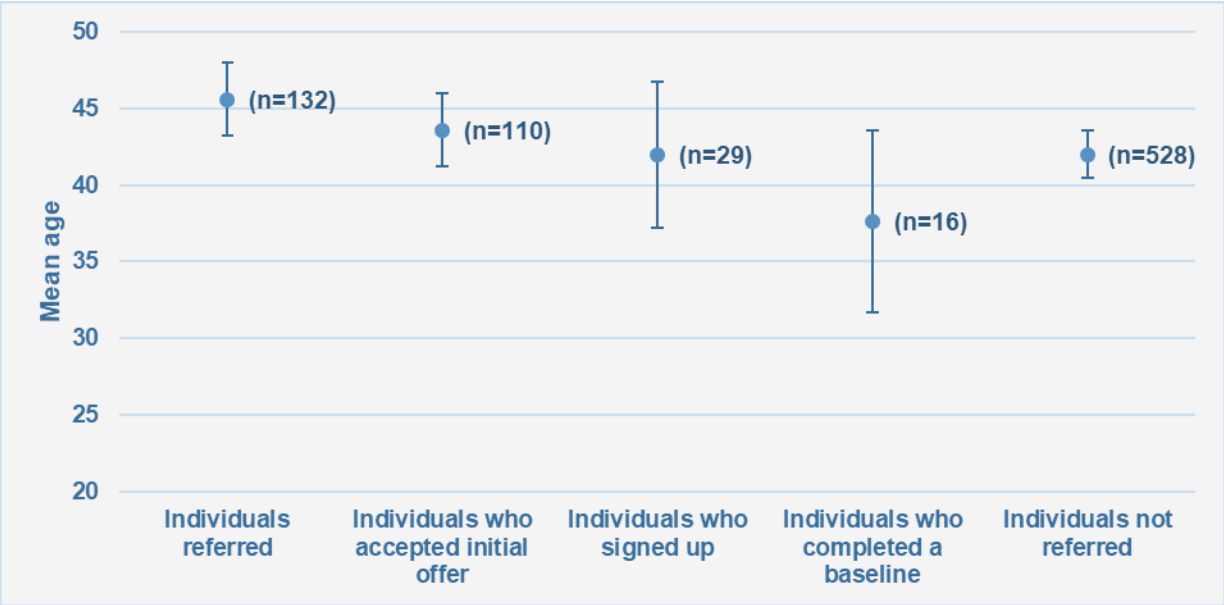
Although demographic information was not complete for all patients, the data available for 43 patients who signed up show that 28 (65.1%) were female and 15 (34.9%) were male, with 19 female patients (63.3%) out of 30 patients that completed an initial baseline. This was largely consistent with the proportion of female patients referred to Sleepio (62.1%) and who accepted the initial offer (60%) (see Figure 8).

Figure 8: Proportion of patients who were female at different levels of engagement with Sleepio



In addition, the 29 patients who signed up to Sleepio and provided complete demographic data had a mean age of 42. 16 patients who were further engaged Sleepio and completed a baseline assessment were, on average, younger (37.6), though this difference was not statistically significant (see Figure 9).

Figure 9: Mean age of patients at different levels of engagement with Sleepio



Fifteen (30%) of the 50 patients who completed the baseline finished the first Sleepio session. This dropped to eight patients completing two or more sessions (16%). Despite the low number of patients completing the latter sessions, patients who regularly used the programme were very positive about Sleepio and mentioned that they repeated some of the sessions.

There were a small number of patients who had a 2-SCI sleep score at baseline and also a 2-SCI score following the completion of at least the second session. Six out of seven (85.7%) of these patients saw an improvement in their scores.

The Care City team supporting the implementation reported that when referred, patients often seemed motivated to use the programme; however, often this did not translate into engagement. Implementation staff and the Care City team reported a number of barriers to patient uptake and engagement (see Table 15).

Table 15: Barriers to patient uptake or engagement

Barrier to patient uptake/engagement	Description/quotes
The sleep test was a challenge for some patients	"The feedback from some of the patients was that there were too many questions." (Implementation team) "You had to be really committed and you had to be someone who really wanted to sort out their sleeping to go through all those questionnaires." (Implementation team)
Language barriers*	"[W]e have a huge BAME [Black, Asian and minority ethnic] population...if you're looking at slightly middle-age to elderly people, they would struggle to do it unless someone was at home constantly interpreting what the questions was…" (Implementation lead)
Digital exclusion: app not available on android phone, patients not having access to the internet and/or computer*	"The other difficulty was that you either had to do it on a PC or an Apple iPhone. You could not do it with any other Android mobile. Now the thing is that in Barking and Dagenham we are quite a deprived area so having Apple is not always easy." (Implementation lead) "A lot of these people if they've got a non-Apple phone they generally don't tend to have a PC at home." (Implementation lead)
Other health conditions	"I just felt like it wasn't always suited to those patients, even though they have had issues with sleep, I feel [like] in terms of their pre-existing health conditions or mental health conditions, it probably wasn't best suited to them." (Care City team)
Other reasons cited by staff	Patients being too busy, some patients preferred to see a doctor face to face and some patients just wanted medication (an immediate solution to take home to help them sleep).

** The barriers relating to language and access via non-Apple devices were discussed with the innovator prior to the implementation and were not able to be amended at that time.*

Those patients who were using or had been using the programme reported varying levels of engagement (i.e. some patients had completed the sessions, while others were still using the programme). For those patients who were no longer using the programme, they reported that it was reassuring that they could still access it and return to the sessions if needed. This might, in part, explain the findings that Sleepio has longer-term sustained benefits in terms of psychological wellbeing and sleep-related quality of life.[44]

Care City staff reported that the three-week follow-up calls supporting patient engagement were challenging; many patients were difficult to get hold of or had not engaged with the programme:

> *The thing that we [kind of] struggled with after a while was making sure that people were continuing to be using the product, [so Sleepio] and that's kind of hard to manage because it's external and it's down to patient motivation… and there's only so much you can do from our end to keep that going, keep the momentum going.* (Care City team)

Patient satisfaction and outcomes

The patients interviewed who were engaging with the Sleepio programme reported improved sleep, and that they would recommend the programme to others; and all but one reported they would continue to use the programme. Interviewees said that the programme had given them the "knowledge" and techniques to "control" their own sleep problems. They reported that Sleepio was simple and easy to use (e.g. they said that the sleep diary was easy to complete and the videos provided information about how to complete each step). However, one interviewee reported challenges relating to changing their routine and sustaining it. One implementation lead also reported that the programme was challenging for patients:

> *I was told by one of the patients that actually it asks you to log in exactly how many times you wake up at night and things like that so [one] of the patients were saying 'oh actually I couldn't sleep because I had to log that in' – so you know it was disrupting in some ways to them.* (Implementation lead)

The patients who were interviewed were happy with how Sleepio was introduced, and the level of information and support provided. One interviewee mentioned that there was no need for additional support from their GP practice as the app explains everything; and another reported that it was reassuring to know the support was there if needed. For those patients who provided feedback and who reported wanting additional support, most cited technical support to help them use the programme – which stemmed from problems downloading the app, setting up and

using the app – and others would have liked emotional and/or moral support to provide encouragement and motivation throughout the programme.

Impact on prescribing

From the GP data we identified 110 individuals who were offered Sleepio and did not decline it. These cases were matched against controls on age, gender, ethnicity and previous use of hypnotics or Promethazine. Each case was matched to two controls from practices in Barking and Dagenham who were not part of the test bed for Sleepio. The proximity of the matching is shown in Table 16. The matching was close with no significant differences between groups.

Table 16: Matching of cases and controls – Sleepio

Variable	Category	Cases		Controls	
Age band	<=39	45	*(40.9%)*	88	*(40.0%)*
	40–44	11	*(10.0%)*	19	*(8.6%)*
	45–49	13	*(11.8%)*	21	*(9.5%)*
	50–54	16	*(14.5%)*	31	*(14.1%)*
	55–59	13	*(11.8%)*	26	*(11.8%)*
	60+	12	*(10.9%)*	35	*(15.9%)*
Mean age (std error)		42.6	*(1.2)*	43.6	*(1.2)*
Gender	Female	66	*(60.0%)*	138	*(62.7%)*
	Male	44	*(40.0%)*	82	*(37.3%)*
Ethnicity	Asian	10	*(9.1%)*	20	*(9.1%)*
	Black	9	*(8.2%)*	20	*(9.1%)*
	White	56	*(50.9%)*	113	*(51.4%)*
	Mixed/other	*		6	*(2.7%)*
	Not stated	*		61	*(27.7%)*
Previous use of hypnotics or Promethazine in past 12 months	No	76	*(69.1%)*	152	*(69.1%)*
	Yes	34	*(30.9%)*	68	*(30.9%)*

** Numbers are suppressed because those in the mixed/other category sum to between one and five.*

The odds ratios for a drug prescription after referral compared with the control group are shown in Table 17. Although more individuals in the control group had further prescriptions by six and nine months, the differences between the two groups were not statistically significant.

Table 17: Odds ratios for drug prescriptions after referral for Sleepio (ratios between cases and controls)

Parameter	Cases (n=110)	Controls (n=220)	Odds ratio	95% confidence limits for odds ratio	
Prescription between one and six months after referral	12 *(11%)*	38 *(17%)*	0.59	0.33	1.06
Prescription between one and nine months after referral	17 *(18%)*	43 *(22%)*	0.75	0.44	1.25

Key implementation findings

The evaluation highlighted several key lessons.

Understand the barriers to patient uptake and engagement. There were a number of barriers to uptake, including digital exclusion, digital literacy problems, language barriers and technological barriers such as the app not being available on android phones and issues with accessing or losing the link. One implementer reported that patients should have been given more information and support with accessing the link, and a number of patients reported that they would have liked additional technical support with downloading or accessing the programme. Some of the technological barriers were perhaps, in part, caused by communication early on, with practice staff referring to the Sleepio app rather than the web-based programme.

Consider when and how the programme is prescribed. These appeared to be important factors in patient engagement – in particular, the timing of the referral and how patients were referred. Some patients reported longstanding issues with sleep, while others reported sleep problems that had emerged relatively recently. Those patients who were interviewed and engaging with the programme were referred during a GP consultation when raising sleep issues and therefore were motivated at that time to address their sleep difficulties. Meanwhile, patients referred retrospectively were less likely to engage, as their sleep problems were perhaps less of

a priority at that moment and they were more likely to have been taking medication for a long time. It might be that the retrospective recruitment strategies employed to boost patient uptake in fact hindered engagement. However, it is important to recognise that consultation times within primary care are limited so issues around insomnia, which often occur alongside other health problems, are often not discussed.

Understand 'drop-off points' in the implementation pathway. There were many drop-off points (i.e. points in the pathway where patients stopped engaging with the innovation) in the digital prescribing pathway, including the initial referral, clicking the link, initial engagement with the programme, the sleep test and the use of the programme over time. However, it is important to note that the innovator has replaced the version of Sleepio used in the test bed with a new version with the aim of increasing engagement with the programme – for example, the sleep test has been shortened. For implementation staff, supporting continued patient engagement with the programme was difficult due to the low levels of uptake. The lack of fixed timing parameters within the programme and the fact that patients do not generally progress through it in a linear manner meant it was difficult to determine at which point support from the practice might be most beneficial:

> *There is no fixed timing that people have to complete the CBT so they could actually take longer, they could take a shorter time [and things like that] so when to follow them up? So there was no clear pathway we could design for it.* (Implementation lead)

Given that the follow-up support calls were suspended due to the Covid-19 pandemic, it is difficult to determine the degree to which patient engagement was impacted by the pandemic.

Consider how the innovation embeds or fits into existing services. It appears that insomnia is typically not well managed within primary care and its diagnosis and treatment are often opportunistic. As a result, there seems to be a lack of knowledge and awareness of insomnia treatment options – some implementers reported that CBT is rarely prescribed for insomnia at their practices. This perhaps, in part, explained the low staff engagement across practices and the low engagement of practices with the training sessions that implementing the innovation felt like providing an additional service or was not viewed as a priority. "It wasn't perfectly integrated into a pre-existing treatment pathway for insomnia. So it would have probably felt a little bit like an add-on or you're trying to create a new service within primary care" (innovator).

The Healthy.io ACR test

National and local context

The albumin to creatinine ratio (ACR) test is an investigation that looks for particles of albumin (a type of protein) in urine. A positive ACR test is an independent risk factor for chronic kidney disease and cardiovascular disease. NICE[45] recommends that all patients at risk of chronic kidney disease – e.g. patients with diabetes, hypertension and other risk factors – have an annual ACR test. The test makes up one of the eight care processes that NICE suggests is integral to improving long-term care in patients with diabetes. However, despite its role in the identification and prevention of kidney disease, ACR testing is the worst performing of all of the eight NICE diabetes care processes.The National Chronic Kidney Disease Audit (2017)[46] found that only 54% of people with diabetes have an annual ACR test.

Healthy.io's ACR service uses a smartphone app and a kit sent to people's homes to improve adherence to the ACR test, focusing on patients who have not engaged with this care process through the traditional method. The key benefits outlined by implementation staff were that the test provides flexibility for patients to carry out the test when and where convenient for them such as their own home, and they are therefore not required to attend the practice. Implementation staff described compliance with the annual ACR test as a particular challenge and were hoping that patients would engage with the Healthy.io ACR test to increase uptake:

> *ACR has always been a challenge for patients and that is one of the areas we fell down in because a lot of patients found it difficult, did not present the sample… So, providing patients with something that is accessible, that they can do at home, you know, without that necessary step of coming to the surgery, bringing the sample back, [thought] probably would benefit patient[s] and as well as improve the care we provide as well, because we have had a few patients that had not had the ACR done for a long time.* (Implementation team)

Diabetes is a priority for the local area. This is because historically the prevalence of pre-diabetic patients in the area was very low, suggesting under-diagnosis and detection. An initiative by Barking and Dagenham Clinical Commissioning Group, which commenced in 2016, offers financial incentives to all GP practices in the area to implement NICE guidelines for diabetes diagnosis, treatment and education. The ACR test is one of the eight care processes, as already noted, and is required to ensure that practices meet targets.

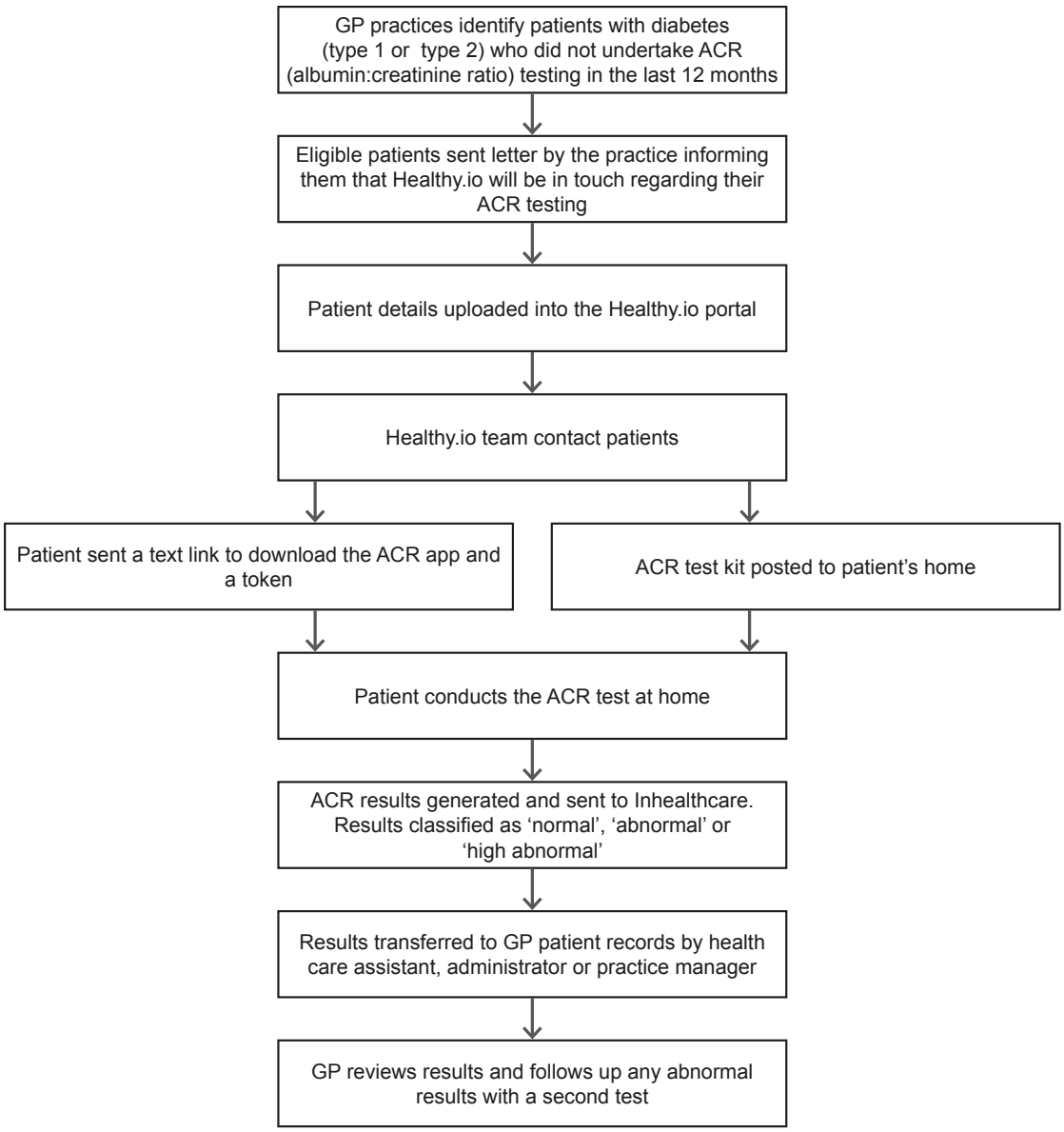
Implementation pathway/process

The implementation process (outlined in Figure 10) ran between March 2020 and July 2020, and took place across three practices. The implementation involved patients diagnosed with

type 1 or type 2 diabetes who had not undertaken an ACR test in the previous 12 months (and therefore had been difficult to engage with).

Eligible patients were identified by screening patient records and were initially sent a text (SMS) informing them about the ACR test and that they would be contacted by the Healthy.io team. Patients were called by Healthy.io and, if they agreed, they were sent a link to the app and the testing kit was posted. The patient completed the test at home and the results were generated and automatically available to view via the Healthy.io portal. Practice staff then transferred results from the portal to the GP patient records. The results were reviewed by practice staff and abnormal results were followed up. Patients were contacted by practice staff to request another test before treatment could be initiated – NICE[47] recommends that any abnormal ACR is confirmed by a subsequent sample.

Figure 10: Implementation pathway for the home-based Healthy.io ACR test



The implementation pathway for the home-based ACR test differed from the standard care pathway in that patients are usually asked to collect an early morning urine sample at home, which they must then return to the practice for lab analysis. If the ACR reading is between 3 mg/mmol and 70 mg/mmol, a repeat test is recommended using another early morning sample. If the first ACR reading is 70 mg/mmol or more, a repeat sample is not needed. A confirmed ACR reading of 3 mg/mmol is seen as clinically important.

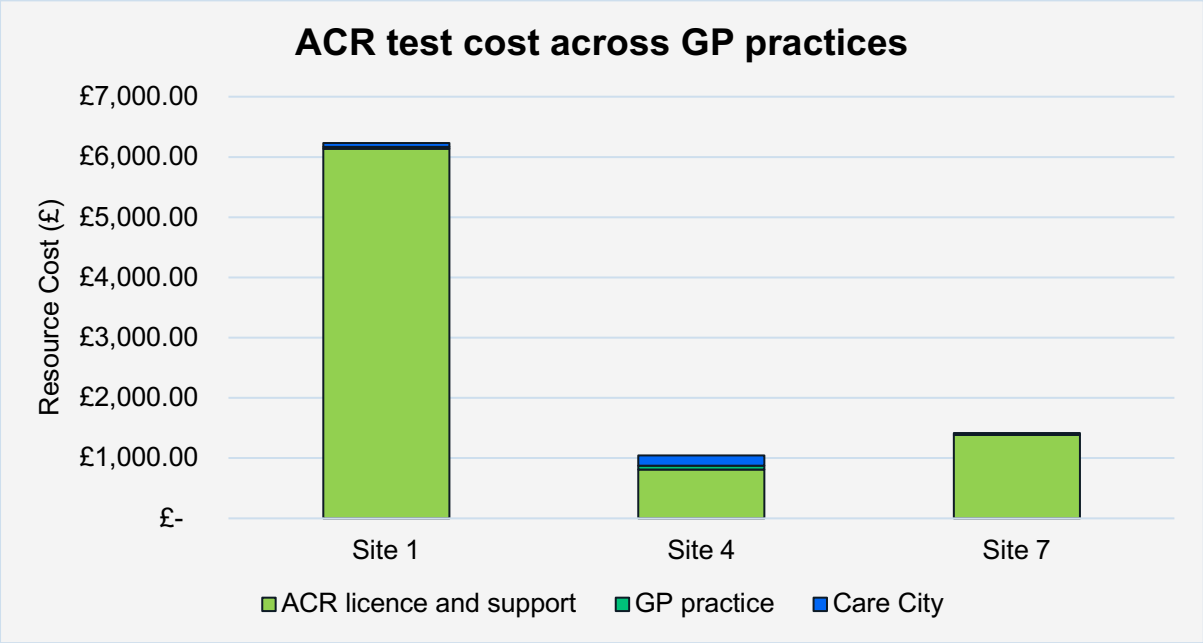
Implementation costs

The total cost of implementing the ACR test was £8,687, and by site this varied between £1,040 and £6,233 (see Figure 11).

The pricing model for the Healthy.io ACR test is a set price of £12 per consenting patient. This £12 includes all activity related to setting up, implementing and delivering the pathway. After also taking into account the cost of administrative activity related to following up patients with abnormal test results and time spent by Care City supporting the implementation, the cost per patient tested was £17.

As Healthy.io's pricing model is determined by the number of consenting patients, variation between sites was mainly due to the difference in the number of consenting patients across GP practices. All additional costs related to abnormal results and implementation support ranged from £33 to £233. The sites with higher costs associated with abnormal results also required a higher level of implementation support from Care City; the site will the lowest number of consenting patients recorded the highest extra cost.

Figure 11: Resource cost across practices



Across the three practices, the implementation was relatively consistent. However, there were differences related to the workforce roles of staff member(s) supporting the implementation with tasks such as transferring the data to the GP patient records and following up the abnormal results. Across the practices, staff supporting the implementation included administrators, healthcare assistants, practice managers and diabetes nurses, but minimal staff input was required and therefore placed little burden on implementation staff time. Practices also varied in the frequency of the data transfer to the GP records: some practice staff completed this daily, whereas others did it bi-weekly depending on their working preferences and test uptake. The

implementation team at practices reported that the set-up was relatively straightforward and the transfer of data did not take much time.

The role of Care City and the innovator

Unlike the other primary care innovations, the implementation of the Healthy.io ACR test required little support from the Care City team. This was primarily due to the role of the innovator in the implementation. The Healthy.io team were responsible for contacting the eligible patients to introduce the app and testing kit, providing information and supporting the download, as well as posting the kits to patients. Across all practices, the implementation teams were very positive about the support received from the innovator.

Impact of the Covid-19 pandemic on the implementation

The Covid-19 pandemic had little impact on the implementation due to the role of the innovation team in the pathway and the minimal practice staff time required to support implementation. Implementation staff reported that the Healthy.io ACR test had fared well due to the implementation model and had been beneficial in providing care during the pandemic, as it allowed patients to complete the test without requiring them to attend the practice:

> *So I think the ACR did really well in Covid because there was no patient, sort of, face-to-face contact offered in the practice so somebody would call them, they would get their kit, they will do the kit at home [and it goes away] and remotely the results come to us. So it actually helped in the challenging time of Covid… but actually improved the care.* (Implementation team)

One implementation staff member reported that uptake might have been increased by the pandemic in that friends and family would be more likely to be at home to support family members with the test and that patients had more time to complete the test. However, one implementation lead did report that the pandemic negatively impacted staff resources and their capacity to follow up abnormal results.

Training implementation sites

Across all practices, the training sessions were delivered by the innovation team and covered how the app and testing kit work, issues around data protection, the evidence base, the functioning of the Healthy.io portal and the setting up of staff accounts. They also provided an opportunity for staff to ask questions. Overall, implementation staff were satisfied with the training and support provided by the innovator. However, one implementation staff member reported that they would have liked further information regarding the functionality of the app and kit in order to support patients better when approached with questions. When introduced to the

innovation, one member of the implementation staff reported concerns relating to the reliability of the kit and confidentiality of patient data; however, they reported that these were addressed satisfactorily during the training.

Implementation team: satisfaction, roles and responsibilities

Practice staff were generally very supportive of the ACR test and viewed it as a priority in order to achieve their diabetes targets – Quality Outcomes Framework (QOF) and local targets – and to ensure that patients received the appropriate care. It was viewed as saving time for practice staff in relation to administrative work and for clinicians during diabetes reviews in that they would only need to discuss the results with patients, rather than needing an additional visit or telephone call. As a result, implementation teams across the practices showed high levels of engagement: “I think it is a fantastic kit, fantastic way of achieving ACR targets” (implementation team).

The test was also viewed positively for its ability to engage patients who perhaps had historically been challenging to engage with in terms of their diabetes care:

> *Getting the harder-to-reach patients engaged – [it] identified people [who] are slightly harder to engage in a normal healthcare environment and plugged them back into a healthcare system which might know that they have abnormal function or in some cases we’ve confirmed [with the GP practices] that actually these patients are abnormal and you need to keep a closer eye on them.* (Implementation lead)

The workforce roles supporting the implementation of the home-based ACR test were varied. However, implementation staff reported increased knowledge of the use of digital technology in healthcare and its benefits. One staff member reported that it was their first time using a digital app in this manner, that they were not aware it was even possible and that they would be more likely to use digital technology in the future. One implementation lead reported upskilling for administrative staff in terms of transferring the results to GP patient records, keeping track of the results and contacting patients. All implementation staff interviewed reported that, given the opportunity, they would continue using the test.

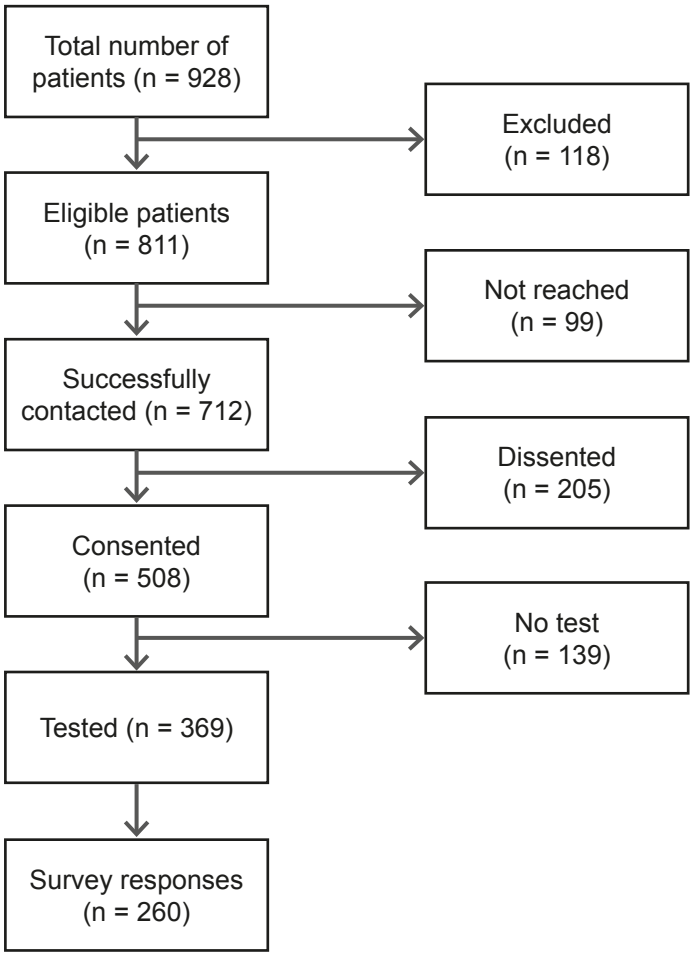
Patient outcomes: uptake, engagement and satisfaction

Patient uptake and engagement

Of the 811 patients who were identified as being eligible for the ACR test, 712 were successfully contacted, of whom 508 (71%) consented. Of those who consented, 369 (73%) completed a test (see Figure 12). The eligible patient pool differed considerably across the three sites, with one practice accounting for 76% of all eligible patients. The overall uptake rate for testing was

52% (369) of those who were successfully reached (712), and this ranged fairly consistently from 51% to 55% across the three implementing practices.

Figure 12: ACR test: pathway from eligibility to testing and survey respondents



Implementation staff reported satisfaction with the number of patients completing the Healthy.io ACR test and that uptake had "surpassed expectations" (implementation lead), particularly among those patients who had historically been difficult to engage. However, implementation staff reported that the home-based ACR test is not suitable for all patients, particularly those who are not confident with technology, those who do not have access to a smartphone, those with a catheter and patients residing in care homes. Of those who declined the test after being successfully contacted, the main reasons cited for declining were that they did not have a smartphone (34%) or would rather bring a sample to the surgery (19%). "The main disadvantage… accessibility to a mobile phone or help because I think a few patients have needed help to use the kit and download it and send it, so it is that problem" (implementation team). One implementation staff member reflected that age could be a barrier to engagement. However, staff had encouraged friends and family members to provide support when possible:

"[W]hat we are doing is that we are telling [patients], if they have their relatives who can help. Most of them they have their relatives or carers" (implementation team).

Patient demographics

Of the 712 individuals who were contacted, 346 (49%) were female and 366 (51%) were male, and the most common age group was people in their 50s, with 202 individuals (28% of the total) (see Table 18). There were no significant differences between men and women in the proportions who declined to take part, did not take the test or took the test. However, the proportions of individuals taking the test was increasingly lower as their age increased. The average age of those who took the test (52) was significantly younger than the average age of those agreed to take one but didn't (57) ($p<0.001$ with a two-tailed t-test), and the average age of those who decided not to take part (65) was significantly greater than the average age of those who did (54) ($p< 0.001$).

Table 18: Characteristics of people by whether they agreed to testing and actually took an ACR test using the home testing kit

	Did not agree to take part (n=204)		Agreed but did not take test (n=139)		Took the test (n=369)		Total
	n	%	n	%	n	%	
Gender							
Female	103	*29.8%*	65	*18.8%*	178	*51.4%*	**346**
Male	101	*27.6%*	74	*20.2%*	191	*52.2%*	**366**
Age							
< 40	6	*7.0%*	16	*18.6%*	64	*74.4%*	**86**
40–49	18	*14.5%*	22	*17.7%*	84	*67.7%*	**124**
50–59	47	*23.3%*	40	*19.8%*	115	*56.9%*	**202**
60–69	44	*29.5%*	28	*18.8%*	77	*51.7%*	**149**
70–79	56	*57.1%*	24	*24.5%*	18	*18.4%*	**98**
80+	33	*62.3%*	9	*17.0%*	11	*20.8%*	**53**

	Did not agree to take part (n=204)		Agreed but did not take test (n=139)		Took the test (n=369)		Total
	n	%	n	%	n	%	
Mean age (std error)	65.3	(1.0)	57.5	(1.3)	52.3	(0.7)	

Test results

Overall, 25% (91) of the 369 individuals who completed a test received either an abnormal or a high abnormal result. Sixty-two tests were classed as 'abnormal' (17%) and 29 as 'high abnormal' (8%). The breakdown of results by age and gender is shown in Table 19. There were no significant differences in the chances of an abnormal or high abnormal result by gender, and the average age of individuals within each category of result was also not significant.

Table 19: ACR test results by age and gender

	Test result						
	Normal (n=278)		Abnormal (n=62)		High abnormal (n=29)		Total (n=369)
Male	147	*(77.0%)*	30	*(15.7%)*	14	*(7.3%)*	**191**
Female	131	*(73.6%)*	32	*(18.0%)*	15	*(8.4%)*	**178**
Mean age (std error)	52.10	(0.76)	52.06	(1.77)	54.83	(2.81)	

Patient satisfaction

Out of the 369 patients who consented to and used the ACR test, 260 completed a survey about the test. There was an equal breakdown of men and women who completed the survey, and no significant difference in the age range of each gender. The vast majority (97.7%) found the test easy or very easy to use. Of those who found it neither difficult nor easy or very difficult, five out of six were male.

The majority of patients (90.4%) preferred the home testing method and practice staff reported that patients appreciated that the test could be completed at home without having to travel to the practice. Only 3% of respondents encountered any problems with the ACR test, and all respondents scored between 5 and 10 when asked how likely they would be to recommend the test to a friend or colleague. Ninety-two per cent chose a score between 8 and 10, and 69% reported a 10. The majority of survey respondents used their own phone to download the app, and among the 10% who did not, 8% used a relative. However, implementation staff reported that a few patients had found the kit and/or app complicated to use and several patients had contacted practice staff for support with downloading the app or reported needing support from family or friends: “We had a few calls off patients who rang up to say that [they had] issues with downloading the app” (implementation team).

Key implementation findings

The evaluation highlighted several lessons.

Consider the value of the innovator in supporting the implementation. The role of the innovator in enrolling patients, supporting the download and sending the kit to patients was acknowledged by implementation teams as a significant factor in the ‘success’ of the implementation, particularly due to the minimal impact on workforce capacity.

> *We have got very, very little time. The fact that Healthy.io do the groundwork, were following the patients up, ringing them up, it really, really saved a lot of time. I do not think we probably would have achieved the same results if we had been doing it ourselves because you would have needed to allocate additional people to follow up any patients who had not carried out the test.* (Implementation team)

This was recognised as a significant factor as to whether the innovation could be scaled to other practices – in the absence of support from Healthy.io, practices would need to consider who would support and oversee the implementation in relation to enrolling patients, sending out the kits and informing patients about downloading the app and its functionality. Due to the role of the innovation team supporting the implementation, if the test is scaled up, a dedicated delivery partner such as Care City would not be necessary. However, a consideration for the innovation team relates to their capacity to continue with this model when scaling up and the level of support that they would be able to provide to implementation sites should, for example, the Healthy.io ACR test become part of a national programme.

One minor challenge arising from the role of the innovator in the implementation related to patients understanding their role. One implementation staff member reported being contacted

by several patients checking that Healthy.io was working with the practice; however, those patients were quickly reassured by the practice staff. As part of the implementation, SMS texts were sent to patients before they were contacted by the innovator – consideration should be given to how best to inform patients that Healthy.io will be contacting them.

Be open and flexible to adaptations to the innovation and implementation pathway. The implementation was considered by practice staff to be straightforward. However, one implementation lead reported a minor issue in the time delay between the practice providing the Healthy.io team with the patient list and the team contacting patients, by which time some patients had completed the test. It was recommended that going forward it might be worth updating the innovator contact list on a fortnightly basis to avoid any duplication. Practice staff also made recommendations relating to the data transfer between the innovator portal and the GP patient records – in relation to how the data were grouped and that it could be more "user friendly" (implementation team). The innovation team have since confirmed that the results are now transferred directly into the GP patient records so this no longer needs to be done manually.

The innovation team should provide regular feedback. Implementation teams reported the benefit of receiving the regular 'dashboard' from the innovation team – this included feedback relating to the number of patients contacted, uptake and test outcomes.

> *Healthy.io has been very well in terms of coming back with the data [to show] where we are with things… if you have those dashboards given to you that you know here you are, you have referred 10 or you have referred 0...* (Implementation lead)

Consider how the innovation fits into the wider pathway/service. Perhaps the biggest challenge in the implementation of the ACR test related to the following up of abnormal test results. NICE guidelines recommend that any abnormal ACR test results are confirmed by a second test. However, one implementation lead reported that it could be difficult engaging with those patients to complete a re-test, which posed a particular challenge for their care. If the test is to be rolled out elsewhere, consideration should be given to the proportion of patients who are being followed up, how best to do this and setting aside adequate resources for this role.

> *It just makes their care going forward a bit challenging for me as a clinician because I know there's an abnormal test which would potentially need treatment but if [the] patient's not going to engage then that test is practically useless.* (Implementation lead)

Liva Healthcare

Liva Healthcare is a digital behaviour change programme consisting of personal coaching, group-based interventions, tailored health plans, goal tracking and self-monitoring. The anticipated clinical benefits for type 2 diabetic patients include reducing HbA1c levels, weight loss and improving physical activity levels and mood.

> *For us to just be able to reduce HbA1c is probably the primary aim. Weight loss is the secondary aim, and then we're looking at external factors such as, can we improve physical activity levels, are we improving patients' mood, are we lowering their alcohol intake, are we lowering their smoking levels, lots of different secondary benefits.* (Innovation team)

Implementation staff listed a number of benefits of the programme (see Table 20):

Table 20: Perceived benefits of the Liva Healthcare programme

Potential benefits of Liva Healthcare	Description/Quote
The remote accessibility – can be accessed at any time or place	"The thing is that it will be handy coaching for a patient, so they can access the guidance from anywhere. They don't physically need to attend clinic" *(*Implementation team)
Of benefit compared with existing programmes – a nine-month programme rather than one day, therefore keeping patients engaged over a longer period of time	"Because the one that we are offering for the diabetic patient, the newly diagnosed patients, is only a one-day teaching, like coaching programme… and for that one, they have to attend somewhere, this one is a nine-month programme, so basically can track what you've been doing…" (Implementation team)
Supporting patients to become more engaged with their own care	"The positive of patients being on Liva is they're encouraged to have their three-monthly, six-monthly check. Whereas some patients you would invite them and they wouldn't turn up, so being on Liva actually prompts them to turn up and have their checks done as recommended." (Implementation team)
Educating and motivating patients early in their diagnosis	"I think it might do wonders because at that point of time they've just been told about the diabetes, they've been told the importance of lifestyle and Liva does have some really good advice and knowledge plus the support with the coach in the community to help and motivate and push and get them the education that they need right at the beginning." (Implementation team)

Potential benefits of Liva Healthcare	Description/Quote
The availability of the health coach to provide support that healthcare professionals do not have the capacity to provide	"I think some patients like somebody to be with them all the way through it and because they've got the coach I think that helps them, you know just gives them that little back-up that they need…" (Implementation team) "It actually provides more access to patients because we only see patients for a very short period of time. They don't have a lot of contact with healthcare professionals and they need additional support in between appointments. So Liva is actually probably trying to improve accessibility for one, provide patients with more support that we potentially can't provide." (Implementation team)
More timely access to educational resources – at the time of diagnosis rather than waiting several months	"It actually also meant that they could access care quite quickly, whereas particularly with newly diagnosed we'd refer them to group education, they would have to wait. Whereas with Liva it's almost instant, yes, and they were contacted fairly quickly, so it's a quicker access to additional care." (Implementation team)

Liva Healthcare has been used as part of the national Digital Diabetes Prevention Programme (DDPP) in the local area. The evaluation of the DDPP will provide further evidence of its relevance to current UK care pathways. An observational study[48] examining the effect of Liva on self-reported weight change among 103 obese diabetic patients in Denmark found patients lost 4.3% of their initial body mass on average, which corresponds to 4.8kg over a mean period of 7.3 months. Patients who used Liva for more than nine months achieved a weight reduction of 6.3% (or 6.8kg).

Patient cohort

Given Liva Healthcare was already being used by pre-diabetic patients in the local area as part of the national diabetes prevention programme, it was decided to only recruit patients to the test bed with type 2 diabetes. This was the first time Liva Healthcare was used with type 2 diabetic patients within the UK.

Initially, the patient cohort was restricted to patients diagnosed with type 2 diabetes in the last 12 months. However, following difficulties with recruitment, this was extended to include patients diagnosed in the last seven years who were not taking insulin. Implementation staff generally

agreed that the cohort was appropriate, and one implementation lead was particularly supportive of the broadening of the eligibility criteria to include both patients who were newly diagnosed and those further along in their diagnosis.

Implementation pathway/process

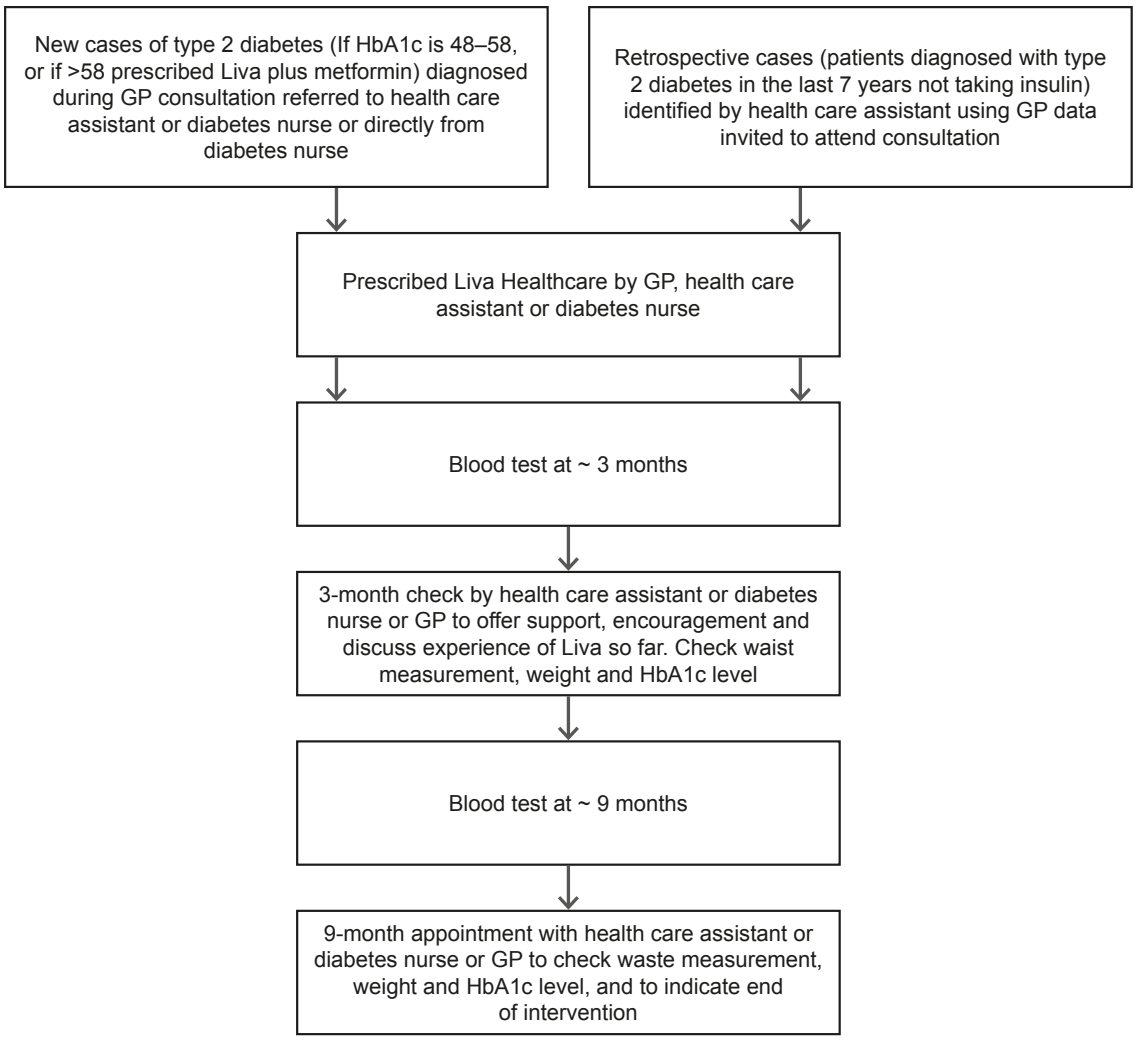
The implementation process (outlined in Figure 13) ran between June 2019 and November 2020, and involved four practices. The two main referral pathways to Liva Healthcare were as follows:

- Newly diagnosed patients or those attending a diabetes review were directly prescribed Liva Healthcare during a consultation with their GP or diabetes nurse, or were referred to the diabetes nurse or healthcare assistant during a GP consultation to then be prescribed.
- Patients diagnosed with diabetes within the last seven years were identified by screening GP patient records and were invited to attend a consultation with the diabetes nurse or healthcare assistant, who then prescribed Liva Healthcare.

For newly diagnosed patients with an HbA1c of 48–58mmol/mol, they were offered Liva only, and if their HbA1c level had increased at the three-month check, they were also offered metformin. However, for newly diagnosed patients with an HbA1c of 58mmol/mol or above, they were offered both Liva and metformin. Patients were required to have baseline metrics taken, including HbA1c level in the last three months of referral date, and weight and waist circumference within 30 days of referral date. At three months, patients attended a health check with their healthcare professional to offer support and encouragement and to discuss progress, as well as check their weight, waist measurement and HbA1c level. At nine months, patients attended a final health check with their healthcare professional to check their weight, waist measurement and Hba1c level and to indicate the end of the programme. On successful completion of the programme, all patients were signposted to local resources.[1]

[1] http://www.carecity.london/livaleavers

Figure 13: Implementation pathway for Liva Healthcare



Liva Healthcare was prescribed to patients in addition to treatment as usual as an additional service or 'treatment option'. To meet the Quality Outcomes Framework (QOF) requirements, practices are required to provide patients with structured education that is delivered to a minimum standard and meet key criteria. One such course is the Diabetes Education and Self-Management for Ongoing and Newly Diagnosed (DESMOND) programme and patients were referred to DESMOND alongside Liva. In addition, the local authority had commissioned a six-week educational course for any patient (whether diabetic or not) with a BMI >30 called Healthy Lifestyles. If eligible, patients were also referred to the Healthy Lifestyles course alongside Liva.

Implementation across sites

Across the test bed practices, 244 eligible individuals were contacted, 56% of whom had been diagnosed with diabetes within the previous year (see Table 21).

Table 21: Length of time with diabetes prior to contact

Duration of diabetes	Patients contacted	
0–3 months	49	*(20.2%)*
3–12 months	86	*(35.5%)*
> 12 months*	107	*(44.2%)*
Total	**242****	

** Includes eight patients with diabetes for more than the maximum of seven years when contacted, but who were within seven years when the selection criteria were run.*
*** Records of a diabetes diagnosis were missing for two patients.*

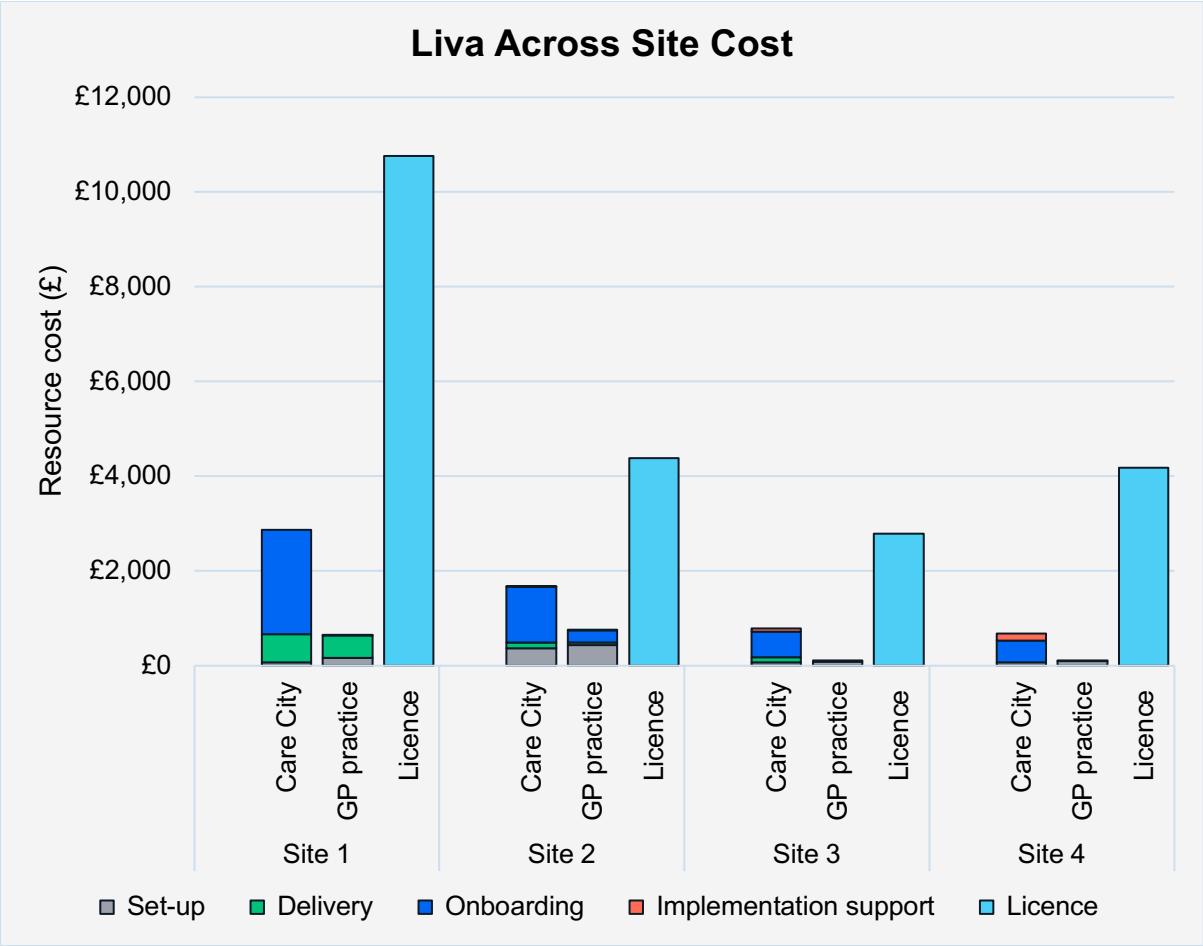
Implementation costs

The cost of implementing the Liva pathway is summarised in Figure 14. Costs are broken down into those related to set-up, onboarding, delivery and implementation support, and according to whether Care City or practice staff carried out the activity. The figure also includes the licence and health coaching support costs per patient recruited to use Liva.

The breakdown of resource costs to implement Liva varied across practices. Some sites incurred greater set-up costs, while others required additional implementation support. The cost of onboarding patients consistently took up the majority of practice and Care City team resources. This is likely due to recruitment and administrative tasks related to enrolment being particularly time and resource intensive (reported by implementation staff), and where practices required most support from Care City. In terms of the total cost, Site 1 in particular accrued a considerably higher cost in comparison to the other practices across the cluster (£3,520), reflecting greater engagement and larger numbers of patients enrolled.

The implementation process varied across the participating practices due to differences in workforce structures, capacity and level of engagement. For example, only one of the four practices had an on-site diabetes nurse and one practice did not have an on-site healthcare assistant. Therefore, there was variation in the workforce roles prescribing the Liva programme and completing the three- and nine-month health checks (in some cases this was a diabetes nurse, a healthcare assistant or a GP). In addition, one site had in-house blood testing facilities whereas others did not.

Figure 14: Resource costs across practices



The role of Care City

Care City supported the implementation primarily with the recruitment of retrospectively diagnosed patients, contacting patients to invite them to attend the practice for a consultation with practice staff and completing enrolment documentation. Care City staff time accounted for 53–88% of the total cost related to implementing Liva across practices. Implementation staff were positive about the role of Care City and most reported that support would be needed by a similar organisation if the innovation was rolled out elsewhere. However, one implementation staff member advised that support would not be required if the app was better integrated into the care pathway – recognising the impact of retrospective recruitment and the evaluation on practice staff time:

> *I think they could initiate it without support, but it needs to be part of the care pathway, it has to be incorporated into the care pathway in some way or the other. That's the only way. And within the incorporation into the care pathway acknowledging that it will take*

time and effort to actually recruit the patients. But if it's part of newly diagnosed [patients] then it won't take any more additional time. (Implementation team)

Impact of the Covid-19 pandemic on the implementation

The Covid-19 pandemic had a significant impact on the implementation across all practices. In most cases, the three- and nine-month health checks were halted due to limited resources.

> *There was crisis at the surgery level because some of them [staff] were self-isolating and we didn't have much staff to actually do the normal work so forget about Liva, so we had a lot of practices they didn't do the follow-up.* (Implementation lead)

One implementation lead also reported issues related to sending patients for blood tests and one implementation staff member reported that patients were reluctant to attend the practice for their health checks due to the pandemic: "It's been quite difficult to get patients to come in just so you get the height, weight and waist measurements done" (implementation team). Some practices resumed these health checks, after time, either face to face or remotely. For remote health checks, patients were encouraged to use their own scales and blood pressure monitors: "We decided that we will encourage people now for, at least, to have telephone [follow-up checks]…" (implementation team).

Patients reported that the Covid-19 pandemic had impacted how they were engaging with the programme. Several reported that they were not able to exercise as they were too scared to go outside or to the gym, but that the health coach had provided alternative exercise options for them. It is difficult to determine the precise impact of the pandemic on patient engagement with the programme and the impact this may have had on outcomes.

Training implementation sites

The innovator delivered two-hour training sessions at each practice. The training covered: real-world outcomes that Liva has achieved in a pre-diabetic population; an overview of the intervention; Liva in the context of the test bed – including eligibility criteria, the consent process, patient cohorts and pathways, and data requirements; an introduction to the health coach assigned to the test bed; and key contacts. The training particularly focused on the pathways, so professionals could refer appropriately and complete the mid-intervention checks. Overall, implementation staff reported feeling confident after the training:

> *[Y]es the training was sufficient. In terms of the app itself and the functionalities of the app, I had to have a bit of practice before I had an understanding of it, but otherwise, once we had the training I was confident to actually prescribe it.* (Implementation team)

However, early on in the implementation, some practice staff stated that they felt the need to have a better understanding of how to navigate the app in order to better explain it to patients and answer any queries. Staff would have liked additional information related to using the data systems and demonstrating the app. As a result, implementation teams were given access to a dummy account and further information about the intervention.

Implementation teams: satisfaction, roles and responsibilities

Implementation staff reported that they would like to continue offering the Liva Healthcare programme to patients, given the opportunity. Staff described the health coach as an extra member of their team, providing an additional avenue to support patients, with the potential of reducing their own workload: “I think it’s working really, really well. So certainly in terms of maybe the number of times I would have to follow up that patient, Liva provides that additional support, so patients actually may not come and see me” (implementation team).

One implementation staff member reflected that the programme benefits patients, which in turn makes their role easier: “It’s helping our patients, so if it’s helping our patients it’s helping us. If their diabetes is good it’s easier for us isn’t it?” (implementation team).

Implementation staff valued Liva Healthcare for helping practices achieve targets: “In terms of the organisation as well it means that it improves our targets. If patients do well, lose weight, HbA1c improves, it’s reflected on our targets as well” (implementation team).

Staff engagement with Liva Healthcare was relatively high across practices, as was organisational commitment and leadership – perhaps helped by the fact that diabetes is considered a priority in the local area. Most implementation staff reported little change to their roles and responsibilities, and that prescribing Liva during consultations required little extra time. However, implementation staff reported a number of challenges. One staff member reported that it could be difficult to prescribe the programme within the scheduled appointment time.

> *[Y]ou have an issue of if you do see a patient and you’ve only got a 15-minute appointment and you want to introduce it, often you will end up giving them a leaflet and then they need to come back. If you do that you know that they might end up not coming back, so you end up saying, ‘let’s go through this’, prescribing it there and then and running late and so that has an impact on other patients as well.* (Implementation team)

Several implementation staff members reported that finding the time to call patients outside of consultations for retrospective enrolment often was not possible and required more time than expected: “Calling the patients sometimes was a lot more time-consuming than I had expected and recruiting the patients actually took longer than what I was anticipating” (Implementation

team). Staff also reported that the additional administrative work related to the test bed was challenging.

Despite implementation staff not reporting the development of new skills, for most staff, this was their first experience of digital prescribing and therefore staff reported a greater awareness of digital innovations and knowledge of how they work: "… a greater understanding about what's available and probably the functionality, how they work and actually downloading and having and actually understanding the app" (implementation team).

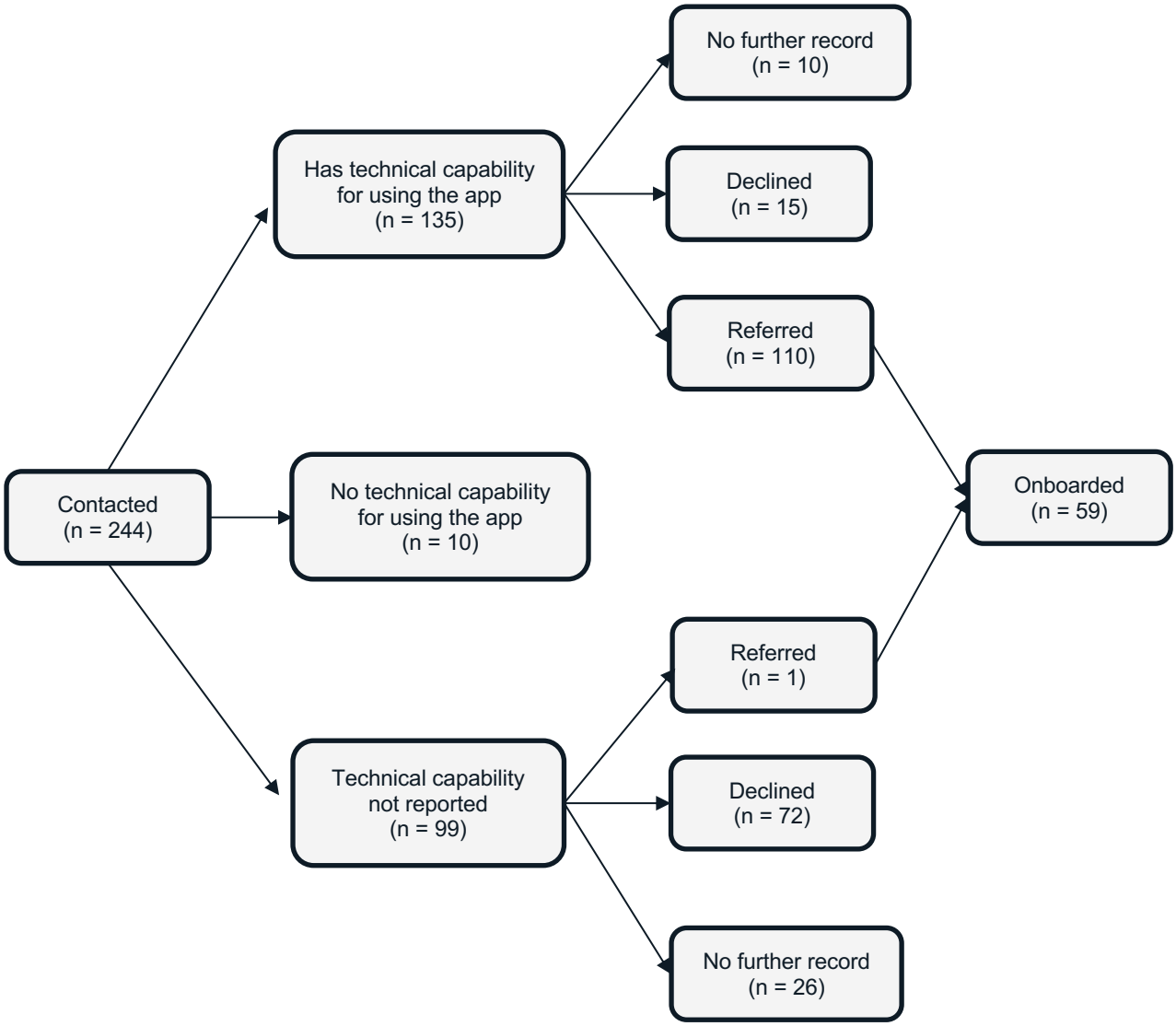
Implementation staff also reported an increased openness towards digital prescribing, that it had helped them to recognise the value and potential benefits of digital apps: "I actually now tend to use social prescribing quite a lot and prescribe patients using apps, so it's really encouraged me to look at other ways of how patient information can be given to patients" (implementation team).

Patient outcomes: uptake, engagement and satisfaction

Patient uptake

Of the 244 individuals who were contacted, 111 (45%) were recorded as having been referred for Liva and 59 (24%) eventually enrolled (see Figure 15). Of those who were not referred, ten were deemed unsuitable because they did not have a smartphone or have the ability to download apps onto their device. Other reasons for declining included: patients being happy with how their diabetes was being managed; language barriers; and a lack of time or commitment. Several patients who were referred were not onboarded because they lacked appropriate consent or the necessary baseline measurements. An attempt was made to onboard 60 patients, but one was not able to download the app.

Figure 15: Liva: pathway from eligibility to onboarding



Between individuals who were referred or not referred, there was no notable difference in terms of the duration of their diabetes (p-value) (see Table 22).

Table 22: Duration of diabetes prior to contact among patients contacted about using Liva

Duration of diabetes	Patient group				
	Patients referred for Liva		Patients not referred**		Total
0–3 months	24	*22.0%*	25	*18.8%*	**49**
3–12 months	34	*31.2%*	52	*39.1%*	**86**
> 12 months*	51	*42.8%*	56	*42.1%*	**107**
Total	**109**		**133**		**242*** **

** Includes eight patients with diabetes for more than the maximum of seven years, but who were within seven years when the selection criteria were run.*

*** This includes patients who were considered unsuitable, did not have the technology or who declined to take part for other reasons.*

**** Records of a diabetes diagnosis were missing for two patients.*

Patient demographics

Characteristics of patients who were contacted and by whether or not they took part, are shown in Tables 23 and 24. Hypertension was the most commonly reported comorbidity. There were only nine patients with other comorbidities: coronary heart disease, COPD, stroke and heart failure.

Across all 111 who were referred as a group, whether or not they were onboarded, their mean age (48.4) was significantly younger than the group that were not referred (p=0.03). There was, however, no significant difference in the mix of genders or in the other physical and clinical characteristics.

Table 23: Characteristics of patients by engagement with the Liva prescribing process

	Patients successfully onboarded (n=59)		Patients referred but not onboarded (n=52)		Patients not referred (n=133)	
Age group						
< 40	13	*(22.0%)*	9	*(17.3%)*	19	*(14.3%)*
40–44	9	*(15.3%)*	12	*(23.1%)*	17	*(12.8%)*
45–49	10	*(16.9%)*	9	*(17.3%)*	23	*(17.3%)*
50–54	9	*(15.3%)*	4	*(7.7%)*	20	*(15.0%)*
55–59	12	*(20.3%)*	9	*(17.3%)*	23	*(17.3%)*
> 60	6	*(10.2%)*	9	*(17.3%)*	31	*(23.3%)*
Mean age (Standard error)	48.4	(1.3)	48.6	(1.4)	51.6	(1.0)
Female	28	*(47.5%)*	26	*(50.0%)*	64	*(48.1%)*
Male	31	*(52.5%)*	26	*(50.0%)*	69	*(51.9%)*

Table 24: Engagement with the Liva prescribing process by clinical or physical status

	Patients referred			Patients not referred		
	Mean value	Standard error	Sample size	Mean value	Standard error	Sample size
HbA1c	56.7 mmol/mol	1.7	109	56.1 mmol/mol	1.4	130
Body mass index	33.8 kg/m^2	0.7	111	33.3 kg/m^2	0.7	130
Waist circumference	104.0 cm	1.3	106	110.8 cm	4.3	28
	n	%		n	%	
BMI category						
Normal	21	*18.9%*		30	*22.6%*	
Overweight	27	*24.3%*		31	*23.3%*	
Obese	63	*56.8%*		72	*54.1%*	
Previous hypertension						
Yes	17	*15.3%*		20	*15.0%*	
No	94	*84.7%*		113	*85.0%*	

Implementation staff identified several barriers to patient uptake (see Table 25):

Table 25: Barriers to patient uptake identified by implementation staff

Patient barrier	Description
Digital exclusion, relating to smartphone use or internet access	"There have been a few patients who could have benefited with that additional support that we are unable to refer because they didn't have the right phones or didn't have WiFi." (Implementation team)
Cultural barriers	"I think one of the things was that they weren't too sure of how apt the app would be with their lifestyle. So would they be talking about Asian diets, Asian meals…?" (Implementation lead)

Patient barrier	Description
Language barriers	"… so half of our population, English is not their first language and that would make engagement really difficult with an app." (Implementation lead)
Other barriers	Patients are too busy to use the app, they have a preference for face-to-face care and experience technological issues.

In spite of these comments relating to language/cultural barriers, individuals from Black or Asian ethnic groups had higher rates of referral than those who were White (see Table 26). When taking account of age, these differences were less marked among those aged under 50 yet important differences seemed to still exist among those aged over 50 (see Table 27). There was no notable change in the proportions of each ethnicity among those who were onboarded, with 18/60 (30%) Black, 25/60 (42%) Asian and 9/60 (15%) White.

Table 26: Uptake by ethnicity

Ethnic group	Patient group (numbers and % by ethnic group)				
	Patients referred for Liva		Patients not referred		Total
Black	29	*58.0%*	21	*42.0%*	**50**
Asian	42	*51.9%*	39	*48.1%*	**81**
White	21	*30.0%*	49	*70.0%*	**70**
Mixed/other	*	*	*	*	**9**
Not stated	*	*	*	*	**34**
Total	**111**		**133**		**244**

* Numbers have been suppressed because the values in the mixed/other group are too small.

Table 27: Numbers and proportions within each ethnic group

Ethnic group	Age < 50				Age 50+			
	Patients referred		Patients not referred		Patients referred		Patients not referred	
Black	13	*54.2%*	11	*45.3%*	19	*63.3%*	11	*36.7%*
Asian	33	*57.9%*	24	*42.1%*	9	*36.0%*	16	*64.0%*
White	11	*44.0%*	14	*56.0%*	11	*22.9%*	37	*77.1%*
Mixed/Other	*	*	*	*	*	*	*	*
Not stated	*	*	*	*	*	*	*	*
Total	**62**		**59**		**49**		**74**	

* Numbers have been suppressed because the values in the mixed/other group are too small.

Engagement

Of the 59 patients who were successfully onboarded, 28 (47%) were no longer active before the end of the nine-month programme (see Figure 16). There was no significant difference in the mean age of those who completed and those who did not (see Table 28). Although a greater proportion of women did not complete than men, the differences between the genders were also not significant.

Figure 16: Overview of patient engagement with the Liva health coaching programme

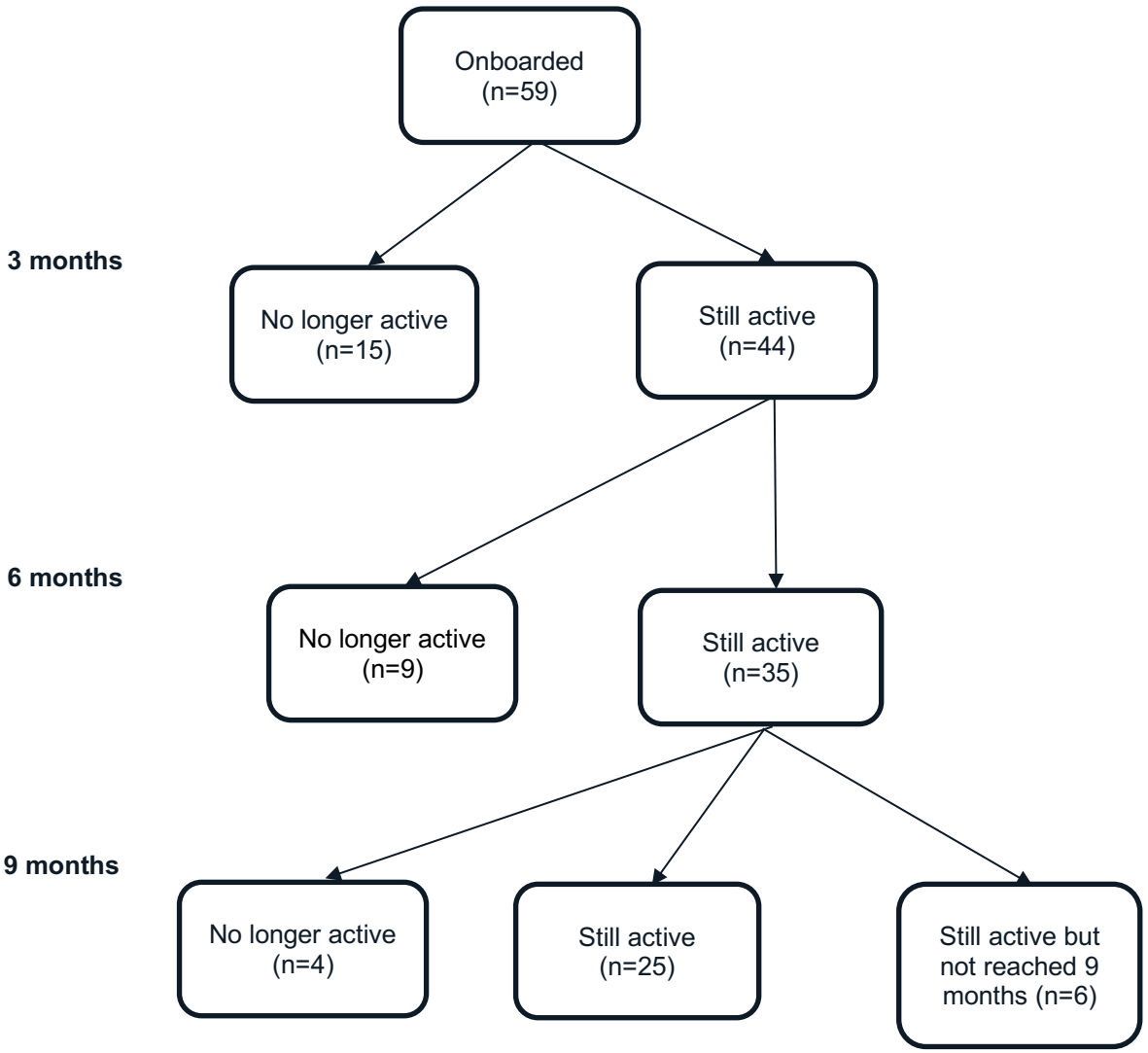


*Table 28: Completion of the Liva programme by age and gender**

	Did not complete		Completed	
Mean age (std error)	48.3	(2.0)	48.9	(1.9)
Female	12	*60%*	8	*40%*
Male	16	*53%*	14	*47%*

**Records of gender were missing for nine patients.*

Implementation staff reported that, on the whole, most patients were engaged with the Liva Healthcare programme: “Extremely engaged and we’ve had a few [patients] probably who haven’t been able to proceed, have fallen, who’ve stopped. But on the whole, all the patients that I’ve met, who started on Liva have found it really, really beneficial” (implementation team).

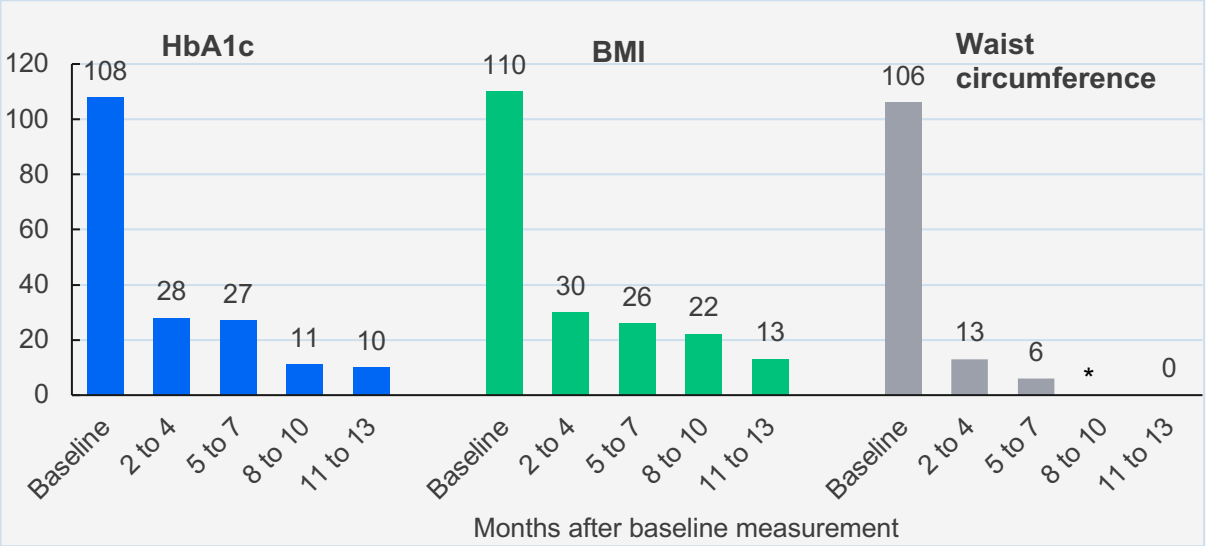
Of the patients who provided feedback, most were using the programme at least one to two times a week. For those patients using the app less often, the main reasons related to other priorities, time and forgetting. For those patients using the app, they reported valuing all aspects; however, most often patients focused on the role of the health coach in providing support. Patients valued the health coach for:

- being accessible and responsive when they needed support
- increasing their knowledge around diet and exercise, such as sending information relating to diet and recipes
- encouraging them to exercise (e.g. motivating them to take up a sport or engage with certain forms of exercise)
- motivating them – checking in on them regularly, such as sending notifications/reminders and monitoring progress.

Clinical outcomes

Patients were excluded from our analysis of outcomes if they had no baseline measurements within 30 days of referral. So, in the referred group, there were 108 patients with baseline HbA1c measurements, 110 with baseline BMI and 106 with baseline waist circumference (Figure 17). By the middle of August 2020, 28 (26%) of these had had a follow-up check for HbA1c between two and four months after referral, 30 (27%) had had a follow-up check for BMI and 13 (12%) had had a waist measurement check. By between five and seven months these numbers fell to 27, 26 and 6 respectively. These are not the same patients, however, since most who had a two- to four-month check did not then have one between five and seven months. In fact, just over half (57) of patients had at least one HbA1c reading after two months, and 67 had at least one BMI reading, whereas only 19 had a waist measurement.

Figure 17: Numbers of patients referred for Liva with measurements recorded by month of follow up (data as at 31 October 2020)



*Low number suppressed

For individuals referred for Liva, Figures 18 and 19 illustrate how HbA1c levels and BMI changed during follow-up and compares the data against predicted changes based on the much larger group of control patients. None of the changes were significantly different to what was predicted thus indicating no observable impact, although because the patient numbers are small any meaningful differences may be undetected.

Figure 18: Changes in HbA1c levels among cases compared with predicted outcomes from the control group (negative values indicate reductions)

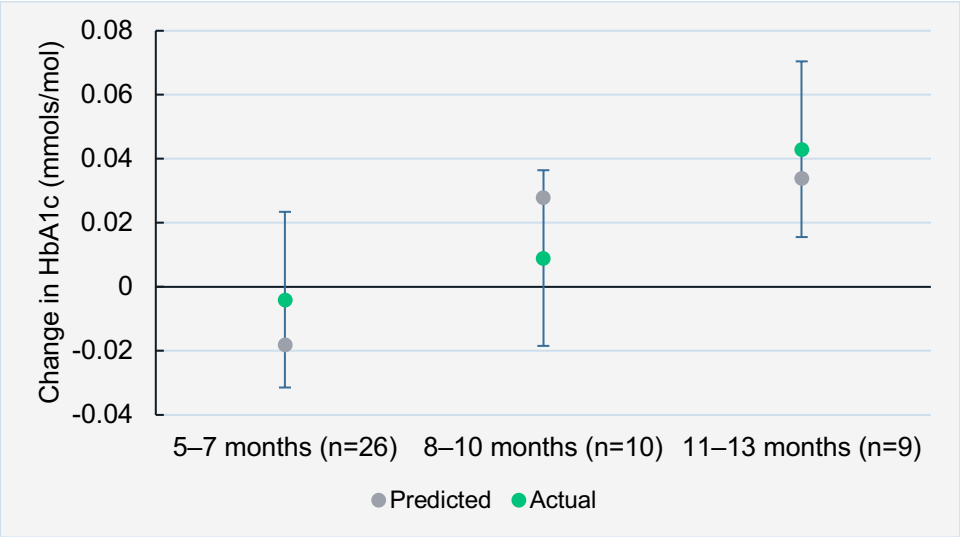
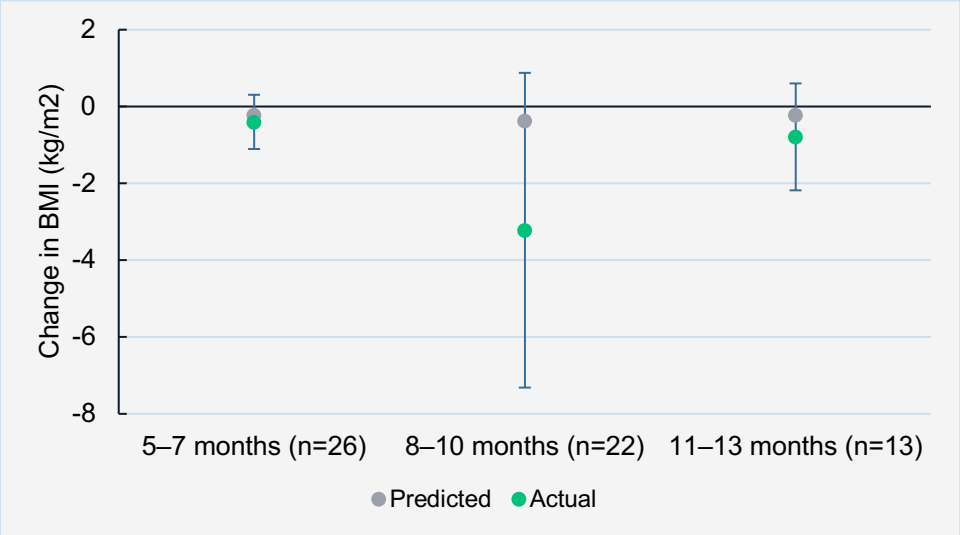


Figure 19: Changes in BMI among cases compared with predicted outcomes from the control group (negative values indicate reductions)



Most patients interviewed reported improved clinical outcomes, particularly HbA1c level and weight loss, and were satisfied with their level of diabetes control. One patient reported that they were now controlling their diabetes without medication, while another reported that they had reduced their diabetes medication. Implementation staff also reported the clinical benefits of the Liva programme: "[I]t's been extremely beneficial for the patients. When the data comes out it'll see in terms of weight loss and HbA1c, what the improvement is and how many people we've managed to keep off medication" (implementation team). One implementation staff member also reported that it had improved patient knowledge relating to the self-management of their diabetes: "I think for patients it's actually improved knowledge and information and how to manage, look after themselves and how to make changes and maintain the changes with support" (implementation team).

Satisfaction

One implementation team member reported that patient feedback relating to Liva Healthcare had been "really positive". All patients interviewed were satisfied with the programme, and reported that they would continue using the app and would recommend it to friends and family if they needed similar care. All patients were happy with the information and support provided by the health coach and by their GP practice (including when they were initially introduced to the programme). Of those patients providing feedback, many reported that they were supported to use Liva by non-health care professionals (such as friends or family).

Key implementation findings

The evaluation highlighted several lessons for implementation.

Consider the impact of local priorities on the implementation. Diabetes is considered a priority within the local area, as shown by the local incentive scheme associated with meeting diabetes care targets. As a result, implementation staff across practices were generally engaged with the implementation. One implementation staff member reflected the importance of the innovation being considered a priority and properly integrated into services in order for the implementation to be successful: "So I think for it to work it has to be a priority, it can't just be seen as an addition, it needs to be seen as part of [the] diabetes service…" (implementation team).

There is no 'one size fits all' approach to implementation. There was considerable variation in workforce structures and organisational set-up across practices. The presence of specialised staff stationed within the practices (e.g. a diabetes nurse) was particularly beneficial to help facilitate the implementation, to prioritise the innovation and to provide leadership. However, one implementation lead suggested that the Liva Healthcare programme would prove more impactful in practices struggling to care for their diabetic population, rather than those that already had good diabetes outcomes. Care City staff and implementation teams reported the importance of leadership and engagement from organisational leads or a digital champion to drive the implementation, monitor progress and solve problems.

> *[F]or it to be successful, I really believe that you have to have leadership that believes in it and that is willing to take that forward and then you need champions within your system to be able to take it forward.* (Implementation team)

Consider the impact of the evaluation on the implementation. Some implementation staff reported that the time and commitment required to support the implementation had been much more than expected. In particular, the enrolling of patients onto the programme was noted to be time intensive – the additional administrative tasks were largely a result of the evaluation documentation: "They [the practices] didn't understand how much input was required of them in the beginning until they started doing it, it was actually quite admin intensive from their perspective…" (Care City team).

Understand the factors that influence patient uptake and engagement. The recruitment of patients to the programme was reported as a particularly challenging aspect of the implementation. Practice staff acknowledged diabetes to be a particular challenge due to patients' lifestyles being difficult to change and requiring patients to take responsibility for

managing their own health. Implementation staff reported that making referrals to the programme face to face rather than on the phone was key for uptake.

> *We invited patients from the patient group and the uptake was very, very poor and we actually even sent text messages, patients were actually called and uptake was still poor. But when we saw patients face to face in clinic and offered them Liva, uptake was better.* (Implementation team)

Several patients acknowledged the support of non-health care professionals (e.g. family members and/or friends) in downloading, accessing and using the innovation, particularly those who were less confident using digital technology (such as smartphones and apps). This suggests that the involvement of friends and family is an important factor in the uptake of innovations.

Early on in the implementation, there were some issues relating to how the innovation was communicated to patients. These related to clarity in how the Liva programme had been explained to patients: that GP practices should reiterate that the appointments with the health coach would be via video call, as some patients had thought they would be conducted in person; GP practices should reiterate the requirement to download and sign up on the Liva app – some patients had missed the sign-up code on the information leaflet; and GP practices needed to inform patients that the Liva helpline number was on the patient leaflet, to make them aware of the support available. A script was developed to support practice staff when telephoning patients to see if they would be interested in using Liva. Some patients were not clear on whether the programme supplemented or was a replacement for the support that they were getting from the GP practice – so it was important when introducing Liva that practice staff explained to patients that they would still receive their usual care in addition to the innovation.

Despite patients reporting the value of the Liva programme, sustaining patient engagement proved challenging. Completion of the three- and nine-month health checks was relatively low – perhaps in part due to the responsibility for booking health checks being placed on patients (despite reminders being provided by the health coach) and there were some issues early on with implementation staff not being alerted by the GP patient records to the due date of the checks. However, the Covid-19 pandemic and the associated disruption of primary care services had the most notable impact on the health checks – leading to the checks at all practices being halted. It is difficult to determine what the level of patient engagement with the health checks would have been had the pandemic not have occurred, but it is likely that it would have been notably higher.

Training for implementation staff should include the functionality of the technology and its capabilities. Early on, implementation staff identified additional training needs related to

understanding how the technology functions. Some implementers reported that they felt they needed to have a better understanding of how to navigate the app in order to better explain it to patients and answer any queries. As a result, the innovator gave professionals access to a dummy account and further information about the intervention, such as what the educational components of the intervention cover. One Care City team member reflected that training should also include processes and IT systems relating to digital prescribing: “I think they’d need to cover the computer, how you can prescribe it at the beginning” (Care City team).

Understand the aspects of the programme that patients value. Patient feedback relating to the Liva Healthcare app was positive. Patients particularly focused on their accountability to the health coach and their support in providing motivation, encouragement, knowledge and education, being responsive to questions, and providing regular check-ups and reminders. Implementation staff valued the role of the health coach in providing support to patients between appointments – that the health coach acted as an additional member of the health care team. However, one implementation staff member did query whether the accessibility of the health coach, and level of support provided to patients within the test bed, would be able to be achieved if the innovation was rolled out more widely: “On a larger scale it would be interesting to see would the health coach be as accessible? And what the capacity is?” (implementation team).

Costs of scaling up digital prescribing innovations

In this section we estimate the costs of scaling up the digital prescribing innovations, using findings from the test bed and previous studies. We also discuss factors that will influence costs to scale up, and published evidence on cost-effectiveness.

Sleepio

The estimated costs of rolling out Sleepio are shown in Table 29.

Table 29: Costs associated with rolling out Sleepio

	Estimate	Notes
Eligible patients	People with insomnia	In the test bed, patients were identified through GP consultations and also patients were contacted proactively if they had a history of sleep disorder.
Unit cost of innovation	£84	Unit costs include implementation costs and the cost of the Sleepio licence (from the test bed).
Estimate of eligible patients per 1,000 population	78 per 1,000 population	Estimated from the prevalence of insomnia and the proportion of the population who are adults.
Estimate of cost to implement across a population of size:		Estimates assume uptake is 10% among patients with insomnia. This is based on previous studies of Sleepio.
1,000	£655	
50,000	£32,753	
300,000	£196,457	

In the test bed, patients were proactively contacted, which increased implementation costs. If Sleepio was offered as part of a consultation where the patient discussed insomnia then these costs would be reduced. Uptake could also be higher. The level of digital engagement and access to a smart phone and data are also likely to influence uptake. The staff groups involved in implementing Sleepio varied across practices, and the approach used will impact on implementation costs. Due to the variation across sites and role of Care City in supporting the implementation, it is not possible to make any comparisons between the implementation models across practices.

As well as providing benefits to patients from improved sleep and wellbeing, use of Sleepio may impact on GP contacts and medication costs in primary care. For the test bed, the planned case control analysis will provide evidence about the impact on differences with usual primary care.

A number of recent studies[49,50,51] provide evidence of the effectiveness of Sleepio. One study[52] has shown reductions in primary care use at a population level following roll-out of Sleepio, although this study did not quantify the costs of implementation or licence costs.

Healthy.io ACR test

The main factors likely to impact on the cost of scaling up the Healthy.io ACR test are the uptake rate, the prevalence of diabetes and the proportion of abnormal results. Higher rates would result in higher costs as abnormal test results are followed up by the practice and a repeat test is required prior to treatment decisions. However, this is an element of standard care that patients who responded to routine requests for an ACR test with abnormal results would be offered ordinarily. In the test bed, 25% of tests were either abnormal or highly abnormal.

The costs of rolling out the ACR test are shown in Table 30.

Table 30: Costs associated with rolling out Healthy.io ACR testing

	Estimate	Notes
Eligible patients	Diabetic patients who have not had an ACR test in the last 12 months	Patients are identified from a search of the GP electronic record.
Unit cost of innovation	£17 per patient tested	Healthy.io undertook the majority of the work including recruiting patients. The unit cost per patient tested allows for the proportion of patients who consented to but did not complete a test, and also includes implementation time within practices, including following up on test results.
Estimate of eligible patients per 1,000 population	11.5 per 1,000 population	Estimated from the prevalence of diabetes, the proportion of the population who are adults and the proportion of diabetic patients with ACR tests in the last 12 months.
Estimate of cost to implement across a population of size:		Estimates assume that uptake is 46%, based on the test bed.
1,000	£89	
50,000	£4,450	
300,000	£26,701	

However, this analysis does not take account of impact on the use of other services or longer-term health benefits from earlier diagnosis of chronic kidney disease. The main changes in a patient's pathway compared with usual care relate to earlier identification of chronic kidney disease enabled by home testing, which allows earlier treatment and reduction in long-term consequences.

A model-based economic evaluation[53] of the Healthy.io ACR test within a primary care setting has been undertaken, which considered future need for care for chronic kidney disease and how this was impacted by earlier diagnosis. This model found that the innovation resulted in cost savings over the patient's lifetime of £2,008 per patient, and cost savings were also reported for one-, five- and 10-year time horizons. The pathway implemented in this study was similar but not identical to the test bed. The costs reported for the test bed relate to implementing the Health.io test only, and not the wider costs of care.

Liva Healthcare

Costs for scaling up Liva Healthcare will be impacted by a number of factors. In the test bed, patients were proactively contacted and asked to take part, which added to the implementation costs. If Liva was embedded as part of usual care, this element would be reduced. However, the uptake rate may also increase if referral to Liva was part of the initial consultation when a patient is diagnosed with diabetes, which would increase costs. The level of digital engagement and access to technology are also likely to influence uptake. As mentioned earlier, there was considerable variation in workforce structures and set-up across practices – therefore the staff groups supporting Liva varied across the sites and included diabetes nurses, healthcare assistants and GPs, as well as Care City staff, which will also have affected costs. An implementation model including the presence of specialised staff (e.g. a diabetes nurse) was particularly beneficial to help facilitate the implementation. Finally, the national prevalence of diabetes has been used in these estimates, and areas with higher population prevalence would have higher rates and therefore more patients enrolled, increasing costs.

The costs of rolling out Liva are shown in Table 31.

Table 31: Costs associated with rolling out Liva

	Estimate	Notes
Eligible patients	Newly diagnosed diabetics	In the test bed, patients were identified through GP consultations and also patients were contacted proactively if they had been diagnosed in the last seven years.
Unit cost of Liva per patient onboarded	£268	Unit costs include implementation costs and the cost of Liva and coaching (from the test bed).
Estimate of eligible patients per 1,000 population	5.3 per 1,000 population	Estimated from the prevalence of diabetes, the proportion of the population who are adults and the proportion of diabetic patients who were diagnosed in the last year.
Estimate of cost to implement across a population of size:		Uptake in the test bed was estimated to be 27% of patients contacted. These cost estimates assume that uptake is 27% among newly diagnosed diabetics.
1,000	£377	
50,000	£18,848	
300,000	£113,088	

The costs above do not take account of changes to the patient's use of other services in either the short term or the long term. In the short term, engagement with Liva could impact on numbers of contacts with the patient's GP, practice or diabetes nurse, and use of medication. In the longer term, the costs of complications of diabetes and increased risk from other illnesses would reduce if progression of the patient's diabetes was slowed or reversed through Liva.[54] For the test bed, the planned case control analysis will provide evidence about the impact on differences with usual primary care in the short term.

There is evidence that lifestyle interventions delivered face to face are cost-effective,[55] and also that lifestyle interventions in the pre-diabetic population are likely to be cost-effective.[56] People with type 2 diabetes are more likely to have comorbidities including cardiovascular disease and depression, impacting on quality of life.[57] A previous study has found evidence of weight loss using a web-based tool; however, evidence of cost-effectiveness has not been reported.[58]

8 Cardiac rehabilitation cluster – implementation and outcomes

Aims of the cluster

The aim of the cardiac rehabilitation cluster was to improve the uptake of cardiac rehabilitation. Originally, the focus was also on upskilling patient administrators to use two innovations: DrDoctor and TickerFit. Only TickerFit proceeded to testing.

This chapter includes findings from both the formative (process) evaluation and the summative (outcomes) evaluation. In the evaluation we aimed to speak with representatives of the implementation team as well as the end users of TickerFit. However, numbers of patients onboarded and challenges caused by the Covid-19 pandemic, we were only able to do two interviews with patients who had used TickerFit during the evaluation period. The information obtained from those interviews was triangulated with other data and incorporated into the themes.

Background on cardiac rehabilitation

Cardiac rehabilitation is an evidence-based intervention for people with cardiovascular disease, including heart failure, and is recommended by NICE.[59] The British Association for Cardiovascular Prevention and Rehabilitation (BACPR) has developed six core standards for the delivery of cardiovascular prevention and rehabilitation, including a multidisciplinary team, assessments of patients' individual needs at the beginning and end of a course and a structured programme which aligns with the patient's preferences and choices.[60]

Cardiac rehab involves a combination of exercise sessions as well as education on topics such as diet and emotional wellbeing and information about different heart conditions. Cardiac rehab should be offered as a 'full menu', offering choice and resources to support patient preference.[60]

However, uptake of cardiac rehab is low, with only 50% of patients on average taking up the offer.[61] There are ambitions for this to increase to 85% by 2028, through 'scaling up and improving marketing of cardiac rehab'.[62] Reasons for not starting rehab are varied – around one

half of patients are not interested, refuse or just do not turn up. Other reasons include patients being too ill, physically incapable or rehab being deemed inappropriate. Once started, many will not complete, and, of these, 31% just fail to turn up without a reason being given. Where reasons are specified, it is mainly because patients are too ill to complete or they have returned to work. Uptake by patients with heart failure is especially low despite being recognised by BACPR as a priority patient group – the National Audit of Cardiac Rehabilitation (NACR) therefore recommends greater 'innovation in recruiting and managing patients' with heart failure in cardiac rehab.[61] During the selection process for the test bed innovations, stakeholders on the panel recognised that heart failure was a particular challenge in East London.

NACR suggests that low uptake of cardiac rehab for people with heart failure may be attributed to the lack of wide-scale adoption of alternatives to group-based therapies, which still make up around 75% of the delivery of cardiac rehab.[61] Consequently, one of the recommendations is that home-based modes of cardiac rehab delivery should be offered to all patients including those with heart failure, and there is optimism that uptake will improve when more home-based options such as the Rehabilitation Enablement in Chronic Heart Failure (REACH-HF) programme are rolled out.[61]

Provision of cardiac rehab services is, however, variable across the country. The use of web- and home-based cardiac rehab is being explored in multiple areas and interviewees recognised that even just in London there were a multitude of different options available, with some being developed by existing services, and others by private companies. The impact of the Covid-19 pandemic has accelerated this; since the start of the pandemic in March 2020 there has been a notable increase in web- and other home-based programmes (see Table 32).

Table 32: Numbers and proportions of people undertaking different modes of cardiac rehabilitation

	2019		2020 (Jan to Aug)	
Group based	31,791	*63.0%**	4,806	*26.3%*
Home based	9,371	*18.6%*	7,940	*43.5%*
Web or app based	482	*1.0%*	1,402	*7.7%*
Other	9,480	*18.8%*	4,842	*26.5%*

** Column percentages do not add up to 100% because some people chose more than one mode of delivery.*

With a median age of between 50 and 59, those eligible for cardiac rehab in the borough local to the implementing hospital are notably younger than the eligible population across England as a

whole, where the median age is between 60 and 69. Also, around 40% of this group are of Bangladeshi origin: an ethnic group that makes up fewer than 1% of those eligible for rehab nationally.

Description of the pre-implementation period

Perceptions of the technology's benefits and limitations

The key advantage of TickerFit as described by partners during pre-implementation interviews was its ability to increase access to cardiac rehab services and support for people who may not otherwise engage. Throughout the project, numerous other benefits were cited by interviewees:

- increasing the capability of the cardiac rehab service to provide more personalised care through the healthcare professional dashboard and weekly motivational calls
- encouraging patients to engage in exercise outside of their gym sessions
- providing flexibility for patients to engage at a time and location that works for them or with family and friends (including beyond the initial eight-week programme)
- addressing some of the resource constraints faced by the service (i.e. limited capacity and space for delivering classes)
- providing an option to continue to access cardiac rehab where unable to attend face-to-face classes (e.g. during the pandemic) or as a supplement (e.g. when returning to work)
- contributing to wider recovery from the cardiac event through exercise improvement and promoting accountability (by being able to see progress).

However, there was some scepticism before implementation from the implementation team about whether an app would actually address the root causes of low uptake for cardiac rehab, which the implementation team felt was often down to individual patient motivation and confidence. The team also recognised that some patients feel vulnerable exercising alone and benefit from the support of having a healthcare professional there at face-to-face classes. People also discussed the advantages of face-to-face group classes as providing an opportunity for social interaction, which was particularly beneficial for people who may feel isolated at home.

> *The type of person who is either going to drop out or not come at all, motivation is a big issue for them rather than logistics often… In other words, the same type of person who will decline rehab face-to-face would probably have the same outcome with the smartphone app.* (Implementation team)

Patient pathway

From November 2019, the target population for TickerFit was anyone eligible for cardiac rehab, who had access to a smartphone.

The project began with the intention to have a more targeted patient cohort – this was patients with heart failure, who were also unwilling or unable to attend face-to-face classes. Concerns about how appropriate this was were raised during pre-implementation interviews, with partners being unsure of how far heart failure patients would engage with TickerFit.

> *Using cardiac rehab apps is really, really useful for patients who have had heart attacks and bypass surgery and have got modifiable risk factors… For a heart failure group though… often those patients actually feel incredibly vulnerable and actually really benefit from a lot of face-to-face contact and socialisation, getting out of the house and doing stuff...*
> (Implementation team)

Consequently, the team decided to extend the offer of TickerFit to anyone eligible for cardiac rehab (not just those who refuse face-to-face classes), as well as patients with conditions other than heart failure.

The usual face-to-face cardiac rehab programme usually lasts eight weeks. The cardiac rehab team receive referrals from outpatient and inpatient settings within the trust. Upon receiving a referral, patients are sent a letter and contacted by one of the team members by telephone to discuss cardiac rehab. If the patient chooses to take it up, they must attend a face-to-face assessment with a member of the team, as well as a face-to-face assessment at the end of the programme (in line with BACPR standards). This allows the team to take baseline and follow-up measurements, including weight, waist circumference, blood pressure and exercise capacity. There are specific classes for the Bengali population, supported by two advocates within the cardiac rehab team.

Where appropriate, TickerFit was discussed in the initial calls. Following an initial consultation and assessments, patients were prescribed the TickerFit exercise programme at the level appropriate to their needs. This was then altered depending on the patient's progress.

Patients also received weekly check-in calls from the cardiac rehab team for the eight-week duration. The team were able to monitor patients' progress using the healthcare professional dashboard. Although the programme ended after eight weeks, patients were able to continue using the app beyond this, and were able to contact the cardiac rehab team at any point if they needed to. This was considered particularly important by both staff and patients when people were not able to see the team face to face.

Impact of the Covid-19 pandemic

Multiple members of the TickerFit implementation team (including the lead implementer and clinical lead) were redeployed to provide direct clinical care during the Covid-19 pandemic. The remaining team members worked remotely. TickerFit was offered to patients alongside another remote programme, Activate Your Heart.[1] Patients were also offered exercise DVDs, alongside telephone support. Referrals to the cardiac rehab service reduced significantly during the period of the pandemic. (This can be seen in Figure 20). There was also a reduction in A&E attendances for cardiovascular diseases, as well as outpatient appointments which would usually lead to a cardiac rehab referral.

There were also changes to the TickerFit onboarding process as a result. Prior to the pandemic, patients' initial assessment would be done face to face and if they agreed to use TickerFit, the team member would talk them through it in the appointment, showing them the content and supporting them to download it if needed. As a result of the pandemic, patients were onboarded over the telephone and required to download the app themselves.

Staff training

Training to use the TickerFit app is usually delivered in three separate two-hour sessions, covering each aspect of the programme respectively (the patient-facing platform, the healthcare professional platform and the process of onboarding), using a video developed especially for training purposes. Healthcare professionals are also given an opportunity to test the app out using dummy accounts. Two innovator-led training sessions lasting approximately 1.5 hours each were held at the trust site.

The team were positive about the potential of the app to facilitate a personalised approach, support patient self-management and reach patients who may not engage for work reasons. The main concerns were that patients might not have smartphones and that they might pretend to view the content (or that another person may view it).

These sessions were a more condensed version of training than is normally used, recognising the very limited amount of time the site had to release staff, and facilities to host the training. On reflection the innovator noted the limitations of this approach as there was less time for them to provide "hands-on training". Pre-implementation, the app was considered straightforward and

[1] Activate your Heart is a web-based programme developed by the cardiac rehab team at the University Hospitals of Leicester NHS Trust, and has been offered to all cardiac rehab teams for free during the pandemic.

“intuitive” (implementation team). For the innovator, the app was also considered easy to use, “quite literal” and “quite self-explanatory” for patients. However, they also recognised the importance of healthcare professionals being able to demonstrate and explain how the app works to patients. The implementation team also noted that they needed to have a sufficient understanding of the app in order to help others use it, and felt that being able to play around with it themselves was a key way of learning this.

Due to the time lag between the initial sessions and the start of implementation, a refresher training session was delivered by Care City in July 2019. The implementation lead also played an active role in supporting other members of the team to use TickerFit, particularly when staff began working remotely as a result of the Covid-19 pandemic. The team all felt the training was sufficient for their respective roles and valued the opportunity to play around with the app using dummy accounts.

Changes during the implementation process

During set-up, the cardiac rehab team identified that TickerFit did not contain any warm-up or cool-down video content for patients, nor a variety of content for patients requiring mid- or high-intensity exercise. The implementation team considered both of these essential for ensuring that patients were both safe and exercising effectively. To address these issues, TickerFit organised a videographer to film the exercise physiologist (who usually hosts the exercise sessions at the trust site) doing warm-up and cool-down exercises, as well as exercises for patients requiring different levels of intensity. This content was finalised before the project went live. The fact that the new exercise content was delivered by a member of the cardiac rehab team was seen as beneficial by the implementation team because patients were already familiar with that person.

After implementation began in September 2019, further changes and amendments were made to the innovation and the pathway in response to feedback from the implementation team informally and during co-design sessions. These are summarised in Table 33.

Table 33: Actions responding to feedback

Timepoint	Action
25 September 2019	Information governance sign-off from trust site; cardiac rehab team began offering TickerFit to patients who declined face-to-face rehab
w/c 11 November 2019	TickerFit offered to patients with conditions other than heart failure TickerFit offered to all patients (not just those who decline face-to-face rehab). TickerFit included in letter sent to all patients
20 March 2020	Last Phase 3 face-to-face session delivered
14 May 2020	Sylheti voiceovers added to the TickerFit app British Heart Foundation link added to the TickerFit app
June 2020	Decision to extend programme until September 2020 to provide support during the coronavirus pandemic and understand impact of changes to the app
w/c 6 July 2020	Patient FAQs added to the app

Care City's role in implementation

Care City primarily fulfilled a project management function. This included managing the relationships between the different stakeholders, organising and co-ordinating the co-design and training sessions as well as internal processes such as information governance sign-off and facilitating the changes to the implementation pathway.

Partners were positive about Care City's role in supporting the project, and they valued the ability of Care City to bring the different stakeholders together through regular communication and engagement, as well as the practical support it provided to the team to make changes to the pathway. Having this project management function was viewed as essential for ensuring that there was an infrastructure for the implementation to get going (and to ensure ongoing feedback was incorporated). "It does need someone to act as a project manager to get it up and running to get all the stakeholders involved, identify how it's all going to be run… it definitely needs some additional support" (implementation team).

Co-design of the patient pathway

Co-design played a significant role in identifying changes and improvements to the pathway (some of these are outlined in Table 33). Prior to implementation, Care City attended two cardiac rehab sessions to speak to patients about their views on using an app to access cardiac

rehab. Two further co-design workshops were held in early 2020 to discuss the process of implementation and how things could be improved, and a final session was held in September to reflect on the project. Feedback from patients included the desire to have a greater variety of exercise content, and the ability to show TickerFit on a bigger screen (for example, by linking it to a television).

Co-design sessions were highly valued by all partners. The sessions provided an opportunity for the stakeholders to meet, build relationships and generate enthusiasm for the project: “The co-design sessions were really, really important because when you feel you’re contributing to an intervention it helps you get behind it. If you can see change being considered it’s really important” (implementation team).

Co-design was also valuable for the innovator to hear first-hand feedback from patients and healthcare professionals on how to improve their product and support offer (such as providing more resources for healthcare professionals). Although being a small company meant it could be challenging to respond to requests, the receptiveness and responsiveness of TickerFit to act on feedback quickly was highly valued by the implementation team. The innovator did, however, reflect that being able to spend time on the ground with the team (especially early on) could have been helpful for them to better understand the pathway and the staff and patient experience.

Implementation team outcomes

Within the cardiac rehab team, the introduction of TickerFit led to limited changes to existing staff roles and responsibilities. Partners felt that this may be a result of the limited numbers using TickerFit – were more people using it, their role would change as more time would be spent on monitoring the patient dashboard and checking in with patients. Aside from this, the change to the core cardiac rehab service was limited as the team continued to contact patients to discuss their options and answer any questions.

There had also been a plan originally for the members of the heart failure team to be able to offer and onboard patients to TickerFit themselves. There was a recognition that due to the expertise of the cardiac rehab team and the limited capacity of the heart failure team, responsibility for offering and onboarding users to TickerFit was best placed with the cardiac rehab team. However, there was some recognition that the incidence of the TickerFit project meant there was a greater focus on cardiac rehab in general among the heart failure team and in cardiology, which was positive. Going forward, people also recognised the potential for

greater working between the two teams, especially if more people with heart failure were interested in pursuing TickerFit as an option.

Although there were concerns expressed about the app content in the early stages, by the end of the project the team were largely satisfied with the innovation, and particularly positive that they had it as an option to offer to patients throughout the Covid-19 pandemic. The healthcare professional dashboard, alongside weekly motivational calls, were considered valuable for ensuring that the technology was not seen as separate from the wider, personal support provided by the cardiac rehab team. The team were also open to using other digital tools, particularly given the ongoing effects of the pandemic on traditional cardiac rehab services. It was also felt that the pandemic had contributed to a wider cultural change in terms of attitudes towards using digital alternatives in healthcare.

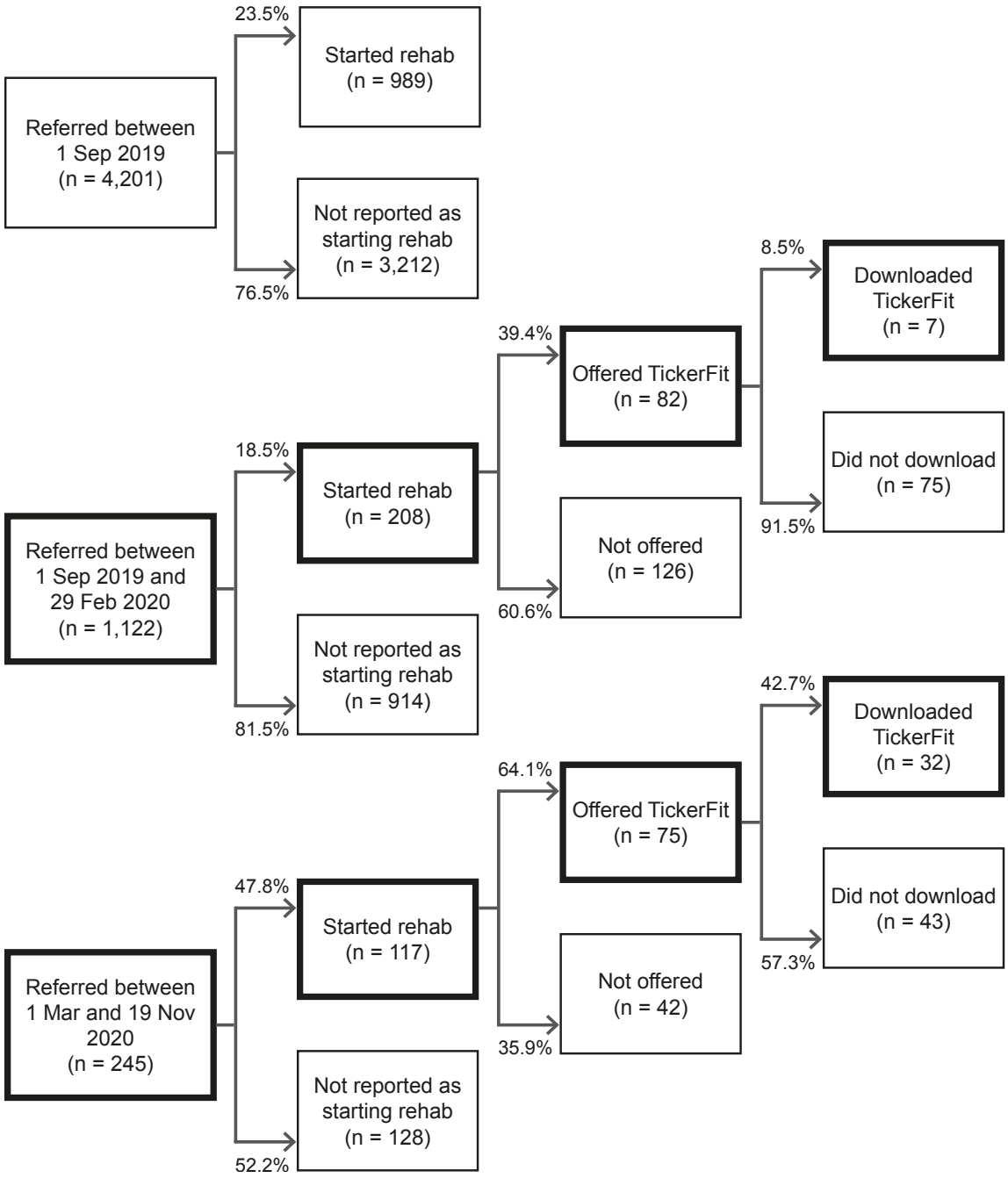
> *We may have to limit numbers due to social distancing… so we won't have a big group and there may be a waiting list but if those who are on the waiting list, that is when we can offer TickerFit.* (Implementation team)

Patient outcomes: uptake, engagement and satisfaction

The different pathways of patients referred for cardiac rehab are shown in Figure 20 and split into three time periods: before TickerFit was offered to patients, while TickerFit was being offered but before coronavirus forced changes to the available modes of delivery, and after the start of the first wave of coronavirus. From March 2020, there was a considerable drop in numbers of patients reported in the data as referred for rehab, although a larger proportion (48%) started a programme, compared with 19% in the six months before March.

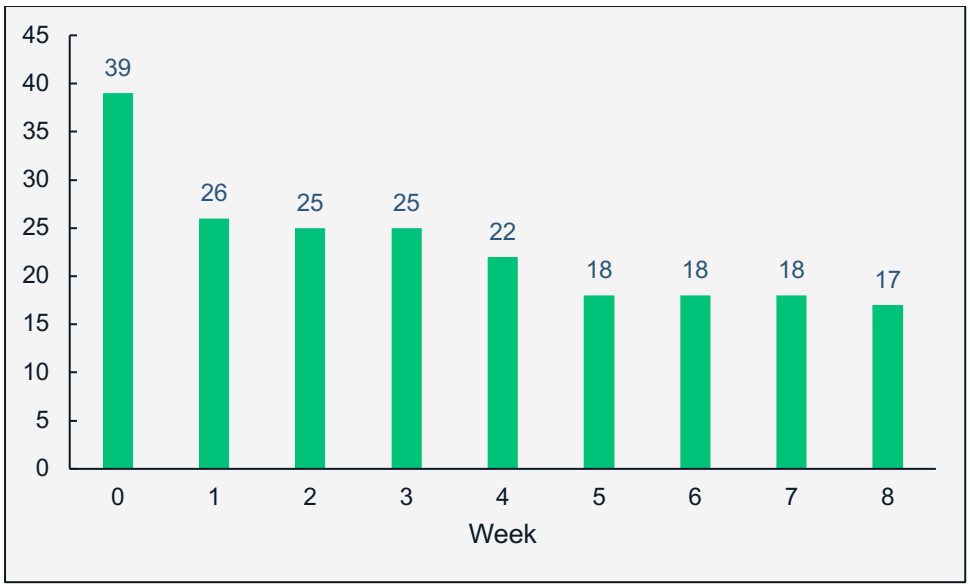
Across the course of the project, 157 patients were offered TickerFit, with 39 (25%) downloading the app. (See the suggested reasons for the low uptake in the Recruitment section below. Rates of downloading increased from approximately 9% to 43% from March 2020, when face-to-face clinics were suspended.

Figure 20: Cardiac rehab pathway including TickerFit



By 30 November 2020, 17 of the 39 patients (44%) downloading TickerFit had completed the course (see Figure 21). Fourteen of those who had not completed started before 1 September 2020 and so may be unlikely to complete.

Figure 21: Patients completing each week of the TickerFit programme



Uptake by patient characteristics

Age and gender

Table 34 shows how uptake of TickerFit varied by age. Uptake was more than three times higher among patients aged below 55 (at 38% compared with 11% for patients aged 55 or over).

Among those offered TickerFit, the mean age who did not use it was 56.7 (standard error, 1.0) compared with a mean age of 45.4 (standard error 1.7) among those who did. These differences in age are significant.

Around 80% of patients who were reported as starting rehab were male, but there was no significant difference in uptake between genders.

Table 34: Variation in uptake by age and gender (patients referred after 1 September 2019)

	Referred	Started rehab	% reported as taking part	Offered TickerFit	% offered	Downloaded TickerFit	Uptake rate
Age							
< 55	385	143	37.1%	82	57.3%	31	37.8%
55+	982	182	18.5%	75	41.2%	8	10.7%
Gender							
Female	391	70	17.9%	30	42.9%	8	26.7%
Male	976	255	26.1%	127	49.8%	31	24.4%

Ethnicity and language

Variation in uptake by ethnicity is shown in Table 35. There was no significant difference in uptake rates across the different ethnic groups. Of those offered TickerFit, the White population had a significantly older mean age, at 58.4 (standard error 1.5) than the Asian population who had a mean age of 50.8 (standard error 1.3). This may mask what could be better uptake among the White population once age is accounted for, but the numbers are too low to analyse this formally.

Table 35: Variation in uptake by ethnic group

	Referred	Started rehab	% reported as taking part	Offered TickerFit	% offered	Downloaded Ticker Fit	Uptake rate
Asian	421	152	36.1%	74	48.7%	17	23.0%
White	531	113	21.3%	53	46.9%	12	22.6%
Other	146	26	17.8%	16	61.5%	*	*
Unknown	269	34		14		*	*
Total	**1,098**	**291**	**26.5%**	**143**	**49.1%**	**37**	**25.9%**

** Numbers have been suppressed.*

Analysis by the first language of the patient shows that a larger proportion of Bengali/Sylheti speakers are reported to take part in rehab, although this may reflect the younger population (see Table 36). However, uptake rate among Bengali/Sylheti speakers (13%) is significantly lower than among English speakers (36%), and all eight Bengali/Sylheti speakers who downloaded TickerFit did so after March 2020. Thirteen patients with other first languages were also offered TickerFit, but the number of those who downloaded it is too small to report.

Table 36: Variation in uptake by first language

	Referred	Started rehab	% reported as taking part	Offered TickerFit	% offered	Downloaded TickerFit	Uptake rate
Bengali/ Sylheti	149	115	77.2%	60	52.2%	8	13.3%
English	189	120	63.5%	72	60.0%	26	36.1%
Other	51	27	52.9%	13	48.1%	*	*
Unknown	978	63	6.4%	12	19.0%	*	*
Total	**1367**	**325**	**23.8%**	**157**	**48.3%**	**39**	**24.8%**

** Low numbers have been suppressed.*

Clinical presentation and comorbidity

TickerFit is more likely to be offered to heart failure patients and patients in the 'other' category (see Table 37). This includes valve disease, post coronary artery bypass graft (CABG) patients, late or self-referrals. Although uptake of TickerFit is higher among heart failure patients, it is not significantly different from that among the other conditions.

Table 37: Variation in uptake by initiating event

Initiating event	Referred	Started rehab	% reported as taking part	Offered TickerFit	% offered	Downloaded TickerFit	Uptake rate
Coronary heart disease/angina	645	104	16.1%	40	38.5%	10	25.0%
Heart failure	64	36	56.3%	23	63.9%	8	34.8%
Myocardial infarction	469	147	31.3%	67	45.6%	15	22.4%
Other	176	37	21.0%	26	70.3%	6	23.1%
Total	**1,354**	**324**	23.9%	**156**	**48.1%**	**39**	**25.0%**

Mean BMI among patients offered TickerFit but who did not download it was 28.0 (standard error 0.8) compared with a mean BMI of 29.9 (standard error 1.8) among those who did. These differences were not statistically significant.

Reported involvement in ehab was far lower among people without comorbidities (see Table 38). However, rates of uptake of TickerFit, when offered, did not seem to be affected by the number of comorbidities (p=0.8).

Table 38: Variation in uptake by number of comorbidities

Number of comorbidities	Referred	Started rehab	% reported as taking part	Offered TickerFit	% offered	Downloaded TickerFit	Uptake rate
0	952	48	5.0%	33	68.8%	8	24.2%
1	81	59	72.8%	29	49.2%	8	27.6%
2	114	78	68.4%	36	46.2%	11	30.6%
>2	220	140	63.6%	59	42.1%	12	20.3%
Total	**1,367**	**325**	**23.8%**	**157**	**48.3%**	**39**	**24.8%**

Across the course of the project up to 10 September 2020, 127 patients were offered TickerFit, with 27 (21%) successfully onboarded. All but two of these were onboarded in the period of coronavirus, when face-to-face clinics were suspended.

Recruitment

Despite the increase in uptake following the Covid-19 pandemic, recruitment was noted as a challenge during interviews.

Representatives from the implementation team suggested numerous possible reasons for the lower than expected uptake:

- technology barriers (access to a smartphone, access to the internet, WiFi or data limitations, may have a phone for calls but not for apps)
- lack of motivation
- the app not being tailored enough to the patient population – the app was originally only available in English, which created a language barrier
- patients preferring a more individually-tailored approach (app content is generic)
- patients preferring face-to-face contact (social interaction with others and healthcare professionals)
- lack of confidence and efficacy to exercise alone (this was considered especially for patients with heart failure who may feel vulnerable exercising without the support of healthcare professionals on hand)
- lack of trust in technology (e.g. what happens to data).

Some of the reasons were not necessarily specific to TickerFit or other web-based platforms, but applied to the willingness of people to engage in cardiac rehab more generally.

> *When they have had a cardiac condition psychologically they are concerned, scared of what they are doing like if they are exercising too much or too little but if they exercise in front of the team who can monitor them then… there is no fear, I am with the expert, if something goes wrong they are there.* (Implementation team)

Technology barriers had been acknowledged as a possible risk during pre-implementation interviews but these had focused around access to a smartphone or confidence using digital technology. However, the implementation team also reflected on something they termed “data poverty”, i.e., even where patients had access to a smartphone, they were not able to access

the internet (for example, they had limited data on their phone and were concerned about the amount of data the app would take up).

Although partners gave suggestions for the low uptake, they all acknowledged that more needed to be done to understand exactly what the barriers are for people accessing rehab, reflecting that perhaps it was not so straightforward as originally envisaged: “There are a number of patients who don’t get access to face-to-face rehab but understanding really what the problem is with these apps is going to be key to developing ones that patients are prepared to use” (implementation team).

Interviewees noted that although uptake was lower than hoped, the patients that had used TickerFit were positive about it, and as a result they were able to record a patient testimonial for inclusion on the app. The numbers of people using TickerFit did increase after March 2020, but it is difficult to determine conclusively what led to this – although Covid-19 is likely to be a significant reason, a number of other factors could also be relevant including changes made to the app which affected patient willingness to engage and changes to staff attitudes and confidence using the app.

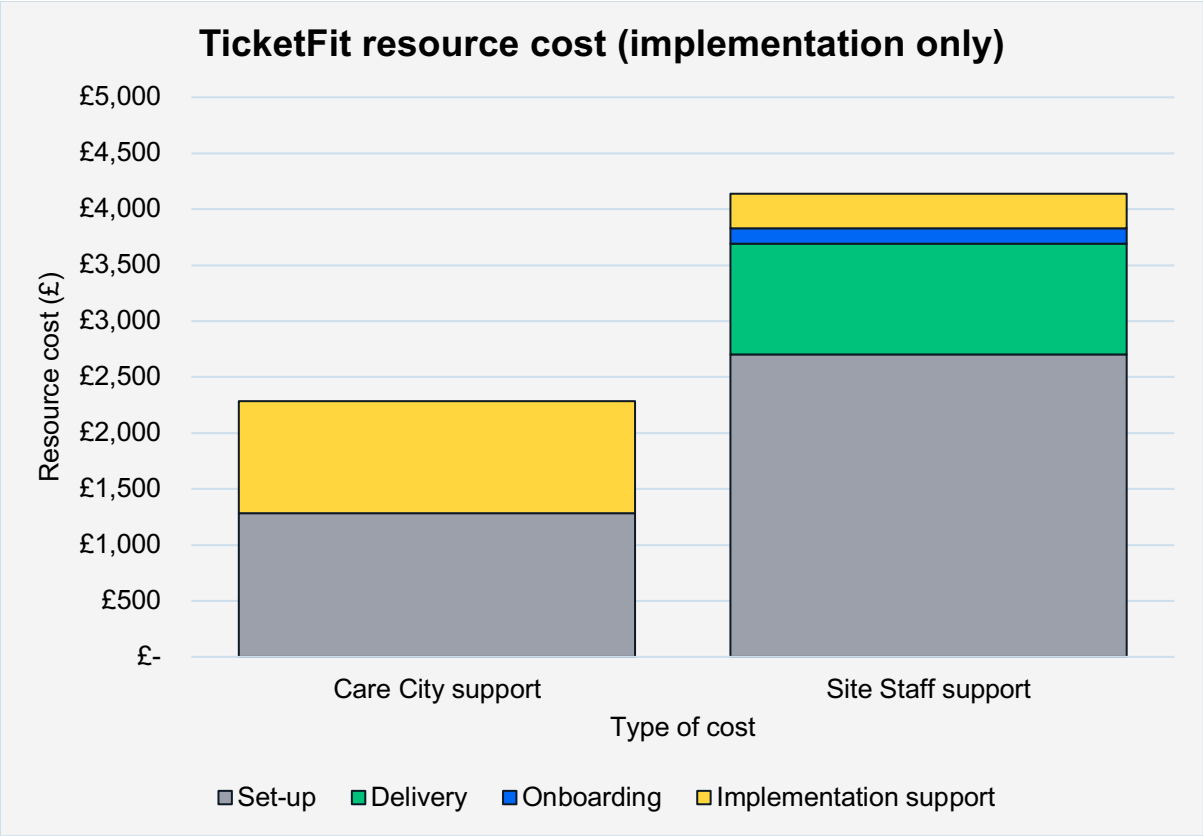
All interviewees recognised that they would have liked more patients to be using it, particularly to ensure a more representative group of people and that more needed to be done to unpick the reasons why patients were reluctant to engage in a digital alternative. However, the implementation team considered their ability to offer an alternative to face-to-face rehab, particularly during the Covid-19 pandemic, as positive.

> *This pandemic has highlighted that yes it’s the golden standard that we need face-to-face [rehab] and it remains the golden standard because physicians are able to interact with patients during the clinics and… provide them with more one-to-one support first-hand instead of remotely, but when those options are taken… off the table then where does that… leave the patients in terms of accessing this vital aftercare that they need.* (Care City team)

Resource cost for implementation

Figure 22 summarises the resources used during implementation by the implementing site and Care City staff. Implementation costs are broken down into those related to set-up, onboarding, delivery and implementation support. The high proportion of costs during the set-up phase reflects the considerable changes required during the course of the test bed. Licence costs are not shown due to the small numbers of patients onboarded to date.

Figure 22: Implementation costs for TickerFit



Patient experience and outcomes

Of the 157 patients offered TickerFit since 1 September 2019, BMI measurements before and after rehab were available for 32 (20%). The mean changes in BMI among patients who downloaded the app and those who chose not to are compared in Table 39. Although these show no significant reductions or differences between groups, the patient numbers are small such that any meaningful differences may be undetected.

Table 39: Numbers of patients referred after 1 September 2019 with BMI readings recorded at the beginning and end of rehab

	Number of patients	Mean increase in BMI (kg/m^2)	Standard error of mean
Offered TickerFit but not downloaded	21	0.30	0.20
Downloaded TickerFit	11	0.02	0.30

Key implementation findings

The evaluation highlighted numerous lessons that will be relevant for future implementations.

Tailor the innovation to the needs of the local population. Given the demographics of the local area, the language barrier had been raised in pre-implementation interviews, with one interviewee expressing anxiety around using an app with the particular patient demographic that was only available in English. This underlined the concern from some staff that the app was trialled with the wrong patient population and despite the addition of the translations, there was a feeling across multiple post-implementation interviews that the particular needs of the population were not catered for. Although the need to increase cardiac rehab uptake is a national issue, understanding what the barriers are for different groups of patients (and therefore what the most appropriate solutions are) is essential for understanding where introducing digital tools can be most effective.

> *The programme could have done better in terms of ensuring that… the app actually targets the majority of the population rather than just providing an answer to a general question, a general need which is we need an alternative option for [face-to-face] cardiac rehab.* (Care City team)

Ensure the implementation team are involved from the beginning. The issues that were highlighted regarding the app content during the pre-implementation phase raised wider concerns for the implementation team in terms of the quality of the product, their lack of involvement at an earlier stage and how this had impacted on the implementation process. There were some concerns that the lack of appropriate warm-up and cool-down content meant that it had less credibility to the team. It was felt that earlier engagement with the cardiac rehab team would have helped secure buy-in to the project, and ensured that any early issues identified with the app could have been addressed at an earlier date. Early engagement could have also supported greater buy-in by providing an opportunity to consider and address any concerns the team had around implementation, for example the possible impact on their job role. Partners reflected that were this project to happen at another site, it would be important for it to be driven by the cardiac rehab team who would be implementing and using the innovation in their everyday practice. Having a champion within the team was also seen as a highly valuable asset, as they would be able to drive forward the project and bring other team members on board.

> *I think the key is… having your cardiac rehabilitation team really keen on doing it… the person who is actually starting someone's rehab or is having in-depth discussions… about someone's cardiac rehab, having them really on board and enthusiastic about the project I think is the key to getting patients interested in doing it… I do think you need a*

champion… and I think [that] is best based in the cardiac rehabilitation department. (Implementation team)

Embed digital innovation within wider care pathways, recognising the need for support. Interviewees recognised the value of TickerFit as an adjunct, or to compliment face-to-face classes. Some level of face-to-face interaction was considered important for a number of reasons and, as a result of the Covid-19 pandemic, the cardiac rehab team began running online group exercise classes:

- to allow the cardiac rehab team to demonstrate how to do the exercises correctly, or to make modifications if needed to take account of other pre-existing conditions
- to provide general support (if for example a person looked like they were struggling with the exercises)
- to provide social interaction and an opportunity for patients to connect with others in the same situation, and to motivate others
- to monitor clinical issues such as blood pressure and heart rate (patients attending online classes received telephone calls to discuss things like whether they had eaten breakfast).

It is valuable to develop and improve the innovation collaboratively throughout the process of implementation. The implementation team and innovator were also positive about the way they had been able to develop the technology collaboratively to make it appropriate for patients, and the lessons that they had learned throughout the process about the cardiac rehab pathway, the barriers for people engaging and how to make the implementation process as simple and efficient as possible in future projects. Partners also recognised the value for the test bed to highlight lessons for other similar projects.

I think there are a lot of people who are trying to develop apps for all sorts of things in heart failure including cardiac rehabilitation and actually having an understanding of… why things don't work… is as important as why things work. (Implementation team)

Were the team to continue using the app, or other digital tools, ensuring that there is an infrastructure in place for ongoing co-design and improvement to the pathway would be important. The team also felt that there was scope for the app to evolve further to replicate some of the elements of face-to-face sessions (such as socialising through virtual forums).

9 The cluster approach in practice

The cluster approach was seen as fundamental to the design of the test bed to allow innovations to work together and to support the upskilling of staff around three distinct workforce roles: domiciliary carers, healthcare assistants and hospital administrators. As the test bed progressed, less emphasis was placed on the innovations working in combination, with focus shifting instead towards workforce development and upskilling roles in each of the clusters.

Despite the complexity of the test bed, the cluster approach worked well for creating a clear narrative, project management, shared learning and partnership working. The shaping of the clusters around workforce roles represented a novel approach to combinatorial design and has generated novel insights:

- **Creating a common vision and clear narrative.** The use of clusters helped clarify the target audiences for each of the innovations through each cluster's focus on a different workforce role, which supported the wider narrative of the test bed of workforce development.
- **Project management of a complex programme.** The cluster approach made it easier to project manage, which was seen as particularly helpful due to the large number of stakeholders involved, and competing interests and motivations. However, the cluster approach also had, at times, overwhelmed implementation sites, whereby implementing several innovations at one time could be challenging.
- **The benefits of shared learning and partnership working.** Innovators valued the opportunity to work with other companies to deliver a solution and share learning through working within a particular service, sharing feedback and drawing on experience. However, trying to juggle the large number of stakeholders made communication and effective partnership working difficult at times. Several innovators regretted not having the opportunity to clearly lay out sooner their own expectations for the test bed and what they could realistically offer, and sometimes felt "at the end of the communication channel" (innovator). Some respondents suggested greater interaction between innovators both within and across the clusters could have helped with troubleshooting.

- **Interdependence between stakeholders can add to delays.** The number of stakeholders added to the complexity of the programme and, particularly in the set-up phase, created delays. Where things needed changing or implementation was dependent on particular innovations, it could be harder to get things moving.

Observations on the workforce agenda

One of the primary areas of focus of the test bed related to workforce development. The test bed was shaped to cluster innovations around three distinct workforce roles – domiciliary carers, healthcare assistants and hospital administrators – who would be best placed to support the implementation, with the aim to increase skills and workforce productivity.

The workforce agenda was achieved to varying extents across the three clusters (more detailed reflections on workforce outcomes are reported in the cluster-specific chapters):

- The domiciliary care cluster demonstrated the greatest evidence of workforce development, among both frontline 'expert' carers who developed a variety of skills, and also lead implementers who made use of project management skills to adapt the operating procedures to the specificity of their settings.
- In the digital prescribing cluster, the development of healthcare assistants was not observed across many of the practices. Instead, Care City staff took on the 'healthcare assistant role' with aspects of the implementation or this role was taken on by other members of staff (such as administrators, GPs or specialist nurses). Despite this, frontline staff who were involved with implementation did report the development of skills and knowledge.
- In the cardiac rehabilitation cluster, the original aim to upskill hospital administrators evolved to focus more on service development and the innovation was used to support the cardiac rehab team to offer a 'menu of options' to service users based on their preferences.

There are a number of lessons for the upskilling of workforce roles in health and social care:

Upskilling occurred in a variety of ways. Across the domiciliary care and digital prescribing clusters, workforce development was observed in several ways beyond the acquisition of new technical skills and increased productivity. For example, expert carers in the domiciliary care cluster also increased in confidence to interpret and communicate health information with other healthcare personnel, service users and their families.

It is important to select staff with appropriate characteristics. The level of staff experience and engagement in their job role, experience of using digital technology, existing skills and knowledge, and aspirations to progress on to more senior roles impacted on how likely staff were to engage with implementation. For example, in the digital prescribing cluster, some staff members had more experience and/or were more confident navigating the clinical systems required to digitally prescribe innovations.

Staff require adequate training, education and ongoing support from organisational leaders. It is important that implementing sites invest sufficient time for training sessions and include information relating to why the innovation/condition is important, both in the set-up phase and throughout implementation. In the digital prescribing cluster, Liva training was modified early on to provide additional information to staff on the functionality of the app and dummy accounts were set up to ensure that frontline staff could feel confident demonstrating the innovations to patients. Additional resources and support provided by organisational leaders to facilitate staff engagement included refresher training sessions with a more hands-on approach in the domiciliary care cluster.

Staff time to undertake their new responsibilities must be protected. Staff capacity was a determining factor in the level of engagement across the clusters and sites. In the digital prescribing cluster, staff often perceived the additional responsibilities as extra workload rather than an opportunity for skill or knowledge development, which impacted on staff engagement. Conversely, in domiciliary care, issues around staff capacity were mitigated by undertaking a majority of the health and wellbeing checks outside of carers' usual delivery routine.

Consider all potential outcomes from upskilling. The potential benefits of upskilling the workforce include increased staff satisfaction, engagement and retention, as well as staff becoming more efficient. However, it will be important to consider possible unintended consequences that could arise from workforce development initiatives. There is a risk that without appropriate pay, (clinical) support and reward systems, staff move on to more senior or better-paying roles. For example, in the domiciliary care cluster, some staff hoped to transition into nursing positions as a result of their newly acquired skills, while others held the goal of being a healthcare professional and viewed their new skills as a step in the direction towards achieving that. Consideration should also be given to whether appropriate support (particularly clinical and for safeguarding) is in place for staff to take on the additional responsibilities.

Use of co-design and logic models

Co-design sessions were used to facilitate ongoing feedback on the implementation process. The Good Things Foundation provided support to Care City to design workshops for each cluster throughout. Interviewees noted the value of an external facilitator in creating an open and honest environment. Co-design led to new insights for all partners, and resulted in practical changes to the implementation process, including changes to service user cohorts and implementation pathways and adaptations to the technology. Although write-ups were published following the sessions, as well as a final co-design report, some interviewees were not, however, aware of the specific outputs from the co-design sessions. There were a number of key findings and lessons relating to co-design and logic models.

'Informal' co-design (i.e. spending time on the ground in the implementing sites) is important. In the pre-implementation phase, there was a lack of consensus among interviewees about what co-design was, with the focus being more on the specific workshops. Partners reflected on the value of more informal co-design, such as spending time in GP practices, and felt that being able to spend more time 'on the ground' would have been helpful for Care City and the innovators to understand the clinical pathways and develop close relationships with the implementation teams.

Co-design is valuable for bringing together a diverse set of perspectives. Co-design sessions were considered a valuable opportunity for bringing different partners together. In particular, attendance from both senior staff responsible for overseeing the implementation and frontline staff using the innovations was considered important. Innovators were present at most sessions throughout the test bed. While on the one hand this was positive as it meant they could hear feedback and answer questions first hand, some interviewees felt that innovators could be quite defensive and were concerned that other participants may not be as honest if innovators were present. Providing an environment that is open and collaborative so everyone is able to share feedback honestly is important for making the sessions as constructive as possible.

Co-design sessions did not always achieve the attendance they were hoping for. Where multiple test sites were involved, attendance was often by the same sites. There was also limited attendance from service users, but where these did attend this was valued by all other attendees. Interviewees felt that lower attendance levels were in part a result of the limited time and capacity of clinical staff to take time away from their day job, and a feeling that the test bed projects were seen as 'additional' work. The Care City team reflected on the need to be clear at

the start of a project what the expectations are for the various partners to be involved in co-design, and the level of commitment required.

Early engagement with partners is important for understanding the pathway and where the innovations can add most value. Interviewees reflected on the limitations of the test bed process for allowing co-design at the bid development stage – particularly the challenges posed by timescales, objectives and funding constraints. Some key stakeholders were not involved in the process of bid development, including frontline staff who, along with service users, were the intended users of the innovations. This led to some interviewees reflecting that the project had begun with the innovations, rather than with the problem, or need, and that if there was more engagement with the implementing sites, their particular characteristics and challenges would have improved understanding of how the innovations would add value to the pathway.

Going forward, partners reflected on the importance of starting with the particular problems and service user needs, and where digital technology might help. This was considered especially important given the impact of the Covid-19 pandemic on the system and the rapid increase in digital technology in healthcare more generally. Going forward, interviewees reflected that spending more time in the particular settings ('in the field') with the implementation teams would be especially helpful for understanding the various pathways, identifying any issues and embedding the project more within day-to-day practice. Care City became a Community Interest Company midway through the test bed project and as a result is now supported by a Community Board of local stakeholders, which will play an important role in supporting co-design in future Care City projects.

Logic models were a requirement of the test bed programme and a key component of the evaluation process, but the complexity of the project meant their use was limited. Logic model workshops were held at the start of the project in December 2018. The purpose of creating the logic models was to ensure that partners had a shared view of the problem that was being addressed and the steps required to address it. However, not all stakeholders were present at these workshops (in particular lead implementers and frontline staff were not present). Some of the test sites had also not been confirmed, which made it challenging to bring everyone together. Due to the complexity of the test bed, producing logic models particularly at the start of the programme was therefore challenging, and it was difficult to keep them up to date as multiple changes were made throughout the programme (for example, when innovations were moved to different clusters).

Not all partners were aware of, or clear about, the purpose of the logic models. In pre-implementation interviews, innovators and the Care City team reported value in the logic model approach for bringing together the views of partners, articulating the wider aims of the test bed, and as a tool in understanding gaps. However, other interviewees (particularly frontline staff and implementation leads) were unclear about the purpose of the logic model and others were unfamiliar with it or its role in the test bed. In post-implementation interviews, multiple partners had not had sight of the logic models, although this may be because they were not updated or communicated to all partners.

Although co-design sessions provided an opportunity for stakeholders to come together and discuss the process of implementation throughout the project, it may have been helpful to bring together partners involved in implementing the different innovations in order to identify a shared view of the problem and understand the current pathways and what needed to happen for implementation to be successful. While the logic models were designed to do this, it was challenging to do this in the early stages of the project, particularly given the complexity of the test bed.

10 Discussion

Within this chapter we include an overview of the test bed findings, key recommendations for the scale and spread of digital health innovations, a discussion of the impact of the Covid-19 pandemic and an overview of the strengths and limitations of the mixed-methods evaluation that forms this report. We also discuss the test bed findings in the context of published literature, particularly evidence relating to implementing complex change and the effectiveness of the digital solutions, as well as covering the national policy context – in particular digital and innovation policy and that relating to the health and social care workforce.

Summary of findings

The Care City test bed was an ambitious programme combining the testing of innovations across a number of patient pathways, alongside creating opportunities to develop new workforce roles across three clusters (domiciliary care, digital prescribing and cardiac rehabilitation services). Five out of the eight innovations identified at the start of the programme progressed to full implementation. The initial intention to implement clusters of innovations was realised in the digital prescribing cluster, while in the other settings only one innovation was fully implemented. The capacity of staff in implementation sites affected how the innovations were implemented. In particular, in the primary care setting, Care City staff took on implementation support roles, including contacting and following up patients.

Across the test bed, over 650 patients were recruited to the innovations, ranging from 39 to 369 per innovation, with rates of uptake of between 25% and 52% among those offered the innovations. Recruitment reached the expected numbers for Whzan and Healthy.io, but was challenging for Liva and Sleepio where changes to the cohort and recruitment approach were needed to speed up recruitment to meet the test bed requirements. Factors impacting on uptake were identified from patient and staff feedback including the records made by the staff contacting potential recruits. While the reasons varied between innovations, notable themes were the relevance and appropriateness of the innovation to patients, lack of time, language barriers and the confidence of patients in using the technology. Comparing the profile of patients who were referred or eligible for referral with those who actually used the innovations, we found that older patients were less likely to take them up. Differences by ethnic group, however, were less clear cut, but first language had an influence on uptake of the TickerFit app.

Although we observed no positive nor negative clinical impact of the innovations on patients, the robustness of the analysis was affected by the short duration of the test bed, the low numbers of patients who had follow-up measurements and the difficulties in linking uptake and outcome data. Feedback from patients who used the innovations were generally positive, although it is possible that patients who were most engaged were more likely to agree to provide feedback.

Our evaluation found that the test bed led to upskilling and the development of workforce roles in both the domiciliary care and digital prescribing clusters. The range of skills developed was more diffuse than anticipated, for example, domiciliary carers and other agency staff reported developing confidence in dealing with GPs and primary care teams, and primary care staff reported developing confidence in and understanding of digital health applications. Feedback from staff involved in the test bed indicated that staff felt empowered to have more options to offer patients.

Across the innovations, there were significant implementation costs, in terms of time and resources required to develop the pathway, as well as to recruit patients and deliver the intervention. It is important for commissioners of innovations to understand that digital solutions rarely stand alone but will need support to be effective, whether this is provided as part of a package by the digital provider, as is the case for Liva and Healthy.io, or whether this needs to be provided by health and care services.

We identified a number of factors which will impact on the cost and effectiveness of implementing digital interventions which it will be useful for commissioners to consider. These include: the demographics of their local population and how this will impact on prevalence of the relevant health condition and also digital literacy; likely uptake of the innovation, which will impact on cost (where this is paid for on cost/patient basis); how the innovation is implemented, including which staff groups are involved; and anticipated impacts on other services that are part of the patient pathway.

Key lessons and recommendations for scale and spread

The lessons for implementing digital innovations in health and care settings that can be drawn from the test bed are outlined in this section. How these recommendations relate to implementation literature will be considered later in the chapter.

Engage early with implementation sites – in order to build trust and ensure staff engagement. Implementation teams are more likely to engage with an innovation if they trust the innovation

and innovation team. For example, for the cardiac rehabilitation cluster, it was felt that earlier engagement with the cardiac rehabilitation team would have helped secure buy-in and ensured that any issues identified with the app could have been addressed at an earlier date.

Ensure all stakeholders affected by the implementation are on board – to prevent barriers to implementation. For example, in the domiciliary care cluster, it was difficult to engage with healthcare professionals such as GPs and paramedics involved with the escalation process. This created challenging situations for carers when they were unable to contact the appropriate health service to help with interpreting service users' health signs and/or take responsibility for their medical care.

Consider the barriers to service users using digital health technology. The barriers identified across the digital prescribing and cardiac rehabilitation clusters were fairly consistent:

- digital exclusion – for example, for the healthy.io ACR test, care home residents were not included in the cohort as it was presumed they did not have access to their own smartphone
- digital literacy – for example, some patients in the digital prescribing cluster reported not feeling confident using smartphones or apps, and/or requiring support from family members to access the innovations
- language barriers – a consistent concern for implementation teams due to the local demographics of the borough
- cultural barriers – for example, implementation teams reported the importance of the Liva Healthcare app being tailored to cultural differences, particularly relating to diet and lifestyle
- technological barriers – for example, in the digital prescribing cluster, several patients reported issues downloading, accessing or setting up the apps
- preference for face-to-face support – for example, in the cardiac rehabilitation cluster there was a strong patient preference for face-to-face support.

Failure to address the above issues when implementing digital technology will only act to increase inequality in access to health care. This may be particularly so between age groups as we have consistently found that older people are less likely to engage with the digital innovations. There is a risk that the digital transformation of services facilitated by the Covid-19 pandemic is likely to only accentuate these barriers and promote further inequalities.

Recognise the importance of non-healthcare professionals in supporting the adoption of digital technology. The importance of friends and family in supporting the use of technology should not be underestimated and their involvement should be encouraged. This was evident in the digital prescribing cluster – the support of non-healthcare professionals in accessing and using digital innovations was a consistent theme, particularly for those patients who were less confident with digital technology. Also, implementation leads in the domiciliary care cluster encouraged family members to be present during the consenting process to increase service user confidence in the innovations.

When training teams for implementing digital technology in health and social care settings, consider the following:

Take into account individuals' level of experience and confidence – for example, in the digital prescribing cluster, some staff members were more confident navigating the clinical systems than others and therefore training related to the systems involved in digital prescribing would have been beneficial for some staff.

Include the right people – for example, in the digital prescribing cluster, by involving wider practice staff such as administrators, they had awareness of the innovation if patients contacted the practice with any queries or concerns. Similarly in the domiciliary care cluster, by involving office staff responsible for escalation in training around NEWS2 scores and the appropriate procedure for different readings.

Provide clarity around the purpose of the training and information to staff beforehand – to avoid information overload, and to assist staff with processing and filtering the information.

Provide a clear understanding of how the technology functions. For example, in the digital prescribing cluster, some implementers reported that they felt they needed to have a better understanding of how to navigate the apps in order to better explain them to patients – as a result, staff were given access to a dummy account.

Organise multiple in-house refresher sessions at which staff can familiarise themselves with the innovations and their required responsibilities. For instance, agencies in the domiciliary care cluster provided in-house additional and refresher sessions for carers to practise on each other and rehearse different scenarios for escalation.

Recognise the enhanced skills developed by staff. For example, in the domiciliary care cluster, care agencies put in place sign-off procedures and certificates of achievement to ensure carers felt valued.

Provide implementation staff with guidance and/or prompts relating to the best way to communicate the innovation to patients. For example, in the digital prescribing cluster, a few problems were noted in how one of the innovations had been explained to patients – so a script was developed to support staff.

Recognise the value of an organisation to facilitate and support the implementation. Implementation teams and other partners valued the role that Care City played, particularly in bringing together different stakeholders, and during the set-up and implementation phases in providing reassurance and practical support, monitoring and working on the ground with organisation leads in order to drive the implementation. For example, in the digital prescribing cluster, sites valued the role of Care City and most doubted whether digital innovations could be implemented in primary care without the support of such an organisation. In the domiciliary care cluster, implementing teams valued Care City's support around project management.

Be clear during set-up about the commitment and time required from implementation sites. It is important to be realistic about resources and commitments, and agree the roles and responsibilities of implementation sites early on during the set-up. For example, in the domiciliary care and digital prescribing clusters, some implementation staff reported that the input required, particularly administrative tasks, was more than expected. The significance of resources needed to implement and sustain the innovations has also been observed in care home settings and implies that plans for wider scaling up should be realistic about the input of resources required.[22]

Identify the factors that impact service user uptake and engagement. Across the clusters, recruitment proved to be more time-consuming and resource-intensive, and with lower uptake, than anticipated. It is important to dedicate time in the set-up phase to predicting potential barriers to service user uptake and engagement and to troubleshoot for potential solutions. Implementation teams should invest sufficient time and resources to recruitment processes. For instance, in the domiciliary care cluster, agency managers spent significant amounts of time during set-up accompanying carers for the service user consenting process, which provided clients with confidence in the innovations.

Service user uptake to the innovations also seemed to be impacted by method of referral. In the digital prescribing cluster, face-to-face referral was seen as key, and referral and endorsement of the innovation by a trusted healthcare professional such as a GP or diabetes nurse seemed to be an important motivating factor for patient engagement. The importance of trust when accessing health information was also raised by patients in the cardiac rehabilitation cluster.

Understand the variation in organisational and workforce structure and capacity across sites. During set-up, it is important to get to grips with the variation across sites in organisational and workforce structure, capacity and service users – there is often no 'one size fits all' approach to implementation. Implementing teams require flexibility in order to adapt operating procedures to the specificities of each site. For example, in the digital prescribing cluster, some practices had a specialist diabetes nurse in-house, others did not, which led to differences in responsibilities taken on across workforce roles. Similarly, variations in the size, service user base and staff make-up of the care agencies in the domiciliary care cluster all led to variations in implementation across sites.

Workforce capacity had a notable impact on implementation across sites and settings; most health and social care services are under significant pressure (financial and staffing). Staff engagement seemed to be dependent on their time and ability to fit the implementation into their work schedule. Consideration should be given to how services can best be supported to implement digital innovations. This was illustrated by the role of the innovation team in supporting the implementation of the Healthy.io ACR test, which was acknowledged by implementation teams as a significant factor in the 'success' of the programme.

Make efforts to understand the priorities of implementation sites. Understanding the priorities of implementation sites is important for staff engagement. This can be seen with the often shifting priorities of primary care services and how resources tend to be geared up towards achieving those priorities/targets. For example, in the digital prescribing cluster, staff engagement appeared greater for the innovations relating to diabetes due to the targets and local incentives in delivering diabetes care. This was also illustrated by the importance of the timing of the introduction of the Healthy.io ACR test in achieving the end-of-year targets.

Determine how the innovation embeds into the current treatment pathway. Consider whether a digital innovation is providing an alternative service or is acting as an adjunct to an existing service – this can be important for both service user and staff engagement. For example, in the cardiac rehabilitation cluster, face-to-face classes were considered the 'gold standard' and implementation teams reflected on the value of the programme as an adjunct, or to compliment face-to-face classes). In addition, patients seemed to have a strong preference for face-to-face care.

Identify a leader and/or a digital champion within implementation sites. Across clusters, partners reported the importance of leadership and engagement from organisational leads at implementation sites to drive the implementation, monitor and troubleshoot. For example, the

lead implementer role in care agencies was key to ensuring successful implementation in the domiciliary care setting.

Select implementing staff members to support the implementation – to ensure, especially during set-up, that staff are sufficiently engaged so that the innovations can be adopted. For example, in the domiciliary care cluster, expert carers were chosen who had previously demonstrated commitment to their agency and their service users, and expressed an interest in moving into more senior social care or healthcare roles.

Ensure regular information flows between the innovation team and the implementing sites. In the digital prescribing cluster, for the ACR testing, implementation teams reported the benefit of receiving the regular 'dashboard' from the innovation team in providing feedback relating to patient uptake and test outcomes and as a means of motivating staff. Also, patient feedback for the Liva Healthcare programme included the importance of linking and information sharing between the app, their health coach and their healthcare team. Generally, however, it was difficult arranging the flow of data, and linkage between the innovation and data collected by the implementing sites was only achieved for one of the technologies.

Consider the wider effects of the implementation. The implementation of an innovation might have an impact on the time and/or resources for (implementation) teams elsewhere. For example, in the digital prescribing cluster, for the ACR test, challenges were reported in the re-testing of patients with an abnormal result. For those patients testing abnormal, a second ACR test was required before treatment could be initiated; however, it was often difficult to engage patients to take a second test.

When designing the evaluation, consider its impact on the implementation, particularly the implications for staff time and capacity. Across the clusters, the evaluation and associated administrative tasks had a significant impact on the time and resources of implementation teams – for example, for Liva Healthcare, implementation teams reported that the enrolling documentation was arduous to complete. The recruitment targets posed by the evaluation also resulted in disruption to the implementation in some cases – for example, the retrospective recruitment strategies employed in the digital prescribing cluster placed a considerable burden on implementation staff time.

Consider the length of time required to embed innovations. For the adoption of innovations in health and social care settings, sufficient time is required to embed them into care pathways in order for change to be sustained.

Impact of the Covid-19 pandemic

The impact of the Covid-19 pandemic on the wider health and social care system has been notable. It has resulted in unprecedented changes to the way that health and social care services are delivered; priorities have shifted, ways of working and resources have changed; and in many services there has been a rapid adoption of digital technology.[63] Unsurprisingly, this has had significant consequences for the test bed implementation across health care settings.

Primary care priorities have shifted, many services are now delivered remotely and there have been changes in workforce capacity. This was evident in the digital prescribing cluster, where the pandemic caused significant disruption to the implementation pathways: the scheduled follow-up health checks for patients enrolled in Liva Healthcare were either suspended or conducted remotely, with ramifications for sustaining patient engagement, and community services such as phlebotomy were disrupted, which, in turn, impacted the implementation. These changes have also been seen in the cardiac rehabilitation cluster, where group and face-to-face classes were suspended.

Traditional relationships between health and care services have evolved, for instance with a greater reliance of primary care services on domiciliary care to provide monitoring over the course of the pandemic. This has been supported at a regional level by commissioning bodies investing more greatly in technology for social care settings.

There has also been a change in patients' behaviour and attitudes – many patients have been less likely to agree to attend services and therefore there has been an increase in patients' uptake of remote health services and digital options. For example, in the digital prescribing cluster, some patients with diabetes were reluctant to attend their follow-up health checks (instead preferring for these to be done remotely) and some patients reported changes to the way they were interacting with the innovations. Similarly, there has been some suggestion of a cultural shift as a result of the pandemic towards greater innovation, and of a change in healthcare professionals' attitudes towards digital technology.[63] More research is, however, needed to understand this.

Given the profound and wide-reaching impact of the Covid-19 pandemic on the health and social care system, it is extremely challenging to disentangle its impact on the test bed implementation, particularly in relation to service user uptake, engagement and outcomes.

Strengths and limitations of the study

The use of a mixed-methods evaluation has been beneficial not only to consider the impact of the digital innovations on patient outcomes but also to provide novel insights and learnings relating to the implementation. The evaluation team worked alongside the implementers, and provided formative feedback throughout the evaluation.

The qualitative evaluation was thorough in that a range of methods were used (observations, interviews and surveys), a range of perspectives were collected (Care City, innovators, implementation teams and service users) and data were gathered over time – from pre-implementation through to post-implementation – to determine how views and processes changed over the course of the test bed.

It is important to recognise the sampling bias in the qualitative evaluation, in that implementation staff and service users were often self-selecting. As a result, the implementation staff and service users who were interviewed were likely to be more engaged with the test bed and the innovations being implemented. A notable omission from the qualitative evaluation across some of the clusters was that it was not possible to gain feedback from service users or staff members who had declined to take part in the implementation, and it was also not feasible to collect data from sites that declined to take part in the test bed. Due to the breadth of the test bed and the impact of the Covid-19 pandemic, sample sizes for the qualitative interviews and surveys were relatively limited, particularly for service users and some implementation staff.

Quantitatively, one of the strengths of the study has been our ability to pull together data from multiple sources, combining findings from routine health records with information collected by the apps themselves about how people use them. Unfortunately, data linkage was not always possible. In the longer term, it will be important for the digital infrastructure in the NHS to allow data to flow from patient-facing apps.

For several of the innovations, robust analysis of outcomes was strongly affected by a lack of recorded follow-up information. In the domiciliary care cluster, where we used bespoke data, there were some problems with completeness. It also took some time before the escalation protocols for Whzan settled, which meant that some of the early data on escalation were unusable. The Covid-19 pandemic either caused or exacerbated these problems, and a sustained period where there was limited access to detailed GP practice data reduced our scope for using the data formatively, i.e. by regularly feeding back to Care City information on the characteristics of individuals who had engaged or not engaged with the innovations as well as their outcomes.

The test bed was of a small scale and relatively short duration, and as such an economic evaluation of the implementation has been out of scope. Further larger-scale studies are needed to develop more robust estimates of cost-effectiveness for this and similar evaluations. Evidence of the cost-effectiveness of the ACR test has now been published, with robust estimates of cost-effectiveness, but similar studies are not yet available for the other innovations we examined.

Findings in the context of other studies

In this section we discuss the test bed findings and recommendations in the context of previous implementation literature and evidence relating to the effectiveness of the digital technologies.

Evidence of implementing complex change

Implementing digital technology in health and social care settings is rarely simple. Literature demonstrates that many innovations implemented within health settings fail to be adopted – the failure rate of technology implementation is particularly high when projects are large, ambitious and complex – so the more complex an innovation or setting, the less likely it is to be successfully adopted.[64,65,66]

Here we relate our key findings to the established implementation literature. In particular, we will discuss the non-adoption, abandonment, scale-up, spread and sustainability (NASSS) framework,[4] which supports the identification of areas of complexity in the implementation of digital technology, and the recently published Phoenix framework,[67] which draws on psychological theory to understand innovation adoption among health professionals.

In this report we make a number of recommendations for the implementation of digital innovations in health care services, many of which echo those in previously published literature. It is widely established within literature that the implementation of interventions should be driven by the need or problem; that a complex health intervention should start with a detailed and theory-based characterisation of the problem and the context in which the intervention will be used.[68] 'Felt need' or the 'perceived problem' is of particular importance in the Phoenix model for whether the adopter views the innovation as a solution and therefore whether they form positive or negative views towards the innovation.[67] The recommendations drawn from the test bed reinforce this notion, and demonstrate some of the challenges of a centrally designed, top-down programme that imposes specific objectives by which to facilitate innovation.

Our recommendations for the early phases of an implementation project, relating to creating a shared vision across stakeholders, reinforce the work of Greenhalgh (2018)[69] – adapted from

Maylor and Turner (2017)[70] – which suggests that success in introducing new technologies into health and social care settings can be aided by the co-production of a shared vision of the aims of the project, which must be maintained throughout. However, implementation literature also shows that success is often defined differently by different stakeholders, and therefore it is crucial to sustain a clear vision while at the same time integrating multiple stakeholder perspectives, building relationships and managing stakeholder conflict.[4] This is reinforced by the test bed finding that the motivations and expectations of partners were varied and that it is therefore important to achieve clarity regarding motivations and expectations, and to set roles and responsibilities early on.

Implementation literature outlines the importance of taking into account the relationship between care practices across a service or pathway, rather than just focusing on the technology and overly simplistic models of adoption.[4] This is reinforced by the recommendations drawn from the test bed set-up phase relating to the importance of considering the potential risks and challenges early on, and being realistic about what can be achieved. It also echoes the test bed recommendations relating to the importance of considering the disruption that the implementation might cause to other services or pathways.

Within the test bed, partners were overwhelmingly positive about the value of Care City as a dedicated team with innovation expertise to liaise and bring partners together – this echoes the recommendations from Greenhalgh[69] relating to the importance of nurturing key relationships between individuals and organisations in order to achieve successful adoption. Not only was Care City crucial in bringing partners together but in its project management role it provided leadership and was responsible for driving the implementation – this reiterates the recommendations proposed by Greenhalgh[69] when implementing complex change relating to the importance of robust programme leadership. The significance of strong leadership when implementing innovation has been reinforced within the test bed – a consistent finding across the clusters related to the importance of organisational leadership and/or digital champions at implementation sites and this should be considered when designing future implementation projects.

Recruitment of service users to the innovations was a particular challenge. However, we have drawn on the findings to make several recommendations for future implementation projects. In particular, we recognise the importance of the involvement of non-healthcare professionals in the implementation – friends and family – in supporting the use of digital technology. This is consistent with literature examining the uptake of digital health apps, which has shown the importance of friends and family.[71,72] Within our recommendations we also highlight the

importance of trust for both health professional and service user engagement with an innovation – this echoes previous research demonstrating the importance of trust among healthcare professionals in using digital tools in primary care.[72] Within our lessons we emphasise the importance of understanding the local context in which the innovations are being implemented – literature has shown that complex interventions in health care and the context in which they are expected to have an impact (e.g. a community with higher rates of digital exclusion) are interrelated.[73]

A key finding across the innovations related to the implementation costs, in terms of time and resources to develop the pathway, recruit patients and deliver the intervention – digital innovations rarely stand alone, and need support to be effective. However, workforce capacity was a significant factor in the implementation of the innovations and had a notable impact on the level of staff engagement at implementation sites within the test bed, as was demonstrated by the need for Care City to step in to support implementation in the digital prescribing cluster. The NASSS framework[74] recognises that a lack of capacity to innovate within participating organisations is an important factor in reducing the likelihood that implementation will succeed. A key challenge for implementation outlined by the Phoenix framework[67] relates to workforce capacity – not a lack of commitment from individuals but difficulty supporting the implementation in practice due to the stress placed on their cognitive capacity. The Phoenix framework considers prioritisation as an important strategy for overcoming these challenges – however, across the test bed, we observed considerable variation in the level of prioritisation across implementing organisations.

Another test bed recommendation linked to workforce roles and capacity recognises the importance of considering which staff members will be best placed to support the implementation. This is compatible with the assumptions of the Phoenix framework, that it is important to understand individuals' profile and experience (e.g. motivation, goals, knowledge), as this sets the context for engagement and shapes their view of the innovation.[67] Across the test bed settings and sites, staff engagement varied considerably and proved a key factor in whether innovations were successfully implemented.

One of the key lessons drawn from the test bed relates to the importance of regular information flows between partners – particularly between implementation teams and innovators, to facilitate motivation, engagement and troubleshooting. This builds on the recommendations of Greenhalgh[69] relating to the importance of capturing data on progress and feeding it into ongoing deliberations.

A key consideration in centrally designed programmes such as the test bed relates to the imposed timescales – it is important to allow sufficient time for the innovations to be embedded into health and social care services, and time to fully evaluate new services and the desired impact/outcomes. The Phoenix framework suggests that for the implementation process to become part of the routine, it requires a sustained effort and commitment over a period of time – months and possibly even years.[67]

The test bed implementation has also generated novel insights and learnings that are perhaps less well established within implementation literature and for implementing digital innovation within settings that are perhaps less well evidenced such as social care – particularly our recommendations related to the training of implementation staff and the focus around workforce roles, workforce development, and facilitators and barriers to upskilling. Our recommendations for training build on the assumptions of the Phoenix framework relating to avoiding information overload during training, which suggests health professionals often have too much information to process.[67] We recommend that information should be provided prior to training for staff to have an opportunity to process the information and that there should be refresher training sessions to reinforce learning.

Evidence of the effectiveness of specific digital solutions

Here we put our findings relating to individual innovations in the context of previous evaluations or effectiveness studies.

Whzan

To our knowledge, this evaluation is the first study to report on the use of early warning score testing in domiciliary care settings, and contributes to a growing evidence base around the use of early warning scores outside of hospital settings. The range of early warning scores we found is comparable to that found in previous community samples, and could provide a baseline for the expected range of results and escalations for services planning wider use of early warning scores in home care settings.

Sleepio

Within the test bed, patients were invited to use Sleepio through targeted recruitment, rather than just during routine consultations. Follow-up calls were also planned after three weeks. These aspects of the implementation were different from other implementations of Sleepio, and might be expected to increase uptake and engagement. However, this approach was not able to engage a higher proportion of patients: for example, we found that 30% of people who

completed the sleep test undertook one or more of the programme sessions, compared with 42% of people in a previous primary care implementation.[38] That study also reported a 56% reduction in prescriptions, compared with our observations of no impact, but they followed up patients for longer (approximately 18 months) and focused on individuals who actually started using Sleepio rather than on the intention-to-treat basis that we applied.

The Healthy.io ACR test

The Care City test bed was the first time this particular mode of care delivery, with Healthy.io supporting implementation, has been used in GP practices. We found that 73% (369/508) of those who agreed to the home-based testing kit actually completed a test, which was similar to the 72% compliance rate demonstrated in a previous study of people with diabetes who had previously been non-compliant (in the previous 18 months). [53] In that same study, only 32% of people with diabetes agreed to be sent the home self-testing kit which is considerably lower than the 71% (508/712) who consented to the home-based testing within the test bed. This is perhaps a reflection of the role of the innovator in supporting the implementation. Considering patient satisfaction with and usability of the test, both evaluations report similar findings. The vast majority report the test easy or very easy to use; 97.7% in our evaluation and 92% in the earlier study.[53] There were similar findings across the two evaluations of the majority of patients (90.4%) preferring the home testing method.[53] Also, both evaluations found that smartphone ownership was the main barrier to uptake.

Liva Healthcare

The evidence base for digital interventions for diabetes is limited, although a systematic review is currently under way in this area.[75] A web-based intervention has previously been trialled to support weight loss among diabetic patients in the UK.[76] Our evaluation found a higher level of uptake than this study (24% compared with 9% of patients contacted), although the previous study contacted patients by letter. Attrition rates at three months are similar, with 27% dropping out in the study compared with 25% in the test bed, although the study reported 39% attrition by 12 months while in the test bed 47% have so far not managed to complete the nine-month programme. Any influence of the Covid-19 pandemic on the higher longer-term attrition rates is unknown. The 24% uptake in the test bed is similar to that observed in lifestyle intervention trials on type 2 diabetics, at 20%[77] and 28%.[78]

TickerFit

Outcomes data on TickerFit from this evaluation are limited due to small numbers, but previous studies have suggested that web-based cardiac rehabilitation programmes can be effective.[79]

Studies have examined alternative methods of delivering cardiac rehabilitation for people with chronic heart disease, as well as the impact of mode of delivery on outcomes more generally and of mode of delivery on psychosocial outcomes specifically.[80] The recent Rehabilitation Enablement in Chronic Heart Failure (REACH-HF) study, funded by the National Institute for Health Research (NIHR), looked specifically at home-based therapy for people with heart failure.[81] The study showed that, compared with usual care, people who received the REACH-HF intervention had higher Health-Related Quality of Life scores as measured by the Minnesota Living with Heart Failure Questionnaire (a disease-specific Patient Reported Outcome Measure [PROM] questionnaire).

Web-based options such as TickerFit also offer an alternative to traditional therapy. The WREN feasibility trial tested the 'Activate Your Heart' intervention, which was developed by the University of Leicester as an alternative to group-based therapy.[82] This programme was not limited to heart failure, but included anyone with a diagnosis of chronic heart disease who declined or dropped out of traditional cardiac rehabilitation. The trial demonstrated that web-based rehabilitation is safe, and can lead to improvements associated with traditional methods of rehabilitation such as exercise capacity. The study also highlighted important considerations around the process of implementing a web-based alternative such as the following:

- **Recruitment.** The most fruitful method of recruitment was to capture patients at the point of declining rehabilitation in a one-to-one assessment (>80%) compared with retrospectively contacting those who had declined or dropped out of a programme previously. It was thought that this may be because uptake was influenced by the healthcare professional. In the test bed, all of those onboarded to TickerFit were introduced to it by a member of the cardiac rehabilitation team.
- **The importance of maintaining access to healthcare professional support if needed.** In the study, contact with staff was low and patients did not use the forum. However, in the test bed project, maintaining the relationship between healthcare professional and patient (through weekly motivational calls supported by the dashboard) was considered essential, particularly during the Covid-19 pandemic.

Like many areas of healthcare delivery, the Covid-19 pandemic has highlighted the value of digital alternatives. Cardiac rehabilitation, being predominantly delivered face to face and in groups, has largely had to switch to remote options, with patients being supported over the telephone or with web/home-based programmes. This has also happened in other countries and studies suggest that participation in remote cardiac rehabilitation programmes has increased as face-to-face groups have been suspended.[83] Although it is arguably too soon to understand the

long-term impact of remote programmes during the pandemic, studies have suggested there are a number of factors to consider to make best use of remote care, such as ensuring staff receive sufficient training and patients continue to have access to their usual care, including medication.[84]

Although wider than cardiac rehabilitation, studies have also shown favourable outcomes for people with cardiovascular disease who access healthcare through remote technologies, but these are noted as highly complex interventions where it is difficult to determine 'the active ingredient'.[85] Furthermore, it seems that no intervention has been delivered without any face-to-face component, even if just for recruitment (and as noted above this can play a key role in encouraging uptake). More research is needed to understand the impact of remote healthcare during the pandemic on patients, healthcare professionals and services.

Studies exist examining the cost-effectiveness of cardiac rehabilitation versus no cardiac rehabilitation, but we were unable to identify any studies comparing the cost-effectiveness of web-based cardiac rehabilitation programmes.

Findings in the context of national policy

Digital and innovation policy

Digital technology and innovation are a key focus for current health and social care policy – the government's 2018 vision for digital, data and technology in health and social care[86] had placed a clear national and strategic focus on the actions required, and digital technology is a key feature of many of the ambitions for the NHS Long Term Plan.[62] Supporting the adoption and spread of innovation is a key part of this, with numerous initiatives (as well as the test bed programme) established to help innovators and NHS organisations to spread new innovations (such as the Accelerated Access Collaborative).

The Covid-19 pandemic has resulted in a rapid acceleration of the adoption of digital technology across the health and social care system, transforming the way traditional services have been delivered to respond to the need to reduce the risk of transmission in NHS settings, enforce social distancing and protect people who are shielding. As well as having an impact on the delivery of the test bed project, the pandemic is likely to have a long-term, transformative effect on the delivery of healthcare services more widely. For example, primary care services' priorities have shifted and have undergone a rapid digital transformation – remote consultations

are now commonplace. Similarly, it is unlikely that traditional cardiac rehabilitation services will resume any time soon, with social distancing meaning classes may be limited in size.

Despite the huge potential of digital technology, the Care City test bed has highlighted a wide range of issues that must be addressed if innovation is adopted in a way that delivers benefits for staff and patients. The project has provided a rich opportunity for learning and it is vital that the NHS makes the most of this, especially given the long-term impact of the Covid-19 pandemic on the use of digital technology in the NHS.

Importantly, considering the capacity of the workforce to implement innovations (including the time needed for training, implementation and ongoing quality improvement) is essential if the innovations are going to be effectively embedded within existing clinical care pathways or new care pathways within the local system. Although the pandemic may have highlighted the potential for technology, it also came with a reduction in staff capacity through redeployment. Similarly, understanding the infrastructure and wider system in which innovations are being adopted is essential in order to properly embed and evaluate their impact, particularly where projects last a limited time. Information governance requirements, for example, caused extensive delays at the start of the project, and throughout the course of the programme, ensuring the necessary data transfer processes were in place (for example between the apps and patients' clinical records in the digital prescribing cluster) was also challenging. This landscape can be challenging to navigate (particularly where multiple information governance approvals are required) – so ensuring support for partners to go through this process and being clear about expectations, including the time required, are important.

A key area of importance is digital exclusion – this acted as a huge barrier to the use of the innovations in the test bed for a wide variety of reasons, including in relation to access to smartphones, language, confidence and the skills to use technology. Given the rapid expansion of digital services as a result of the pandemic, the importance of ensuring people are not subject to digital exclusion will become increasingly apparent. However, the project revealed that a more nuanced understanding of digital exclusion may be required to fully understand the willingness of people to engage with digital solutions – for example, while an individual may have access to a smartphone, their willingness to use it for their healthcare may be limited, or they may have limited access to the internet or available space to accommodate the apps. Similarly, while some aspects of healthcare can be emulated using a digital alternative, it is important to recognise the wider benefits of face-to-face interaction, such as the opportunity to socialise with others with similar conditions.

We also found that the top-down approach can be counterproductive: promoting innovation through programmes which are designed centrally can result in greater challenges with implementation, due to imposed timescales or objectives. A specific challenge is that time-limited programmes are often not long enough to fully evaluate new services and pathways. It is also important to ensure continuity in terms of learning – some innovators involved in the test bed were not clear about what would happen next. It will be important to consider how to spread the learning from the test bed, including the implications for the scale, spread and sustainability of the innovations.

Workforce

Both the NHS and the social care sector face significant workforce challenges. Supporting and developing the NHS workforce continues to feature as a key element of national health policy; even more so in light of learning from the Covid-19 pandemic and the recent publication of the NHS People Plan.[87] Revisiting the skill mix, task shifting and achieving a greater balance of generalist/specialist roles have been identified as potential solutions to workforce shortages in health and social care.[88] Furthermore, developing a digital workforce with a specific skillset adapted to the technological change required will be essential if health and social care organisations are to make the best use of digital opportunities.[89]

The focus on workforce development in the Care City test bed has provided novel insights and opportunities for learning, including some of the facilitators and barriers to upskilling, and in settings such as domiciliary care which have traditionally not received much attention.[90] Workforce development was demonstrated in two of the three settings; namely in the domiciliary care and digital prescribing clusters. In these clusters, the development of new skills was more diffuse than the increase in productivity satisfaction, and digital capability that was initially anticipated; rather it also involved increased knowledge of health information, confidence and empowerment.

Upskilling was also experienced by a wider range of staff roles than originally planned. In the domiciliary care cluster, implementation leads within care agencies made use of creativity and project management skills to adapt the technologies to the specificity of their setting. Implementation literature finds that embedding technologies into health[91] and social care[92] settings is best achieved when middle management roles are well supported to 'diffus[e] information, synthesis[e] information, mediat[e] between strategy and day-to-day activities, and sell innovation implementation'.[91] In addition, studies have demonstrated the value of having a specific role dedicated to supporting implementation.[1] The findings of the Care City test bed

suggest that the role of implementation lead should be considered a key element to scaling up to wider settings, and in particular in domiciliary care.

The test bed findings also highlight the importance of selecting appropriate roles for upskilling. In the digital prescribing cluster, Care City had a significant input in supporting healthcare assistants to recruit service users, and in the cardiac rehabilitation cluster, focus was shifted away from patient administrators. Clarity over whose role changes are necessitated in order to adopt and implement innovations can help to accelerate progress.

The upskilling evidenced in domiciliary care and primary care led to increased empowerment and job satisfaction for staff. However, local and national plans to adopt similar roles will need to consider the potential consequences of over-skilling a workforce role where additional responsibilities are not linked to opportunities for pay and progression and changed attitudes to risk.[88] Successful change at scale will need to consider payment systems which reward staff for making the desired changes to their working practices and support the additional responsibilities their new role entails. This is especially important in the domiciliary care sector, where no structured career pathway currently exists;[7] a consequence of which could be staff moving on to other roles. Efforts to embed the expert carer role, alongside appropriate remuneration, are currently under way in East London under the expertise of Care City.

Concluding remarks

The Care City test bed programme demonstrates the complexity of implementing digital solutions in practice, as well as what can be achieved through collaborative working between service providers and innovators, along with dedicated implementation support. Our evaluation, undertaken alongside the Care City team, informed the implementation of the innovations and has generated detailed evidence about each of the pathways within the test bed, and wider lessons for national policy, local teams and systems, innovators and evaluators. These lessons are drawn together in the key messages chapter of the report.

The test bed programme was impacted by the Covid-19 pandemic. Some testing was halted or postponed, and data collection required for the evaluation was also curtailed or delayed. Significantly, the pandemic resulted in changes across the health system, with a reduction in some services, such as cardiac rehabilitation, and primary care services moving rapidly to a digital-first model.[63] These changes make comparison between the test bed patients and those receiving usual care difficult to interpret, and alter the context in which services operate significantly. In particular, digital services have become the norm rather than the exception, which may have made the test bed innovations more acceptable to patients and staff during the course of implementation.

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Appendix 1: Qualitative evaluation

Table 1: Pre-implementation qualitative evaluation activity

	Qualitative interviews				Observation	
	Care City team	Innovators	Implementation leads	Clinical lead	Co-design sessions	Training sessions
Test Bed wide	✓ N = 4	-	-	-	-	-
Domiciliary care cluster	✓ N = 1	✓ N = 2	✓ N = 3	✓ N = 1	✓ N = 2	✓ N = 4
Digital prescribing cluster	✓ N = 1	✓ N = 4	✓ N = 3	✓ N = 1	-	✓ N = 6
Cardiac rehabilitation cluster	✓ N = 1	✓ N = 3	✓ N = 1	✓ N = 1	✓ N = 2	✓ N = 2

Table 2: Implementation qualitative evaluation activity

	Qualitative interviews		Surveys		Observation	
	Frontline staff	Service users	Frontline staff	Service users	Follow-up calls	Co-design sessions
Domiciliary care cluster	✓ N = 7	✓ N = 2	✓ N = 4	✓ N = 10	-	✓ N = 1
Digital prescribing cluster	✓ N = 8	✓ N = 10	-	✓ N = 31	✓ N = 11	✓ N = 3
Cardiac rehabilitation cluster	✓ N = 3	✓ N = 1	-	-	-	✓ N = 2

Table 3: Post-implementation qualitative evaluation activity

	Qualitative interviews				Observation	
	Care City team	Innovators	Implementation lead	Clinical lead	Co-design sessions	Training sessions
Test Bed wide	✓ N = 4	-	-	-	-	-
Domiciliary care cluster	✓ N = 1	✓ N = 2	✓ N = 4	✓ N = 1	✓ N = 1	-
Digital prescribing cluster	✓ N = 5	✓ N = 4	✓ N = 4	✓ N = 1	-	-
Cardiac rehabilitation cluster	✓ N = 1	✓ N = 1	✓ N = 1	✓ N = 1	-	-

Appendix 2: Sample interview topic guides

Sample baseline interview protocol with Innovator / Care City team

**The topics covered were revisited for follow-up interviews to see how views had changed over time, follow-up interviews also included questions related to scaling up and lessons.*

Your role and responsibilities

1. When did you join [Care City / Innovation team]?
    - *When did you start working on the test bed?*
2. Describe your key roles and responsibilities in relation to the test bed.
    - *What amount of time did you spend working on the test bed?*
3. What barriers have you faced in delivering on your assigned role and responsibilities?
    - *Having to do things that were not initially described*
    - *Unable to deliver on things described*

The innovation *(for innovators only)*

4. Describe the key features of the innovation.
    - *Target patient group? Expectations of participating patients?*
    - *Have there been any changes to the patient cohort?*
    - *Main aims/ value (compared to usual care)?*
    - *Target organisations (primary care, hospitals, care homes)?*
5. What are the benefits that you focus on in your marketing?
    - *Improved quality/patient experience? Reductions in other care costs (prescribing)? Staff time/workload savings? Risk reduction?*
6. What sources of evidence do you use for your marketing?
    - *Published research? Own data/case studies?*
7. What training (knowledge/ support) is required to use the innovation?
    - *Staff?*
    - *Patients?*

Test bed and cluster development

8. What were your motivations for getting involved in the test bed?
9. What would you say is the purpose of the test bed?
10. What would success look like for the test Bed?
    - *As a whole?*
    - *For you as part of the test bed?*
    - *In the local or wider national context?*
    - *Has your perception of success changed as the test bed has progressed? If so, how?*
11. What is your understanding of why a cluster approach was adopted?
    - *What do you think are the benefits and drawbacks of a cluster approach?*

12. What is your understanding of how your cluster was developed?
    - *How and why were particular innovations chosen?*
    - *How and why were the innovations grouped together?*
    - *How and why were the groups of innovations matched with particular workforce roles or vice versa?*
13. How far do you think the innovation is amenable to upskilling the [domiciliary carer, healthcare assistant, patient administrator] workforce?
    - *Do you think [the workforce] wanted to use the innovation?*
    - *Do you think [the workforce] was be able to use the innovation?*
        - *Capacity*
        - *Skills*
        - *Prioritisation*
        - *Contextual*
14. What do you see as the barriers to staff using the innovation?
15. How far do you think the innovation is amenable to the particular patient cohort?
    - *Do you think they wanted to use the innovation?*
    - *Do you think they were be able to use the innovation?*
        - *Capacity*
        - *Skills*
        - *Prioritisation*
        - *Contextual*
16. What do you see as the barriers to patients using the innovation?
17. How far do you think implementing [the innovation] is a priority for the [pilot sites]?
    - *Engagement/ buy-in to the test bed?*
    - *Problem innovation aims to address is a priority (e.g. diabetes, non-adherence to cardiac rehab)*

<u>Working with partners</u>

Co-design (For Care City team)

18. What does successful co-design look like for this cluster?
    - *At bid stage/pre-implementation/post-implementation*
    - *How does this differ for patients and professionals?*
    - *What are the deliverables and milestones?*
19. Has this vision been achieved to date? Why/why not?
    - *What activities have taken place to date?*
    - *What are the main issues to have come out of co-design?*

Clinical leads

20. What are your expectations of clinical leads?
21. Have clinical leads meet those expectations so far? If not, why not?
22. Have you experienced any challenges when working with clinical leads?
23. If so, why do you think those challenges have occurred?

- *How have you addressed them?*

Implementing sites

24. What are your expectations of implementing sites?
25. Have the implementing sites met those expectations to date? If not, why not?
26. Have you experienced any challenges when working with the implementing sites?
27. If so, why do you think those challenges have occurred?
    - *How have you addressed them?*

Innovators (for Care City team only)

28. What were your expectations of the innovators?
29. Have the innovators met those expectations so far? If not, why not?
30. Have you experienced any challenges when working with the innovators?
31. If so, why do you think those challenges have occurred?
    - *How have you addressed them?*

Adoption partners (for Care City team)

32. What are your expectations of adoption partners?
33. Have adoption partners met those expectations to date? If not, why not?
34. Have you experienced any challenges when working with adoption partners?
    - *If so, how have you addressed them?*

Challenges and risks

35. Overall, what are your reflections of the test bed programme so far?
    - *Structure of the programme*
    - *Effectiveness as an approach for testing innovations*
    - *Particular challenges faced*
36. If not already covered, what have been the biggest challenges so far?
37. How have you addressed these challenges?
38. What do you see as the main risks to successful implementation as the test bed progresses?
39. Have there been any unintended consequences from the work you have done to date?

Sample baseline interview protocol with implementation leads

You, your role and responsibilities

1. What is your understanding of the purpose of the Care City Test Bed as a whole?
2. What is your understanding of the Lead Implementer role within the Test Bed?
    - *How did you end up taking on that role?*
3. Describe your key roles and responsibilities in relation to the Test Bed.
    - *What innovation are you working on?*

- *Who are you working with?*

4. Have you faced any barriers in delivering on your assigned role and responsibilities? If so, what?

<u>The innovation</u>

5. What is/ are the problem/s that the innovation is aiming to solve?
6. How far is addressing this problem a priority for your organisation/ team?
    - *Are there sufficient resources?*
    - *Is there organisational leadership/ buy-in to the innovation?*
7. To what extent is implementing the innovation an appropriate solution to the problem?
8. Do you know if the innovation has been used elsewhere in a real-world setting?
    - *Understanding of other evaluations/ academic literature?*
9. What is your understanding of the potential benefits of the innovation relative to usual care?
    - *What needs to happen to deliver these benefits?*
    - *What is your view on whether the innovation will deliver these benefits in your organisation? Why/why not?*
10. What is your understanding of the potential disadvantages of the innovation relative to usual care?
11. Compared to their usual role, what will staff have to do differently to implement the innovation?
    - *Do you think [the workforce] will want to use the innovation?*
    - *Do you think [the workforce] will be able to use the innovation?*
        - *Capacity*
        - *Skills/ confidence*
        - *Prioritisation*
12. Will staff gain additional skills in supporting use of the innovations?
    - *If so what?*
    - *How will they be supported to gain those skills? (e.g. additional training)*
13. What do you see as the barriers to staff using the innovation?
    - *How might they be overcome?*
    - *What is Care City's role in this?*
14. What is your understanding of how the service user cohort was decided?
    - *Do you think they will want to use the innovation?*
    - *Do you think they will be able to use the innovation?*
        - *Capacity*
        - *Skills/ confidence*
        - *Prioritisation*
15. What do you see as the barriers to service users using the innovation?
    - *How might they be overcome?*
    - *What is Care City's role in this?*

<u>Preparing for implementation</u>

16. Describe the training you have received on the innovation.
    - *What was the format? (E.g. Demonstrations of how the app works, workshops, manuals etc.)*
    - *Who delivered the training? (Care City, innovators?)*
    - *What (if any) issues were raised during the training? (E.g. potential barriers for staff, service users, technological issues)*
    - *Was the training sufficient?*
    - *How confident do you feel using the innovation with service users?*
17. Beyond the training, how have you engaged staff around using the innovation?
    - *Have any of the implementation team expressed any concerns around the innovation/ Test Bed pilot? Have they been addressed? If so, how?*
    - *Has anyone outside the implementation team (e.g. any organisational leaders) expressed any concerns around the innovation/ Test Bed pilot? Have they been addressed? If so, how?*
18. What is your understanding of the role of the logic model in implementation?
19. What things have helped with implementation planning so far?
    - *Care City role/ the innovators*
    - *Support from colleagues/ Clinical Lead*
    - *Time/ capacity*
20. What challenges with implementation have you faced to date?
    - *Site specific*
    - *Technology*
    - *Service user/ staff lack of engagement*
    - *Care City issues*
21. What are the main risks to implementing the innovation successfully?
    - *Site specific*
    - *Technology*
    - *Service user/ staff lack of engagement*
    - *Care City issues*

<u>Working with partners</u>

Innovators

22. How have you worked with innovators?
23. Have they provided support with implementation? If so, what?
    - *Was this sufficient?*
24. Have you experienced any challenges working with innovators? If so, what?
    - *How have these been addressed?*

Care City

25. What is your understanding of Care City's role?
26. How have you worked with Care City?
27. Have they provided support with implementation? If so, what?

- *Was this sufficient?*

28. Have you experienced any challenges working with Care City? If so, what?
    - *How have these been addressed?*

The evaluators

29. How have you worked with the evaluators?
30. Have they provided support with implementation? If so, what?
    - *Was this sufficient?*
31. Have you experienced any challenges working with the evaluators? If so, what?
    - *How have these been addressed?*

Success and scale

32. What would successful implementation of the innovation look like?
    - *At the end of the Test Bed (March 2020)?*
    - *Beyond the end of the Test Bed?*
33. What factors would influence how successful implementation might be outside of the Test Bed context?
    - *Role of Care City*
    - *Characteristics of the site*
    - *Local context/ population*

Sample interview protocol for users of the innovation

Part 1: Introductory questions

1. When were you diagnosed with [your health condition]?
2. What support have you previously received from health professionals for [your health condition]?
    - *Discussed with GP? Contact with other services?*
    - *When?*
    - *Ongoing problem or new problem?*
3. Are you currently taking any prescribed medication for [your health condition]?
    - *If so, what is it?*
    - *How long have you been taking it?*
    - *Why were you prescribed it?*
4. Why did you decide to use [the innovation]?

Part 2: Introduction to the innovation

5. Please describe how you were introduced to [the innovation]
    - *Description of pathway – e.g. during routine appointment, upon diagnosis, on referral*

6. To what extent did you understand what using [the innovation] would entail when it was first explained to you?
    - *Was there anything you were unsure of at the time?*
    - *Looking back, is there anything you would have liked more information about?*
7. How did you feel about using [the innovation] when you were first told about it?
   Ask in relation to:
    - *Acceptability of using a digital app*
    - *Confidence in own skills to successfully use the programme*
8. How confident did you feel to start using [the innovation] after you were introduced to it?
    - *Why?*

Part 3: Engagement with the innovation

9. Please talk me through how you used [the innovation].
10. How easy did you find [the innovation] to use?
11. Did you experience any challenges when using [the innovation]?
    - *E.g. Language, technical barriers*
12. How far has your healthcare professional supported you to use [the innovation]?
    Prompts below depending on pathway:
    - *Weekly calls or follow-up calls*
    - *Is there any support you would have liked your healthcare assistant to provide that they didn't provide?*
13. How satisfied are you with the professional support you had to use [the innovation] overall?
    - *Why?*
    - *If not satisfied, what did you need additional support with?*
14. Has anyone other than your healthcare professional/Care City supported you to use [the innovation]?
    - *If so, what support have they provided?*
    - *Would you have liked this support to have been provided by a healthcare professional?*

Part 4: Levels of satisfaction

15. How far do you feel [the innovation] has supported you to (depending on pathway/ health condition):
    - *Improve understanding of your condition*
    - *Make lifestyle changes with regard to diet and exercise*
16. How far will you continue to use [the innovation]/ tips and advice recommended in the programme?
17. How likely are you to recommend [the innovation] to friends and family if they needed similar care or treatment?
    - *Why/why not?*
18. Is there anything that would have improved your use and experience of [the innovation]?
    - Why?

Concluding question

19. Is there anything about your use or experience of [the innovation] that we have not covered that you would like to add?

Appendix 3: Regression models for predicting outcomes among patients referred for Liva

This appendix describes the regression models that were developed from the control patients in order to predict outcomes among those referred for Liva.

There are six models in total: three for predicting HbA1c levels, at six, nine and twelve months follow-up, and three, similarly, for BMI. In practice, since follow-up visits did not occur exactly at these intervals, we chose follow-up periods of 4.5 to 7.5 months, 7.5 to 10.5 months and 10.5 to 13.5 months respectively. If more than one measurement was taken in those periods, we chose that which was taken closest to the mid-point of the period. This also enabled us to make best use of the amount of follow-up data we had.

The parameters for the HbA1c models are shown in Table 1, and for the BMI models in Table 2.

Table 1: Regression models for predicting HbA1c levels at six, nine and twelve months.

	6 month follow-up		**9 month follow-up**		**12 month follow-up**	
Parameter	**Estimate**	**95% confidence interval**	**Estimate**	**95% confidence interval**	**Estimate**	**95% confidence interval**
Intercept	0.23	(0.148, 0.312)	0.242	(0.120, 0.364)	0.325	(0.229, 0.421)
Baseline HbA1c	0.615	(0.560, 0.669)	0.7	(0.617, 0.784)	0.596	(0.523, 0.670)
Baseline BMI	0.001	(-0.001, 0.002)	0.001	(-0.002, 0.004)	0	(-0.002, 0.002)
Ethnicity						
White	Reference category		Reference category		Reference category	
Asian	0.007	(-0.020, 0.034)	-0.012	(-0.052, 0.029)	-0.015	(-0.045, 0.014)
Black	0.026	(-0.004, 0.056)	0.007	(-0.035, 0.049)	0.005	(-0.028, 0.039)
Mixed	-0.039	(-0.127, 0.049)	-0.064	(-0.172, 0.043)	-0.075	(-0.187, 0.038)
Not stated	0.008	(-0.023, 0.040)	0.018	(-0.028, 0.063)	-0.028	(-0.064, 0.007)
Other	0.04	(-0.044, 0.123)	0.033	(-0.077, 0.143)	-0.016	(-0.128, 0.096)
Age band						
< 40	Reference category		Reference category		Reference category	
40-44	-0.019	(-0.073, 0.035)	-0.052	(-0.132, 0.028)	-0.051	(-0.115, 0.014)
45-49	-0.02	(-0.069, 0.030)	-0.07	(-0.143, 0.002)	-0.024	(-0.085, 0.038)
50-54	-0.003	(-0.050, 0.046)	-0.087	(-0.158, -0.016)	-0.045	(-0.107, 0.016)
55-59	0.015	(-0.032, 0.061)	-0.079	(-0.149, -0.009)	-0.023	(-0.082, 0.036)
60-64	-0.031	(-0.079, 0.017)	-0.062	(-0.133, 0.008)	-0.046	(-0.107, 0.015)
65-69	-0.035	(-0.085, 0.015)	-0.104	(-0.181, -0.028)	-0.089	(-0.151, -0.027)
70-74	-0.01	(-0.065, 0.046)	-0.109	(-0.188, -0.029)	-0.066	(-0.132, -0.001)
75-79	-0.01	(-0.070, 0.049)	-0.126	(-0.212, -0.040)	-0.084	(-0.152, -0.016)
80+	-0.048	(-0.107, 0.011)	-0.125	(-0.210, -0.041)	-0.086	(-0.153, -0.020)
Gender						
Male	Reference category		Reference category		Reference category	
Female	-0.008	(-0.029, 0.012)	-0.002	(-0.031, 0.027)	-0.007	(-0.029, 0.015)
Prior Metformin use	-0.016	(-0.037, 0.004)	-0.012	(-0.042, 0.018)	0.001	(-0.022, 0.024)
Use of DESMOND	-0.012	(-0.064, 0.040)	-0.014	(-0.076, 0.048)	-0.037	(-0.090, 0.017)
Duration of diabetes prior to baseline						
< 3 months	-0.092	(-0.156, -0.027)	-0.02	(-0.111, 0.071)	-0.063	(-0.131, 0.004)
3 to 12 months	-0.035	(-0.070, 0.000)	-0.019	(-0.074, 0.035)	-0.047	(-0.082, -0.011)

1 to 7 years	Reference category		Reference category		Reference category	
> 7 years	-0.009	(-0.048, 0.031)	0.051	(0.001, 0.102)	0.027	(-0.020, 0.074)

Table 2: Regression models for predicting BMI at six, nine and twelve months.

	6 month follow-up		**9 month follow-up**		**12 month follow-up**	
Parameter	**Estimate**	**95% confidence interval**	**Estimate**	**95% confidence interval**	**Estimate**	**95% confidence interval**
Intercept	1.026	(-0.281, 2.333)	3.083	(1.752, 4.415)	1.568	(0.158, 2.979)
Baseline HbA1c	-0.497	(-1.394, 0.399)	-0.181	(-1.235, 0.872)	0.279	(-0.793, 1.350)
Baseline BMI	0.948	(0.922, 0.974)	0.909	(0.883, 0.935)	0.921	(0.893, 0.948)
Ethnicity						
White	Reference category		Reference category		Reference category	
Asian	-0.327	(-0.783, 0.128)	-0.309	(-0.761, 0.143)	-0.193	(-0.652, 0.266)
Black	0.145	(-0.334, 0.624)	-0.17	(-0.638, 0.298)	0.131	(-0.370, 0.633)
Mixed	0.075	(-1.398, 1.549)	0.963	(-0.654, 2.580)	0.223	(-0.895, 1.340)
Not stated	-0.745	(-1.262, -0.228)	-0.487	(-1.002, 0.028)	-0.861	(-1.441, -0.281)
Other	-0.602	(-1.695, 0.492)	-0.27	(-1.708, 1.168)	0.201	(-1.017, 1.419)
Age band						
< 40	Reference category		Reference category		Reference category	
40-44	0.93	(0.014, 1.847)	0.152	(-0.732, 1.037)	0.598	(-0.364, 1.561)
45-49	1.015	(0.162, 1.867)	-0.405	(-1.210, 0.401)	0.273	(-0.602, 1.147)
50-54	1.037	(0.211, 1.864)	-0.057	(-0.830, 0.716)	0.348	(-0.519, 1.215)
55-59	0.943	(0.102, 1.784)	-0.423	(-1.186, 0.341)	0.559	(-0.306, 1.425)
60-64	0.81	(0.000, 1.621)	-0.131	(-0.922, 0.661)	0.692	(-0.185, 1.569)
65-69	0.728	(-0.135, 1.591)	-0.801	(-1.616, 0.014)	0.34	(-0.558, 1.239)
70-74	0.704	(-0.231, 1.639)	-0.298	(-1.135, 0.538)	0.478	(-0.479, 1.434)
75-79	0.656	(-0.426, 1.737)	-0.864	(-1.806, 0.078)	0.411	(-0.589, 1.411)
80+	0.712	(-0.302, 1.725)	-1.263	(-2.225, -0.301)	-0.024	(-1.030, 0.983)
Gender						
Male	Reference category		Reference category		Reference category	
Female	0.173	(-0.161, 0.508)	0.126	(-0.205, 0.456)	0.261	(-0.080, 0.602)
Prior Metformin use	0.149	(-0.190, 0.488)	-0.097	(-0.438, 0.243)	0.376	(0.024, 0.728)
Use of DESMOND	0.072	(-0.711, 0.855)	0.408	(-0.299, 1.115)	-0.034	(-0.754, 0.686)
Duration of diabetes prior to baseline						
< 3 months	-0.148	(-0.875, 0.579)	0.026	(-0.777, 0.830)	0.21	(-0.559, 0.979)

3 to 12 months	-0.034	(-0.616, 0.547)	0.258	(-0.286, 0.803)	0.619	(0.008, 1.231)
1 to 7 years	Reference category		Reference category		Reference category	
> 7 years	0.133	(-0.444, 0.710)	0.259	(-0.309, 0.828)	0.159	(-0.599, 0.916)

Appendix 4: unit cost of innovations and eligible populations for scale up

Unit costs of innovations were calculated to provide an estimate of the cost of scaling up the innovation to a larger population, and to apportion costs across sites where the innovation was not already costed on a per patient basis.

The total cost for each innovation (table 1) was calculated including:

- Implementation time from the Care City team
- Implementation time from staff at implementing sites
- Innovator costs within the Test Bed. These costs are those relevant to pathway and service implemented in the Test Bed, and are not necessarily indicative of implementation costs in other settings, or pricing model currently used by innovator.

In this analysis, average costs have been used across sites. It should be noted that there was considerable variation between sites, depending on how they implemented the innovation and level of engagement and uptake.

The denominators for calculating unit costs were those most relevant to the costing model, usually based on the number of people who received the service. Estimates of costs to scale up the innovation therefore take account of estimates of uptake of the innovation (table2).

*Table 1: Unit costs of innovations**

Innovation	Unit	Implementation costs (Care City and implementors)	Licensing/kit costs for test bed	Total cost for test bed	Unit cost
Whzan	Clients tested	£11,880	£19,857	£31,737	£529
Liva	Patients onboarded with Liva	£7,634	£22,111	£29,745	£268
ACR test	Patients tested	£260	£8,326	£8,586	£17

Sleepio	Patient engaged with Sleepio	£6,292	£2,917	£9,209		£84

* not undertaken for Dip.io or TickerFit due to small number of users in the test bed

*Table 2: Eligible population estimates for scaling up innovations**

Innovation	Eligible cohort definition	Eligible cohort – source	Eligible population rate/1,000	Uptake rate	Notes re uptake	Expected users/1,000 population adjusted for uptake
Whzan	People receiving domiciliary care	Number of domiciliary care users in England estimated to be 576,600, ie 10.3/1000 population	10.3	0.25	Estimated from test bed - uptake rate for the agency which invited all clients to use Whzan. Other agencies were selective or had only CCG funded (and therefore more frail clients)	2.58
Liva	Newly diagnosed diabetics	Estimated from prevalence rate of diabetes, proportion of adults in population and rate of newly diagnosed diabetics	5.30	0.266	Estimate of 111/418 from test bed	1.41
Healthy.io	Diabetics who have not had an ACR test in last 12 months	Estimate from QOF data (adult patients only)	11.5	0.46	From test bed	5.25
Sleepio	People with insomnia	Estimated from prevalence of diabetes and proportion of adults in population	78	0.1	Sleepio estimate from previous studies	7.80

* not undertaken for Dip.io or Tickerfit due to small number of users in the test bed

Nuffield Trust is an independent health think tank. We aim to improve the quality of health care in the UK by providing evidence-based research and policy analysis and informing and generating debate.

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