A rapid mixed-methods evaluation of remote home monitoring models during the COVID-19 pandemic in England

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Disclosure of interests of authors

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Primary conflicts of interest: Professor Fulop is an NIHR senior investigator and was a member of the NIHR Health Services and Delivery Research (HS&DR) Programme Funding Committee (2013–18), HS&DR Evidence Synthesis Sub Board (2016). She was a trustee of Health Services Research UK (to November 2022). She is the UCL-nominated non-executive director for Whittington Health NHS Trust (2018–) and non-executive director on the board of Covid Bereaved Families for Justice. Professor Morris was formerly a member of the NIHR HS&DR Programme Funding Committee (2014–16), the NIHR HS&DR Evidence Synthesis Sub Board (2016), the NIHR Unmet Need Sub Board, the NIHR HTA Clinical Evaluation and Trials Board (2007–9), the NIHR HTA Commissioning Board (2009–13), the NIHR PHR Research Funding Board (2011–17), and the NIHR Programme Grants for Applied Research expert subpanel (2015–19). The remaining authors have no competing interests to declare.

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Scientific summary

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Scientific summary

Background and rationale

Delays in the presentation of patients with COVID-19 has led to patients arriving at hospital with very low oxygen saturations often without breathlessness ('silent hypoxia'). This has resulted in patients being admitted to hospital with advanced COVID-19, thus requiring invasive treatment, potential admission to intensive care and poorer outcomes.

Remote home monitoring models that systematically record and communicate patients' physiological parameters to clinicians are currently being used globally for a variety of conditions. These models offer a potential solution for reducing the delays in providing appropriate treatment for patients with COVID-19 by identifying at-risk patients earlier.

As a result, services providing remote home monitoring using pulse oximetry for patients with COVID-19 were developed ad hoc in some areas in England during the first wave of the pandemic (March to July 2020). Learning from these earlier services, NHS England and NHS Improvement (in November 2020) launched a national roll-out of a model of care called 'COVID Oximetry @home (CO@h)', followed by early discharge models, referred to as 'virtual wards' (in January 2021). We refer to these services as COVID-19 remote home monitoring services. All of these services provide patients with an oximeter and ask them to regularly record and relay their oxygen levels (alongside other generic COVID-19 symptoms) to a supporting team of administrators and clinicians via a smartphone application (app), e-mail or online portal, or over the telephone. Patients being monitored are escalated to receive additional care if necessary.

Previous research has explored remote home monitoring for other conditions, but there is a lack of research on the effectiveness, cost, implementation and staff/patient experiences of remote home monitoring models for COVID-19. This study explored the impact and implications of these COVID-19 remote home monitoring services during the first and second waves of the pandemic.

Phase 1

Phase 1 of this evaluation (during the first wave of the pandemic) aimed to answer the following research questions:

1. How have remote home monitoring services been implemented for COVID-19 and what are their main components, processes of implementation, target patient populations, impact on outcomes, costs and lessons learned?
2. What were the characteristics of remote home monitoring models for COVID-19, experiences of staff implementing these models, data processes and lessons learned during wave 1 of the pandemic?

Phase 2

Phase 2 of this evaluation (during wave 2 of the pandemic) aimed to answer the following research questions:

1. Are COVID-19 remote home monitoring services associated with changes in mortality and use of hospital services? Does the use of tech-enabled oximetry have a measurable effect on mortality and hospitalisations?

2. What were the costs of setting up and running COVID-19 remote home monitoring services and how do these costs vary between tech-enabled and analogue, and analogue-only data submission modes?
3. What are the factors influencing delivery and implementation of COVID-19 remote home monitoring services? Do these vary by type of model, geography, mode of remote monitoring approach (tech-enabled vs. analogue)?
4. What are the experiences and behaviours (i.e. engagement with services, use of other services) of patients receiving COVID-19 remote home monitoring services? Do these vary by type of model, patient characteristics, mode of remote monitoring (tech-enabled vs. analogue)?
5. Are there potential impacts on inequalities?
6. What are the experiences of staff delivering COVID-19 remote home monitoring services? Do these vary by mode of remote monitoring (tech-enabled vs. analogue)?

Methods

This study used mixed methods consisting of two phases.

Phase 1

Phase 1 (data collected between July and August 2020) comprised a rapid systematic review (*n* = 27 articles) and an empirical mixed-methods implementation study of staff experiences, the use of data for monitoring progress against outcomes, variability in staffing and resource allocation, patient numbers and impact and lessons learnt (in eight sites).

Phase 2

Phase 2 (data collected between January and June 2021) was a large-scale, multisite, mixed-methods study, including: effectiveness, cost analysis, implementation and patient/staff experience (in 28 sites). To explore impact and effectiveness of remote home monitoring services relating to hospitalisations and mortality, we used routinely available data, hospital administrative data and aggregated and other information produced by the programme. To explore costs of setting up and running COVID-19 remote home monitoring services, we collected aggregated data on patient numbers, staffing models, and allocation of resources from 26/28 sites. To explore implementation, staff experiences of delivering these services, patient experiences of receiving and engaging with these services (including a focus on inequalities and technology-enabled and analogue vs. analogue-only models), we conducted surveys and interviews with staff, patients and carers, and interviewed national leads.

We involved patients, carers and the public throughout the project. Members of the study team met with members of the Birmingham, RAND and Cambridge Evaluation Centre and Rapid Service Evaluation Team patient and public involvement groups throughout the project (four meetings), to discuss various aspects of the project, including but not limited to the research questions, data collection tools and findings.

Results

A summary of findings is provided in *Figure A*.

FIGURE A Summary of key findings.

Phase 1

Findings from the systematic review indicated that remote home monitoring services have been implemented internationally for COVID-19. Findings from the review and empirical study highlighted that models of remote home monitoring for COVID-19 varied internationally and within England.

Many factors facilitated implementation, including good communication within clinical teams, culturally appropriate information for patients and carers, and the combination of multiple approaches for patient monitoring (app and paper based).

Findings from phase 1 were disseminated widely and used to inform decisions in relation to the future roll-out of services and the design of phase 2.

Phase 2

We received surveys from 292 staff (39% response rate) and 1069 patients/carers (18% response rate), and conducted interviews with 58 staff, 62 patients/carers and 5 national leads.

The rapid development of national remote home monitoring services took place in three phases: local development (during wave 1 of the pandemic), national development and roll-out (between waves 1 and 2 of the pandemic) and local implementation (during wave 2 of the pandemic). Despite national roll-out, enrolment of people to COVID-19 remote home monitoring services was lower than expected and there was large variability in the models of remote home monitoring services that were implemented. This variation was influenced by patient, workforce, organisational and resource factors.

The overall enrolment rate to the service across 37 clinical commissioning groups judged to have complete data was 8.7%. We found that for every 10% increase in enrolment to the programme, mortality was reduced by 2% (95% confidence interval [CI] 4% reduction to 1% increase), admissions increased by 3% (95% CI −1% to 7%), in-hospital mortality fell by 3% (95% CI −8% to 3%) and lengths of stay increased by 1.8% (95% CI −1.2% to 4.9%). None of these results are statistically significant. For COVID virtual wards (CVW), we found that the roll-out of virtual ward services for COVID-19 did not reduce rates of readmission (adjusted odds ratio 0.95, 95% CI 0.89 to 1.02) or lengths of stay in hospital. In fact, our analysis indicated longer lengths of stay (adjusted incidence rate ratio 1.05, 95% CI 1.01 to 1.09).

The mean running cost per patient monitored under the CO@h services was slightly lower compared with CVW services (£527.5 vs. £599.1). For CO@h and CVW services the mean cost per patient monitored at home was lower in sites using both tech-enabled and analogue modes of data submission compared with the sites using analogue-only modes. The majority of staff involved in running COVID-19 remote home monitoring services were clinical staff. Over 50% of staff (clinical and non-clinical staff combined) were employed at band 5 or below in the CO@h service, whereas in CVW services there were slightly more staff on band 6 or above.

Staff generally reported positive experiences of delivery (75% of staff reported a positive impact of their role on job satisfaction); they felt that services were easy to deliver and they valued the support provided. However, findings indicated that staff would have benefited from further training; 41% of service leads and 12% of delivery staff identified further training or support needs. Factors influencing delivery of remote home monitoring services for COVID-19 included: staff knowledge and confidence, NHS resources and capacity on staff workload, multidisciplinary team dynamics, and patient (dis) engagement.

Patients and carers reported positive experiences (93% rated the service as good or excellent) and felt that services and human contact received as part of these services reassured them and were easy to engage with. Findings indicated that patients with COVID-19 can engage with remote monitoring services but may require support from staff and family/friends to do so. Engagement was conditional on a range of factors including patient factors, support and resources, and service characteristics. Findings indicate that burden of treatment may be experienced by patients and families with acute conditions.

Many sites designed their service to be inclusive of the needs of local populations to ensure broad reach, and many sites adapted their service locally to suit specific patient needs to encourage engagement. Despite these local adaptations to services, disparities were reported across patient groups. Age ($p < 0.001$) and level of education ($p < 0.001$) were related to whether patients reported a problem with the service, and health status, ethnicity, gender and level of education were associated with engagement with services, and age ($p = 0.005$) and ethnicity ($p = 0.001$) were associated with patient reports of understanding information.

Most of the services included in this evaluation offered tech-enabled and analogue data submission options to patients. Older patients ($p = 0.005$), patients with a lower level of educational attainment ($p = 0.011$) and ethnic minorities ($p = 0.043$) were more likely to relay symptoms through phone calls with the service. Staff considered the tech-enabled models better equipped to manage large patient numbers; however, many improvements were suggested to improve functionality of technology systems to better fit clinical and operational needs. For patients and staff, tech-enabled and analogue models were not a substitute for human contact, which was a feature of all models. Staff used phone calls to gain comprehensive knowledge of their patients' condition and ensure they had care in the most appropriate setting.

Limitations

One limitation of our evaluation was that data were commonly incomplete or absent and services were not used as extensively as expected; therefore, we were unable to conclusively determine the effectiveness of services. Additional limitations included the inability to link data on service use to outcomes at a patient level, low survey response rates and the under-representation of some patient groups.

Conclusions

Our evaluation was unable to provide conclusive evidence regarding the effectiveness of COVID-19 remote home monitoring services on hospitalisations, lengths of hospital stay and mortality, due to low rates of enrolment and lack of data. Findings also outline large variability in the models implemented in relation to design and intensity of monitoring, workforce, enrolment levels and criteria.

A number of factors influenced implementation including patient, staff, organisational and resource factors. Services were viewed positively by staff and patients alike, but some challenges to delivery and engagement have been identified, so services may not be appropriate for all groups without adaptations. Future remote home monitoring services for COVID-19 and other conditions should ensure that staff are well supported and have capacity to deliver these services, that patients have appropriate support, ability, and understanding to engage with these services. Findings from these studies highlighted the need for quality data to be collected as part of future service implementation in order to enable evaluations of effectiveness in future.

Future research is needed in several areas. For example, longitudinal evidence on the effectiveness and cost-effectiveness of COVID-19 remote home monitoring services (requiring high-quality complete

linked data sets) is needed. Additionally, research on the appropriateness of different models of remote home monitoring services for different groups of patients, and experiences of staff, patients and carers whose views may not have been captured within this evaluation are needed.

Study registration

This study is registered with the ISRCTN (14962466).

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This report

The research reported here is the product of an HSDR Rapid Service Evaluation Team, contracted to undertake real time evaluations of innovations and development in health and care services, which will generate evidence of national relevance. Other evaluations by the HSDR Rapid Service Evaluation Teams are available in the HSDR journal.

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RSET: The Rapid Service Evaluation Team

The Rapid Service Evaluation Team ('RSET'), comprising health service researchers, health economists and other colleagues from University College London and the Nuffield Trust, have come together to rapidly evaluate new ways of providing and organising care. We have been funded by the National Institute for Health Research (NIHR) Health Service and Delivery Research (HS&DR) programme for five years, starting on April 1st 2018.

RSET are completing rapid evaluations with respect to:

1. The impact of services on how well patients do (e.g. their quality of life, how likely patients are to recover);
2. Whether services give people the right care at the right time;
3. Whether these services are good value for money;
4. how changes are put into practice, and what patients, carers, and staff think about how the changes happened and whether they think the changes made a difference;
5. What lessons there are for the rest of the NHS and care.

BRACE: The NIHR Birmingham, RAND and Cambridge Rapid Evaluation Centre

The NIHR BRACE Rapid Evaluation Centre (National Institute for Health Research Birmingham, RAND and Cambridge Evaluation Centre) is a collaboration between the Health Services Management Centre at the University of Birmingham, the independent research organisation RAND Europe, the Department of Public Health and Primary Care at the University of Cambridge, and National Voices. BRACE carries out rapid evaluations of innovations in the organisation and delivery of health and care services. Its work is guided by three overarching principles:

1. Responsiveness. Ready to scope, design, undertake and disseminate evaluation research in a manner that is timely and appropriately rapid, pushing at the boundaries of typical research timescales and approaches, and enabling innovation in evaluative practice.
2. Relevance. Working closely with patients, managers, clinicians and health care professionals, and others from health and care, in the identification, prioritisation, design, delivery and dissemination of evaluation research in a co-produced and iterative manner.
3. Rigour. All evaluation undertaken by the team is theoretically and methodologically sound, producing highly credible and timely evidence to support planning, action and practice.