Rapid evaluation of remote home monitoring models during COVID-19 pandemic in England

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RSET BRACE Rapid Evaluation Centre

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Study aims

- Develop a typology of remote home monitoring models (including their key characteristics) operating during first wave of the COVID-19 pandemic
- Explore experiences of staff implementing these models
- Understand the use of data for monitoring progress against outcomes
- Document variability in staffing and resource allocation
- Document patient numbers and impact
- **Draw out lessons learned for development of models for winter 2020-2021**
- Identify areas for further research

Methods

- Workstream 1: Rapid systematic review of the use of remote home monitoring during the COVID-19 pandemic

- Workstream 2: Qualitative fieldwork
  - **22 telephone/online interviews** with staff in **eight pilot sites** across England (project leads, staff delivering interventions and data analysts)
  - Documentary analysis

- Data analysis
  - Resource use
  - Staffing
  - Patient numbers and outcomes

- Study timeframe: July – September 2020

Workstream 1: Rapid systematic review design

Research questions

1.What are the aims and designs of remote home monitoring models?
2.What are the main stages involved in remote home monitoring for COVID-19?
3.What are the patient populations considered appropriate for remote monitoring?
4.How is patient deterioration determined and flagged?
5.What are the expected outcomes of implementing remote home monitoring?
6.What was their impact on outcomes?
7.What are the benefits and limitations of implementing these models?

Designed as a rapid systematic review based on the method developed by Tricco et al. (2017).

Followed PRISMA and protocol registered on PROSPERO (CRD:42020202888).

Developed a phased search strategy based on key terms and ran searches on MEDLINE, CINAHL PLUS, EMBASE, TRIP and Web of Science (including peer-reviewed and grey literature).

Dual screening and cross-checking of study selection and data extraction. Quality assessment was not carried out due to the variability of included articles.

16 articles reporting on 17 examples of remote home monitoring models from seven countries were included in the review.

15 led by secondary care, 2 by primary care.

9 functioned as pre-admission, 3 as step-down wards, and 5 models combined both.

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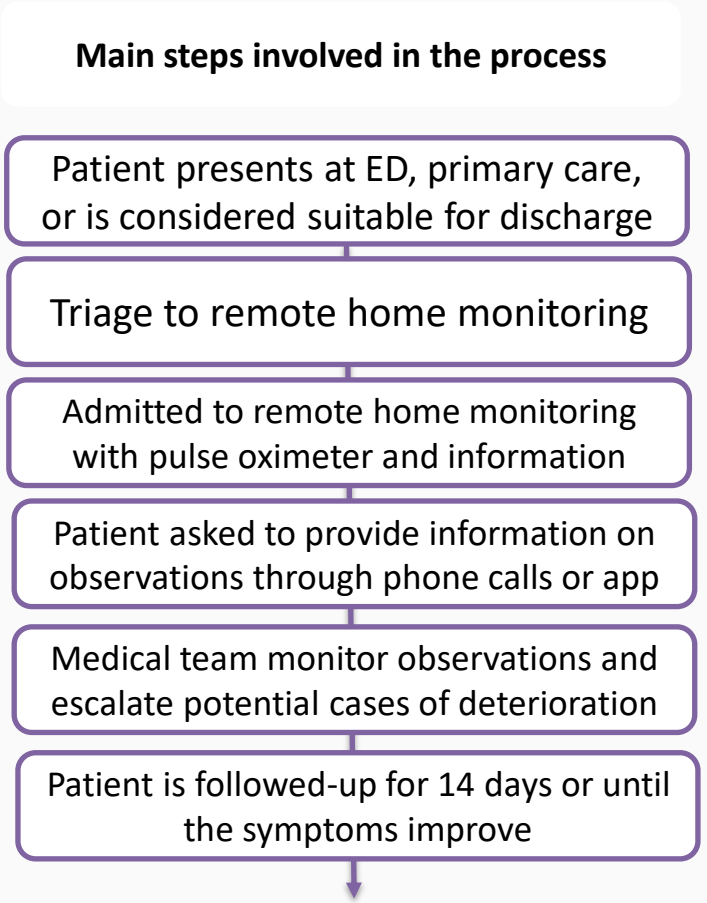
Rapid systematic review: findings

- Important to avoid framing the remote home monitoring model as an admission avoidance model; instead see it as an approach to **maintain patients safe in the right setting.**
- **Use of apps** for monitoring allowed the follow-up of a higher number of patients (compared to paper-based models), but some of the studies indicated that models based on **telephone calls were more inclusive** (i.e. including patients without internet access or technological literacy).
- **Patient/carer training** was identified as a key determining factor of the success of these models.
- **Coordination between primary and secondary care** facilitated implementation
- **Primary care led** models were considered in some cases as more adaptable to evolving patient and system needs, and easier to replicate in contexts with limited secondary care access and capacity.
- A few models have **integrated mental health and social care support** during and after patient monitoring, highlighting a wide range of patient needs.

Source: Vindrola et al (preprint): https://www.medrxiv.org/content/10.1101/2020.10.07.20208587v2

Workstream 2: Rapid empirical study of remote home monitoring models

- ***Aim***: monitor patients considered high-risk who can be safely be managed at home to: 1) avoid unnecessary hospital admissions (appropriate care in the appropriate place), and 2) escalate cases of deterioration at an earlier stage to avoid ventilation and ICU admission.



Workstream 2: sites operating remote monitoring using pulse oximetry during first wave

	Pilot site name	Setting	Population size	Implementation stage	Main outcomes of interest	Patient-reported data
1.	Royal Free	Secondary care (ED)		Started 23 March	Reattendance ED Admission 30 day mortality Patient satisfaction	Phone/paper-based
2.	Winchester City	Primary care	17,500	Started 6 April	O2 saturation Use of antibiotics Admission hospital ICU admission 30 day mortality	Phone/paper-based
3.	Winchester (Royal Hampshire)	Secondary care (ED)	570,000	Implementation (started 14 May)	Ventilation Mortality Reattendance to ED Admission ICU admission 999 call	Phone/paper-based
4.	Royal Berkshire Hospital (TICC-19), Reading	Secondary care (referrals from ED, ward step down, and primary care)	500,000	2 April	Re-admission rate Patient experience	Phone/paper-based
5.	West Hertfordshire (Watford)	Secondary care (ED)	500,000	14 March	Readmission ICU admission Mortality	App (Medopad) and phone/paper-based
6.	Manchester University Foundation Trust *	Secondary care (step down model)	500,000	19 March	Mortality Re-attendance Avoid unnecessary admissions	Phone/paper-based
7.	NHS Tees Valley CCG COVID-19 Virtual Ward Vanguard Bid	Secondary care (step-down model), planning primary care model	700,000	Early implementation (started 8 June only for secondary care) Primary care started late July.	Unplanned admissions Mortality Protected hospital capacity	App (My M Health) and phone/paper-based
8.	North West London	Primary care model	2,000,000	Mid-April	Admission ICU admission Mortality	App and phone/paper-based

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*used pulse oximetry for a sub-set of patients based on clinical assessment

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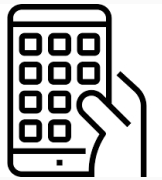
Remote home monitoring models: a typology

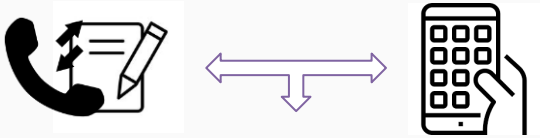
Pre-hospital

- **Primary care model** — Patient presents at primary care and is followed-up by primary care team
- **2ndary care model** — Patient presents at ED and is followed-up by secondary care team
- **Step-down care model** — Patient is discharged from hospital and is followed-up by secondary care team
- **Mixed (pre-hospital and step-down care model)** — Patient is onboarded from primary care, ED or after discharge from hospital and is followed-up by secondary care team

Phone call + paper-based system for patient recording (medical team uses spreadsheets or uploads information to EHR)



App for patient recording (medical team reviews observations submitted by patients on dashboard)



Model with both options for patients (phone calls or app)

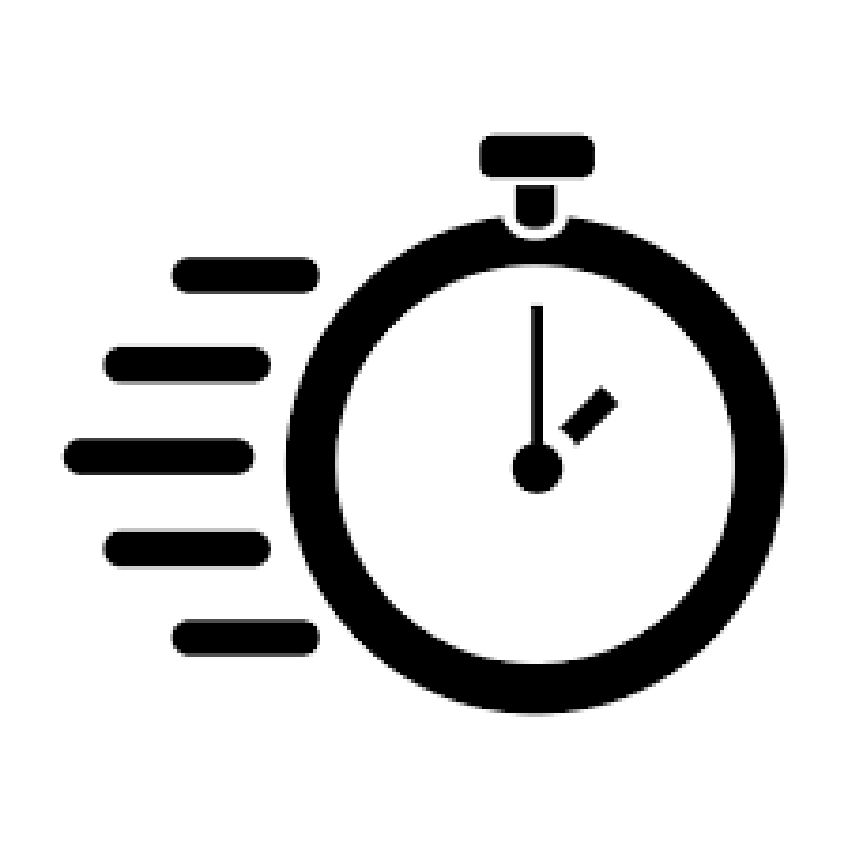
Expected outcomes (as identified by sites)

All models
Minimize patient mortality
Early identification of cases of deterioration
Appropriateness of escalation
Positive patient and staff experience

Pre-admission models (primary care and ED)
Minimize attendance/reattendance to ED (as appropriate)
Increase cases that can be treated with non-invasive ventilation

Step-down models
Minimize readmission rate (to hospital and to ICU), as appropriate
Reduced length of stay (as appropriate)

Strategies to organise care



- Models were designed and implemented very **rapidly**
- Staff drew from experiences of **previous** remote home monitoring or ambulatory care **pathways** (and used staff familiar with these)
- The **staffing models** were highly dependent on staff who were redeployed, shielding, students or volunteers. And good will.
- Some pilots had **early conversations** with each other to share learning and materials
- Some pilot leads consulted existing **evidence** or collected information on the experiences of other countries

Staffing models (1)

Note: wide variation of staffing models across sites; & given context, provide limited basis for future planning

	Pilot site name	Setting
1.	Royal Free	Pilot lead, staff in the ED became involved as there were additional staff available to cover a COVID rota with collaboration from other teams, and an ED registrar was particularly involved in phoning patients.
2.	Winchester City	Very small core team of GP partners, practice manager and ANP; led by senior GP partner
3.	Winchester (Royal Hampshire)	Delivered using three ANPs, senior and junior clinicians, and specialist registrar conducting data collection and analysis.
4.	Royal Berkshire Hospital (TICC-19), Reading	One ICU consultant, 1 ultrasound fellow, 1 medical student, 4 PAs, admin support and 3 furloughed middle grade BAME ED doctors (from high-risk groups) provided assistance
5.	West Hertfordshire (Watford)	A mixture of consultants, cardiologists, five physiotherapists, three physiologists, house officers (largely data collection and completing telephone calls); medical secretaries, and a medical student setting up and monitoring the database
6.	Manchester University Foundation Trust	Across two settings: specialist Consultant team of 3, band 8 nurse lead, team of 12 nurses and AHPs in total making up 7 WTEs, 1 administrator (site 1); 1 x consultant, team of 8 nurses/AHPs , 1xadministrator (site 2)
7.	NHS Tees Valley CCG COVID-19 Virtual Ward Vanguard Bid	Secondary care: patients monitored remotely by respiratory nurses Primary care: delivered using federation funded primary care nurses who have worked in the community
8.	North West London	Pilot lead and model delivered mainly by nursing staff based in primary care

Staffing models (2)

Note: these provide limited basis for future planning

	Staff's band/function	Pre-hospital Model		Step-down Model	
		Number of staff	Number of hours	Number of staff	Number of hours
The total number of staff involved in setting up the pilot					
Tees Valley	band 5, band 8b, band 9	12	770	-	-
Manchester University FT	-	-	-	6	40
West Herts (Watford)	-	0	0	-	-
Winchester City	GP, ANP, band 5	4	27	-	-
Royal Hampshire	ANP, band 5, band 7, band 8	6	46	-	-
Royal Berkshire	PA student, ST3, band 9	3	240	1	58
The total number of staff involved in running the pilot					
Tees Valley	band 7	1	1,064	-	-
Manchester University FT	band 5, band 8, band 9	-	-	11	5,000
West Herts (Watford)	band 3, band 4, band 8a, band 8d	22	13,577	-	-
Winchester City	GP/ANP	9	633	-	-
Royal Hampshire	ANP band 7, band 8	22	2,199	-	-
Royal Berkshire	PA student, band 6 (nurse), ED specialist, ST3, band 2	9	21,467	2	5,148

Note: Data available from 6/8 sites for the period March-August 2020. 4 sites pre-hospital model only; 1 site step-down model only; 1 site both pre-hospital and step-down.

Patient experience

- 7 of the 8 pilot sites documented patient experience through surveys or questionnaires.
- In general, patient experience was described as ***positive***
- Staff described high levels of patient engagement and appreciation by patients of **reassurance** the service provided.

- Some of the ***problems*** that were raised were:
  - Increase in patient anxiety
  - Reduction in patient engagement during later follow-up calls or at later stages of 1st wave

Differences between primary care and secondary care models

- Greater data linkage in secondary models with existing patient systems within hospitals; data integration not well established in primary care models
- Lower patient referrals in primary care models early on during the pandemic; readmission in secondary models varied across sites
- Greater range of senior staff involved in providing clinical oversight in secondary care models (e.g. cardiology, respiratory, geriatrician) (although many questioned whether this was necessary)

Data and evidence

1. Collection and set-up

- Collected combinations of clinical readings, demographics, patient experiences and outcomes
- The need to act quickly early in the pandemic meant there was not time to carefully plan data collection or Information Governance (IG) implications
  - Data collection outside the apps could be cumbersome
  - Data quality is variable
  - Data sharing between and within sectors has not been established
  - Data linkage has been difficult
- Relatively little external evidence to advise on set up
  - Some studies from China and Italy were cited

Data and evidence

2. Use

- More sophisticated analyses of the data have started, e.g. predictive impact of oximetry readings
- Suggestions of overcoming small numbers by combining data from different sites
- Some proactive use of data to inform improvements
- Other outcome measures which will be more elusive:
  - long-lasting effects of COVID-19 on patients
  - Mental health consequences for staff
- Comparators are difficult to establish

Patient numbers and impact

Note: these data on patient numbers and impact are from study sites i.e. there is no comparison group

Throughput and outcome	Pre-hospital Model		Step-down Model	
	No. of patients	% of monitored patients	No. of patients	% of monitored patients
Patients triaged	1,861	107.1%	354	102.1%
Patients remotely monitored	1,737	100.0%	347	100.0%
Patients deteriorated and escalated	174	10.0%	42	12.2%
Deaths	20	1.1%	3	0.9%
Discharged alive from remote monitoring service	1,639	94.4%	320	92.2%

Note: Data available from 7/8 sites period March-August 2020. 5 sites use pre-hospital model only; 1 site step-down model only; 1 site both pre-hospital and step-down models.

Patients deteriorated and escalated	Pre-hospital Model		Step-down Model	
	No. of patients	% of deteriorated & escalated patients	No. of patients	% of deteriorated & escalated patients
Seen in ED	133	76.7%	39	91.8%
Admitted to hospital	92	52.7%	31	74.5%
Admitted to ICU	3	2.0%	4	8.5%
Treated in primary care	17*	17.7%*	17**	44.7%**

Note: *) data available for 3 sites; **) data available for 1 site.
Data available from 7/8 sites period March-August 2020. 5 sites use pre-hospital model only; 1 site step-down model only; 1 site both pre-hospital and step-down models.

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Costs of pre-hospital model

Note: Given set-up and operating context during first wave pandemic, these costings provide limited basis for future planning.

Resources used for setting-up and running the pilot	Mean cost per site (£)
Set-up costs	
Staff costs	£21,559
Non-staff costs	
Medical equipment	£31,524
Development of patient information materials	£3,514
Development of mechanisms for patient data reporting	£2,275
Running costs	
Staff costs	£191,928
Non-staff cost	£1,240

Note: Data available from 5 sites for period March-August 2020. During this period of time: 4 sites pre-hospital model only; 1 site both pre-hospital and step-down models.

Mean running costs	Patient triaged	Patient monitored
Mean cost per patient	£516	£553
Mean cost per week	£15,047	

Note: Data available for 6/8 sites for period March-August 2020. Sites operated for different lengths of time over that period. 4 sites pre-hospital model only; 1 site both pre-hospital and step-down models.

Costs of Step-down model

Note: Given set-up and operating context during first wave pandemic, these costings provide limited basis for future planning.

Resources used for set-up and running the pilot	Mean cost per site (in £)
Set-up costs	
Staff costs	£1,218
Non-staff costs	
Medical equipment	£1,501
Development of patient information materials	£193
Development of mechanisms for patient data reporting	£0
Running costs	
Staff costs	£69,375
Non-staff costs	£0

Note: Data available from 2 sites for period March-August 2020. During this period of time: 1 site step-down model only; 1 site both pre-hospital and step-down models.

Mean running costs	Patient triaged	Patient monitored
The mean cost per patient	£256	£400
The mean cost per week	£5,717	

Note: Data available for 2 sites for period March-August 2020. Sites operated for different lengths of time over that period. 1 site step-down model only; 1 site both pre-hospital and step-down models.

Implementation: facilitators (1)

Key stakeholders

- Role of **influential, dedicated clinical leaders** in establishing
- Significant **support and 'buy in'** from senior management within acute trusts and across CCGs to set up virtual wards
- Some acute hospitals had **pathways in place** (i.e. ambulatory care) which supported the set up of virtual wards more quickly

Patients

- Developing paper and video **patient information** (as well as using digital platforms) was very useful to explain the concept of virtual wards and how to take measurements
- Positive **engagement from patients** and trust in clinical staff

Implementation: facilitators (2)

Staffing

- The majority of interventions can be delivered by nurses (both in primary and secondary care) with **minimal senior clinical oversight** (GPs, respiratory consultants)
- Many of the virtual wards **driven by collective spirit and goodwill** from NHS staff going above and beyond their day-to-day roles
- **Clear staff communication**
- Acute trust IT teams **willing to adapt** from perceived best practice protocols

Implementation: barriers (1)

Appropriateness of referrals

- Early on, **referral criteria and processes were unclear**, which led to unsuitable patients being referred to virtual wards. In part, this was caused by an evolving criteria for patient referrals

Monitoring

- **Difficult to do non-verbal assessment** using telephone and video consultation alone
- Some patient groups are difficult to monitor remotely e.g. homeless community; monitoring using a **app only model is not sufficient** for all populations
- Availability of **culturally appropriate patient information** in different community languages

Implementation: barriers (2)

Resourcing

- Lack of administrative/project management support and **resources, especially equipment** e.g. difficulty obtaining pulse oximeters quickly
- Challenging to deliver seven day service due to **workforce availability**; requires flexible, skilled, and trained staff

Evidence and data

- **Linking data** from apps/spreadsheets to existing primary and secondary care datasets proved difficult (especially when purchasing "off the shelf" app products e.g. Medopad)
- Linking data with **NHS Test and Trace**
- **Lack of published evidence** to support design of virtual wards
- Can be difficult and **time consuming** to collect desired data even when using apps/wearable technology

Lessons learned

Patients and staff

- Patient experience was described as positive; staff described high levels of patient engagement
- Monitoring patients remotely perceived to reduce the risk to staff from contracting Covid-19
- No control group so not possible to compare effectiveness. Mortality rate (1%) appears low, especially versus other COVID-related mortality rates; but caution needs to be taken when drawing comparisons as populations, severity, etc., are likely to be different.

Personalised care

- Patient/carer training key to success
- App only model not appropriate for everyone – need paper/phone option
- Personalised support required to avoid patient anxiety and reach those who may be difficult to monitor remotely e.g. homeless people
- Information needs to be culturally appropriate and in different languages

Resourcing

- Site leads considering whether monitoring can be carried out by lower band roles (with senior-level input).
- Concern over sustainability of services – set up on discretionary input but require dedicated funding, clinical and admin/project management support
- 7DS a challenge; need to consider links with 111 and OOH
- Opportunity to flex services to demand and in due course to expand beyond COVID

Implementation

- Services established rapidly (in days/weeks, not months)
- Whether primary or secondary care led depends on where initiative arose and existing assets/services
- Clear referral criteria and processes needed to ensure service targeted at patients that can benefit most
- Timely access to pulse oximeters essential
- Data a challenge particularly for primary care led models and across primary and secondary care.
- Better integration with Test and Trace required to streamline referral process

Potential areas for future research

- Outcomes / benefits (with comparators)
- Sustainability of services during second wave, incl staffing models
- Patient/family perceptions and experience
- Impact on inequalities and innovations to address these
- Comparison of secondary care and primary care-led models
- Study of models expanded to include other respiratory and long term conditions
- Cost analysis/cost-effectiveness