Technology enabled remote monitoring of blood pressure

Insights from the literature

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Working paper

The DECIDE (Digitally Enabled Care in Diverse Environments) centre is a new programme of work for rapid evaluation of technology-enabled remote monitoring in health and care. Funded by the NIHR Health and Social Care Delivery Research (HSDR) programme, the programme is a partnership between the University of Oxford and RAND Europe.

Disclaimer: This is a working paper summarising insights from a literature review that forms part of a wider rapid evaluation of technology-enabled remote monitoring of BP. The full report is expected to be available in late 2025. Until that time, the contents presented here should be treated as a working project document.

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Summary

This paper presents findings from a scoping review of published evidence on technology-enabled remote monitoring in blood pressure monitoring pathways. It sets out the context for the review, including the prevalence of hypertension, use of health and care services and experiences of patients, as well as policy relating to the use of technology to support remote monitoring for patients with hypertension in the UK. It sets out findings about how technology is used for remote monitoring for patients with hypertension in research and real-world settings, the evidence on its impact on patient outcomes, cost effectiveness and user experience.

The work presented here forms one part of a rapid evaluation of technology-enabled remote monitoring of blood pressure, running from March 2024 to May 2025. The evaluation consists of this review alongside interviews with four NHS sites that are using technology-enabled remote monitoring of blood pressure. The work is on-going and will be reported, along with recommendations for policy and practice, separately. Findings from the review are presented as an interim piece of work, to identify and potentially address evidence gaps and inform policy and decision-making in this rapidly evolving field.

The rapid evaluation of technology-enabled remote monitoring for hypertension, including this review, is being conducted by DECIDE (Digitally Enabled Care In Diverse Environments), a partnership between the University of Oxford and RAND Europe, and funded by the National Institute for Health and Care Research (NIHR) Health and Social Care Delivery Research programme to support a programme of work evaluating technology-enabled remote monitoring in health and social care. Further information on this and other rapid evaluation projects is available via the DECIDE website, which is updated as new findings become available.

Abbreviations

AHSN	Academic Health Science Networks
BP	Blood Pressure
CFIR	Consolidated Framework for Implementation Research
CVD	Cardiovascular Disease
DECIDE	Digitally Enabled Care in Diverse Environments
GP	General Practitioner
HCP	Healthcare Professional
ICB/ICS	Integrated Care Board/System
NASSS	Non-Adoption, Abandonment, Scale-Up, Spread, Sustainability
NHS	National Health Service
NIHR	National Institute for Health and Care Research
PCN	Primary Care Network
PHE	Public Health England
RCT	Randomised Controlled Trial
UCL	University College London
UK	United Kingdom
WHO	World Health Organisation

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1. Executive Summary

1.1. Introduction

1. **This executive summary presents key findings from a narrative review of the published evidence on technology-enabled remote monitoring of blood pressure (BP).** The scoping review is part of a wider rapid evaluation which aims to increase understanding of how interventions focused on the remote monitoring of BP can be designed, implemented, spread, scaled and sustained to optimise patient outcomes and impacts on health services in the United Kingdom (UK). The evaluation is funded by the National Institute of Health Research (NIHR) Health and Social Care Delivery programme and being conducted by Digitally Enabled Care in Diverse Environments (DECIDE), a partnership between RAND Europe and University of Oxford. DECIDE is a centre focusing on rapid evaluation to build the evidence base on technology-enabled remote monitoring in health and social care.
2. By remote BP monitoring, we mean the use of technology, devices and apps to help people to monitor and manage their BP at home, and to enable the remote exchange of information, primarily between a service-user and health or care professionals to assist in diagnosis, monitoring and management of BP. All BP monitoring relies on monitors and so all remote monitoring is to some extent tech-enabled, although to different degrees.

1.2. Context and methods for the narrative literature review

1. **Hypertension is a key public health issue with high prevalence and links to risks of cardiovascular disease (CVD).** Over a quarter of the adult population have hypertension and many people may be undiagnosed and untreated. Hypertension is a key risk factor for cardiovascular conditions such as coronary artery disease, congestive heart failure and atrial fibrillation.
2. **There is growing interest in policy and practice in innovative approaches for managing hypertension.** Several recent or ongoing national and regional programmes focus(ed) on various aspects of improving BP control and cardiovascular outcomes (e.g. BP@home programme, BP Optimisation programme, CVD Prevent Audit in England, Scale-Up BP programme and Connect

Me in Scotland, several Integrated Care Boards/Integrated Care Systems (ICBs/ICSs), Primary Care Network (PCN) and general practice levels efforts).

3. **Adequately controlling BP can be challenging and there is growing interest how technology, including remote monitoring of BP in home settings can help.** This is nested in wider efforts to support and empower individuals to manage their own BP, and as part of efforts to manage demand for health services and health service capacity.
4. **We conducted a rapid narrative review of the literature on technology-enabled remote monitoring of BP, with a primary focus on remote monitoring in the UK context.** Searches of academic literature were conducted in Scopus (Elsevier) and PubMed (NLM/NIH). A Google search complemented the academic literature search to identify recent reports and case studies. In addition, some information sources identified from initial scoping conversations that were conducted when the approach to this evaluation was being designed, were also included. A total of 18 papers from the peer-reviewed literature and 12 papers grom the grey literature were identified as relevant to include. Learning was synthesised based on thematic analysis. Further detail on methods is available in the full review.

1.3. Key findings from the scoping review

1. **Remote monitoring of BP at home has been found to be effective in improving clinical outcomes (BP control in patients) but there is a paucity of evidence on the impacts of remote BP monitoring on diverse population groups, related to a lack of diversity among the studied populations.** Generally, the individuals engaged in these studies tend to be younger, possess a higher socio-economic status, be less likely to be of non-white ethnic minorities and exhibit greater digital literacy. This limits the generalisability of findings on a national level.
2. **Evidence of impact on health services is inconclusive both in terms of impact on healthcare professional (HCP) workload and service utilisation, and cost-effectiveness.** Further research is also needed to understand whether impact varies on different types of HCP (e.g. might it relieve pressures on some but increase pressures on other staff types).
3. **There is variation in ways of implementing care pathways involving remote BP monitoring, but the evidence base on the details of implementation processes is scarce making it difficult to understand the causal links between different implementation approaches and outcomes for patients and health services.** Variation applies a to multiple aspects:
    a. **The patient selection approach** into a remote monitoring pathway can include proactive targeting of specific patient groups, opportunistic recruitment, and service-user self-selection:
    b. **The duration and frequency of monitoring** can also vary depending on the purpose of monitoring (e.g. diagnosis, management), the BP readings, and preferred approaches of different types of healthcare providers (e.g. general practices).

c. **The level of tech enablement** varies from low tech enablement (i.e. just use of BP monitor) and reliance on the patient to convey readings to a HCP in person, by phone call or by post; text-messaging approaches; through to systems that support service-user input of readings onto an IT platform via app, web portal; automated capture of readings requiring no patient manual input; and electronic transfer of readings to a HCP via a third party app/system or directly to GP systems.

d. **There is diversity across practices with regards to the nature and organisation of workforce in the remote monitoring pathway.** Different types of HCP staff are discussed in the literature as having roles to play (e.g. healthcare assistants, pharmacists, nurses as well as GPs).

e. **Governance approaches** in terms of ownership of decisions about the nature of care pathways, accountability for these decisions and for financial governance can vary and evolve over time. Oversight of care pathways can happen at different levels in the health system in different contexts (e.g. general practice level, PCN) and there are diverse approaches to financing and distribution of BP monitors.

4. **Overall, evidence from the literature suggests that both service-user and staff experience with remote monitoring of blood can vary – many studies report positive experiences, but some also flag negative experiences.** Further research is needed to understand the extent to which the experience relates to the nature of the technology, care pathway or personal characteristics. Positive patient experiences have been described as being linked to feelings of reassurance, motivation and a sense of control, as well as flexibility and convenience. Negative service-user experiences are linked to feelings of anxiety related to worrying about health, uncertainty about readings and actions to take, difficulties in adherence to remote monitoring procedures, and issues of trust in technology. Positive healthcare staff experiences are linked to perceptions of remote monitoring saving time, improving access to data, improved patient care and increased patient engagement. Negative staff experiences have been linked to factors such as lack of standardised approaches (leading to a need to collect BP readings across multiple formats (paper, SMS); circumstances when there is a lack of clarity, support and capacity to engage effectively due to nature of pathway implementation and resourcing, or issues related to the technology used.

5. **There are diverse influences on the implementation or remote BP monitoring care pathways, that are discussed in the literature.** These have to do with the technology, people-related factors or wider health system features. The same type of influence can manifest itself as a challenge in some contexts and an enabler in others. To illustrate:

    a. Technology—related challenges identified in the literature span issues to do with interoperability and integration of data with GP electronic health record systems and tech malfunctions). People-related challenges have related to issues with accessibility issues (e.g. ability to access internet, physical frailty, skills, attitudes to tech, digital literacy) affecting capabilities and capacities of patients and clinicians to engage and be appropriately

supported in remote monitoring pathways. Wider system challenges flagged in the literature relate to issues with purchasing, distribution, storage and tracking of monitors; selection of eligible patients; and issues with ensuring consistent and sustainable funding support from national schemes.

b. Enablers have also been reported in the literature. Examples of enablers related to technology include user-friendly tech, interoperability working well, user-friendly data and analytics provided). Enablers related to people-related aspects include having clear division of labour and staff roles for delivery, technical support and upskilling of staff; flexible approaches to recruiting patients onto remote monitoring pathways; appropriate information and support for patients from both healthcare staff and tech suppliers; service-users knowing a health professional is engaging with their monitoring data, good communication between service-users and health professionals and patients and patients that are motivated to engage with remote monitoring. Wider health system related enablers considered in the literature focus on good communication between national stakeholders/programmes and local delivery organisations; financial support for monitors, and having a clear value proposition and business case for the service.

1.4. Summary and conclusion

1. **Our analysis of the literature points to the potential in remote monitoring of BP, but also to several areas in need of better evidence to inform decision making about service design, implementation, sustainability, spread and scale.** This includes research and evaluation on (i) understanding which types remote monitoring approaches can support optimal patient outcomes and impacts on health services, how and why; (ii) how care pathways involving remote monitoring of BP can be successfully sustained, spread and scaled and (iii) how implementation challenges can be addressed; (iv) how considerations of inequalities (including intersectionality between multiple categories of disadvantage) can effectively be brought into remote monitoring care pathway design and implementation; and (v) how remote monitoring pathways affect key measures of health service utilisation and contribute to efforts to manage pressures facing the National Health Service (NHS).
2. **The need for rapid evaluation is especially urgent, given the public health significance of hypertension and CVD, the need for innovative care solutions, and the demand for robust evidence to guide decision-makers in timely ways.**

2. Introduction

2.1. Introduction

This paper presents findings from a rapid narrative review of published evidence on technology-enabled remote monitoring of blood pressure (BP). It sets out the context for the review, as it relates to the prevalence of hypertension; evidence related to the use and impacts of remote monitoring of BP, including insights into variation of remote monitoring care pathways; evidence on healthcare professional (HCP) and patient experience and known implementation challenges and enablers. In doing so, the literature review takes stock of what is known from prior research and evaluations that can help inform a rapid evaluation of remote monitoring of BP being conducted by the Digitally Enabled Care in Diverse Environments (DECIDE) centre. DECIDE is a partnership between the University of Oxford and RAND Europe and funded by the National Institute for Health and Care Research (NIHR) Health and Social Care Delivery Research programme. DECIDE is conducting a programme of work on evaluating technology-enabled remote monitoring in health and social care. Technology-enabled remote monitoring involves the use of technology, devices or apps to help people to monitor and manage their health and wellbeing in a setting they call home, and it is supported by the remote exchange of information between a service user and health or care professionals who support a person's care. Further information on this and other rapid evaluation projects is available via the DECIDE website[1], which is updated as new findings become available. The literature review forms one part of a rapid evaluation of technology-enabled remote monitoring for hypertension, running from March 2024–May 2025.

The evaluation consists of a combination of literature review, case studies of four sites centred around GP (general practitioner) practices implementing diverse approaches to remote monitoring of hypertension (i.e. high BP), and service user as well as wider stakeholder (i.e. HCPs, system leads, technology supplier) workshops. The case studies involve a combination of desk research and semi-structured interviews with healthcare providers, health system leads, technology suppliers and patients (and potentially carers).

The evaluation is ongoing, and the findings will be made publicly available once the project is completed. The insights from the literature review that we present in this document are being used to inform qualitative inquiries in the case studies and will also provide an important foundation and context for interpreting and triangulating our empirical findings with the existing evidence base.

2.2. The policy context

Given the potential that controlling BP holds for improving cardiovascular disease (CVD) outcomes, coupled with growing public interest in taking actions to support an individual's own health and wellbeing[2], health system decisionmakers and care providers are interested in innovative approaches to supporting patients with hypertension[3-6]. This includes an interest in approaches that can help manage demand and pressures on health services capacity. Using technology to enable remote monitoring of BP in home settings[7-12] is an approach that may help to support and empower individuals manage their own health, and help manage demand for health services and health service capacity.

In England, the BP@home programme, BP Optimisation programme and the CVD Audit (CVDPREVENT)[13] focus (or focused in the case of the BP optimisation programme) on various services and aspects of improving BP control and cardiovascular outcomes. Initiated in October 2020, the BP@home programme included the rollout of over 220,000 BP monitors during the COVID-19 pandemic, which accelerated efforts towards remote monitoring[14]. As well as the distribution of BP monitors, the BP@home programme developed guidance to practices delivering the programme[15], including in relation to the identification, recruitment and management of patients[16]. NHS England also funded the BP Optimisation programme through the Health Innovation Networks (formerly Academic Health Science Networks [AHSNs]) from April 2022 to March 2023[5]. This programme aimed to implement a framework developed by University College London (UCL) Partners (one of the then AHSNs), which included a tool for risk stratification and patient selection for individuals who should be targeted for interventions such as BP remote monitoring[5]. CVDPREVENT is an ongoing national audit of GP records to support understanding of the prevalence of CVD and its risk factors. There is diversity in terms of how these national hypertension programmes are (or were) locally implemented and how they interact in different regional and local health system footprints. Funding for the BP Optimisation programme ended in September 2023.

Scotland has been working on remote BP monitoring, initially through the Scale-Up BP pilot programme from 2019 to 2021[17], which provided funding to support remote monitoring, and more recently through a nationwide Connect Me programme[18, 19]. The Connect Me programme refers to a series of services that support patients to communicate with HCPs virtually [20]. One of these services supports patients to manage hypertension with a BP monitor and third-party website to record their results[19]. During the pandemic, the Welsh government piloted the Huma remote monitoring platform as part of a £150,000 digital solutions fund to help patients with heart failure better manage their health[21]. In Northern Ireland, the Telemonitoring Northern Ireland service has been in operation since 2011, providing a similar service for patients with chronic conditions, including heart failure[22].

In addition to such national programmes, many regional health system decision-makers at Integrated Care Boards/Integrated Care Systems (ICB/ICS), Primary Care Network (PCN), and general practice levels have been involved in rolling out remote monitoring services[3, 5, 23].

Current tech-enabled remote BP monitoring efforts appear to be, to the best of our knowledge, initiated at the local level and supported by local funding and decision-making.

2.3. The analytical context

The evaluation will be rooted in tried and tested theoretical frameworks which will serve as sensitising devices to ensure we consider a diversity of influences on implementation, spread, scale and sustainability in our enquiries, with inequalities being an integral consideration. More specifically, we will use the Non-adoption, Abandonment and challenges to Scale-up, Spread and Sustainability (NASSS) framework, complemented with the Consolidated Framework for Implementation Research (CFIR). We will also draw on the Intervention-Generated Inequalities framework to underpin our understanding of the role of BP remote monitoring in mitigating or exacerbating inequalities.

For this literature review the NASSS framework, was adapted to consider influences on technology-enabled remote monitoring as they relate to three overarching themes: technology, people-related influences (i.e. skills, capabilities, capacities, attitudes and beliefs of healthcare staff and patients) and the wider health system[24].

2.4. Research questions and evidence gaps

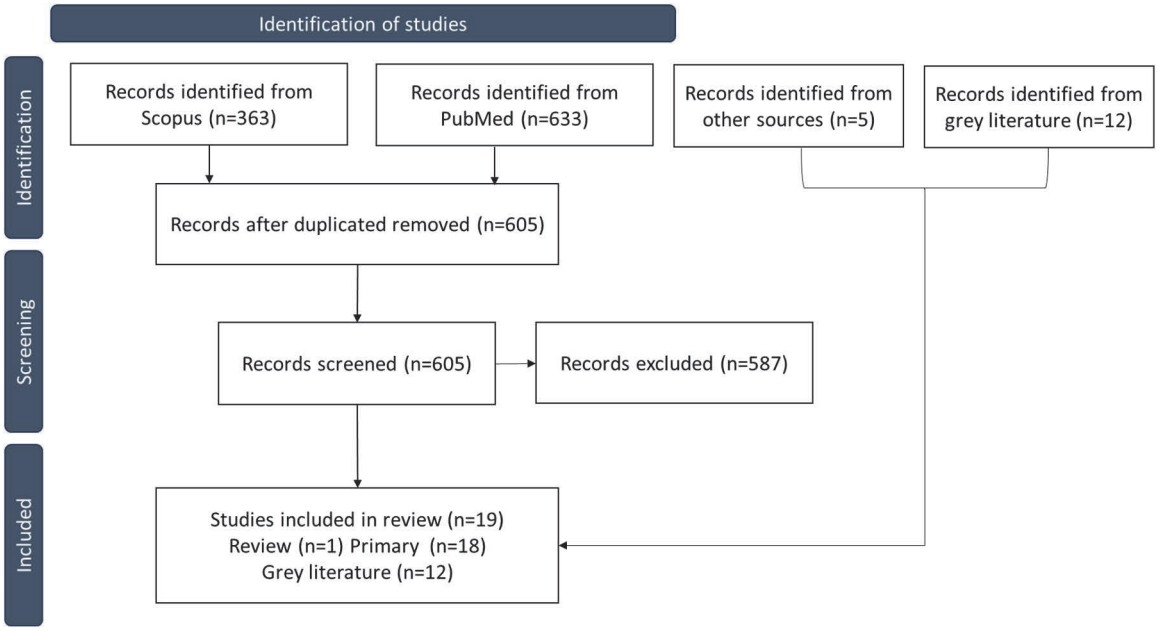
The evaluation aims to improve the evidence base on what works, how, why and in which contexts, as it relates to services involving remote BP monitoring. Our primary research question is: **How can interventions focused on the remote monitoring of BP be designed, implemented, spread, scaled and sustained to optimise patient outcomes and impacts on health services in the United Kingdom (UK)?**

There is relatively well-established evidence in support of the effectiveness of remote BP monitoring on controlling BP in patients with hypertension. However, there are also significant evidence gaps related to understanding different implementation approaches, and which approaches can support optimal patient outcomes and service impacts in specific contexts.

3. Literature review methods

A search strategy was developed by the study team and refined by a specialist librarian at RAND Knowledge Services. The search strategy sought to identify both peer-reviewed and grey literature that have been published on remote monitoring of BP in the home setting since 2014. Search strategies for both elements of the review are provided below and summarised in Figure 1.

Figure 1. PRISMA flow diagram



3.1. Academic literature search

As we were primarily interested in remote monitoring in the UK context, we included UK-specific terms in the search strategy. The searches were conducted in both Scopus (Elsevier) (see Table 1 and PubMed National Library of Medicine / National Institute of Health (see Table 2). The searches were conducted on 5 April 2024. Both searches targeted English-language papers published from 1 January 2014 onwards. The search process found 603 papers in total after de-duplication.

Table 1. Scopus search string (ran on 5 April 2024, restricted to articles published since 2014).

Set #	Search	# of results
1	TITLE-ABS("hypertensi*" OR "hypotensi*" OR "hyper tensi*" OR "hypo tensi*" OR "blood pressure")	946,892
2	TITLE-ABS("self manag*" OR "self monitor*" OR "self care" OR "telemonitoring" OR "tele-monitoring" OR "remote care" OR "remote patient monitor*" OR telehealth OR "tele health" OR (("remote monitor*" OR "remote sens*") **W/3** (patient* OR health* OR care OR medic*)) OR ((inhome OR "in home" OR "telecare" OR "home based" OR tele*) **W/3** monitor*))	122,650
3	#1 AND #2	5,821
4	#4 AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (AFFILCOUNTRY , "United Kingdom")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j")))	**363**

Table 2. PubMed search string (run on 5 April 2024, restricted to articles published since 2014).

Set #	Search	# of results
1	hypertensi*[tiab] OR hypotensi*[tiab] OR "hyper tensi*"[tiab] OR "hypo tensi*"[tiab] OR "blood pressure"[tiab] OR "Hypertension"[Mesh:NoExp] OR "Hypotension"[Mesh:NoExp] OR "Blood Pressure"[Mesh:NoExp] OR "Blood Pressure Monitoring, Ambulatory"[Mesh] OR "Blood Pressure Monitors"[Mesh] OR "Blood Pressure Determination"[Mesh:NoExp]	951,515
2	"self manag*"[tiab] OR "self monitor*"[tiab] OR "self care"[tiab] OR "telemonitoring"[tiab] OR "tele monitoring"[tiab] OR "remote monitoring"[tiab:~2] OR "remote care"[tiab] OR remote sens*[tiab] OR "home monitoring"[tiab] OR "home monitor"[tiab:~2] OR "home monitors"[tiab:~2] OR "in-home monitoring"[tiab] OR "home telehealth"[tiab] OR "home tele health"[tiab] OR "telecare"[tiab] OR "tele care"[tiab] OR "telemedicine"[tiab] OR (("in home"[tiab] OR "inhome"[tiab] OR "home based"[tiab] OR remote[tiab] OR tele*[tiab]) AND (monitor*[tiab] OR "Monitoring, Physiologic"[Mesh] OR "Monitoring, Ambulatory"[MAJR:NoExp])) OR "Self-Management"[Mesh] OR "Self Care"[MAJR] OR "Telemedicine"[MAJR:NoExp] OR "Telemetry"[Mesh] OR "Remote Sensing Technology"[Mesh]	174,423
3	("United Kingdom"[tiab] OR "UK"[tiab] OR "U.K."[tiab] OR Britain*[tiab] OR British*[tiab] OR England[tiab] OR English[ti] OR "Northern Ireland*"[tiab] OR "Northern Irish*"[tiab] OR Scotland*[tiab] OR Scottish[tiab] OR Wales[tiab] OR Welsh*[tiab] OR "National Health Service*"[tiab] OR NHS[tiab] OR "United Kingdom"[Mesh] OR "England"[Mesh] OR "London"[Mesh] OR "Northern Ireland"[Mesh] OR Scotland[Mesh] OR Wales[Mesh] OR "United Kingdom"[ad] OR "UK"[ad] OR "U.K."[ad] OR "Great Britain"[ad] OR "England"[ad] OR "Scotland"[ad] OR "Scottish"[ad] OR "Wales"[ad] OR "Welsh"[ad] OR "Northern Ireland"[ad] OR "Northern Irish"[ad]) NOT ("New South Wales"[tiab] OR "New England"[tiab] OR "New South Wales"[ad] OR "New England"[ad])	2,225,315
4	#1 AND #2 AND #3	860
5	#4 AND ((2014/1/1:2024/12/31[pdat]) AND (english[Filter]))	**633**

3.2. Grey literature search

For grey literature, a Google search identified recent reports and case studies of BP remote monitoring within the UK, in particular targeting the known initiatives described in Section 2.2. Several relevant information sources were also identified on the NHS Futures NHS@home BP@home site for home BP monitoring. In addition, some information sources were included that were identified from initial scoping

conversations that were conducted when the approach to this evaluation was being designed. A total of 12 papers from the grey literature were identified as relevant to include.

3.3. Screening

Inclusion and exclusion criteria (see Table 3) were applied to the results of the literature search to identify relevant articles. First, a pilot screening was conducted where 30 journal articles were dual screened (HT, SMo) for eligibility based on title/abstract, in line with the inclusion and exclusion criteria. The criteria were then further refined for clarity, after which a single reviewer screened the remaining articles (title and abstract screen).

Table 3. Inclusion/exclusion criteria

Criteria	Include	Exclude
Topic relevance	Remote monitoring AND blood pressure OR hypertension/hypotension	Where no reference made to remote monitoring Having to do with remote consultations, i.e. virtual visits, self-care or self-management interventions that only provide treatment, without provide monitoring component Experience of remote monitoring specific to the pandemic context General 'out of office' monitoring which includes both waiting room and home measurement Pregnancy-related blood pressure remote monitoring Other conditions such as diabetes, kidney failure etc.
Scale and spread of intervention	At all scales and geographic levels from individual site to national coverage	None
Paper type	Only articles with an empirical component will be included	Theoretical and commentary articles Trial registrations (i.e. articles registered on ClinicalTrials.gov or the WHO ICTRP registry) Prevalence studies Case report Protocols
Country	Includes UK	Does not include UK
Year of publication	January 2014 onwards	Before 2014
Language	English	Languages other than English
Availability	Full text availability	Title and/or abstract only available, conference proceedings

A total of 14 papers from the academic literature search and screening met the inclusion criteria at screening, with a further 5 identified via snowballing from included papers during the extraction stage. This resulted in a total of 19 papers from the peer-reviewed literature. Of these, 18 were primary studies while 1 was a review.

3.4. Extraction, analysis and synthesis

The papers were then extracted by two reviewers using a MS Excel template, based on the aims of the literature review and informed by the It is important to recognise that people-related influences (skills, capabilities, capacities, attitudes, beliefs) manifest themselves as a result of dynamic interactions between inherent personal traits and dispositions, features of a technology and/or the conditions in the wider system.

Once the extraction of these articles was completed (for the grey and scientific literature), the information collected reviewed and discussed amongst the research team to inform the thematic qualitative analysis and identify main areas of learning.

4. Results

4.1. Description of data

Of the 31 extracted papers, 1 was a systematic review, 18 were primary studies and 12 from the grey literature. Amongst this body of literature, primary papers included cost-effectiveness analyses, randomised controlled trials (RCTs), one quasi-experimental studies and mixed-methods evaluations. The grey literature included qualitative and quantitative local and national evaluations as well as case studies.

4.2. Evidence on the impact of remote monitoring

Home monitoring of BP, with necessary co-interventions, has been found in RCTs to be effective in improving BP control in patients with hypertension[4, 6, 8, 25, 26], including for high-risk individuals with existing CVD, diabetes or chronic kidney disease[27]. Compared to usual care, home monitoring (monitoring BP at home using a BP monitor) was found to lead to significantly lower BP than when titration was guided by a clinic reading, regardless of the levels of technology used. In other words, both comparatively low-tech solutions that rely on the use of BP monitors and traditional means of sharing measurements back with HCP professionals (e.g. over the phone or on paper) and more tech-enabled remote monitoring approaches that involve digital/data platforms to capture and convey BP readings were found to effectively control BP[8]. The evidence on the impacts of remote monitoring on BP control from real-world implementation contexts (as opposed to trials) is scarce, although results from a Scottish implementation study similarly show reductions in BP effective reductions in BP[11, 28].

Despite compelling evidence on clinical outcomes from remote BP monitoring (i.e., BP control in patients), evidence on the impacts of remote BP monitoring on health service utilisation is inconclusive. Various studies have arrived at different conclusions regarding the workload impacts of remote monitoring and its effect on demand for appointments with HCPs[11, 29]. Further research and more detailed information are needed to make sense of the findings, including whether impact may be differential based on different types of HCPs; there is limited detail on the impact on specific staff subgroups in the literature, and hence we cannot conclude whether impact on use of some HCP time might decrease, while demand for other types of staff might increase or not. For example, a multicentre RCT across 20 practices in Scotland found that supported self-monitoring at home was associated with additional GP and nurse time[29] while a quasi-experimental implementation study across 75 primary care practices, also in Scotland, found that remote monitoring was associated with fewer face-to-face appointments and less consultation time compared to non-telemonitoring patients[11]. Using a time and motion analysis in a single

general practice in Dorset, one case study of workforce activity redistribution found that remote monitoring of BP resulted in a 45% and 73% reduction in GP equivalent appointments the first and second years after implementation, respectively[23]. Comparison across studies in terms of service implementation is challenging due to variation across evaluations in terms of consultation time, practice workload, implementation pathways and staff involved, and medication use[11, 12, 29].

Evidence on the cost-effectiveness of remote monitoring of BP is also mixed and dependent on model assumptions, particularly around sustained health gains and over what length of time assessments are conducted[12, 26, 30]. Some cost-effectiveness analyses have found remote monitoring to be more expensive than usual care due to more resources and often an initial investment in training and staff time[12, 30]. However, depending on assumptions made related to how long health gains are sustained, i.e., over how many years the person experience reductions in BP, monitoring may be cost-effective overall – for example, one study of the cost effectiveness of telemonitoring and self-management for hypertension management in the UK found that BP remote monitoring is cost effective for health gains over two years for men and five years for women (with a willingness to pay threshold of £20,000 per QALY gained)[30].

A noted limitation in many studies is the lack of diversity among the studied populations[4, 8, 11, 31-33], meaning we lack sufficiently granular evidence on the impacts of remote BP monitoring on diverse population groups, and how effectiveness might relate to population-level traits. Generally, the individuals engaged in these studies tend to be younger, possess a higher socio-economic status, be less likely to be of non-white ethnic minorities and exhibit greater digital literacy. This limits the generalisability of findings, as issues of inequality and intersectionality that shape potential access to and use of services are not reflected in the evidence base.

4.3. Variation in BP remote monitoring care pathways

There is considerable variation in the implementation and delivery of care pathways involving remote BP monitoring, as well as limited detail on the nature of care pathways and implementation processes in the existing evidence base. This points to the need to better understand diverse approaches, implementation processes and their relations to outcomes and impacts, and to consider the fit of an approach to its use context[5, 15, 34]. Evaluations (especially in the grey literature) often focus on pilot sites and typically do not provide detailed information on what the remote monitoring pathway entailed[3, 23]. This includes how patients are requested to take their measurements, how measurements are shared back with the healthcare team and in what form, which members of healthcare staff are involved in reading or interpreting the measurements, what if anything was communicated back to patients and what follow up with patients by healthcare providers look like.

Where information is available, variation in care pathways is discussed as applying to: the patient selection approach, duration and frequency of monitoring, nature of tech-enablement, and governance of care pathways and workforce organisation in service delivery[24, 35, 36, 37]. We discuss these aspects below in turn.

4.4. Patient selection into remote monitoring pathway

The patient selection approach can include proactive targeting of specific patient cohorts, opportunistic recruitment when patients present to health system, and self-selection into the pathway. Numerous approaches have been implemented by healthcare decisionmakers (e.g. at general practice and PCN levels) to identify and prioritise patients for remote BP monitoring. Some practices employ a proactive patient selection process to target and/or include patients in consideration of features such as age, BP measurements, deprivation, pre-existing CVD and other risk factors (as identified in a UCLPartners framework to support identification and prioritisation of patients for remote monitoring)[15]. Another approach for patient selection relies on opportunistic identification when patients visit the practice[15]. However, according to an evaluation by HealthWatch, a significant proportion of patients also 'self-select' to participate by purchasing personal BP monitors, thereby taking charge of monitoring their BP, and communicating their readings to GPs when they feel its necessary[35].

4.5. Duration and frequency of monitoring

The duration and frequency of monitoring can vary depending on the purpose of monitoring and how elevated BP readings are and diversity in approaches taken by general practices. Studies included in our review suggest that remote monitoring is used for both the diagnosis[36, 37] and management of hypertension[35-37]. For hypertension diagnosis, ambulatory monitoring is typically required which involves the constant monitoring of hypertension for a period of 24 hours[32]. However, for hypertension management, monitoring is required usually over a week and on a monthly or annual basis; the frequency of monitoring is based on clinical judgement and typically dependent on how elevated the BP readings are[33] in addition to other patient information. The role of patients in decisions regarding the duration or frequency of monitoring is not mentioned in the literature.

4.6. Nature and scale of tech enablement

All BP monitoring relies on monitors, making remote monitoring inherently technology-enabled, although the level and nature of technology enablement vary. This can range from low technology enablement involving patients using a BP monitor to take the readings and communicating readings to a HCP in person or by post; higher levels of technology enablement involve patients SMS-messaging their readings back to HCPs or using other systems that support patients inputting their readings onto an app or web portal to share back with HCPs[15, 35].

Most studies identified in our literature review reported on the use of approaches relying on relatively simple technology for data entry and transfer (input of readings via a link texted to the patient or via an app). Examples of approaches that use data transfer platforms include a WhatsApp-based software programme (Doctaly Chatbot) where patients directly message their BP readings[38], and other telemonitoring systems such as Flo and ACCURX[11, 36] which allow patients to input their measurements via SMS-message and website link, respectively, using their mobile phone.

Where and how data are stored vary across remote monitoring systems, and how HCPs then access and read the measurements also vary. Some systems require HCPs to access and read measurements from a third-party app or website and manually input values into the GP electronic health record systems, while other systems store measurements on the routinely used GP system as per usual care[11, 36]. Few of the studies we analysed included detailed information about communication back to patients[35, 4, 36, 8, 33]. This may be an artefact of the evidence base or perhaps linked to wider challenges in communication with patients (a matter we return to in Section 6.1). Where mentioned, the communication varies from automated algorithm-based alerts such as through SMS or messages asking patients to initiate contact with HCPs if readings are out of the desired range[4, 8, 31].

4.7. Governance of remote monitoring pathways

Governance approaches vary and evolve over time, with oversight and decision-making happening at different health system levels. Insights on governance are very limited in the current evidence base. Governance approaches refer to ownership of decisions about the nature of care pathways involving tech-enabled remote monitoring, and accountability at PCN or GP levels for these decisions and for financial governance. Some schemes which existed during the COVID-19 pandemic, such as the BP@home programme, provided free BP monitors to Clinical Commissioning Groups which were distributed to local practices[34]. However, how governance of remote monitoring of BP works in the health system in post-pandemic times is less clear from this review.

4.8. Workforce organisation and roles

There is diversity with regard to the organisation of labour within general practices and other parts of the health system, and in the types of professions engaging with and acting on monitoring data. Different types of HCPs are discussed in the literature as having roles to play – this includes healthcare assistants, pharmacists, nurses as well as GPs[5, 34]. In some cases, pharmacists are involved in leading implementation at the PCN level, whereas in other cases implementation is led by a team of staff at the practice level such as clinical pharmacists healthcare assistants and nurses[5].

5. Patient and staff experience

5.1. Patient experience

Overall, evidence from this review suggests that patients experience high levels of satisfaction and acceptability for remote BP monitoring, driven by benefits like reassurance, convenience and a sense of control, though some patients report concerns related to a lack of guidance and distrust.

High levels of satisfaction and acceptability of remote BP monitoring among patients are reported by several studies[31, 33, 35]. Whilst these studies span a variety of approaches with regard to monitoring (e.g. in terms of healthcare providers involved, apps used and feedback mechanisms) they typically focus on exploring patient acceptability in terms of confidence in managing readings and acceptability with managing a long-term condition from home. Patient satisfaction is often attributed to the reassurance and motivation patients get from seeing their BP readings[33] and feeling a sense of control[35]. Additional benefits reported include the flexibility, convenience, and peace of mind provided by remote monitoring[35, 38].

However, evidence from multiple studies also suggests a notable minority of patients report negative experiences or encounter barriers to remote monitoring[11, 32, 33, 35, 38]. These include feelings of anxiety[32] which stem from worrying about health, uncertainty around readings and subsequent actions, and the challenges of adhering to the needed procedures [35]. Some of these concerns may also be due to a poorer user experience as a result of a lack of guidance and instructions on the monitoring process[35]. One evaluation also highlighted concerns about the authenticity of the chatbot they had used[38], i.e. trust in the technology itself. A study which compared usual self-monitoring (monitoring BP at home using a BP monitor) with ambulatory monitoring (which involves having a monitor attached for a continuous period of time to track BP at home), found self-monitoring to be more acceptable than ambulatory monitoring which has a greater impact on daily activities[32].

The generalisability of these findings is limited due to little evidence about populations who do not engage or are hesitant to engage, as well as an overrepresentation of better-educated, digitally literate and younger populations[8, 11, 35, 39] (see section 6 on inequalities).

5.2. Staff experience

Staff experiences of remote BP monitoring are mixed but the reasons for this are not well documented in the current evidence base.

Some studies report overall high levels of satisfaction among staff involved in remote BP monitoring[15, 34], with perceived advantages including time savings, improved access to patient data, improved quality of patient care and increased patient engagement[15]. However, there may also be differences in experience across different staff groups. For example, one evaluation found that non-clinical staff seemed less optimistic about the effectiveness and efficiency of the service than clinical staff. The evaluation suggested this may be due to the role of non-clinical staff in collecting BP readings across multiple formats such as paper, SMS and others, rather than having a standardised approach[15], which can add to the administrative burden.

Reasons for staff dissatisfaction with remote monitoring for BP relate to various challenges experienced with either the tech itself[29], the nature of pathway implementation and resourcing[11], or with wider health system conditions[11] (as detailed in Section 7.1.1). These impact on the scale and nature of healthcare staff workload[11, 29, 34] and on the extent to which they feel they have the clarity, support and capacity[11] needed to carry out their roles in the pathway and the ability to do so. Some studies also report HCPs expressing concern that remote BP monitoring might exacerbate inequalities or exclude certain groups due to challenges related to digital access and literacy[11, 15].

However, most evidence on staff perceptions comes from the height of the COVID-19 pandemic, when healthcare services were under particularly acute strain, making it challenging to draw lessons and definitive conclusions from that time (albeit that significant pressures on health services still exist)[15, 34]. In addition, there is very little information in the identified studies about the types of workforce skills and capabilities needed for delivering remote monitoring of BP services, although an evaluation of primary care perspectives of BP@home found that high staff turnover led to constant training and organisational memory loss[34].

6. Inequalities in access, experience and outcomes of remote monitoring

There is limited evidence on how the uptake and outcomes of remote BP monitoring vary based on diverse patient characteristics. In two papers reporting on randomised controlled trials[4,40], patients had similar BP-related outcomes across individual characteristics including sex and deprivation, although one study (HOME BP, which looked at 76 general practices across the UK) found differences by age. Studies to date have not said much on differential effects based on ethnicity or markers of disadvantage (e.g. people experiencing homelessness, refugees). One study examined the influence of ethnicity on the acceptability of different types of BP monitoring (namely at a clinic, at home and ambulatory monitoring) and found lower acceptability across all types of monitoring amongst ethnic minority participants[39]. Another evaluation carried out in Lewisham found high acceptance of remote BP monitoring in black African and Caribbean populations but with some concerns around trusting equipment, communications and guidance[39]. Some patients felt they were already managing their condition without remote BP monitoring.

A small number of existing evaluations and case studies have highlighted approaches that may help address certain types of inequalities such as digital exclusion[3, 17] focusing on actions such as a targeted formal onboarding process, ongoing guidance and enabling different methods to returning readings[11]. Some practices have also adapted their approach to remote BP monitoring to combat issues related to patient drop-off, for example by requiring fewer readings and working more closely with a smaller number of patients to provide more personalised care[3]. However, there is little evidence on the effectiveness of these approaches. Additionally, the literature identified does not explore how multiple categories of disadvantage may interact and play out in the area of BP remote monitoring[41].

There is a notable oversight in the inclusion of diverse populations within these study designs. These exclusions persist in more recent research and can lead to biased data and an incomplete understanding of how remote BP monitoring impacts various demographic groups.

7. Influences on implementation and outcomes

The influences on the implementation of tech-enabled remote monitoring care pathways relate to (i) features of the technology, (ii) people-related aspects, such as patient and clinician dispositions, skills, capacities and capabilities to engage; and (iii) wider system aspects (such as funding conditions, decisions pertaining to eligible populations for a service). It is particularly important to flag that the same type of feature may be experienced as a challenge in some contexts and as an enabler that works well in others. While many studies discuss enablers or challenges, they often fail to consider how these relate to the complexity of the sociotechnical context in which a tech-enabled care pathway unfolds and on interactions between the technology, people and the wider system of organisations involved in care pathway governance, design and delivery. The enabling or constraining nature of a feature is likely to co-evolve as a result of the interactions between the technology, user and adoption contexts.

With this limitation of the literature in mind, Sections 7.1 and 7.2 report on the challenges and enablers, as discussed in the literature on remote monitoring of hypertension.

7.1. Challenges

Diverse challenges affect the implementation of remote BP monitoring[17, 35, 42]. Examples include: (i) challenges related to technology, such as issues with the transfer of data to general practices[3, 11] and data integration with GP electronic health record systems[42]; (ii) people-related challenges to do with patient and clinician skills and capacities to engage[35]; and (iii) wider system challenges, affecting a range of issues such as purchasing, distribution, storage and tracking of monitors, the nature of support around the tech in terms of patient-clinician engagement in care pathways or selection of eligible patients into remote monitoring efforts [3]. We elaborate on these three categories of challenges in turn.

7.1.1. Challenges related to technology

Challenges affecting healthcare staff

Several studies flag poor interoperability of health data systems as a significant technical challenge facing healthcare staff. The literature discusses that HCPs rely on multiple digital platforms to manage patient electronic health records and integrate BP readings[29, 34, 43, 44]. In addition, HCPs are expected to code BP readings into their clinical systems using standardised SNOMED codes. An evaluation of the BP@home programme found that staff can find coding to be complex and difficult to do consistently, often leading to incorrect entries and general practices adopting their own coding systems[43].

Technical malfunctions can impact the overall usability of the remote monitoring platforms for healthcare staff. For example, in one evaluation of the BP@home programme, staff reported experiencing malfunctions with the web portal used to manage BP readings, especially when caseloads were high. Other technical challenges identified in the literature relate to patient data processing[29].

Some studies also report staff concerns about an increasing workload that can accompany the implementation of new technology[15, 34].

Challenges affecting patients

Other technology-related challenges considered in the literature relate to internet access issues and technical design issues which impact patient ability to access and engage with technology[11, 44]. To engage with remote monitoring, patients often need internet access[40] and to be comfortable with using technology[15]. Difficulties with using equipment such as BP monitors, smartphones or apps for submitting BP readings and the need for each patient to manage many different communication channels can present challenges[11]. For example, in an evaluation of BP@home based in London, patients found that weblinks provided within SMS messages to submit measurements expired after only a few days, preventing them from submitting measurements at a later time[34]. The literature also describes issues related to the monitors themselves, such as a lack of larger cuff sizes[15, 38, 44].

7.1.2. People-related challenges

As introduced earlier, people-related challenges can be manifested in skills, capabilities, capacities, attitudes and beliefs. While these influence people's actions, they are not likely to be the sole result of factors in healthcare staff or service user control or resulting from their inherent traits alone. More specifically, the features of a technology (e.g. levels of complexity, nature of design) and/or the conditions in the wider system (e.g. support for onboarding people onto tech-enable care pathways, funding for monitors) are likely to influence people-related attitudes, capacities and capabilities to engage with remote BP monitoring care pathways.

Challenges affecting health care staff

A lack of sufficient clarity and support can compromise healthcare staff abilities to effectively and sustainably deliver their roles in remote BP monitoring care pathways. The literature identified discusses these challenges as being associated with shifting project directions, lack of national guidance and insufficient resources and high staff turnover[11].

Staff values and beliefs about the implications of remote monitoring on their own workload as well as concerns over inequalities in access to care can present challenges to staff buy-in. Several studies report concerns about losing face-to-face contact with patients[35] and that remote monitoring may increase workload[19, 30, 11, 29, 34]. Some studies report that HCPs have expressed concern that remote BP monitoring might exacerbate inequalities or exclude certain patients[11, 15].

Challenges affecting patients

While patient acceptability of BP remote monitoring generally appears high, engagement challenges identified in the literature relate to various patient characteristics and features of the technology itself that affect accessibility and usability in light of individual capacities, circumstances and capabilities[4, 11, 15, 34, 44]. Examples include age-related factors and physical frailty[15]. Some patients are also not physically able to use monitors on their own. Skills or attitude-related influences such as lack of confidence with technology[4, 15] "techno-phobic" individuals and those with poor literacy skills or for whom English is a second language[4, 15, 37] can also play a role. Some studies report on patients not having the guidance they need in relation to submitting BP readings to a GP, lack of awareness about why they should monitor their BP and uncertainty around follow-up processes are documented[3, 35, 38].

The literature reports other influences that may impact the accessibility of tech-enabled remote monitoring to patients, such as the environment in which patients live (e.g. patients living in rural areas[22], lack of or poor internet access[40], and to the remote monitoring technology itself, which can compound features related to patients .

7.1.3. Wider health system-related challenges

Challenges relating to the wider health system that receive particular attention in the literature focus on the need for greater national support for remote monitoring of hypertension services[34, 43]. For example, an evaluation of the BP@home programme flagged the need for more national (e.g. NHS England) support and funding for service delivery, post launch of the national programme. The evaluation also identified a lack of awareness of the programme among clinicians and PCN leaders (and hence a need for more awareness raising support) and noted that more resources were needed to develop patient education and national-level guidance. Consistent and dedicated funding to sustain the programme and additional workload implications in early implementation were also identified as a challenge[43].

Other system-related challenges relate to issues with the supply, distribution, prioritisation of BP monitors. Examples include delays in the procurement of monitors, along with issues related to obtaining and delivering the monitors[44]. During the BP@home programme, identifying eligible patients[15] as well as prioritising patients to receive free monitors was a challenge for general practices, including tracking which patients had their own monitor or could purchase their own[43]. Tracking of BP monitors (when loaned), was also identified as a logistical challenge due to the absence of adequate systems for tracking loaned monitors[34, 44]. One evaluation looking at the BP@home programme flagged logistical issues related to the storage and distribution of BP monitors[34, 43].

7.2. Enablers

While the literature tends to focus more on the challenges than on enablers of remote monitoring of BP care pathways, some papers also discuss facilitators that aid implementation and impact.

For both healthcare staff and patients, key enablers discussed in the literature span features related to the technology, people-related factors pertaining to the organisation of workforce roles as well as staff and patient capacities and skills to effectively engage with the remote monitoring pathways, and influences related to wider health system governance and organisation.

As mentioned earlier in this document, it is important to flag that the same type of feature which may be a challenge in some contexts and implementation experiences, was found to be an enabler and work well in others. The enabling or constraining nature of a feature is likely to be a result of the interactions between technology, user and adoption features characteristics and the sociotechnical nature of enablers and challenges is seldom considered in the literature on remote BP monitoring.

7.2.1. Enablers related to technology

Enablers for healthcare staff

Specific technical features of data platforms and the interoperability between platforms and general practice electronic health record systems impact usability by staff. Two qualitative evaluations of remote monitoring found that IT systems which automatically calculate average BP readings and provide visual metrics are important for successful implementation[34, 45]. Interoperability and the capacity for integration of BP readings into HCPs' usual reports or electronic patient records has also, when available, been identified as helpful in the literature[11, 42].

Enablers for patients

Features of the tech-enabled care pathway that are discussed in the literature as enablers of effective engagement with patients mainly relate to the user-friendliness of the technology interfaces. For example, in a qualitative process evaluation of a telemonitoring RCT, reminder texts prompting patients to submit BP readings, along with access to simple and easy-to-use technology (i.e. not requiring too many steps to upload readings) have been identified as important enablers, helping ensure the effective remote monitoring[45]. An evaluation by HealthWatch found that receiving guidance on submitting BP readings and support selecting a monitor was also helpful for patients and could ease their fears[35].

7.2.2. People-related enablers

Enablers for healthcare staff

While workforce roles in the delivery of remote BP monitoring can vary widely across contexts, a clear division of labour and clearly specified roles for staff involved in care pathway delivery are seen as key enablers of remote BP monitoring pathway implementation. Some studies consider the types of staff roles, including non-GPs, and collaborations between different types of roles that can help in pathway delivery[34], but there is no optimal workforce organisation model identified in the literature, which is unsurprising given the importance of a fit with a health system context. A study of the implementation of the BP@home programme in London found that having a dedicated roles at practice level (in charge of onboarding and follow up tasks) and at the PCN level (guiding local teams) to be important enablers for healthcare staff[34]. An evaluation of home BP remote monitoring in Scotland found that most HCPs who were interviewed felt a remote monitoring model led by nurses with dedicated time would work best[42].

Technical support to staff has also been identified as key for enabling effective healthcare staff engagement. For example, an implementation study of remote monitoring in Lothian, Scotland linked the ability of HCPs to access continued technical support from an implementation team[11] as key for effective engagement.

Enablers for patients

Key people-related enablers of patient engagement and experience relate to patient recruitment into remote monitoring pathways, and to the nature and type of information and support patients receive from healthcare providers system. For example, case studies of remote monitoring across England found that identifying and recruiting patients into remote monitoring pathways can be aided by awareness raising and community outreach efforts such as pop-up clinics and distributing information through local institutions like mosques and food banks[5]. Another study of remote BP monitoring in Scotland found that establishing a routine with patients, for example creating an expectation that someone would check in with them supported their engagement with remote monitoring[42]. An evaluation of the BP@home programme flagged the importance of effective patient communication with GPs/clinician around the results of remote monitoring readings and education about the risks of hypertension[15]. The same report flagged the importance of patient motivation[15].

7.2.3. Wider system-related enablers

The literature flags the importance of effective communications between local and national stakeholders involved in care pathway delivery in enabling implementation of remote BP monitoring. An evaluation of BP@home in London, found that despite funding challenges (outlined in Section 4), communication between ICSs and NHS England through regular meetings and updates, as well as practices within the ICS, were noted as key enablers to successful remote BP monitoring[34]. The same study also found that onboarding materials shared by NHS England and input from UCLPartners to support identification and prioritisation of patients for remote monitoring were helpful in care pathway implementation[34].

Finally, clarity around the value proposition and business case for remote monitoring has been identified as an enabler of service rollout in some contexts. For example, in an evaluation of BP@home pilot sites, understanding how the service worked and the benefits to HCPs such as time saving and improved patient care was noted as an enabler to a successful adoption[15].

8. Reflection on the evidence gaps

Our analysis of the literature has identified several areas in need of better evidence to inform evidence-based decision making on remote BP monitoring service design, implementation, sustainability, spread and scale.

There is relatively well-established evidence in support of the effectiveness of remote BP monitoring in terms of controlling BP in patients with hypertension. However, there remains limited understanding in key areas, including:

- **How care pathways involving remote monitoring of BP can be successfully sustained, spread and scaled.** We conceptualise spread as entailing efforts to transfer successful interventions beyond the original adoption context; scale-up as establishing the infrastructure that can support widespread adoption, and sustainability as maintaining an intervention (in its original or adapted form) over time, where that is merited and supports desired outcomes[46]. Most of the literature is focused on case studies. The scarcity of evidence on how to spread, scale and sustain remote BP monitoring is not surprising, given the relatively limited focus on local implementation.
- **Understanding which types of remote monitoring approaches can support optimal patient outcomes and impacts on health services in specific contexts, how and why.** Understanding the diversity of remote BP monitoring care pathways, their constituent components and mechanisms of action, and how these may relate to realisation of desired outcomes and impacts is crucial for informing future pathway design, sustainability, and scalability. Current models vary significantly in tech-enablement, user-professional interactions, governance, financing, and patient selection. While diversity is not inherently problematic, it is essential to learn from these varied approaches to understand how different implementation approaches and processes affect outcomes and impacts. In addition, thematic gaps persist in key areas that could support learning about how to effectively implement (as well as spread, scale and sustain remote monitoring pathways), such as insights related to governance approaches, workforce organization and the broader national influences that shape these care models. Our review also showed that staff and patient experiences are varied and thus the evidence base on positive or negative effects in this regard is inconclusive. While more research is needed in this area, it is plausible that diverse experiences relate to and depend on the type of care pathway design, implementation approach and context of use, ability to address challenges (both more common and more context specific) as well as to individual and population level characteristics).
- **How implementation challenges can be addressed effectively.** While the challenges of implementing remote BP monitoring pathways are somewhat understood, there is a lack of systematic learning on how to effectively overcome these challenges to achieve desired outcomes in specific contexts. There is also very limited consideration of how challenges are a result of co-

evolving interactions between the technology, users and use contexts/adoption contexts and their levels of complexity.

- **How considerations of inequalities relate to remote BP monitoring care pathway design, implementation, outcome and impacts.** The evidence base at present is biased with little consideration of inequalities or how multiple categories of disadvantage interact and determine patient access, experience and outcomes. Strengthening the evidence base on intersectionality is a key research and evaluation need.
- **How remote BP monitoring pathways affect key measures of health service utilisation and contribute to efforts to manage pressures facing the NHS.** There are relatively few well-designed studies that examine impacts of remote BP health service utilisation (for example, using quasi-experimental approaches), as well as cost-related evidence. In part, this is related to challenges in the ability to access such datasets.

The need for rapid evaluation is especially urgent, given the public health significance of hypertension and CVD, the push for innovative care solutions, and the demand for robust evidence to guide decision-makers. The COVID-19 pandemic accelerated the adoption of remote monitoring pathways, underscoring the importance of generating evidence that supports informed decision-making in an evolving health systems landscape.

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