Remote monitoring

for long-term physical health conditions

Protocol for an evidence and gap map

Version 3

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1 Background

Worldwide, rates of chronic conditions such as Type 2 diabetes, chronic obstructive pulmonary disorder (COPD) and cardiovascular disease are increasing (1). The challenges this creates for health and social care services are exacerbated by population demographics (2), as the likelihood of developing many of these conditions increases with age (1, 3). Globally, the proportion of the population over the age of 60 will double by 2050 (2). In the UK, it is estimated that one in seven people will be aged over 75 by 2040 (3). New models of care are needed to meet these changes in demand, and the use of technology offers opportunities for innovation in service provision and self-care (3, 4). The NHS Long Term Plan (for England) outlines plans to invest in and increase the use of technology in the health care system (5), an aim that has been accelerated by the Covid-19 pandemic. The Covid-19 pandemic has led to a rapid adoption of technologies that enable the remote provision of health services in England and around the world (6, 7).

There are a range of technologies available to support or deliver healthcare remotely and they are being used in different ways for different purposes. With the proliferation of technology capable of delivering health services, there has been a corresponding increase in the terms used to describe this provision (4). Although definitions vary, eHealth is typically used as an umbrella term, encompassing the use of digital health records as well as delivery of healthcare via electronic means (8). Telehealth, telemedicine, telecare, and mHealth are all used to refer to the delivery of different types of health care or services via new technologies (e.g. smartphone apps) or older technologies (such as telephones) to aid self-management, diagnosis or treatment (8, 9).

Remote monitoring is a subset of these services and could be particularly beneficial for people with long-term conditions. While definitions vary, we define remote monitoring as:

> An intervention, involving the monitoring of a patient (using medical devices, applications, clinical investigation results, or other assessment tools), including self-monitoring, and which allows care professionals from a health care provider to assess and manage a patient's condition remotely - without the need for the patient to be seen face-to-face.

From the perspective of the individual, monitoring increases knowledge of their condition and can contribute to effective self-management (10). For health care providers, remote monitoring supports health assessment and clinical decision-making, including timeliness of care through the identification of exacerbations (11). By enhancing communication between patient and provider, it can assist in shared decision-making and the delivery of more

personalised care (4). Remote monitoring could also have wider benefits for the health care system. In the UK, there is increasing financial pressure on the NHS and social care services (12), creating a need to reduce the costs of healthcare where possible. Remote monitoring offers opportunities to increase the efficiency of care delivery in a number of ways (9). Firstly, through more effective use of time, by contributing to connected healthcare and as it means neither patient nor health care practitioner need to travel to appointments (13). It can also reduce health service use, both through the avoidance of unnecessary routine appointments and reducing acute admissions (14).

1.1 What is remote monitoring?

Remote monitoring is the periodic or continuous assessment or recording of someone's health or symptoms without a healthcare professional being with the patient. A range of remote monitoring technologies exist, from invasive (15) or non-invasive wearable sensors (11) e.g. heart rate monitors or blood pressure monitors, to home sensing technologies e.g. to monitor falls or night time disturbances (16). They may take constant measurements or require the patient to carry out readings at intervals (17, 18). Some are used specifically for certain conditions, such as the measurement of blood glucose by diabetic patients, whereas others can provide an indication of health status for multiple conditions.

Remote monitoring interventions themselves also vary in a number of ways. These include:

- frequency of data upload, and whether this is passive or active;
- frequency of contact with, and feedback provided, by health care professionals;
- mode of contact with health care professionals, whether in person or via phone or mobile application;
- inclusion of educational or other engagement activities in the intervention.

1.2 Existing evidence

Background scoping of the literature found reviews on the effectiveness of remote monitoring as well as factors which influence its acceptability for patients and providers and implementation by the health care providers.

1.2.1 Effectiveness of remote monitoring

Remote monitoring may be more effective for certain health conditions and in improving certain health outcomes. In their review of reviews, McBain et al. (14) found significant reductions both in hospitalisation and re-admissions to hospital as a result of self-monitoring for three chronic conditions, heart failure, hypertension and COPD. However, whilst a narrative synthesis of studies on the impact of using eHealth tools on changes to medication

use indicated that tools led to positive medication change and improved patient symptoms, there was little evidence showing improvement to outcomes such as medication use or quality of life (10). A recent meta-analysis found that remote monitoring did not have a statistically significant effect on clinical outcomes including body mass index, weight, waist circumference, body fat percentage, systolic blood pressure and diastolic blood pressure (17). The majority of patients in this analysis had either cardiovascular disease, pulmonary disease, or were overweight or obese.

1.2.2 Acceptability and implementation of remote monitoring

There are a number of reviews detailing barriers and facilitators to the implementation of remote monitoring interventions. In their realist review of potential mechanisms reducing, or leading to, acute care use, Thomas et al. (19) identified six theories of intervention success: (1) targeting populations at high risk; (2) accurately detecting a decline in health; (3) providing responsive and timely care; (4) personalising care; (5) enhancing self-management, and (6) ensuring collaborative and coordinated care.

Reviews focusing on the views of clinicians (13), patients (20), and both clinicians and patients (21), found similar themes regarding both the positive and negative aspects of remote monitoring. Potential benefits included reduced travel and clinician workload whilst concerns were raised regarding lower quality of care and additional burden for providers (13, 20, 22). Reviews concentrating on the technology itself have detailed usability issues ranging from difficulties reading devices to the importance of instructions for users (23) as well as barriers to adoption include connectivity issues and the potential need for increased data processing (24).

1.3 Overall aims and objectives of the review

1.3.1 Aim

To identify, classify, appraise and map recent systematic reviews of the effectiveness of remote monitoring and its acceptability and implementation in people living with long-term physical health conditions.

To meet this aim, we will produce an evidence and gap map (EGM). EGMs summarise key characteristics of existing studies to provide an overview of the current research on a topic. We will 'map' the evidence by categorising the studies that exist according to key dimensions (e.g. aims, methods, type of intervention, type of long-term condition), then visually representing the number of studies in particular combinations of categories (usually in a two-dimensional grid). EGMs do not synthesise findings or research; their purpose is to

allow users to identify and access the research evidence (or evidence gaps) most relevant to their patient groups and intervention focus.

Our specific research objectives are to:

- Map recent systematic reviews of the effectiveness of remote monitoring interventions for adults living with long-term physical health conditions.
- Map recent systematic reviews of the acceptability and implementation of remote monitoring interventions for adults living with long-term physical health conditions.

We have decided to map systematic reviews of remote monitoring for two reasons. Firstly, we identified a large number of systematic reviews in our initial scoping searches of the literature, so producing a map will allow identification of evidence gaps – populations, interventions, or outcomes where there are no systematic reviews - preventing duplication of effort. Secondly, our conversations with relevant policy, commissioner and clinical contacts linked to NHS England's NHS@home initiative indicated that knowledge of the breadth of evidence on remote monitoring would be most useful in supporting their work.

1.3.2   Research Question

What is the volume, diversity and nature of recent systematic reviews about the use of remote monitoring interventions for adults living with long-term physical health conditions?

2 Methods

2.1 Identification of studies

The bibliographic database search strategies will be developed using MEDLINE (via Ovid) by a team of information specialists (NS/AB) in consultation with the review team. The search strategy will combine search terms for remote monitoring and evidence syntheses using both controlled vocabulary when available (e.g. MeSH in MEDLINE) and free-text searching. Search terms will be partly derived from the titles and abstracts of pre-identified systematic reviews of remote monitoring and the search strategies of pre-identified systematic reviews as well as any relevant search filters. Results will be limited to English language studies and date limited from 2012 to-date.

We plan to search the following bibliographic databases:

- Cochrane Database of Systematic Reviews (via the Cochrane Library)
- Epistemonikos (www.epistemonikos.org).
- CINAHL Complete (EBSCOhost)
- Embase (Ovid)
- MEDLINE (Ovid)
- Web of Science Core Collection (Clarivate)
- Scopus (Elsevier)
- PEDro
- OTseeker
- ProQuest Dissertations & Theses Global (via ProQuest)

A provisional search strategy for the MEDLINE (Ovid) bibliographic database can be seen in Appendix A.

Web searching will be conducted via Google Scholar using Publish or Perish (Harzing). Manual checking of references and forward citation searching using Scopus and Web of Science will be conducted on studies that meet our inclusion criteria. Ongoing systematic reviews will be identified through searches of PROSPERO.

2.1.1 Inclusion and exclusion criteria

Below we detail the inclusion criteria and exclusion criteria (according to the PICO and other categories) which will be applied to the studies identified through the search strategy. Some of these criteria differ depending on whether the study focuses on effectiveness or acceptability and implementation.

Table 1. Inclusion and exclusion criteria, where these differ depending on the outcome(s) measured in the study this is noted in the appropriate column

Category	Include		Exclude
	Effectiveness	**Acceptability/ implementation**	
Population	Adults (aged 18 years or over) with a long-term physical health condition, defined as: "a chronic disease, defined as a physical illness that is prolonged in duration, does not often resolve spontaneously, and is rarely cured completely"(25)		- Children or young people (aged under 18) with long-term health conditions. - Populations without a long-term health condition. - Exclude if intervention is preventative for a specific population e.g. physical activity trackers for older adults.
Study participants	Adults (aged 18 years or over) with a long-term physical health condition.	- Adults (aged 18 years or over) with a long-term physical health condition. - Carers of adult patients. - Healthcare professionals providing/using remote monitoring.	
Interventions	Interventions must involve delivery of remote monitoring as defined below:		Interventions not meeting the definition or described poorly enough to preclude assessment of intervention type.

	Include		Exclude
Category	**Effectiveness**	**Acceptability/ implementation**	
	"An intervention, involving the monitoring of a patient (using medical devices, applications, clinical investigation results, or assessment tools), including self-monitoring, and which allows care professionals from a healthcare provider to assess and manage a patient's condition remotely - without the need for the patient to be seen face-to-face."		Exclude studies focussing on: - Multi-component interventions including remote monitoring where the effects of remote monitoring cannot be distinguished from other intervention components.
	Include monitoring: - of objective or self-reported health status; - occurring in the place where a person lives, either their home or a residential setting such as a care home; - using a device or written output, as long as data is transferred to a care professional.		
Comparator(s)/ control	Any comparator eligible for inclusion. Examples may include: wait-list control or treatment as usual but there has to be either no remote monitoring or a different level or type of remote monitoring. Studies may also compare different forms of remote monitoring.		No exclusion based on this
Outcomes	All reported outcomes on effectiveness are of interest, including: - safety or adverse events (as an important aspect of effectiveness); - self-efficacy.	All reported outcomes on acceptability or implementation are of interest, including: - patient adherence (as an important aspect of implementation,	

Category	Include		Exclude
	Effectiveness	**Acceptability/ implementation**	
		especially for interventions that are essentially self-administered); - intervention fidelity (another aspect of implementation); - patient satisfaction (as a construct/outcome domain that overlaps considerably with acceptability).	
Study design	Systematic reviews which aim to evaluate the effectiveness, acceptability, and/or implementation of remote monitoring interventions, and which: 1. Include a clear and pre-specified research question, 2. have used a search strategy that is sufficiently clear and detailed to be reproducible, 3. have pre-specified inclusion/exclusion criteria and screening methods, 4. have conducted quality assessment of included studies, and 5. report a clearly described method of data analysis (26).		- Systematic reviews which do not meet our definition of a review. - Systematic reviews which do not evaluate effectiveness, acceptability, and/or implementation. - Scoping reviews that do not follow a systematic methodology. - Conference abstracts or posters without full details
	Systematic reviews including comparative outcome evaluations	Systematic reviews including comparative outcome evaluations, other	

	Include		Exclude
Category	**Effectiveness**	**Acceptability/ implementation**	
	(randomised and non-randomised controlled trials, and other study designs e.g. controlled before-and-after trials, interrupted time series designs)	quantitative designs (e.g. single-arm trials, cohort studies, surveys), and/or qualitative studies	
	Only systematic reviews with searches conducted in 2012 or later will be included in the evidence map, due to the rapid advancement of remote monitoring technology.		Systematic reviews with searches conducted prior to 2012.
Context	Studies reported in English and conducted within any high-income countries as defined by the World Bank list. This is to ensure that included studies are as relevant as possible to the needs of the UK health service delivery, commissioning and policy community.		Studies not reported in English. Studies conducted in low- or middle-income countries.

2.1.2 Process for applying inclusion criteria

Once the search results have been obtained, all reviewers will independently apply the inclusion and exclusion criteria to a representative sample of citations (e.g. n=100). Decisions will be discussed in a group meeting to ensure consistent application of criteria. This will allow us to clarify the inclusion and exclusion criteria, and revise them where necessary, enabling consistent reviewer interpretation and judgement of the criteria.

After the initial calibration exercise has been completed, two reviewers will independently apply the revised inclusion and exclusion criteria to the title and abstract of each identified citation. We will obtain the full text of papers where either reviewer judges it to meet the criteria, and for those where it is not possible to make a decision using the information in the title and abstract alone.

Two reviewers will assess the full text of each record independently for inclusion, with disagreements settled through discussion with a third reviewer. This will include deciding whether each study is a systematic review according to the five criteria detailed above. The study selection process will be detailed using a PRISMA-style flowchart, with a reason reported for exclusion of each record retrieved at full text (27).

As systematic review authors may not define remote monitoring as we do, we will judge whether we believe the types of intervention sought within each systematic review are sufficiently aligned with our definition. Only reviews which we believe are mainly focused on interventions that include remote monitoring, or compare different types of remote monitoring, will be included. We will judge this during full-text screening, at the level of the systematic review aims. In the case of systematic reviews which may include studies which do not meet our criteria e.g. other eHealth interventions or studies from high- and low-income countries, we will include them if over 75% of included studies are relevant. We will not check primary research studies so if this is not evident from the information reported in the paper the study will be excluded. Similarly, we will not check for duplication of primary studies between reviews as the map is intended to capture the breadth of evidence available.

2.2 Data extraction

EPPI-Reviewer 4 software (EPPI-Centre Software, London, UK) will be used to construct a standardised data extraction coding set. This will be piloted by the review team on a sample of included studies and, once finalised, used to collect information from each included full text item. We define items as a single study (sample); these may include multiple reports or

publications. For ongoing reviews, we will judge whether enough information is provided about the population, intervention, and outcomes of focus to include the review on the map. One reviewer will perform data extraction. Their data will be checked by a second reviewer, with disagreements being settled through discussion and, if necessary, involvement of a third reviewer.

Examples of data which will be extracted include:

- Authors
- Publication year
- DOI/citation
- Date of searches
- Review question(s)
- Population(s)
- Included (or sought) study designs
- Number of includes
- Type of SR/synthesis
- Characteristics of remote monitoring
- Types of comparators included
- Outcomes

We have used the NIHR-INCLUDE guidelines (28) to reflect on Equality, Diversity and Inclusion (EDI) whilst designing the protocol. We will consider EDI at the review level, by identifying whether included reviews consistently consider PROGRESS-Plus characteristics, as health inequity may be experienced as a result of these characteristics (29, 30). We will extract data for those characteristics, such as age, which are reported consistently and might impact on the effectiveness, acceptability or implementation of remote monitoring interventions.

2.3 Study quality assessment strategy

Following full-text screening, the AMSTAR 2 (*A MeaSurement Tool to Assess systematic Reviews*) quality appraisal tool (31) will be used to assess the quality of all systematic reviews identified as eligible for inclusion. We have chosen critical domains for determining the overall quality of the review by reflecting on the domains used by other researchers (32, 33) and discussing the most important domains for this area of research (31), in order to accurately represent the quality of the included reviews. AMSTAR 2 is intended to appraise quantitative studies of healthcare interventions with randomised or non-randomised designs, as we are including a broader range of study designs in the map, we will use adaptations to

certain questions suggested by Lam et al. (33) to allow us to appraise the quality of these studies (Table 2).

Table 2. AMSTAR 2 questions for quality appraisal, including adaptations for different study designs and chosen critical domains.

** indicates the critical domains which will be used to assess overall study quality

	Quantitative comparative outcome evaluations e.g. RCTs	Other quantitative studies e.g. single arm evaluations, survey studies	Qualitative
1.	Did the research questions and inclusion criteria for the review include the components of PICO?	Did the review have a clear research question and inclusion criteria?	
2.**	Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?		
3.	Did the review authors explain their selection of the study designs for inclusion in the review?		
4.**	Did the review authors use a comprehensive literature search strategy?		
5.	Did the review authors perform study selection in duplicate?		
6.	Did the review authors perform data extraction in duplicate?		
7.	Did the review authors provide a list of excluded studies and justify the exclusions?		
8.**	Did the review authors describe the included studies in adequate detail?		
9.**	Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?	Did the review authors use a satisfactory technique for assessing the methodological limitations of individual studies that were included in the review?	
10.	Did the review authors report on the sources of funding for the studies included in the review?		
11.	If a synthesis was performed did the review authors use appropriate methods to combine the results of individual studies?		

12.	If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	Not applicable	
13.	Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review?	Did the review authors account for methodological limitations in individual studies when interpreting/ discussing the results of the review?	
14.**	Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?	Did the review authors provide a satisfactory explanation for, and discussion of, variations in study characteristics and outcomes observed in the results of the review?	Did the review authors provide a satisfactory explanation for, and discussion of, variations in perspective observed in the results of the review?
15.	Did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review? *Partial Yes - where reviews of quantitative studies (with or without meta-analysis) have discussed the likelihood and impact of publication bias.*	Not applicable	
16.	Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?		

Quality appraisal will be performed by one reviewer and checked by a second, with disagreements settled by discussion and, if required, a third reviewer.

2.4 Data analysis and presentation

EPPI-Reviewer 4 software will be used to produce an interactive evidence and gap map. This will visually represent the distribution of evidence across different intervention types and outcome domains. Users will also be able to filter the map so that it only contains evidence relating to certain population/patient types or types of review.

The final format of the map will be dependent on the studies found and the information that they contain. However, we expect that the first, initially visible, layer of the map will display recent, high quality systematic reviews in a matrix, with broad intervention domains (e.g. type of remote monitoring, mode of contact with health care professionals) forming the rows, and broad outcome domains (e.g. health outcomes, barriers and facilitators) forming the columns. In the second layer of the map, it will be possible to expand these domains, to obtain finer detail as to which reviews contain information on specific intervention and outcome categories.

Each cell in the matrix will contain a graphical representation of the evidence, in the form of a 'bubble' with dimensions and colours determined by the number, type and quality of studies available e.g. larger bubbles will indicate more evidence, different colours will indicate level of quality. An example of an interactive map previously produced by the review team is available here.

Users will be able to select bubbles in the matrix, which will provide them with a list of studies focusing on that particular combination of intervention and outcomes. Clicking on any study listed will take the user to the summary box for that study.

Data detailed within the summary box will be obtained during data extraction and finalised in consultation with our stakeholder group. It will include:

- DOI and full citation of review
- Quality of review
- Research questions
- Population(s) of interest
- Stated intervention(s) of interest
- Number of included studies
- Date of searches

- Outcomes of interest

To accompany the interactive evidence and gap map, which will be accessible by URL, we will produce a narrative summary of key findings. We will map the data by population group, intervention categories, and outcome domains, identifying areas of evidence concentration as well as gaps in the evidence. This will include reflection on health equity through discussion of how/whether included reviews consider PROGRESS-Plus characteristics and their impact on the effectiveness, acceptability or implementation of remote monitoring interventions (29, 30).

Evidence and gap maps aim to provide an overview of the available evidence. This map will not:

- summarise or describe the findings of included systematic reviews;

- provide detailed description of the remote monitoring interventions in included systematic reviews.

3 Stakeholder and patient/public involvement

3.1 Stakeholder involvement

Members of the NHS@home team form the core stakeholder group for the production of this evidence and gap map. Other relevant individuals will be identified using word of mouth and snowballing techniques. They are likely to include policy makers, commissioners, health care professionals, and academics.

We will consult stakeholders throughout the review process, seeking their input on the scope of our research questions and the development of the protocol to ensure that the evidence and gap map includes key intervention and outcome categories. Once an interactive map has been produced, we will seek stakeholder feedback on the accessibility and information provided by the map. Their comments will be used to produce subsequent versions of the map.

3.2 Patient and public involvement

We will recruit and consult a Patient & Public Involvement (PPI) group to gain feedback from users of remote monitoring technology for managing heath conditions. This will ensure that our evidence and gap map is accessible and inform the plain language summaries describing our review and its findings. We will arrange the meetings in consultation with the PPI group to suit the project progress and their availability.

4 Dissemination plans

The interactive evidence and gap map will be shared with the NHS@home team, who will facilitate onward dissemination, which may include sharing the EGM with service commissioners (e.g. CCGs) and clinical teams responsible for providing remote monitoring programmes.

Academic outputs/reports:

Alongside the evidence and gap map, we will produce four main outputs:

- an evidence briefing, giving a plain language summary;

- a report on the distribution of evidence identified in the map, published as an (Open Access) Health Services and Delivery Research Topic Web Report;

- an article in an academic journal identified as being relevant to stakeholders for this review; and

- presentations at key national and regional meetings.

Our plan is to co-produce these materials in collaboration with our stakeholders. They will be disseminated via the Exeter HSDR Evidence Synthesis Centre webpage and social media. Additional material may be produced to promote them, such as a blog post based on the evidence briefing and report. We will continue to develop a dissemination plan as the findings of the review emerge, allowing us to identify key audiences and the most appropriate delivery mechanisms for each.

References

1.   Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet. 2020;396:1204-22.

2.   World Health Organisation. Ageing and health Geneva: World Health Organisation; 2021 [Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health.

3.   Government Office for Science, Foresight. Future of an ageing population. London: Government Office for Science; 2016.

4.   Harst L, Lantzsch H, Scheibe M. Theories predicting end-user acceptance of telemedicine use: Systematic review. Journal of Medical Internet Research. 2019;21:e13117.

5.   NHS England. The NHS Long Term Plan. London; 2019.

6.   Vindrola-Padros C, Singh KE, Sidhu MS, Georghiou T, Sherlaw-Johnson C, Tomini SM, et al. Remote home monitoring (virtual wards) for confirmed or suspected COVID-19 patients: a rapid systematic review. eClinicalMedicine. 2021;37:100965.

7.   Horton T, Hardie T, Mahadeva S, Warburton W. Securing a positive health care technology legacy from COVID-19 2021 [Available from: https://www.health.org.uk/publications/long-reads/securing-a-positive-health-care-technology-legacy-from-covid-19.

8.   Barbabella F, Melchiorre MG, Quattrini S, Papa R, Lamura G. How can eHealth improve care for people with multimorbidity in Europe? : European Observatory on Health Systems and Policies; 2016.

9.   Kvedar J, Coye MJ, Everett W. Connected health: A review of technologies and strategies to improve patient care with telemedicine and telehealth. Health Affairs. 2014;33:194-9.

10.   Lancaster K, Abuzour A, Khaira M, Mathers A, Chan A, Bui V, et al. The use and effects of Electronic Health Tools for patient self-monitoring and reporting of outcomes following medication use: Systematic review. Journal of Medical Internet Research. 2018;20:e294.

11.   Iqbal FM, Lam K, Joshi M, Khan S, Ashrafian H, Darzi A. Clinical outcomes of digital sensor alerting systems in remote monitoring: a systematic review and meta-analysis. npj Digital Medicine. 2021;4:7.

12.   Health Foundation, Kings Fund, Nuffield Trust. Budget 2018: What it means for health and social care. 2018 [Available from: https://www.kingsfund.org.uk/sites/default/files/2018-11/budget-2018-what-it-means-for-health-and-social-care_0.pdf.

13.   Davis MM, Freeman M, Kaye J, Vuckovic N, Buckley DI. A systematic review of clinician and staff views on the acceptability of incorporating remote monitoring technology into primary care. Telemedicine and e-Health. 2014;20:428-38.

14.   McBain H, Shipley M, Newman S. The impact of self-monitoring in chronic illness on healthcare utilisation: a systematic review of reviews. BMC Health Services Research. 2015;15:565.

15.   Veenis JF, Radhoe SP, Hooijmans P, Brugts JJ. Remote monitoring in chronic heart failure patients: Is non-invasive remote monitoring the way to go? Sensors (Basel). 2021;21:887.

16.   Husebo BS, Heintz HL, Berge LI, Owoyemi P, Rahman AT, Vahia IV. Sensing technology to monitor behavioral and psychological symptoms and to assess treatment response in people with dementia. A systematic review. Frontiers in Pharmacology. 2019;10:1699.

17.   Noah B, Keller MS, Mosadeghi S, Stein L, Johl S, Delshad S, et al. Impact of remote patient monitoring on clinical outcomes: an updated meta-analysis of randomized controlled trials. npj Digital Medicine. 2018;1:20172.

18.   Choi WS, Shin I-S, Yang J-S. Understanding moderators of home blood pressure telemonitoring systems in urban hypertensive patients: A systematic review and meta-analysis. Telemedicine and e-Health. 2020;26:1016-34.

19.   Thomas EE, Taylor ML, Banbury A, Snoswell CL, Haydon HM, Gallegos Rejas VM, et al. Factors influencing the effectiveness of remote patient monitoring interventions: a realist review. BMJ open. 2021;11:e051844.

20.   Walker RC, Tong A, Howard K, Palmer SC. Patient expectations and experiences of remote monitoring for chronic diseases: Systematic review and thematic synthesis of qualitative studies. International Journal of Medical Information. 2019;124:78-85.

21.   Ferguson C, Inglis S, Hickman L, Byiers V, Macdonald P, Breen P, et al. 766 Acceptance and uptake of wearable cardiac technologies in older adults: A systematic review and meta-synthesis. Heart Lung and Circulation. 2020;29(Supplement 2):S381.

22.   Ferguson C, Hickman LD, Turkmani S, Breen P, Gargiulo G, Inglis SC. "Wearables only work on patients that wear them": Barriers and facilitators to the adoption of wearable cardiac monitoring technologies. Cardiovascular Digital Health Journal. 2021;2:137-47.

23.   Saeed N, Manzoor M, Khosravi P. An exploration of usability issues in telecare monitoring systems and possible solutions: a systematic literature review. Disability and Rehabilitation: Assistive Technology. 2020;15:271-81.

24.   Baig MM, Gholam Hosseini H, Moqeem AA, Mirza F, Linden M. A systematic review of wearable patient monitoring systems - current challenges and opportunities for clinical adoption. Journal of Medical Systems. 2017;41:115.

25.   Australian Institute of Health and Welfare (AIHW). Chronic diseases and associated risk factors in Australia 2001. PHE 33rd ed. Canberra: AIHW; 2002.

26.   Krnic Martinic M, Pieper D, Glatt A, Puljak L. Definition of a systematic review used in overviews of systematic reviews, meta-epidemiological studies and textbooks. BMC Medical Research Methodology. 2019;19:203.

27.   Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Systematic Reviews. 2021;10:89.

28.   National Institute for Health Research. Improving inclusion of under-served groups in clinical research: Guidance from the NIHR-INCLUDE project. UK: National Institute for Health Research; 2020.

29.   Cochrane Methods Equity. PROGRESS-Plus no date [Available from: https://methods.cochrane.org/equity/projects/evidence-equity/progress-plus.

30.   O'Neill J, Tabish H, Welch V, Petticrew M, Pottie K, Clarke M, et al. Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. Journal of Clinical Epidemiology. 2014;67:56-64.

31.   Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ. 2017;358:j4008.

32.   Finucane AM, O'Donnell H, Lugton J, Gibson-Watt T, Swenson C, Pagliari C. Digital health interventions in palliative care: a systematic meta-review. npj Digital Medicine. 2021;4:64.

33.   Lam AA, Lepe A, Wild SH, Jackson C. Diabetes comorbidities in low- and middle-income countries: An umbrella review. Journal of Global Health. 2021;11:04040.

Appendix 1. Search strategies

Stage 1 MEDLINE (Ovid) search strategy

Ovid MEDLINE(R) ALL <1946 to March 22, 2022>

1   Remote Sensing Technology/   3617

2   Telemetry/   10077

3   Telemedicine/ 32700

4   monitor*.ti,ab. 900789

5   3 and 4 [combined with monitor* as telemedicine/ concept much broader to include remote consultations etc]   4977

6   Monitoring, ambulatory/   8593

7   Wearable electronic devices/ 5748

8   Fitness trackers/   986

9   ((remote* or home* or digital or virtual* or telephon* or smartphone* or phone* or smartwatch* or smart watch* or ambulatory or app or apps or mobile* or device* or location* or GPS or global positioning or acceleromet* or gyroscop* or wearable*) adj5 monitor*).ti.
        10564

10   ((remote* or home* or digital or virtual* or telephon* or smartphone* or phone* or smartwatch* or smart watch* or ambulatory or app or apps or mobile* or device* or location* or GPS or global positioning or acceleromet* or gyroscop* or wearable*) adj2 monitor*).ab.
        21761

11   ((remote* or digital or home*) adj2 (sensor* or sensing or tracker or tracking)).ti,ab.
        11072

12   (remote* adj2 (measurement* or supervision or surveillance)).ti,ab.   911

13   "distant patient monitoring".ti,ab.   1

14   (biosensor* or biosensing).ti. 18621

15   ((body or motion or inertia* or wearable* or worn or activity or ingestible* or implant* or insertable or patch* or location* or GPS or global positioning or acceleromet* or gyroscop* or wireless or fitness) adj2 (sensor* or sensing or tracker* or tracking)).ti,ab.   23838

16   ((wearable* or sensing) adj2 (device* or system* or technolog*)).ti,ab.   18640

17   (virtual adj2 (ward* or healthcare or "health care" or hospital* or monitor*)).ti,ab.   474

18   telemonitoring.ti,ab.   1805

19   ((telecare or telemedicine or telemetry or telehealth* or m-health* or mhealth* or e-health* or ehealth* or electronic health*) adj8 monitor*).ti,ab.   3017

20   (assistive technolog* adj5 monitor*).ti,ab.   17

21   (smart home* adj5 monitor*).ti,ab.   74

22   (smart house* adj5 monitor*).ti,ab.   2

23   (home automation adj5 monitor*).ti,ab.   9

24   ("Internet of things" adj5 monitor*).ti,ab.   155

25   (gerontechnolog* adj5 monitor*).ti,ab.   1

26   "electronic patient reported outcome".ti,ab.   173

27   (ePROM or ePROMs or ePRO or ePROs).ti,ab.   274

28   1 or 2   13626

29   or/5-27 108332

30   28 or 29   117401

31   (metaanalysis or meta-analysis or metasynthesis or meta-synthesis).ti,ab. 198936

32   (systematic adj (review or overview or search*)).ti,ab.   228569

33   (systematically adj (review* or search*)).ab. 30524

34   evidence synthesis.ti,ab.   5678

35   thematic synthesis.ti,ab.   1109

36   (evidence adj2 map*).ti,ab.   1170

37   ((scoping or rapid or realist or mapping) adj2 review).ti,ab. 15858

38   (qualitative adj2 synthesis).ti,ab.   3925

39   ((mixed-stud* or (mixed adj stud*) or (mixed adj method*) or mixed-method*) adj2 review).ti,ab.   836

40   cochrane.jw.   15903

41   systematic reviews.jn. 2245

42   systematic review/   189020

43   or/31-42   373508

44   30 and 43   1766

45   limit 44 to yr="2012 -Current" 1601