



## **Establishing the impact of remote monitoring in general practice in North East England – Real-World Evaluation.**

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## Summary

This project was funded by the Academic Health Science Network for the North East and North Cumbria (AHSN NENC), now Health Innovation North East and North Cumbria (HI NENC). HI NENC led the project in collaboration with five general practitioner surgeries within the Tyne and Wear area and commissioned the University of Sunderland to produce this independent real-world evaluation report.

This project aimed to evaluate the effectiveness of newly implemented remote monitoring pathways in five general practice surgeries, and clinician experiences of implementing remote monitoring pathways. To summarise, this mixed methods evaluation demonstrates the benefits, challenges, and future directions for remote monitoring within general practice surgeries.

### **Aims and associated Findings of the evaluation:**

**1) Aim:** How effective is remote monitoring in reducing GP/Nurse/Healthcare appointments?

**Finding:** The data indicates that an increase in remote monitoring is associated with a decrease in GP/nurse/healthcare appointments as a whole, including face-to-face appointments.

**2) Aim:** How effective is remote monitoring in improving patient access to appointments?

**Finding:** The analysis indicates that an increase in remote monitoring is associated with improved patient access to appointments.

**3) Aim:** Does remote monitoring reduce cost?

**Finding:** Demonstrated a significant time and cost reduction with a reduction in the length of appointment.

**4) Aim:** Does remote monitoring reduce appointment time?

**Finding:** The outcome of the analysis appears to be most effective for number and time-reduced appointments.

**5) Aim:** What are the experiences of clinicians when implementing remote monitoring into practice?

**Findings:** The thematic analysis identified three themes, which collectively highlight the benefits of remote monitoring to both patients and staff, the

challenges clinicians experienced during the intervention period, and their thoughts on the future of remote monitoring in general practice.

## Background

General Practitioners (GPs) are considered the bedrock of the NHS, with public and patient satisfaction previously reported as higher than 85% in 2017 (NHS, 2017). Each year GPs in the UK conduct over 300 million consultations with patients. Compared to Accident and Emergency, which experience approximately 23 million patient visits per year. The cost of general practice consultations is considerably less than the cost of Accident and Emergency visits. However, patient satisfaction, particularly in the 16–25-year-old demographic has declined (NHS, 2019). The NHS *Long Term Plan* (2019) is committed to every patient having the right to digital consultations with GPs. According to the NHS (2019), many GPs now offer telephone or eConsult appointments. The NHS (2019) asserted the need to modernise and digitalise primary care, referring to a '*digital-first primary care*' within the next five years, due to cost saving, convenience, popularity, improved access, and time-saving potential. Remote patient monitoring is commonly referred to as telemonitoring, and it is a strategy that enables practitioners to observe their patient's physiology remotely, which allows for intervention where needed (Serrano et al., 2023).

UK policymakers have asserted that the use of alternative methods of appointments in primary care settings may have a transformative effect on both staff and patients, such as reducing staff workload and increasing appointment accessibility for patients (Department of Health, 2012; NHS, 2016). Although such methods have been encouraged at a policy level, general practices were slow to implement such practices (Brant et al., 2016). The NHS long-term workforce plan (2023) and the NHS productivity plan (2024) have both been driven in part by the idea that technology can increase clinical activity and free up time (Horton and Moulds, 2024). Hesitancy to implement such changes was related to concerns about patient safety and staff workload (Atherton et al., 2013). However, the use of telephone appointments has been utilised widely in general practice. Atherton et al.'s (2018) mixed methods evaluation of implementation for alternative appointments to traditional face-to-face methods in general practices identified several barriers and facilitators of implementing face-to-face alternatives. Barriers included patients being unaware of alternative options and staff struggling to communicate these options. Additionally, getting patients to engage was a challenge. Concerns about how

alternative methods would affect staff workload and lack of understanding regarding the role and reason for alternative methods also worked as a barrier. Concerns regarding inequity and inequality regarding who would be contacted for alternative methods of appointments were also a barrier, with some patients being chosen for alternative appointments and others being selected for traditional methods.

Receptionists, whose role was to ensure uptake of new methods of appointments did not receive training or have their new role acknowledged by other staff members.

Other barriers were related to technological challenges, where the facilities were not able to implement alternative methods successfully. Finally, a central barrier to uptake and attitude was the professional identity – the foundation of this identity is the doctor-patient relationship, which did not adapt to alternative methods.

Telemedicine thrived during the COVID-19 pandemic as a method of ensuring continuity of care in times of social distancing (Barkai et al., 2020). However, a systematic review conducted by Tucker et al. (2017) determined that self-monitoring of blood pressure in hypertensive patients does not lower blood pressure unless it is combined with other interventions such as medication titration, education or lifestyle counselling, which maintains a lowered blood pressure over a minimum of 12 months. This research highlights the need for a greater understanding of how to implement remote monitoring to ensure patient safety. Likewise, remote consulting is still in its infancy, and moving to whole remote consulting would be premature, as more research, training, and user-friendly technology are required (Neunaber & Meister, 2023).

Greenhalgh et al. (2021) established a conceptual exploratory framework (PERCS) to understand and evaluate remote consultation services and offer a holistic examination and overview of this complex system. PERCS comprises eight interdependent domains which have emerged in the literature relating to remote monitoring: *the reason for consulting, the patient, the clinical relationship, the home and family, technologies, staff, the healthcare organisation, and the wider system* (Greenhalgh et al., 2022). Greenhalgh et al.'s (2021; 2022) research highlighted some populations whom professionals felt it would be inappropriate to utilise remote consultations, most were patients with complex needs, however, some patients with complex needs preferred the option of alternative modalities, demonstrating the need for patients to be provided with choice, congruent with person-centred values (Greenhalgh et al., 2022; McCormack & McCance, 2006). There were concerns

regarding the quality of the therapeutic relationship when remote monitoring from both the professional and patient perspective, and concerns regarding the 'hidden agenda', whereby skilled clinicians can elicit information about underlying worries and concerns that the patient may not initially mention. It was felt that remote monitoring would reduce GPs' ability to diagnose underlying difficulties experienced by the patient (Greenhalgh et al., 2022). In Greenhalgh et al.'s 2022) study general practices were frequently understaffed and overstretched, which made it difficult to implement change.

Greenhalgh et al. (2024) conducted a mixed methods study that examined the unmet training needs of clinical and non-clinical staff in general practices and learning method preferences. This study identified that learning and implementation of remote consultation methods commonly occurred under disadvantageous circumstances such as low staffing, high workloads, and complex workflow systems and were often combined with insufficient training, low confidence, and capability. Additionally, methods of training were often didactic, which acted as a barrier to learning and, subsequently, action. Didactic learning facilitated basic understanding but did not lead to enhanced confidence and capability; such attributes emerged from observations, experiential learning, and informal discussions with team members. Likewise, training sessions seldom involved a whole-team approach, which exacerbated the barriers to learning.

Thiyagarajan et al. (2020) systematic literature review identified that different patient demographics highlighted those patients with long-term conditions had a greater preference for in-person consultations, than any other demographic. Clinicians also shared concerns regarding patients from disadvantaged backgrounds and those with vulnerabilities may not have the capability or resources to engage, exacerbating already established health inequity and inequality. Within the UK and North East England particularly, there are high rates of digital exclusion (Roscoe & Johns, 2021).

## **Evaluation project process**

Ethical approval was applied for and awarded from the University of Sunderland under application 022505 in December 2023. Project governance approval was applied for and awarded in November 2023

Five GP surgeries were provided with funding to implement a minimum of one remote pathway. The initial meeting occurred in July 2023, and the implementation of pathways occurred in July 2023. GP surgeries and remote monitoring champions were instructed to collect baseline and intervention data specific to their pathways.

Pathways for each surgery are listed below:

- 1) UTI Pathway
- 2) Contraceptive pill check pathway
- 3) BP self-monitoring pathway and Diabetes pathway
- 4) Hypertension and HRT new starters pathway.
- 5) Contraceptive pill check and new patient pathway

The evaluation utilised a mixed methods methodology, integrating qualitative and quantitative approaches, to provide a more holistic understanding (Creswell & Plano Clark, 2017). Mixed methods designs are valuable when the research undertaken aims to inform policy (Brannen, 2005).

The researchers designed a bespoke template to enable data collection of both quantitative and qualitative data. The template was designed to be flexible, ensuring all GP surgeries could share data regardless of the pathway they had implemented. (See Appendix 2). Likewise, they could complete the template in their own time to reduce further burden on primary care clinicians. The template was divided into two separate parts: the quantitative section aimed to elicit data on the aforementioned aims, and the qualitative data aimed to further understand the experiences of primary care clinicians when working remotely.

Quantitative descriptive data was analysed from the completed template carried out via a survey and MS Teams call, which asked for baseline and intervention on appointment usage, cost, professional involved in the appointment, response rates, length of appointment, frequency of appointments, cancellations, and population demographics. Clinicians were requested to complete the template for each pathway implemented. The qualitative method was analysed using thematic analysis (Braun & Clarke, 2006). Not all surgeries returned the data to the research team however data was received for

- Contraceptive pill check pathway
- BP self-monitoring pathway
- HRT new starters pathway



New patient pathway

UTI pathway

## Quantitative Findings

The quantitative findings present the analysis conducted to evaluate the effectiveness of remote monitoring in the five General Practice surgeries. The key findings include improved patient outcomes, cost and time savings, enhanced access to care, provider satisfaction, cost savings, and challenges and barriers. Descriptive statistics were used to provide an analysis to the collected data. Descriptive statistics summarise and describe the main features of a dataset. Descriptive statistics help to identify patterns and relationships between variables.

### **Number and Time of Appointment Pre-intervention.**

The time taken for each pathway appointment implemented differed across each surgery. However for each pathway implemented where data was sent to the research team there was a reduction in the time spent at each appointment following the implementation of the technology supported pathway. The time reduction ranged from 5 minutes to 20 minutes per appointment. For some of the pilot sites this change in pathway resulted in a reduction in face to face appointments to eConsult in some cases meaning that senior admin could manage the cases rather than a GP, Nurse or HCP. This did allow for cost calculations based on Ref: [Unit Costs of Health and Social Care 2022 Manual - Kent Academic Repository](#)

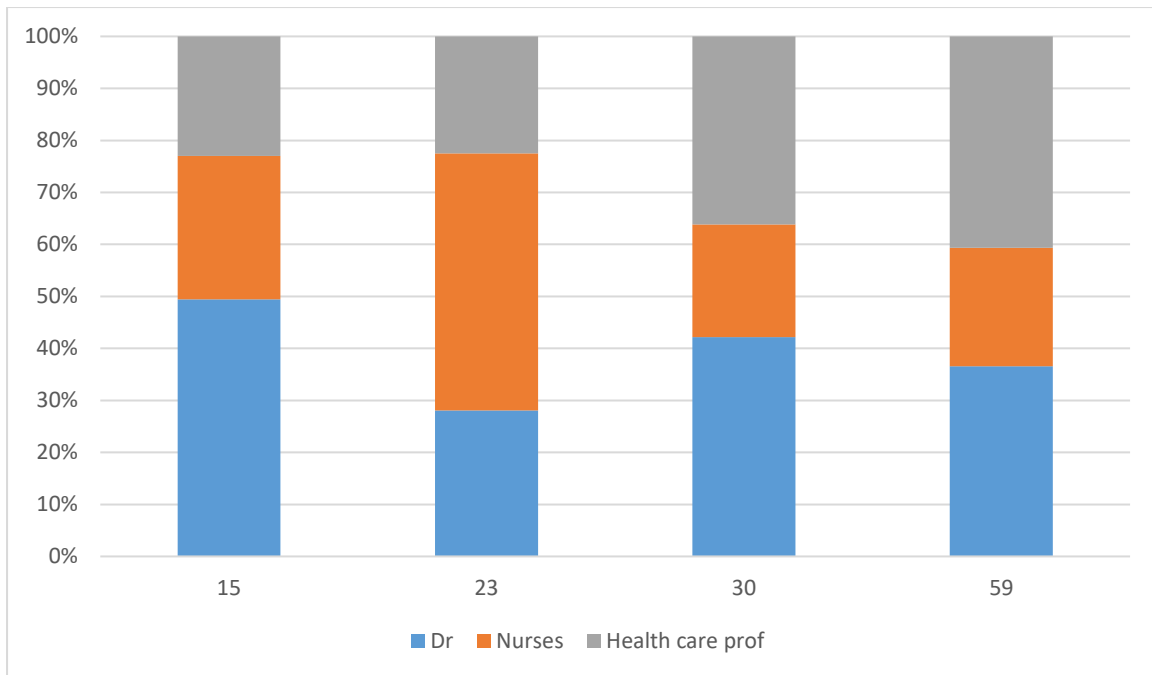


Figure 1: Number of appointments pre-intervention.

### Type of Appointment

Moving from face-to-face to eConsult appears to be most effective at reducing time spent for each appointment. This demonstrated a significant time and cost reduction with a reduction in the length of appointment and general practice attendance. For some of the pilot surgeries the change to the type of appointment not only reduced the time spent but also the professional managing the appointment; for example a nurse and HCP would have completed the appointment but these could now be managed by a senior admin. For one site the eConsult meant that the appointments were managed by pharmacies with the surgery only picking up red flag patients. In this surgery the pre technology assisted pathway appointments involved both GP and Nurse appointments (32 pre intervention appointments) but post intervention there was a change to Pharmacy intervention with only 11 HCP appointments required for weight checks.

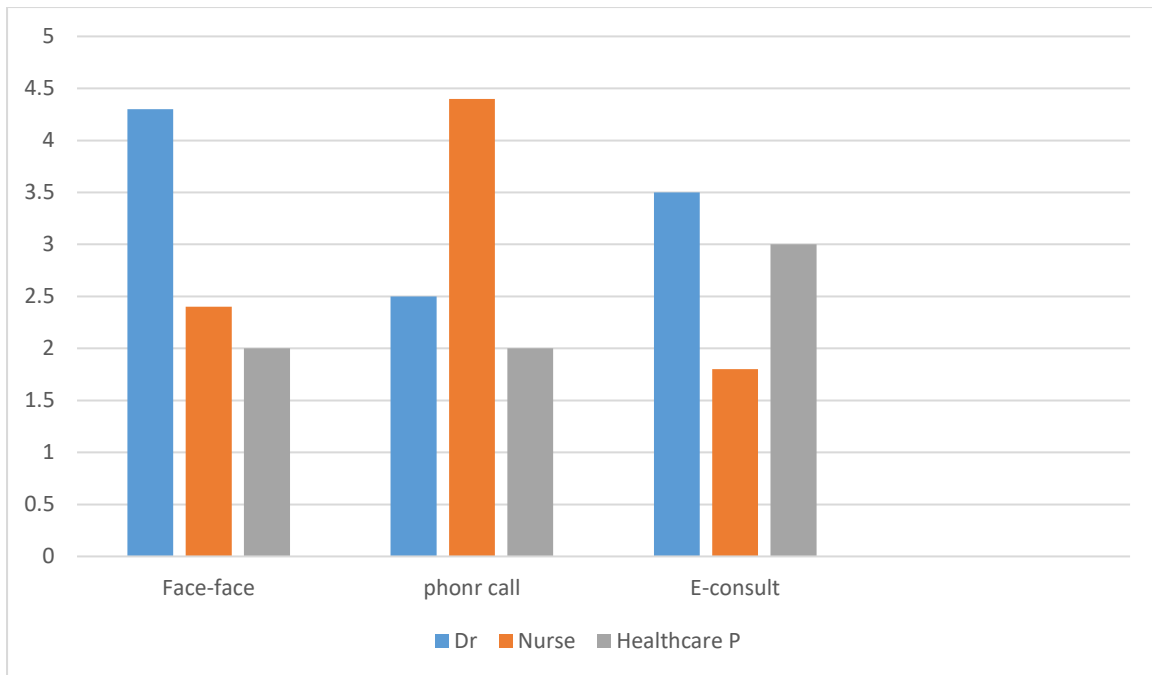


Figure 2: Type of appointment and health profession

### Number and Time of Appointment Intervention.

There is a reduction in the length of time for appointments and the number of appointments/consultations during the remote monitoring implementation. The contraceptive pill check pathway, BP self-monitoring pathway and the new patient check pathway are the most effective for number and time-reduced appointments. The new patient checks moved their appointments to an online system. These were overseen by a nurse prior to the implementations of the new pathway and a HCP post intervention. Prior to the online form there were 30 face to face appointments of 20 minutes each with a nurse however only 1 patient required a HCP face to face appointment after the online form was introduced. For the contraceptive pill checks the surgeries who implemented this pathway stated that there was a time saving for each face to face appointment pre pathway saving a 15 minute nurse appointment post pathway via eConsult. There was also a reduction in appointment cancellations at one site from 4 pre intervention to zero post.

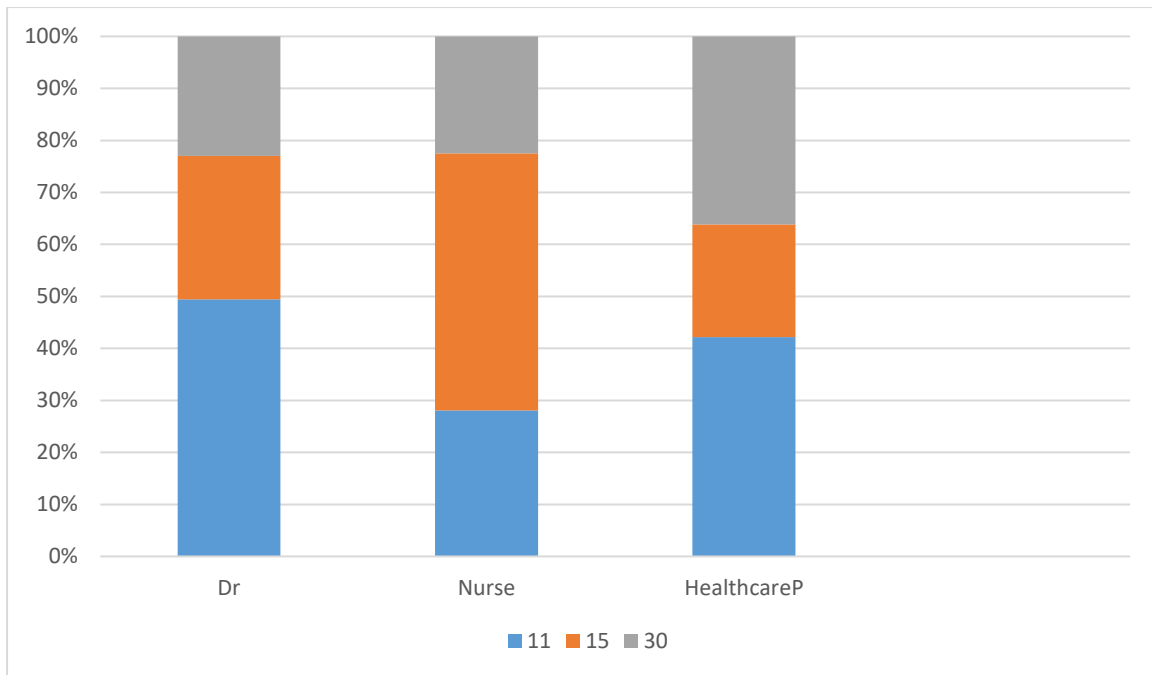


Figure 3: Number and Time of Appointment Intervention

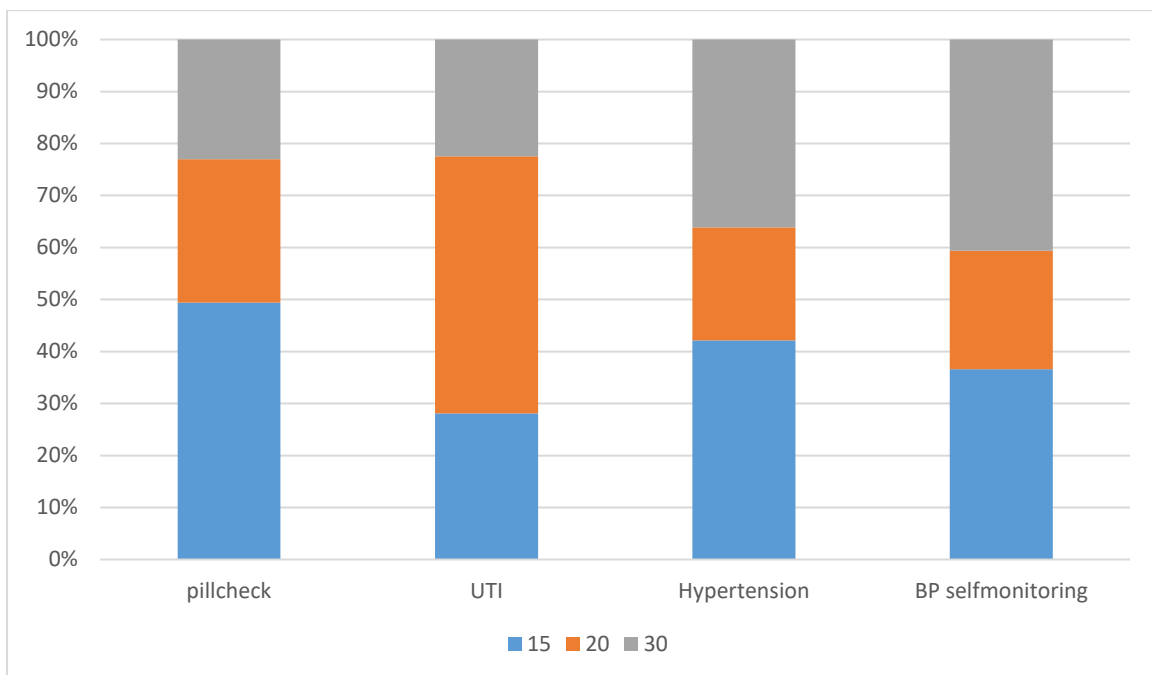


Figure 4 Pathway and Appointment Time

Certain appointment types and professions may influence appointment frequency and patient responses. Professional interventions and patient response interventions may play critical roles in shaping patient responses and engagement with healthcare

services. Thus, the analysis showed remote monitoring can reduce appointment time, cost, and increase patients' response. However, effectiveness varies within and between patients. Remote monitoring effect on other conditions is inconclusive due to limited pathways. Further study is required to understand underlying mechanisms causing variation in remote monitoring interventions. These findings should be considered alongside other benefits of remote monitoring, including increased quality of life for patients, economic and cost saving for patients.

The analysis indicates that an increase in remote monitoring is associated with improved patient access to appointments. Overall contraceptive pill check, BP and new patient check, were reported to have reduced appointment time and cost. GP surgeries outcomes for patients on remote monitoring have been effective. GP surgery remote monitoring might improve a patient's health literacy and self-efficacy to manage their condition.

Remote monitoring holds great promise for improving patient outcomes, enhancing access to care, and reducing healthcare costs in general practice settings. However, addressing challenges such as regulatory barriers, education gaps, and interoperability issues is crucial for realising the full potential of remote monitoring. The success of this pilot was attributed in part to the work to introduce technology alongside complementary innovations in the form of revised or new treatment pathways. These facilitated the uptake of the technology from both the surgeries and the patients. Horton and Moulds (2024) reported that it was unclear if changes made in one setting could be replicated on another and this study has shown that to be a positive experience if pathways and technology are used to share learning.

See appendix 1 for further quantitative analysis

## **Qualitative Findings**

Three themes were identified from the thematic analysis (Braun & Clarke, 2006).

Theme One, *Benefits of remote monitoring*, has two subthemes: subtheme one, *Benefits for staff* and subtheme two, *Benefits for patients*.

Theme Two: *The challenges of remote monitoring*.

Theme Three: *Future directions for remote monitoring*.

### **Theme One: Benefits of remote monitoring**

This theme illustrated the value of remote monitoring for both patients and clinicians. The first subtheme, *Benefits to staff*, highlighted a positive experience with a myriad of benefits, including time-savings, cost-savings, decreased workload, appointment reductions, and timely reviews. Subtheme Two identified the benefits of remote monitoring for patients, which included a greater sense of empowerment, more access to appointments where needed, enhanced patient safety and greater provisions of person-centred practice.

#### **Subtheme One: Benefits to staff**

This theme illustrated the benefits of remote monitoring for both staff and patients. Subtheme one – benefits to staff, highlighted how the new remote monitoring pathways have increased GP time as well as nurses and receptionists, thus providing whole system benefits—the new method of working decreased workload and work-related sense of burden by creating more efficient pathways. The saved time enabled better preparation for appointments updated patient information and ensured reviews were conducted promptly.

The remote monitoring pathways implemented by GP practices proved beneficial for staff by saving time, increasing efficiency, and decreasing workload:

*‘Saving GP time’ (GP 4.1).*

*‘Less receptionist time used in contacting patients to book in’ (GP 4.1).*

Staff felt that workload had been decreased from the remote monitoring pathways:

*‘Yes. Especially GP and nurse appointments for a contraception review’ (GP 3.1).*

*'Yes. Streamlined the task from HCA to admin team. Therefore, freeing up more HCA appointment's. Appointment time is now shorter and in dedicated clinics' (GP 5).*

Likewise, staff felt the new way of working was more efficient:

*'Yes. Patient no longer has to attend an appointment unless there are any concerns about their contraception or BP and weight is out of range for UK MEC' (GP 3.1).*

*'Removal of waste from the system: 1. allowing appointment or those patients who need to be seen.*

*2. Less monthly prescriptions for the pill needed, which are issued while waiting for the patient to have their pill review' (GP 3.1).*

*'Ability for self-management or direction to other available services (local pharmacy, for example)' (GP 1).*

Additionally, GPs felt the new remote monitoring processes were also more cost-efficient. The responses were not elaborated upon but a straight forward agreement:

*'Yes' (GP 3.1).*

*'Yes' (GP 3.2).*

*'Yes' (GP 2).*

*'Yes' (GP 1).*

There were also additional benefits to both staff and patients:

*'Self-checking of BP leaves more time for health promotion' (GP 4.1).*

*'Ensures clinicians have appropriate information prior to the appointment' (GP 1).*

*'Timely reviews' (GP 3.1).*

*'Reduced number of papers diary's- Greener practice initiative' (GP 5).*

GPs felt more time enabled greater preparation and access to relevant information, a greater focus on health promotion and prevention and timely reviews, which had previously been missed. Likewise, one GP practice felt the new pathway was greener, demonstrating benefits to broader systems.

### **Subtheme Two: Benefits to patients**

This subtheme identified the numerous benefits for patients from the remote monitoring pathways. Such benefits included a sense of empowerment in managing their own health and greater autonomy and self-management skills. Likewise, patient safety was enhanced during this period, as patient registrations were occurring more rapidly, reviews were being conducted, and patients were provided enough time to answer questions regarding their health, thus increasing the likelihood of accurate diagnosis. There was greater access to appointments for patients, and face-to-face appointments were available for patients who needed these. Additionally, the new pathways offered more options for patients and thus enhanced person-centred care.

GPs felt there were numerous benefits to patients from the remote monitoring pathways; central to these benefits was a greater sense of empowerment:

*'Empowering for patients – they are given the choice and flexibility of not having to make appointments' (GP 2).*

*'Patients feel more empowered and for the contraceptive demographic in particular they tend to be younger and in work – getting appointments can be hard' (GP 2).*

*'Empowered if measuring own blood pressure' (GP 4.1).*



*'Empowerment, self-management/responsibility' (GP 3.1)*

*'Self management – the patient can manage their registration process to suit their needs' (GP 3.2).*

*'Self-management, more aware of own BP and need to keep in target set' (GP 5).*

GPs felt providing patients with the opportunity and resources to self-manage their health was a positive outcome of the remote monitoring pathways.

GPs also felt they could meet the needs of their patients to a greater extent since implementing the changes:

*'Yes. Some patients were slipping through the net and not being invited for checks' (GP 4.1).*

The new pathway ensured patients who were overdue for a review were contacted, thus enhancing patient safety.

Patients were provided with more time to consider how to answer the questions accurately, which reduced the risk of misdiagnosis:

*'The patient who participated said it gave her more time to consider her answers' (GP 4.2).*

The changes made enhanced patient safety by reducing the risk of misdiagnosis.

*'The registration process is quicker and they'll be able to book appointments sooner' (GP 3.2).*

Likewise, a more rapid registration process enabled patients to book appointments sooner, thus enhancing patient safety.

Additionally, moving to online recordings rather than paper versions increased patient safety:

*'Also safer as not trying to interpret patients writing, no lost paper diary's, unidentifiable diary's' (GP 5).*

The new method of recording blood pressure ensured that readings were interpreted accurately, thus enhancing safety.

GP practices experienced an increase in appointment availability.

*'Yes.'* (GP 1).

*'Yes'* (GP 3.1).

*'Yes'* (GP 2).

*'Yes'* (GP 5).

*'There are more nurse/HCA appointments available'* (GP 3.2).

Greater appointment availability improved access to appointments for patients.

Additionally, patients who required in-person assessments had greater access to the following:

*'Face to face appointments saved'* (GP 2).

*'Saves face-to-face appointments for patients that may need them'* (GP 1).

The offer of online appointment booking made it more accessible for patients:

*'Booking own appointment avoids the challenge of getting through on phone and can offer more visible choices'* (GP 4.1).

Likewise, such approaches to appointments may better meet the patient's needs.

*'Ensures good use of the patient time (can be managed by a phone call rather than needing to come to the surgery)' (GP 1).*

Hence, such approaches may enhance person-centred care.

Remote monitoring pathways may improve person-centred outcomes for patients:

*'Patients given preference of remote vs traditional appointments' (GP 2).*

*'Patient convenience' (GP 3.1).*

*'Yes. More nurse appointments are now available to manage patient with long term conditions' (GP 3.1).*

*'Convenience for those patients who work 9-5' (GP 3.1).*

More flexibility and options regarding appointment type and time enhance person-centred outcomes for patients, and such changes increase access and availability for patients with long-term conditions, and it was also felt the intervention was more time consuming than previous working methods.

## **Theme Two: Challenges of remote monitoring**

There were a multitude of challenges experienced during the implementation period. For some, short staffing during the implementation increased work-related strain. Others felt there was little reward for the extent of work put into implementing the changes. There were concerns that the new approach was symptom-centred rather than person-centred. Some GPs felt there was a risk of exacerbating already established health inequalities and disparities of some populations who are already hardly reached by services. There were also concerns about patient satisfaction, particularly in the ageing community.

GP practices reported some challenges they faced when implementing the changes:

Some GPs felt the timing of the implementation was a challenge due to a lack of resources:

*'Have had to introduce changes at a time when medical staffing has been particularly tight' (GP 2).*

Other GPs felt there was a lack of reward from the extent of work put into to implementation:

*'Lots of work to set up pathway but not yet a reward – the hope was to generate additional ANP capacity going forwards' (GP 4.2).*

Here, the benefits did not outweigh the limitations because the outcome was not as positive as hoped.

Additionally, it was felt that the new process was more time-consuming than previous methods:

*'More time consuming for receptionist to explain new process than just booking an appointment without question' (GP 4.2).*

Implementing the new pathway increased the staff's sense of work-related burden.

Other GPs had similar experiences. However, they felt things were improving over time:

*'It's a new system and patients are getting used to it, sometimes they fill in an eConsult without providing BP/weight, a second contact is then needed. However, this is improving as the patients get used to the new system' (GP 3.1).*

Some GPs felt new pathways were less person-centred:

*'This moves towards a symptom-centred approach rather than a person-centred approach' (GP 1).*

Here, the GP identifies how the changes implemented were more congruent with the medical model approach to patient care rather than person-centred approaches.

Participants expressed concern that such changes may not be suitable for some populations in their care:

*'Risk from lack of access to remote monitoring due to poverty or inability to understand e.g. due to English as second language, not familiar with technology' (GP 4.2).*

Thus highlighting that some communities may be isolated and unable to access support, communities who are often hardly reached by services currently. Such difficulties were illustrated during the intervention period in this practice:

*'Poor take up of self-booking link' (GP 4.1).*

*'10% of patients could not be sent text messages' (GP 4.1).*

Some patients did not have access to resources to receive a self-booking link, and overall, there was poor uptake, which may be related to a lack of opportunity and capability.

Likewise, there were concerns about patient satisfaction regarding online appointment methods:

*'Some elderly patients do prefer face to face contact with appointments' (GP 3.2).*

*'Reduced patient satisfaction if they expected to see a clinician' (GP 1).*

*'Patients often prefer seeing people in person – worry that they may feel railroaded into changing their behaviour' (GP 2).*

In-person appointments were viewed as more appropriate to meet the needs of some patients, such as the ageing population, who may prefer this mode of contact. Likewise, online methods may decrease practitioner-patient rapport and support, mainly when focussing on behaviour change.

GPs also identified the risk of patients being less honest with online appointments, which may hinder accurate diagnoses and treatment:

*'Potential to be a little less safe – feel that patients are more likely to give honest answers to a human than a computer' (GP 2).*

Such sentiments were also shared by another practitioner:

*'Patients may provide inaccurate data' (GP 5).*

The practitioner continued to describe other risks which may occur from remote monitoring:

*'Risk that patients who purchase their own BP monitor may have the wrong size cuff and therefore readings may be inaccurate' (GP 5).*

Inaccurate blood pressure readings could have severe consequences for patients.

Likewise, a lack of in-person appointments may reduce the potential for essential health prevention and promotion:

*'Missed opportunities for brief health interventions and checking for other health problems' (GP 1).*

These opportunities are critical to the promotion of health behaviours and preventable diseases.

### **Theme Three: Future steps for remote monitoring**

In this theme, GPs discussed the changes they want to see before a permanent roll-out. Some GPs felt no changes were required and were motivated to support a permanent roll-out. However, some GPs felt staff training was needed to enhance uptake and success. Likewise, staff motivation to engage before implementation was viewed as key to success. Furthermore, it was felt that more appropriate apps for the specific task were required to reduce the burden and increase efficiency.

Some GP surgeries felt no changes were required and they would support a permanent roll-out in the future:

*'No Changes' (GP 1).*

*'No Changes. Would support a permanent roll-out' (GP 3.1)*

*'No Changes. Would support a permanent roll-out' (GP 3.2).*

*'No Changes'. Would support a permanent roll-out' (GP 5).*

Whereas some GP surgeries felt changes were needed before a permanent roll-out:

*'All staff need to be aware of the technology and how things work – not just those exposed to this on the front line' (GP 2).*

Here, training staff was viewed as central to a permanent roll-out.

Similarly, ensuring staff are motivated to participate was viewed as vital for future uptake:

*'Check willingness of ANPs to consider the pathway first' (GP 4.2).*

It was also felt that assigning other relevant professionals to this role may increase uptake:

*'We will consider trying this in a different way - perhaps GPs seeing these patients?' (GP 4.2).*

Finally, changing the app to a more appropriate and user-friendly version:

*'Send reminder texts promoting self-booking using NHS app rather than Accurx self-booking link as the former can be sent in batches. Retain self-booking link for individual cases that we are mopping up' (GP 4.1).*

The challenges and subsequent changes identified would reduce staff experiences of work-related burden and strain and enhance positive outcomes for both staff and patients.

## **Limitations and Recommendations**

The major limitation is the initial staff apprehension about the new technology, which was addressed through meetings, discussion, and ongoing support. Not all of the pilot sites provided the data as requested and this caused some limitations in the data analysis. From the data, remote monitoring implementation faced several limitations. These include concerns regarding data security and privacy, interoperability issues with existing healthcare systems, and the need for adequate reimbursement models (Shah, et al., 2021). Additionally, some patients may experience difficulties in using remote monitoring devices or may be resistant to technology adoption.

However, from our findings, we recommend the following.

- 1) **Invest in Education and Training:** Healthcare providers and patients should receive adequate education and training on how to effectively use remote monitoring technologies. This includes training on device operation, data interpretation, and communication protocols. Education efforts should also focus on addressing concerns and misconceptions about remote monitoring to encourage adoption (Atherton et al., 2018; Greenhalgh et al., 2024).
- 2) **Collaboration and Integration:** Collaboration between healthcare stakeholders, including providers, technology developers, and policymakers, is essential for the successful integration of remote monitoring into general practice. This



includes promoting interoperability between different remote monitoring platforms and integrating remote monitoring data into electronic health records (EHRs) to ensure seamless care coordination (Greenhalgh et al., 2022; Neunaber & Meister, 2023; Greenhalgh et al., 2024).

- 3) Support Research and Innovation: Continued research and innovation are needed to further enhance the effectiveness and usability of remote monitoring technologies. This includes developing advanced sensors and algorithms for more accurate monitoring, as well as exploring new applications of remote monitoring in areas such as mental health and preventive care (Taylor et al., 2021; Greenhalgh et al., 2022).

Other recommendations include targeted patient education initiatives, and continuous monitoring of technical aspects to ensure seamless operation. Consideration for expanding remote monitoring to other chronic conditions.

## **Future Directions and Next Steps**

Focusing on future directions and next steps, stakeholders can continue to advance the field of remote monitoring in general practice, improve patient outcomes, and enhance the delivery of healthcare service. We highlight the following future directions and next steps.

Conduct longitudinal studies to assess the long-term impact of remote monitoring in general practice. This could involve tracking patient outcomes, healthcare utilisation, and cost savings over an extended period to evaluate sustainability and effectiveness over time (Neunaber & Meister, 2023; Greenhalgh et al., 2024).

Effectiveness in different patient populations: Investigate the effectiveness of remote monitoring in diverse patient populations, including elderly patients, paediatric patients, and those with complex healthcare needs. Understanding how remote monitoring impacts various demographic groups can inform tailored interventions and improve patient outcomes across the board.

Patient and Staff Education and Engagement: Focus on staff and patient education and engagement strategies to maximize the benefits of remote monitoring. Develop user-friendly interfaces, educational materials, and support systems to empower patients in managing their health and utilizing remote monitoring technologies effectively (Shah et al., 2021).

Interoperability and Data Sharing: Address interoperability challenges and promote data sharing between remote monitoring systems and electronic health records (EHRs). Establish standardized protocols and integration frameworks to ensure seamless exchange of patient data across healthcare settings and improve care coordination.

Collaborative partnerships between healthcare providers, technology developers, researchers, and patient advocacy groups to drive innovation and implementation of remote monitoring initiatives. Engage stakeholders in co-designing solutions, conducting research, and sharing best practices to maximize the impact of remote monitoring in general practice (Taylor et al., 2021).

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## Appendix 1

Table 1 Means, standard deviations, and correlation with confidence intervals.

Variable	M	SD	1	2	3	4	5
GP1	-0.05	.095					
GP2	-0.06	1.07	0.47** [.31, .56]				
GP3	0.04	1.00	0.56** [.41, .70]	.042** [.25, .57]			
GP4	-0.00	0.73	30** [.11, .44]	.05 [-.14, .26]			
GP5	-0.11	.65	24* [.04, .41]	.32** [.14, .48]	45** 30, .58		
Gp6	-0.06	.077	28** [.09, .45]	11 [.08, .27]	37** [.18, .53]	50** [.35, .63]	53** [.37, .67]

Note: M=Mean, SD= standard deviation, values in brackets s confidence interval at 95% for each correlation

In Table 1 the correlation coefficients are listed between pairs of variables. The correlation coefficient measures the strength and direction of a linear relationship between two variables (GP1 has significant correlations with GP2 (0.47) and GP3 (0.56), GP2 has a significant correlation with GP3 (0.42), GP4 has significant correlations with GP3 (0.30) and GP5 (0.24), GP5 has significant correlations with GP3 (0.32) and GP6 (0.30) and GP6 has significant correlations with GP3 (0.28), GP4 (0.37), and GP5 (0.53)).

These correlations provide insights into the relationships between the variables. For example, GP1 and GP2 are correlated positively, thus an increase in GP1 was associated with an increase in GP2. The strength of these relationships is indicated by the correlation coefficients, and their significance indicates they are real associations not simply due to random chance.

GP1 has significant positive correlations with both GP2 and GP3. This suggests that as GP1 increases, GP2 and GP3 tend to increase as well. GP2 also has a significant positive correlation with GP3, indicating a similar relationship between these variables. Indicating that the utilisation of time, and response rate during the intervention reduced across the GPs.

GP4 and GP5 both have significant positive correlations with GP3, though the correlations are weaker compared to GP1 and GP2. This suggests that changes in GP3 are associated with changes in GP4 and GP5 but to a lesser extent.

GP6 has significant positive correlations with GP3, GP4, and GP5. This indicates that GP6 is related to all three of these variables, potentially reflecting underlying patterns. Also, confidence intervals provide a range of values within which we are confident that the true correlation coefficient lies.

The analysis suggests that there are significant relationships between the variables GP1 through GP6; all exhibit some level of association with each other, as evidenced by their correlation coefficient.

Therefore, the analysis provides valuable insights into the relationships between the variables (pathways), to understand their interdependencies and potential implications for decision-making processes.

### **Pearson Correlation Analysis**

The Pearson correlation coefficients which measure the strength and direction of the relationship was used (Table 2). The type of appointment has a -negative

relationship with the number of appointments pre-intervention (-0.640), indicating that as the appointment type changes, the number of appointments pre-intervention tends to decrease. The correlations with patient response and patient response intervention are significant and positive (<.0010] suggesting a tendency for patient responses to increase as the appointment type changes.

The allocated professional intervention has a strong positive correlation with the number of appointments pre-intervention (.029), indicating that as the allocated professional intervention increases, the number of appointments pre-intervention tends to increase. The correlations with patient response and patient response intervention are both strongly negative (-0.816), indicating a tendency for patient responses to decrease as the allocated professional intervention increases.

Number of appointments Pre-intervention has a moderate positive correlation with appointment type (.029), meaning that as the number of appointments pre-intervention increases, the appointment type tends to change. At the same time, the correlation between patient response and patient response intervention was positive and significant statistically (.006)

In summary from the table below (Table 2) Patient Response and Patient Response intervention both have positive correlations with appointment type and allocated professional intervention, indicating patient responses to increase as these variables increase. The analysis highlights complex relationships between appointment types, allocated professions, professional interventions, and patient responses.

Certain appointment types and professions may influence appointment frequency and patient responses.

Professional interventions and patient response interventions may play critical roles in shaping patient responses and engagement with healthcare services. Thus, the analysis showed remote monitoring can reduce appointment time, cost and increase patients' response. However, effectiveness varies within and between patients.

Remote monitoring effect on other conditions is inconclusive due to limited pathways. Further study is required to understand underlying mechanisms causing variation in remote monitoring interventions. These findings should be considered alongside other benefits of remote monitoring, including increased quality of life for patients, economic and cost saving for patients.

Table 2: Correlation

Correlations											
	Appoint ment Type	Allocat ed profess ion	Allocat ed Professi onal Intervent ion	Number of Appointm ents Pre- Interventi on	Number of Appointm ents Interventi on	Patient respo nse	Patient respons e interven tion	Lenth of Appoint ment baseline	Length of Appoint ment Interventi on	Frequenc y of Appointm ents Baseline	Frequen cy of Appoint ment Interventi on
Pearson Correlatio n	-0.381 [.456]	-0.608 [.200]	.672 [.214]	1	.858* [.029]	-0.471 [.423]	-0.161 [.761]	-0.354 [.491]	-0.002 [.998]	-0.015 [.978]	-0.239 [.648]
Appointm ents Pre- Interventi on											
Number of Appointm ents Interventi on	-0.332 [.520]	-0.393 [.441]	.695 [.192]	.858* [.029]	1	-0.274 [.656]	-0.483 [.331]	-0.167 [.752]	.006 [.991]	-0.452 [.368]	-0.481 [.334]
Patient response	-0.612 [.272]	.764 [.133]	-0.816 [.184]	-0.471 [.423]	-0.274 [.656]	1	1.000** [<.001]	-0.244 [.692]	-0.264 [.668]	.913* [.030]	-0.131 [.833]
Patient response interventi on	-0.511 [.300]	.417 [.411]	-0.733 [.159]	-0.161 [.761]	-0.483 [.331]	1.000* [<.001]	1	-0.442 [.380]	-0.317 [.540]	.935** [.006]	.535 [.274]

\*Correlation is significant at the 0.05 level (2-tailed). \*\*. Correlation is significant at the 0.01 level (2-tailed).

### Regression Analysis

Regression Analysis Table 3 using the five GPs: The R which measures the correlation between the observed values of the dependent variable and the values predicted by the regression model using the independent variables is 0.972, indicating a strong positive linear relationship between the predictors and the



dependent variable. R Square is 0.946, suggesting that approximately 94.6% of the variance in the dependent variable is accounted for by the predictor variables. Overall, this model summary suggests that the regression model, with the predictors, explains a significant amount of variance in the dependent variable, as indicated by the high R Square value. Additionally, the F test suggests that the model is statistically significant, implying that at least one of the predictors has a significant effect on the dependent variable. Therefore, the positive coefficient indicates that an increase in remote monitoring is associated with improved patient access to appointments. The model appears to be highly effective in predicting the dependent variable based on the predictors included. The predictors (pill check, BP, UTI) collectively explain a substantial portion of the variance in the outcome, as evidenced by the high R-squared value. The statistically significant F-change statistic indicates that the model is significant, suggesting that the predictors collectively contribute to predicting the outcome variable.

Overall pill check, BP, UTI were reported to have reduced appointment time and cost. GPs outcomes for patients on remote monitoring have been effective. While this association was held across the five pathways, it was most evident for pill check, BP, and UTI. The outcome demonstrated that the way remote monitoring services are implemented are highly variable and intervention characteristics could be a determinant of outcomes. Also, GP remote monitoring might improve a patient's health literacy and self-efficacy to manage their condition.

Table 3

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.972 <sup>a</sup>	.946	.925	3.68442	.946	46.355	3	8	<.001

a. Predictors: (Constant), pill check, BP, UTI

Note: R= multiple correlation coefficient, R Square= coefficient of determination, Adjusted R Square =modified version of R Square, Std. Error of the Estimate = average distance that the observed values fall from the regression line.

Also, the ANOVA table (Table 4) provides evidence that the regression model, which includes the predictors, significantly explains the variance in the dependent variable with a significant value of less than 0.001 (denoted as <.001), which

indicates that the regression model is statistically significant at the conventional significance level (typically  $\alpha = 0.05$ ). Thus, the Model Sum of sum (SS) represents the variation in the dependent variable that is explained by the predictors (independent variables). The model SS is 1887.817, with 3 degrees of freedom associated with the predictors ( $df = 3$ ), the Mean Square for the Regression is 629.272, which is the average variance explained by each predictor variable.

Table 4

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1887.817	3	629.272	46.355	<.001 <sup>b</sup>
	Residual	108.600	8	13.575		
	Total	1996.417	11			
a. Dependent Variable: Teams						
b. Predictors: (Constant), pill check, BP, UTI						

Note: Model Sum of Squares (SS) = variation in the dependent variable,  $df$ = degrees of freedom for the Regression model

Appendix 2

Generic Template for Data Collection

These questions have been designed to help the research team measure changes that may have occurred while implementing new pathways/procedures. To understand the significance of these changes, we will need to analyse data before and during the implementation.

For example, if you have implemented a new HRT pathway, please provide data on this pathway only.

If you have implemented two or more new pathways, please complete this form separately for each pathway.

Some questions may not be relevant to your pathway. If so, please respond with N/A

General Information

1. Please provide an overview of the changes you made:

provide the average time for an appointment

2. Please

Please provide (if known) the cost of appointments:

GP	£
Nurse	£
Health care	£

Remote Monitoring Information

1. Please select which member(s) of staff were allocated to appointments on this pathway before implementing the new processes:

GP	
Nurse	

Health care

1.1 If the assigned member of staff has now changed due to the new pathway, please select who is allocated to these appointments now:

GP

Nurse

Health care

1.2 If more details are required, please detail below:

## 2. Number of Appointments

Pre-intervention

Intervention period

## 3. Response Rates

Pre-intervention

Intervention period

## 4. Length of Appointment

Pre-intervention

Intervention period

## 5. Frequency of Appointments Per Patient (for specific pathway, e.g. HRT)

Pre-intervention

Intervention period

6. Cancellations of Appointments:

Pre-intervention

Intervention period

7. Please detail any demographic information you have collected:

Age

Male

Female

Other

Gender

If you have collected other demographic information, please provide a description followed by the numeric values:

**Your Experiences**

1. Do you feel the remote monitoring intervention has decreased/increased your workload?

Increased

Decreased

Other: Please Describe

2. Do you feel the intervention has enabled a more efficient way of working?

Yes

No

Other: Please Describe

3. Can you describe two positive factors of remote monitoring?

Factor 1:

Factor 2:

4. Can you describe two negative factors of remote monitoring?

Factor 1:

Factor 2:

5. Do you feel your patients are having their needs met better due to the intervention?

Yes

No

Other: Please Describe

6. Would you support a permanent roll-out of remote monitoring?

Yes

No

Other: Please Describe

7. If this were to become a permanent feature in GP surgeries, is there anything you would change?

No Changes

I Would Change:

8. Do you feel you can provide a more person-centred approach to in-person appointments since implementing the remote monitoring pathway?

Yes

No

Other: Please Describe:

9. Do you feel you have more time in these appointments to meet your patient's needs?

Yes

No

Other: Please Describe:

10. What do you feel are the benefits to the patients of this new way of working (empowerment, self-management, health awareness, timely reviews)?

Benefit 1:

Benefit 2:

Additional  
Benefits  
(Optional)

11. Do you feel this new way of working is more cost-efficient?

Yes

No

Other: Please Describe:

12. Do you feel you have more availability for appointments since online monitoring?

Yes

No

Other: Please Describe: