Qualitative evaluation of a rapid rollout of home blood pressure monitoring in pregnancy during Covid-19

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Abstract:	In March 2020, the World Health Organisation named the severe acute respiratory syndrome coronavirus 2 (Sars-CoV-2), which causes corona virus disease 2019 (COVID –19), as a pandemic. Pregnant women were considered at increased risk of developing severe COVID-19 after viral infection. As such, maternity services reduced face-to-face consultations with high-risk pregnant women by supplying blood pressure monitors for supported self-monitoring. This paper explores the experiences of patients and clinicians of the rapid roll-out of supported self-monitoring programme in Scotland during the first and second wave of the COVID-19 pandemic. Semi-structured telephone interviews were conducted with high-risk women and healthcare professionals using supported self-monitoring of BP in four case studies during the COVID-19 pandemic. 20 women, 15 midwives and 4 obstetricians took part in the interviews. Interviews with healthcare professionals showed that while implementation occurred at pace and at scale within the NHS, implementation differed locally, resulting in mixed views. Several barriers and facilitators were named by study participants. The characteristics of digital communication platforms that women valued (i.e. simplicity of use) were distinct from those that healthcare professionals valued (i.e. not adding to current workload). Women largely found self-monitoring acceptable, with only a few exceptions. These results show that rapid change can occur in the NHS at a national level when there is a shared motivation. Self-monitoring is acceptable to most women, however, decisions regarding self-monitoring should be made jointly and on an individual basis.
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Financial Disclosure Enter a financial disclosure statement that describes the sources of funding for the work included in this submission. Review the submission guidelines for detailed	The project was funded by the Scottish Government Health and Social Care Directorate (https://www.sehd.scot.nhs.uk/aboutus.html). Fiona Dennison and Helen Cheyne were the grant holders. There was no grant number as this was commissioned work not competitive grant funding. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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19th November 2021

Dear Dr Chenette,

We would like to submit a manuscript for a research article entitled “Qualitative evaluation of a rapid rollout of remote blood pressure monitoring in pregnancy during Covid-19”, by Charlotte Paterson, Elaine Jack, Brian McKinstry, Sonia Whyte, Fiona Denison and Helen Cheyne, to be considered for publication in PLOS One.

We conducted a qualitative case study approach to explore patients’ and clinicians’ experiences of the rapid roll-out of supported remote self-monitoring of blood pressure in high-risk pregnant women during the COVID-19 pandemic. We believe the findings will be of interest to the readers of your journal involved in antenatal telehealth and remote monitoring and will meet .

The study results provide scientific knowledge on the acceptability and implementation of remote monitoring and digital health in maternity services in characteristically different geographical areas. A number of barriers and facilitators to implementation are identified, which are in keeping with other digital health literature. This study also highlights women’s and clinicians’ views according to their geographical location, therefore contributing to the evidence base on the acceptability of introducing digital self-monitoring within maternity services. Women tended to have positive experiences, which is in line with previous research, while clinicians’ views varied, depending on the geographical location and local processes. Overall, this study demonstrates that rapid change can occur in the NHS at a national level, which is notoriously difficult. The difference between previous attempts at widespread change and this rapid change is likely due to a shared motivation to adapt to the global pandemic which drove the rapid rollout of supported remote self-monitoring.

We suggest Anna Palatnik as an appropriate Academic Editor to handle our manuscript, given her area of expertise. We have no opposed reviewers.

We declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

Thank you for considering the manuscript. We look forward to your response.

Kind regards,

Charlotte Paterson

Research Fellow
Nursing, Midwifery and Allied Health Professional Research Unit
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Qualitative evaluation of a rapid rollout of remote blood pressure monitoring in pregnancy during Covid-19

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Abstract

In March 2020, the World Health Organisation named the severe acute respiratory syndrome coronavirus 2 (Sars-CoV-2), which causes corona virus disease 2019 (COVID –19), as a pandemic. Pregnant women were considered at increased risk of developing severe COVID-19 after viral infection. As such, maternity services reduced face-to-face consultations with high-risk pregnant women by supplying blood pressure monitors for supported self-monitoring. This paper explores the experiences of patients and clinicians of the rapid roll-out of supported self-monitoring programme in Scotland during the first and second wave of the COVID-19 pandemic. Semi-structured telephone interviews were conducted with high-risk women and healthcare professionals using supported self-monitoring of BP in four case studies during the COVID-19 pandemic. 20 women, 15 midwives and 4 obstetricians took part in the interviews. Interviews with healthcare professionals showed that while implementation occurred at pace and at scale within the NHS, implementation differed locally, resulting in mixed views. Several barriers and facilitators were named by study participants. The characteristics of digital communication platforms that women valued (i.e. simplicity of use) were distinct from those that healthcare professionals valued (i.e. not adding to current workload). Women largely found self-monitoring acceptable, with only a few exceptions. These results show that rapid change can occur in the NHS at a national level when there is a shared motivation. Self-monitoring is acceptable to most women, however, decisions regarding self-monitoring should be made jointly and on an individual basis.

Keywords

Pregnancy; digital health; telehealth; COVID-19; Sars-CoV-2; pandemic.

Introduction

In March 2020, the World Health Organisation designated the severe acute respiratory syndrome coronavirus 2 (Sars-CoV-2), which causes corona virus disease 2019 (COVID –19), as a pandemic. To try and slow growth of the pandemic, the UK government instigated a nationwide lockdown. Individuals identified as being clinically vulnerable or extremely vulnerable, due to an increased risk of developing severe COVID-19 following viral infection, were recommended to adopt additional protective measures including limiting social contact. Pregnant women were classified as being at increased risk of developing severe COVID-19 following viral infection. To mitigate this risk, the Royal College of Obstetricians and Gynaecologists (RCOG) issued UK wide recommendations that face-to-face consultations should be reduced for high-risk pregnant women to reduce their risk of viral exposure (1). This required National Health Service (NHS) maternity services to urgently find ways to reduce face-to-face contacts for women without compromising safe care.

While many aspects of antenatal care can be safely accomplished using virtual contacts, blood pressure (BP) monitoring and urine analysis undertaken as a routine at each antenatal contact, are key aspects of antenatal care and involve physical assessment. Raised BP affects approximately 10% of pregnancies worldwide; almost half of these women develop pre-eclampsia. Globally, around 15% of maternal mortality is due to pre-eclampsia so early detection and prevention are paramount. Therefore, vigilance in relation to BP remained imperative, in particular, for the 10% of pregnant women considered to be at higher risk of developing progressive hypertension (1).

Supported self-monitoring of BP remotely has been implemented in non-pregnant populations in diverse care settings with good evidence for its acceptability and effectiveness (2). It can either be used to replace BP measurements on the day of a scheduled clinic (i.e., intermittently) or can be done routinely and more frequently (e.g., daily or weekly) in addition to usual care. Studies in non-pregnant populations have demonstrated that supported self-monitoring of BP is associated with increased

convenience, empowers patients, encourages adherence to anti-hypertensive medication and improves BP control (3,4). However, despite supported self-monitoring of BP being safe and preferred by patients, the experience in the non-pregnant population is that telemonitoring of BP at scale has not been widely adopted although a recent Scottish Technology Enabled Care Project Scale-Up BP has shown promise (5). Nonetheless, implementing new models of care at scale is challenging (6,7), and it was highly likely that implementing change during a pandemic might encounter unexpected and unanticipated barriers to adoption and roll-out.

This paper explores the experiences of patients and clinicians of a rapid roll-out of supported remote self-monitoring programme in Scotland during the first and second wave of the COVID-19 pandemic.

Aim

The aim of this study was to explore the experience and acceptability, for women and healthcare professionals, of supported remote self-monitoring of BP for high-risk and shielded pregnant women across Scotland during the COVID-19 pandemic.

Specific objectives were to:

1. Explore the way in which the supported self-monitoring programme was implemented across contrasting sites,

2. Assess the acceptability, views and experiences of women participating in the supported self-monitoring of BP programme, and

3. Assess the views and experiences of staff involved in the supported self-monitoring programme, including perceptions of barriers and facilitators of successful implementation.

Methods

Design

The evaluation involved case studies and qualitative semi-structured telephone interviews with women and healthcare professionals using supported self-monitoring of BP during the COVID-19 pandemic to obtain a range of experiences. This study was approved by two NHS Research and Development departments and one Caldicott Guardian of participating health boards. This study is reported in line with Standards for Reporting Qualitative Research (SRQE) (8).

of two participating health boards and the Caldicott Guardian for one participating health boards.

Reflexivity

Research team members in close contact with the data were experienced in health services research, with a range of expertise. CP is a post-doctoral research fellow with a background in systematic reviewing, implementation science, mental health service evaluation and a clinical background in psychology. HC is a midwife with extensive experience of leading trials and evaluations in maternity services. CP had no relationship with the participants prior to the study. As a senior midwife academic in Scotland HC had worked with some participants in a professional capacity.

Setting and sample

In Scotland, universal maternity services are provided through 14 geographical NHS Boards, with oversight and strategic direction provided by Scottish Government Health and Social Care Directorate, and guidance provided by NHS National Services Scotland. This structure enabled a multi-professional working group to be established in March 2020, to co-ordinate the move to remote consultation and monitoring in maternity care, and to develop clinical and technical guidance to support home monitoring of BP and urine analysis for high-risk pregnant women. This was available in paper and online form (9). The Scottish Government also purchased 5000 blood pressure monitors which were distributed to the 14 NHS Boards in May 2020 to enable women to undertake supported home monitoring of their BP. Consistent with UK wide guidelines issued by the RCOG, this national oversight

was intended to ensure that the programme of supported self-monitoring of BP monitoring and urine analysis was rolled out consistently across Scotland. Some tailoring to local NHS Board requirements was anticipated, for example, different digital platforms were used for communications between healthcare professionals and women (see Table 1 for details).

Table 1. Summary of Home BP Monitoring Rollout by Health Board

Implementation Ingredients	NHSB1	NHSB2	NHSB3	
			NHSB3 North	NHSB3 South
What service(s) was it rolled out in?	Central Maternity DAU	Central Maternity DAU and community maternity teams	Rural midwife and midwife/obstetrician led maternity teams	Rural midwife lead maternity teams with obstetrician input from different NHS board
Who led the rollout?	Two obstetricians with support from a research midwife	Consultant midwife	Two midwife team leads	One consultant midwife with support from the midwife leading digital health
Who was the local champion?	One DAU midwife	One DAU midwife and one midwife in each community maternity team	One midwife in each team	One midwife in each team
What training was provided to staff?	Information on the Scottish Perinatal Website[a] ; a 'sit down' with lead obstetrician; training delivered by the research midwife including a presentation on identifying eligible women and how to use Florence[b]; written guidance on how to manage medication. During the study period, more detailed guidance on responding to and managing women was developed. Health Improvement	Information on the Scottish Perinatal Website[a]; training provided by the consultant midwife and technology team including a presentation via MS Teams[c], a local training package and continual on call support. Training detailed (i) how to use Florence and home monitors, (ii) locally developed protocols on eligibility and how to interpret and respond to readings, and (iii)	Information on the Scottish Perinatal Website [a]; one lead midwife developed and delivered training via MS Teams[c]. Training covered (i) guidance on how to use machines, and (ii) 'what to do, when to do it, what do you do it something's not right, the implementation of it.'(S49). Health Improvement Scotland facilitated one shared learning session or all health boards during the rollout.	Information on the Scottish Perinatal Website [a]; the digital midwife developed and provided training via MS Teams [c]. Training covered how to identify eligible women and how to manage self-monitoring women. Health Improvement Scotland facilitated one shared learning session or all health boards during the rollout.

	Scotland facilitated one shared learning session or all health boards during the rollout.	test running Florence as a patient. Health Improvement Scotland facilitated one shared learning session or all health boards during the rollout.		
Who received training?	DAU midwives had access to materials	DAU midwives received training. After rollout began, a cohort of trainee obstetricians received training and one community midwife in each team disseminated information throughout team.	Midwife team leads across NHSB3 North and some obstetricians received training. Team leads disseminated information throughout team after rollout began	Midwives across NHSB3 South received training.
How did women access self-monitoring?	DAU, community teams, GPs	Initially via DAU, then via DAU and community teams	Routine maternity appointments	Routine maternity appointments
Methods for recording and communicating BP	Women used Florence to record and communicate their BP. Midwives received recordings via Florence and transferred readings to TRAK[d]	Women used Florence to record and communicate their BP. Midwives received recordings via Florence and transferred readings to BadgerNet[e].	Women recorded and communicated their BP via 15-minute appointments on the BadgerNet application, via weekly telephone appointments with midwives or via a text message including a photo of the machine reading.	Some women tried to record and communicate their BP using Florence, however, there were network and connection issues. Other women used weekly NearMe[f] appointment with their midwives, text messages to named midwife and email to the team email address.
What were the local processes for managing women who were self-monitoring (e.g., provide training and	One DAU midwife managed self-monitoring women two days a week. This included transferring readings from Florence to TRAK, phoning	Named midwives reviewed readings and transferred them onto BadgerNet. Emails from Florence were sent to personal accounts	Named midwives reviewed readings when required. Some midwives had laptops for remote working. Arrangements were made for annual	One midwife reviewed readings once weekly. Women were organised so they communicated readings on the same day weekly.

information, review readings, receive phone calls, etc.)?	women who had not submitted readings, setting new women up with Florence, and taking Florence related phone calls from women and staff. Emails from Florence were sent to the team DAU account when readings were not submitted. Guidance from hospital obstetricians was sought when needed, e.g., regarding medication commencement.	when readings not submitted. A buddy system was to cover annual leave. The DAU used hospital computers to manage women who were already on their caseload. Community midwives used remote laptops to manage home monitoring women who were on their caseload, unless a visit to the DAU was required. Obstetricians in DAU provided advice regarding abnormal BPs when needed.	leave cover. Obstetricians either in the local service or nearby services provided guidance when needed.	Midwives had laptops for remote working. Input from obstetricians from a different NHS health board was sought, when needed.
Methods and arrangements for contact with women	Telephone appointments were conducted two weeks after commencing self-monitoring to check in. Women were told by midwives to phone their midwife or triage if readings were abnormal. Women were also prompted to do so by text messages from Florence when readings were abnormal.	Some community midwives text women to 'check in' weekly. Women were told by midwives to phone their midwife or triage if readings were abnormal. Women were also prompted to do so by text messages from Florence when readings were abnormal.	Individual plans for contact with the named midwife via NearME and telephone. Women told by midwives to phone their midwife or triage if readings were abnormal.	Individual plans for contact with the named midwife via NearME and telephone. Women told by midwives to phone their midwife or triage if readings were abnormal.
Approach to BP abnormal parameters	Midwives and obstetricians linked with rollout were aware of and followed parameters set in guidelines (10). Obstetricians not linked to project used various parameters	Each woman was given 'sticker' with personalised abnormal BP parameters.	Guidelines were mostly followed. Personalised abnormal parameters were given to women who had particularly low BP or had existing hypertension.	Guidelines were followed. Please note that few women recruited to home monitor were 'high risk'.

Retrieving home monitors	Plan to retrieve machines via community midwives during last post-natal appointment or by GP. Administration took on role to follow-up missing machines which was previously done by DAU midwives.	No standardised process. Women tended to drop off machines.	Monitors returned at discharge where possible. No formal process for retrieving machines being used post-natal.	Informal agreement in place that women would return monitors to names midwife at last post-natal check.

Blood Pressure (BP); Day Assessment Unit (DAU); General Practitioner (GP); Microsoft Teams (MS Teams); National Health Service (NHS); National Health Service Board (NHSB).

a. Scottish Perinatal Website (9)
b. Florence: digital platform supporting one way communication of self-monitoring results from women to service via text messaging, with automated feedback.
c. MS Teams: digital platform supporting video conferencing.
d. TRAK: digital platform supporting electronic maternity records.
e. BadgerNet: digital platform supporting electronic maternity records and communication between women and staff via the smartphone application.
f. NearMe: digital communication platform supporting video calls.

Three NHS boards were recruited as case study sites, with sites being selected to represent a range of geographical and clinical contexts (11). In NHS Board one (NHSB1) 58% of the population lived in large urban areas. Maternity services involved one tertiary referral centre and one district general hospital. In NHS Board two (NHSB2) 39% of the population lived in large urban areas and 40% in semi-urban communities. Maternity services involved one district general consultant unit. In NHS Board three (NHSB3), over 50% of population lived in rural or remote rural areas and 26% in remote small towns, with maternity services being provided via one district general hospital and 10 community midwife units. Within NHSB3, organisation of maternity service differed between the north (NHSB3 north) and south (NHSB3 south) of the Board. All boards had community midwifery services.

The anticipated sample was 15-20 women (5-7 from each site), up to 15 midwives (5 per site) and 10 obstetricians (3-4 per site). This sample size was anticipated be sufficient to provide an adequate range of experiences of women and healthcare staff within the time limited study period.

Recruitment

Women and healthcare professionals were recruited from the three NHS Boards. A member of the local clinical care team gave eligible women a consent to contact form, explaining the aims of the evaluation. Women were asked if their personal details (e.g., postcode, age, parity, email and telephone) could be passed to the research team. If permission was given, they signed the form and contact details were recorded by the local clinical lead for the supported self-monitoring programme and passed securely to the researcher. A sample of women were selected and approached using a sampling frame to maximise diversity. A range of women from high and low sociodemographic, age and parity groups were chosen. Healthcare professionals involved in the programme were initially identified by the local rollout leaders. Relevant staff were then sent a participant information sheet by email. A telephone call was arranged between the researcher and potential participants (women and healthcare professionals) to discuss the evaluation and arrange a suitable time for interview if permission was given. Oral consent to participate was obtained using a predefined script which was recorded at the beginning of each interview.

Eligibility criteria

Pregnant women in the three NHS boards were eligible to participate in the evaluation if they were taking part in the supported home BP monitoring programme. The programme eligibility criteria are presented in Table 2. To participate in the evaluation, women had to speak English or have access to an interpreter. Healthcare professionals (midwives and obstetricians) who provided antenatal care to women and who had experience of the supported self-monitoring programme were eligible for the evaluation.

Table 2. Programme eligibility criteria for women by group.

Group	**Group 1**	**Group 2**	**Group 3**
Description	'High risk' of hypertensive complication	'Increased risk' of developing pre-eclampsia	Other
Relevant conditions	Chronic hypertension	Hypertensive disease during a previous pregnancy	Type 1/ Type 2 Diabetes

	Current gestational hypertension	Chronic Kidney disease	Multiple pregnancy
	Current pre-eclampsia	Autoimmune disease	
	Cystic fibrosis		
	Solid organ transplant		
	Cardiac Conditions		

Data collection

Telephone interviews were conducted and audio recorded with women, midwives and obstetricians from three NHS boards between August 2020 and December 2020. All interviews were conducted by one researcher (CP). Two semi-structured topic guides were used. The interview topic guides were refined iteratively in response to the initial interviews, e.g. prompt questions were added or reworded. For women, prompts included:

- How confident do you feel in using your home BP kit?
- How well was the process explained to you?
- How do you feel about monitoring your own BP?
- Do you feel that you know enough about how to recognise normal/abnormal BP?
- Do you know who/how to contact someone if you have any concerns?
- Do you feel that your midwife/ doctor are available to support you if you need this?

For staff, prompts included:

- How confident are you in teaching women to use the BP kits?
- What is your experience of using home BP monitoring with women in your care?
- Do you have any particular concerns?
- Do you feel there any benefits/ risks?
- What infrastructure do you feel needs to be in place to ensure implementation is successful?
- How does home BP affect the normal care pathway for women in your care?

Analysis

Participants were anonymised and assigned a code which is used to refer to participants in the results, e.g. S1. Qualitative data analysis software (NVivo version 12) (12) was used to support systematic and rigorous organisation and analysis of the interview audio recordings. Relevant sections of the audio recordings were transcribed and coded. Thematic analyses were conducted by one researcher (CP) using a Framework Approach (13). The analysis framework included the following overarching themes: outcomes (including clinical, service and psychosocial), and barriers and facilitators to implementation. Once coding of the first three interviews was complete, two researchers (CP and HC) met to examine, discuss and refine all coded excerpts and codes. The remaining interviews were then analysed. Tables were developed in Microsoft Word to create a matrix into which the data was charted by participant type (i.e., healthcare professional and women) and health board. Opposing and similar views between healthcare professionals and health boards were explored. Preliminary results were shared during a stakeholder webinar to check relatability and accuracy of the findings. No changes were suggested by stakeholders.

Results

Participants

Interviews were conducted with 20 women, 15 midwives and 4 obstetricians overall from the three NHS Boards (see Table 3).

Table 3. Number of interviewees by site and participant type.

Case study site		Women	Midwives	Obstetricians
NHSB1		8	5	2
NHSB2		7	5	2
NHSB3	NHSB3 North	3	3	0
	NHSB3 South	2	2	0
Total		20	15	4

Rollout by Site

A description of the programme rollout by NHS board, as described by staff, is presented in Table 1. NHSB3 north and NHSB3 south are charted separately to record differences in service design which

had potential to impact supported self-monitoring roll-out, and associated experiences of women and staff. In NHSB3 North, the rural midwife was supported by a locally based midwife/obstetrician led maternity teams, whereas in NHSB3 South, the rural midwife was supported by midwife/obstetrician led maternity teams based in a geographically different health board.

Staff's Experiences of Self-monitoring

There were mixed views and experiences among staff, depending on the health board and the staff member. These views are summarised below and have been organised as Outcomes (including Clinical Outcomes, Service Outcomes and Psychosocial Outcomes) and Barriers and Facilitators to Implementation.

Clinical Outcomes. Some staff believed that self-monitoring changed clinical outcomes for some women in some health boards. In NHSB1 and NHSB2, staff thought that the rollout led to more women being identified as 'at risk' earlier in their pregnancy, i.e. in the first half of pregnancy. Some of these women were also believed to have subsequently started medication earlier. Earlier identification and treatment were mostly seen by midwives and obstetricians as a positive outcome for women and a major benefit of self-monitoring. One midwife in NHSB1, however, expressed concerns about over-medication of women that previously did not need treatment.

Staff from NHSB2 and NHSB3 North described being able to use the home-monitors as 'an evaluation tool'(S35) to differentiate between women who had genuine hypertension or pre-eclampsia and those that had 'white coat' syndrome. Staff explained that women would briefly monitor BP at home so that results could be compared to BP measurements taken in hospital. As such, self-monitoring helped to inform treatment (or no treatment) pathways.

Finally, staff also reported that a benefit of self-monitoring was that women had more autonomy, independence and control with regards to their BP.

Service Outcomes. Various service outcomes were perceived to result from the self-monitoring programme rollout, for example, reduced unnecessary testing and changes in workload.

One midwife and one obstetrician (NHSB2 and NHSB1) reported that self-monitoring discouraged and minimised 'unnecessary' or 'unscheduled'(S17) tests. Staff described previously checking additional parameters when seeing women face-to-face just because women were in hospital rather than being driven by clinical guidelines. Self-monitoring was therefore viewed as having reduced these unnecessary tests.

Despite a perceived reduction in unnecessary tests, the observed effect of the self-monitoring rollout on workload varied, depending on the health board and the profession. All staff in NHSB1 reported an increased workload for midwives in the DAU, while staff in other health boards thought workload had not changed or was reduced. Workload reductions were seen to stem from reduced face-to-face contacts and reduced travel to visit women. It should be noted, however, that community midwives in NHSB2 and midwives in NHSB3 North and NHSB3 South reported having few women using the monitors. All staff in NHSB1 described an increase in women who were seen daily for scheduled and unscheduled face-to-face visits, in their overall caseload and in phone calls coming into the DAU. The DAU was described as an already busy service and midwives reported the challenge of balancing new self-monitoring responsibilities with delivering usual care.

'*it's one person that we've kinda set up to try and do that [self-monitoring related duties], but then that takes away from all the other people that are coming in and if we've got three midwives on that can be stressful cause it leaves the other two doing everything else'*(S16).

Differences in local processes for the self-monitoring rollout and local approaches to the guidelines for maternity BP management seemed to contribute to the differences in workloads experienced across health boards.

Local Processes for the Self-monitoring Rollout. Local arrangements for the self-monitoring rollout seemed to affect patient pathways, and subsequently workload, differently across health boards. In NHSB1, self-monitoring was only rolled out in the DAU, however, midwives reported that women were referred from community maternity services and general practitioners (GPs) (see Table 1), who DAU then had to manage. As such, the DAU caseload and workload increased:

'*we have one main desk with one phone and it's constantly going with either midwives referring people for the home blood pressure monitoring to be setup on it, or that they're seeing someone who's already on the monitoring and their blood pressure is high, or women just phoning in with high blood pressures'*(S16).

NHSB2 is similar to NHSB1 in that they had a central 'high risk' maternity service, however, they did not report the same workload or caseload issues. It may be that there were fewer 'high risk' women in NHSB2, however, it may also be due to the involvement of community teams. Self-monitoring was rolled out in community teams, as well as the central 'high risk' service, in NHSB2. In NHSB2, home monitors were administered by DAU and community midwives, who then reviewed and managed their respective self-monitoring caseloads. Care for self-monitoring women who were identified in the community therefore stayed in the community, unless their BP level required a face-to-face appointment with the DAU, which was seen as a benefit by midwives.

'*they're slightly on a red pathway if they're on this Flo monitoring, but it keeps them at home and it lets their community staff see them more and their community staff can have much more input instead of coming in and being more medicalised.'*(S09).

It is likely that this local arrangement avoided the increase of phone calls and self-monitoring tasks experienced by the midwives in the central high risk service in NHSB1. Interestingly, while speculating on workload, the lead obstetrician for self-monitoring in NHSB1 said that '*because what we set up was in the day assessment unit as opposed to in the community… that has led to a little bit of duplication of work because the assessment unit is also doing telephone follow-ups for the women, while they're*

still having their regular [community] midwife checks'(S13) and proposed that '*if it was more community based I would suspect that we would see workload to the day assessment unit would go down.'*(S13).

Local Approaches to Abnormal BP Parameters. Different local approaches to the abnormal BP parameters for close monitoring and treatment, defined by NICE (10), may have also contributed to differences in perceived workloads between health boards. Staff in NHSB1 described 'strictly'(S05) following new guidelines. As such, women whose BP was classified as "borderline" for treatment or 'high normal' were perceived to significantly contribute to midwives' workloads:

'*people that were sort of borderline treatment level, but weren't quite treatment level, we knew they were gonna be a lot of work because they kept phoning back because, as per Florence, they were told to.'*(S52).

Midwives in NHSB1 reported that these calls also sometimes lead to face-to-face appointments, further increasing their workload. In NHSB2, this problem was not reported. Instead, staff described personalising BP parameters for women who had 'high normal' BPs. As such, there was a higher threshold for asking women to contact the service, which likely reduced the number of calls and face-to-face visits to hospital compared to NHSB1. These categories of women were also highlighted by other health boards as potentially increasing workloads if more women were using home monitors.

Psychosocial Outcomes. Several subthemes relating to psychosocial outcomes were identified within data collected from staff, including Reassurance, Professional Stress, Suitability of Women and Measures to Avoid Risk.

Reassurance. Many midwives and obstetricians across health boards described feeling reassured when women home monitored. This was the case, for example, where women whose BP was borderline for treatment were sent home without treatment. This was particularly true in NHSB3 North and South where women lived a significant distance from a health centre or hospital.

Similarly, self-monitoring provided reassurance for midwives in confirming that women with white-coat syndrome did not need further monitoring or treatment.

Professional Stress. A range of factors relating to self-monitoring were reported which led to sense of unease among some staff. They described anxiety that important symptoms, other than raised BP or protein in urine, may be missed when women were not seen face-to-face:

'*sometimes I think it takes away from that face-to-face contact and visually looking at your women and making sure that they're okay regardless of what their blood pressure says.'*(S08).

There was concern that misinformation had been given to women, due to midwives' confusion about clinical guidance at the beginning of the rollout:

'*I realise I've actually not been giving the correct information to women which has led to a bit of miscommunication on our part. They've not been phoning in with certain things or they've not known to phone in if that makes sense. So that thing [self-monitoring] has started to really get to me because there's things we've missed on people that maybe should've been phoning us but haven't, and I think that's been pretty stressful.'*(S16).

There were also concerns that some women would submit inaccurate reading or not follow the guidance:

'when one of the readings is a little bit high and Florence says sit for five minutes and repeat the blood pressure, a lot of women don't do that, they just do it the next day. So it's like women just making it up a little bit.'(S13)*;*

'I think they may, eh, sort of, eh, put in a lower reading than what it might actually be so that they don't have to go to hospital. That is one of the concerns that we actually had.'(S45).

Technology issues were identified by a few midwives as another source of concern. Two midwives from NHSB3 North and South specifically reported that a variety of home monitors had given '*wildly*

different readings'(S49), or that home monitored readings were extremely high compared to the midwives' readings. These issues left midwives feeling worried about inaccurate readings and having a lack of trust in the reliability of the machines. Midwives also expressed fear that they may miss women's results when submitted to an electronic system (e.g. Florence or BadgerNet (see Table 1)) or through text. This occurred, for example, if appropriate processes had not been set up for when a named midwife was on annual leave, or if a woman or midwife did not have mobile signal.

Despite some of these concerns, it was also recognised by some midwives and obstetricians that they would get used to this new way of caring for women in time.

Suitability of Women. All midwives and obstetricians identified various categories of women that were considered unsuitable to home monitor. This included those who were not likely to take responsibility for their own health, those who did not understand the instructions (e.g., due to learning disabilities), who received complex care (e.g., social work was involved), who had illiteracy or language barriers, who were very young (i.e., <16 years old), who were homeless or in a refuge centre, or who were vulnerable in any other way. Midwives also discussed the suitability of self-monitoring for women who were anxious:

'I would say that the benefits could also be the risks. So the benefit is that if you have an overly anxious person then they have that peace of mind that they have that machine there that they can press a button and it can tell them that their blood pressure is fine. Equally, if you have that anxious person she could be doing it every 2 minutes, becoming more anxious that it could go up, so you know they're much and much the same.'(S45).

Measures to Avoid Risks. Midwives and obstetricians discussed measures to avoid potential risks associated with women self-monitoring, i.e. that something important would be missed. For example, staff highlighted the importance of communicating to women that they were responsible for contacting someone if they experienced symptoms other than high BP, and the importance of doing so. In NHSB1 follow-up telephone appointments were used to check up on women two weeks

after receiving the home monitors to ensure they understood what they were doing, and that they were doing it. For health boards using Florence, there were text messages to women to remind them to measure their BP and there were automated emails to midwives when women did not submit a reading and women were subsequently phoned. There was consensus among all staff in all health boards that some women would not be suitable for self-monitoring and that decisions regarding who was appropriate should be made on a case-by-case basis. The 'teach-back' method (i.e. women were asked to teach back what they had just learned from midwives, to verify understanding) was used in two health boards to ensure women understood what they were to do and to identify unsuitable women. Finally, the lead midwife in NHSB3 South described their entire approach as 'risk-adverse'(S41), in that they initially recruited women that were not 'high risk' to test the self-monitoring processes before administering to the 'at risk' population. This was largely due to the added risk of distance in rural and island areas:

'it's also making sure that the women understand how to use things, how to record things, and how to action things so that there's absolutely no risk of someone sitting there with a result that you would want acted on for example and it's not connected in, especially when it's not a wee walk round the corner to the midwife.'(S41).

Barriers and facilitators to implementation

Staff buy-in. Buy-in from obstetricians was seen as essential for successful implementation by all staff because, for most women considered to be 'high risk', '*the obstetrician determines what that care plan is going to* be'(S39). Some obstetricians believed that colleagues and junior trainees had received information about self-monitoring and had responded positively. However, midwives in NHSB1 and NHSB2 reported that obstetricians, other than those directly connected with the project, either did not know about or did not 'buy-in' to the self-monitoring service. In NHSB1, this was seen to create inconsistencies in care and in NHSB2 this was perceived to have reduced promotion of self-monitoring by midwives and uptake by women. In one hospital in NHSB1, one obstetrician stopped the rollout completely reportedly due to a lack of resources.

Lack of obstetrician buy-in was also a barrier to implementation in NHSB3 South. Maternity services in NHSB3 South are supported by midwives and obstetricians working in a different and geographically distinct NHS Board which had yet to rollout self-monitoring services during our study period. As such, obstetricians may have lacked information and buy-in for the project, therefore restricting the number of 'high risk' women that midwives in NHSB3 South could recruit to supported self-monitoring.

Buy-in from midwives was also seen as essential for successful implementation, however, the extent of which this occurred tended to vary. Some midwives initially viewed the rollout negatively, but those leading the rollout believed that buy-in increased over time due to the second wave of COVID-19 and a realisation that remote monitoring may be required longer-term. Inversely, other midwives reported seeing the benefits of self-monitoring that were initially 'sold' to them, i.e., that it would reduce workload for midwives and foot fall in hospital. However, over time, due to unmet expectations, i.e., workload increases rather than decreases in NHSB1, some midwives viewed self-monitoring towards the end of the study period as *'just another task that's been added to their role'*(S05). It was also acknowledged that *'for…midwives who are not used to working with technology so much, it's been, it's maybe been more of an adjustment.'*(S35).

Rollout Leader. The person leading the rollout appeared to be an influential factor of implementation. The rollout leader developed training, paperwork and protocols, provided support to staff during the rollout, and they promoted the use of home monitors amongst midwives and obstetricians. The rollout leader varied between health boards (see Table 1) and appeared to be most effective when they were a midwife who knew the maternity teams, had experience of implementing new initiatives, was visible to staff during the rollout and had the authority to make decisions regarding local processes for the rollout.

Staff time and capacity. Throughout the rollout, time and capacity were seen as barriers to implementation across all NHS Boards. There were time limitations owing largely to midwife and obstetrician shortages during the COVID-19 pandemic. There were also competing demands

between training and professional development, including new mandatory training, training for using new methods of holding video consultations (e.g. Near Me), BadgerNet training and new ways of working during COVID-19. There were concerns across health boards that midwives were being '*saturated'*(S39) or '*bombarded*'(S07) with new information and new ways of working at the beginning of the rollout and some midwives initially felt that, in that context, self-monitoring was '*quite difficult to deal with'*(S45). In NHSB1, NHSB2 and NHSB3 North, midwives also reported time challenges in developing protocols for responding to and managing women, delivering training to all team members or getting the whole team together to discuss news ways of working. Later in the rollout, the added support of bank staff that knew the service well was identified as a facilitator in NHSB1.

Training and Guidance. Many midwives and obstetricians appreciated the information that was available across Scotland. The shared learning across health boards, facilitated by Health Improvement Scotland, was seen to be beneficial to implementation, and staff thought the guidance from the Scottish Perinatal Website (9) was clear. As such, all midwives reported feeling confident in teaching women how to use the machines.

There were mixed views between health boards regarding the information, training and guidance provided locally. Standardised procedures for managing women locally after the initial self-monitoring appointment was seen as essential for successful implementation, particularly for women with a 'high normal' BPs and for women beginning or changing medication. Midwives in NHSB2 reported that their localised training, with involvement from the technology team, and guidance was beneficial to the smooth running of the service, however, this was thought to be lacking in NHSB1 and NHSB3 North. Some midwives believed that the rollout was '*slightly rushed'*(S48), which led to '*teething issues at the start'*(48). Specifically, in the initial stages of the rollout, Midwives in NHSB1 and NHSB3 North described having insufficient guidance and training on which self-monitoring women to phone or see face-to-face and when to do so, and '*what to do when A, B, or C happens'*(S44) and '*how to document*

it'(S48). This lack of clarity led to team members working in different ways and resulted in midwives feeling as though they '*just kind of muddled through'*(S44) and that *'it was all a bit chaotic'*(S44). While some midwives accepted that new ways of working had to be learned on the job during a pandemic, others felt that '*there could have been a lot more work done before it started about how to implement it.'*(S44).

In NHSB1, specific guidance was being developed during the study period and there was a perception that the organisation of local processes improved over time, which was received well and valued by some midwives:

'we've got better processes in place, we've got better files in place, which I've done and are now in date order. Just a bit more organisation of all our documentation to know where we are with things. So in the defence of it all, things have improved'(S52).

However, others felt that the guidance was still '*really complicated'*(S44) and there was remaining uncertainty on how to manage women who were on treatment or who had previous pre-eclampsia.

Communication/Dissemination of Information. Adding to midwives' uncertainty and frustration in NHSB1, midwives and obstetricians described inconsistencies between the decisions being made by obstetricians regarding how to manage women, particularly relating to *'when doctors should start treatment for people'*(S16). This may have been due to restricted dissemination of information to obstetricians outside of the DAU and community maternity teams. Indeed, communication between staff from community, triage and centralised high-risk services was thought to be a facilitator to implementation by midwives and obstetricians in NHSB2.

Infrastructure and equipment. Infrastructure and equipment were highlighted as both a barrier and facilitator to implementation. Community midwives in NHSB2 and NHSB3 South each had a laptop and therefore had remote access to NHS databases, which was seen as beneficial to implementation. In the DAU in NHSB1, midwives had been promised a dual monitor to streamline

the process of reviewing and calling women who were self-monitoring. Unfortunately, they did not receive this equipment, which was perceived to slow down self-monitoring tasks. Midwives in the DAU also experienced issues finding an available phone and computer in an appropriate location to make confidential phone calls.

Midwives in NHSB2 and NHSB3 North reported that the cuffs on the BP monitors were too small for some women, leading to skewed readings. Larger cuffs did not arrive in NHSB3 North until 6 weeks after the monitors, therefore slowing down recruitment. There were also issues with some home monitors providing unusual readings in NHSB3 North and South, as previously mentioned.

Mobile networks were identified as another problem for implementation in rural and island areas. Some mobile networks blocked texts from Florence, and, in rural areas of NHSB3 North and South, issues with mobile signal and Wi-Fi were major barriers for communication between women and midwives, e.g., women did not receive reminders from Florence or midwives did not receive readings from women. As such, different ways of communicating were tested and used for different women, depending on their location and preference. For example, women submitted their readings via the BadgerNet application or weekly telephone or NearMe appointments with their midwives.

Women's Experiences and Perception of supported self-monitoring of BP

Most women had a very positive experience of the supported self-monitoring of BP programme, describing it as '*fabulous'*(S10), '*really positive*'(S30), and '*nice and easy'*(S29). Some women even commented that they would want to use it again in future pregnancies, that they would like to have used it earlier in their current pregnancy, or that they wish they had use it in previous pregnancies. Overall, five themes were clustered from the qualitative data collected from women, including (1) Using the equipment and Interpreting Results, (2) Support, (3) Methods for Submitting Readings, (4) Benefits for Women, and (5) Anxiety.

Using the Equipment and Interpreting Results. Most women felt confident using the monitors, particularly when they had confirmation from their midwife that they were doing it correctly, and after practicing at home. Women commented that the BP machines and the urine dip sticks were '*quite straightforward to use*'(S30) and '*relatively simple'*(S27). The information and guidance given to women by their midwives was perceived as clear, easy to follow and thorough. As such, women also tended to feel confident in judging a normal or abnormal BP and using the materials provided to make that judgement. Only two women reported finding self-monitoring of their BP unsettling and that they would '*prefer a professional to do it'*(S24) because that was more reassuring.

A few women had misplaced the information given to them and suggested that it would be helpful to have the information attached to the machines.

Support. Most women viewed supported self-monitoring as an addition to their care rather than a replacement for midwives. Where women had uncertainties or concerns, they reported knowing who to phone. Most women noted that they felt a sense of reassurance and support from their midwives because '*you always have people to help at the other end of the phone'*(S38). Some women reported having regular phone advice from their midwives and feeling '*really supported'*(S27), however, one woman did express feeling as though midwives did not have time for her and that '*it was just "here you go, have a machine, do it yourself" kind of thing'*(S43). This individuals' perception may have been driven by her broader experience of maternity services during the COVID-19 pandemic and her associated anxiety (see Anxiety for more detail).

Methods for Communicating Readings. Women using Florence described liking its simplicity and appreciated the reminders, feedback and guidance included in the texting system. Some women, however, found that the feedback from Florence was not accurate for their individualised 'normal' BP range. It should be noted that one woman in NHSB1 reported submitting slightly lower BPs in order to avoid further messages from Florence because she knew her health professionals would not be concerned about the machine reading:

'*I've kinda found 85 a little bit, you know, if you text back and say it's 84 then you know it's going to leave you alone basically [laughs] just by that one digit, cause certainly a blood pressure like that, that wouldn't concern me'*(S14).

Women using the BadgerNet application to submit readings found the system to be complicated and difficult to use: *'that was just impossible, most of the time you could barely read it and it would just crash'*(S43). Women also found the window for submission (15 minutes) too short, leading to missed submissions, increased stress and additional phone calls to the service. As such, some women stopped using the application and submitted readings during telephone or virtual midwife appointments instead.

Anxiety. For a minority of women in the study, anxieties relating to self-monitoring were reported. A few women had concerns about their health which led to measuring their BP excessively (e.g., every day or multiple times a day), which sometimes increased their concern, particularly when readings were high. One woman described personal events, which increased her anxiety, leading to higher BP readings, which in turn lead to more anxiety. Another woman seemed anxious about the personal responsibility of self-monitoring and reported feeling uncertain that she was using the monitor correctly. She also felt as though midwives did not have time for her, however, it should be noted that this woman had also experienced routine maternity appointments being cancelled due to COVID-19 and her midwife being on long term sick leave during her first pregnancy.

Benefits for women. Women reported that self-monitoring benefited them in a number of ways. For a few women, monitoring their own BP had made them more in tune with themselves:

'*It just feels like, if you can do it at home, it makes you think a bit more about your own health, which I think is a good thing*.'(S25).

For most women, travelling to fewer appointments was beneficial. Less travel reduced the risk of contracting COVID-19, reduced childcare issues, increased flexibility for those that worked and saved

women time, especially for those living remotely in NHSB3 North and South. Women reported appreciating the flexibility of choosing the time to submit their BP readings, particularly when women were still working or had busy lives.

For most women, self-monitoring was reassuring because they were able to keep track of their health between appointments, which some women thought contributed to lower BP measurements. Women also believed there were clinical benefits to self-monitoring. For example, women described instances where protein in urine or high BP had been identified and treated faster due to self-monitoring. Women also reported that self-monitoring had reduced the anxiety of going into hospital, particularly for those with white coat syndrome, therefore reducing BP readings.

Discussion

Principal Results

There is a need for reducing face-to-face contacts for pregnant and postnatal women in the NHS in the context of COVID-19. Women who are at high-risk of developing hypertensive complications of pregnancy or are shielding due to serious underlying medical conditions therefore need to monitor BP and protein in urine at home. This study investigated the experiences and acceptability of self-monitoring for women, midwives and obstetricians in three Scottish Health Boards with four distinct services: NHSB3 North, NHSB3 South, NHSB1 and NHSB2.

Overall, this study shows that radical change can occur at pace and at scale within the NHS. Implementing change in the NHS is notoriously difficult. For example, continuity of midwifery care has been shown to confer clinical and psychosocial benefits for women and their babies and has been central to UK maternity policy for over 30 years yet sustained implementation at scale has not been achieved (14,15). However, based on this research, it appears that the Covid-19 pandemic acted as a

catalyst for change at a national level. It is possible that the pandemic created a shared motivation for innovation that has facilitated digital health implementation on a national level.

Prior to this research, a national working group developed guidance to inform the role out of the programme across Scotland (9), however, it is clear that implementation ultimately differed across case study sites. As such, staff experiences also differed across sites, primarily relating to perceived local planning prior to rollout and the impact this had on workload and caseload. Specifically, a perceived lack of local training, local clinical protocols and information dissemination to wider staff, and a rigid approach to abnormal BP parameters reportedly increased workload. Clear direction, standardised processes and support have previously been cited as important factors for midwives to implement practice change (16).

Various barriers and facilitators to implementation were highlighted by study participants. For example, facilitating factors included buy-in from healthcare professionals, clear communication and dissemination of local guidance and training, and adequate staff time resource. These findings are unsurprising given that allocating adequate resources and time, sufficient implementation planning, provision of educational materials, and engagement from local leaders with authority have previously been identified as key components to successful implementation of new digital health interventions into routine healthcare in the NHS (7,17). Audit and feedback are also facilitating factors previously identified for digital health implementation (17). Characteristics of the rollout leader also appeared to affect implementation in the current study. A leader who was a consultant midwife, had experience in implementing new initiatives, was regularly visible and accessible to midwives affected by the rollout and was able to make decisions about local processes during the rollout helped implementation. It may be that midwife leaders were trusted and considered more accessible than obstetricians, who may be perceived as imposing change in working within a different discipline.

This study showed that women largely found home BP monitoring acceptable and highlighted various benefits, such as saving time, being easier to monitor amidst a busy lifestyle and increasing awareness

of and responsibility for their own health. However, there were a few exceptions where women had heightened anxiety: one due to personal circumstances and one possibly due to a uniquely bad experience of having multiple maternity appointments cancelled due to Covid-19. Self-monitoring had reportedly increased anxiety and their preference was to be monitoring by a healthcare professional. While this was partly mirrored by the healthcare professionals, a number of staff did report a preference for face-to-face appointments. This was primarily to enable a more holistic assessment of women, which is consistent with other research investigating staff experiences of digital health (3,18). Healthcare professionals in the current study also universally agreed that some self-monitoring was not appropriate women whose anxiety increased as a result, along with women who had learning disabilities, complex care needs, language barriers, or poor literacy skills.

The healthcare professionals in the current study also expressed concerns relating to women self-monitoring, primarily that women may not submit BP readings or submit incorrect readings to avoid hospital visits, despite begin given specific instructions. This tension has also been reported in other research. For example, recent discourse analysis shows women's motivation for self-surveillance and that paternalistic medical advice is often contested (19). Although staff in the current study reported anxieties of women's self-surveillance, there was also an understanding that they would get used to this new way of working in time.

Results showed that various digital communication platforms were used across study sites and that clinicians and patients valued different characteristics of the available digital communication platforms. For example, patients appreciated digital platforms that were easy to use, while clinicians valued digital platforms that streamlined their work. In future, it is important to find one platform that suits both staff and patients, i.e., that does not increase staff workload and that is user friendly for patients.

Strengths and Limitations

This study represents views of clinicians and women working and residing in characteristically different geographical areas and it had a good response rate from women. However, there are some limitations to this study. Recruitment was slow in NHSB3 North and South, leading to a small sample for qualitative data collection. As such, generalising the results of this study should be done with caution. Additionally, we were unable to recruit any obstetricians from these sites and the sample of obstetricians was low across other sites and did not meet the planned sample size. Another limitation of this study is that transcriptions were not used during data processing and analysis and one researcher coded most of the data, following discussion of data from the first few interviews. However, we used credibility checks to ensure our findings were relevant and accurately captured participant experiences, e.g. researcher meeting and stakeholder webinar.

Conclusions

Overall, this research demonstrates that rapid change can occur in the NHS on a national level when there is a shared motivation for change. Implementation varied across study sites and a number of influencing factors were identified which, which should be considered in future implementation strategies for digital health. This study showed that women were almost universally supportive, in comparison to staff, therefore, digital health can be embraced by the NHS without reducing patients' perceived quality of care. In doing so, it is key to use a digital platform that suits both staff and patients. Finally, it is clear that self-monitoring is not appropriate for all women, and deciding who should self-monitor should be a shared decision made on an individual basis.

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Abbreviations

DAU: Day assessment unit

BP: Blood pressure

COVID –19: corona virus disease 2019

MS Teams: Microsoft Teams

NHS: National Health Service

NICE: National Institute for Health and Care Excellence

NHSB: National Health Service Board

RCOG: Royal College of Obstetricians and Gynaecologists

RCT: Randomised controlled trial