Evaluation Report:

Personal Bluetooth CO (iCOquit) Monitor Pilot for Smoking Cessation in Pregnancy

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Mums2Be Smokefree

Contents

SOMERSET
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Executive Summary

Background

In March 2020, the Mums2Be Smokefree Service of Somerset County Council had to replace all face-to-face appointments with telephone support in response to the COVID-19 pandemic. In-person Carbon Monoxide (CO) monitoring by Stop Smoking Practitioners to validate the smoking quit status of service users was no longer possible. Though face-to-face support has been reinstated since April 2021, the number of sessions has been reduced for the foreseeable future. In April 2021, the service started a 12-month personal Bluetooth CO (iCOquit) monitor pilot to support service users remotely to quit smoking and remain quit throughout their pregnancy and post-partum. These mobile devices (N=150) were funded by Public Health Somerset County Council.

Design of the iCOquit monitor pilot

A pragmatic design was used for the pilot. In case of a high loss to follow-up (LTFU) at 4-weeks resulting in the loss of iCOquit monitors, the design allowed 20 service users to receive a monitor for their 4-weeks quit CO validation, and other service users for their 12-weeks validation. Using quota sampling, all service users were invited by their Stop Smoking Practitioner to participate in the pilot. The pilot sample (N=58) comprised 20 (34%) service users who received their iCOquit monitors at 4-weeks, and 38 (66%) at 12-weeks for their CO validation. The self-reported CO readings were verified by the Stop Smoking Practitioners through face-to-face measurement at 4- and 12-weeks quit.

Aims of the iCOquit monitor evaluation research

To evaluate if the use of an iCOquit monitor enables service users to strengthen self-care skills to quit smoking and remain quit, throughout their pregnancy and post-

partum when face-to-face support by Stop Smoking Practitioners are not available. And to evaluate if the iCOquit monitor enables Stop Smoking Practitioners to offer sustained support to strengthen the self-care quit skills of service users.

Objectives of the evaluation

The objectives of the evaluation are to:

a. Establish if the iCOquit monitor helps monitoring a quit attempt and leads to increased quits and reduced LTFU.

b. Assess the self-care value of the iCOquit monitor as experienced by the service users.

c. Identify recommendations for improving the use of iCOquit monitors to strengthen self-care skills as experienced by the service users.

d. Assess the value of and recommendations for the use of iCOquit monitors to offer sustained support to strength the self-care quit skills of service users as experienced by the Stop Smoking Practitioners.

Design of the evaluation

Orem's Self-Care model, with its focus on enabling patients (service users) and care agents (Stop Smoking Practitioners) to strengthen self-care skills, was used as the theoretical framework for the mixed-method evaluation research design. A structured outcome evaluation, through a mini survey with a nested qualitative component comprising semi-structured and unstructured questions, was conducted to evaluate the real-life value of the iCOquit monitor enabling the strengthening self-care skills to quit smoking and remain quit, throughout pregnancy and post-partum. The purposive sample comprised all adult service users (N=58) issued with an iCOquit monitor at 4-weeks (n=20, 34%) or 12-weeks (n=38, 66%) pregnant for remote self-management of their CO validations. Out of these, 29 (50%) participate in the digital evaluation survey.

A brief semi-structured questionnaire was used to evaluate the value of the iCOquit monitor to enable self-care skills as experienced by Stop Smoking Practitioners (N=5).

Data analysis and findings

Simple descriptive analysis of the quantitative data was undertaken. In addition to analysis of the evaluative data, the pilot sample quit outcomes were analysed first, followed by comparison of the quit rates and LTFU reported as routine service data during quarters 1 and 4 in 2020/21 (pre-pilot) and 2021/22 (post-pilot.

The age range of the pilot sample (N=58) was 18 to 30 years. They conducted between one and two iCOquit monitor readings leading up to their 4-weeks quit, and subsequently between two and four readings towards their 12-weeks quit. Face-to-face CO readings by Stop Smoking Practitioners at 4-weeks and 12-weeks quit verified accuracy of the remote iCO monitor readings submitted by the service users, no discrepancies were reported. Their quit rates for 4-weeks, 12-weeks and 36-weeks were 96.55% (n=56), 94.83% (n=55), and 94.83% (n=55) respectively; with a LTFU of 3.44% (n=2) at 4-weeks and 1.72% (n=1) at 12-weeks. Though iCOquit monitor use was the only change in service offer at the time, the effect of confounding variables was not analysed.

The comparative pre- and post-pilot findings suggest that, since integration of the iCOquit monitor, service user attendance of first appointments increased by 26.78% (n=105), with an increase in 4-weeks (15.35%, n=61) and 12-weeks quit rates (3.47%, n=55). Both 4- and 12-weeks CO validations increased by 100%, marked by 62.8% (n=130) of 4-weeks quits, and 67.88% (n=112) of 12-weeks quits. LTFU at 4-weeks decreased by 3.94% (n=7) and not quits at 4-weeks by 9.36% (n=24). There was a

decrease of 4.16% (n=1) in LTFU at 12-weeks, and not quits at 12-weeks by 1.87% (n=5). Use of the voucher incentive scheme, offered to those who quit smoking, increased from 38 vouchers in 2020 to 353 in 2021.

The evaluative findings suggest that nearly all the participants (93.1%, n=27) understood the instructions for use of the iCOquit monitor as explained by their Stop Smoking Practitioners. Over 40% (44.83%, n=13) found the monitor useful throughout their entire quit attempt, 20.7% (n=6)) found it useful in the early weeks, 20.7% (n=6) found it motivated them to quit, and 13.8% (n=4) found the monitor most useful after they had been quit for a while. Nearly all the participants (93.1%, n=27) found the monitor either very (55.2%, N=16) or somewhat helpful (41.4%, N=16) to quit and sustain their quit. Over half (51.72%, n=15) found seeing the monitor results to be supportive of their quit. Motivation to stay quit was another important benefit of the monitor (31.03%, n=9), followed by monitor efficiency (13.8%, n=4) in relation to access at home and not having to attend regular face to face appointments.

The qualitative date was subjected to thematic analysis. Three themes emerged concerning the value of the iCOquit monitor. Strengthening Self-Care Skills: the participants and practitioners reveal that the ease of self-management of the iCOquit monitor coupled with its value of motivating self-monitoring, reinforcing achievement and self-empowerment enabled service users to strengthen their self-care skills to quit smoking and remain quit. Expanding Practitioner Support for Self-Care: the findings illuminate the value of the iCOquit monitor for both service users and practitioners by increasing service reach and access, and by enabling and strengthening sustained service support. Moreover, the findings reveal that the value of the monitor integrated with the important Stop Smoking Practitioner Role enabled sustained support to strengthen the self-care skills of service users to quit and remain quit. Requiring

Technological Advancement: the participants and practitioners reveal the need for some technological advancement of the iCOquit Application (App) log in and monitor connectivity to enable service users to strengthen self-care and Stop Smoking Practitioners to offer sustained support to quit and remain quit.

The key recommendations from the participants and practitioners are to: a) integrate the iCOquit monitor as a self-care enabling tool to all service users, b) introduce a person-centred monitor needs assessment, c) undertake a cost-benefit analysis of the monitor, d) advance the monitor App and connectivity, and e) continue participatory monitoring and evaluation of service user and Stop Smoking Practitioner experiences of iCOquit monitors as part of a continuous improvement cycle.

Conclusions

The combined findings from the mixed-method mini survey suggests that the iCOquit monitor enabled service users to strengthen self-care skills to quit smoking and remain quit throughout their pregnancy and post-partum when face-to-face support by Stop Smoking Practitioners were not available. And the monitor enabled Stop Smoking Practitioners to offer sustained support to strengthen the self-care quit skills of service users. In addition, the iCOquit monitor opened more conversations and improved service user relationships and quit outcomes through sustained supported self-care without the need for seeing them face to face at every appointment.

1. Background

Smoking and second-hand smoke exposure during pregnancy are linked to a higher rate of stillbirths, miscarriages, and birth abnormalities. As part of its maternal safety mission, the NHS has prioritised lowering smoking during pregnancy in recent years. This is a positive step, but it has failed to result in significant reductions in national smoking rates, which have remained stable at just under 11% since 2015 (NHS England, 2019).

Despite considerable progress in lowering stillbirth rates over the last decade, infant mortality rates have remained stable since 2010. In 2021 there were 2,628 stillbirths, an increase of 199 from 2020 when there were 2,429 stillbirths; this is similar to the 2,596 stillbirths observed before the coronavirus pandemic in 2019 (ONS 2021). The goal of the UK Government to halve stillbirth and newborn mortality rates by 2025 will be challenging to achieve if smoking is not reduced during pregnancy, resulting in devastating outcomes for many families.

COVID-19 appears to have exacerbated inequities, putting an additional burden on poorer communities with high infant mortality rates, which are partially due to high smoking rates. To ensure an equitable recovery from the epidemic, improve population health resilience, and reduce infant mortality, it is critical to combat smoking in the poorest communities (Action on Smoking in Health 2021). All women should undertake a co-screen at their booking appointments and all smokers should be referred for support to quit (NICE 2021).

2. Smoking in pregnancy in Somerset

In 2012 NHS Somerset was recorded as having a high rate of smoking in pregnancy. In 2011/12 18.2% of mothers delivering in Somerset were recorded as Smoking at the Time of Delivery (SATOD) compared to 13.5% across the Southwest and nationally. Somerset smoking rates were also higher than in similar PCT areas (NHS Somerset, 2012; NHS Somerset SATOD Audit 2012.)

A pilot smoking in pregnancy programme called Mums2Be Smokefree was launched in South Somerset and in 2013/14 the programme was rolled out Countywide. Between 2010-2018 the SATOD dramatically reduced from 18.9% to 11.6% at a rate of double the national average as indicated in Figure-1. But the reduction has become somewhat static since 2018 (NHS Somerset, 2012; NHS Somerset SATOD Audit 2012).
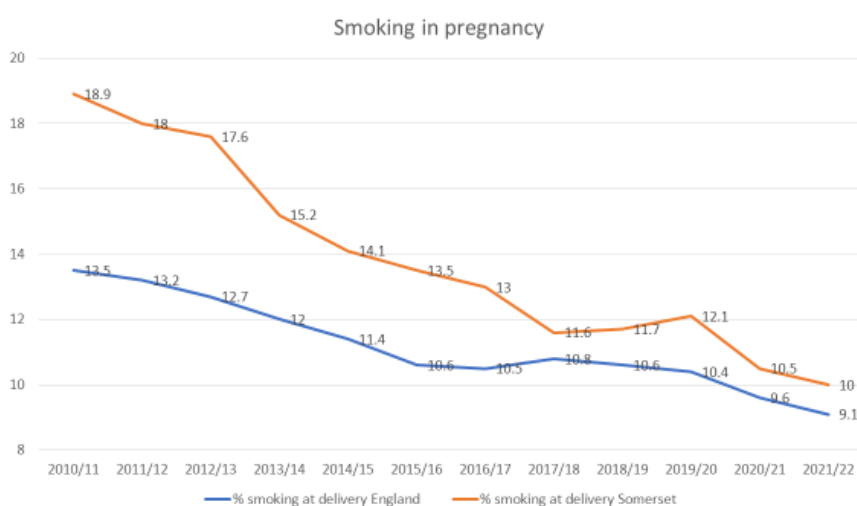
In March 2020, the Mums2Be Smokefree Service had to replace all face-to-face appointments were replaced with telephone support due to COVID-19. In-person Carbon Monoxide (CO) monitoring by Stop Smoking Practitioners to validate smoking quit status of service users were no longer possible. Though face-to-face support has been reinstated in April 2021, the number of sessions has been reduced for the foreseeable future to four set measures at weeks 1, 4, 12 and at 36 weeks pregnant. This is to strengthen infection prevention and control in line with risk assessment measures.

Self-reporting of being and remaining smokefree is not accurate and therefore creates errors with validating SATOD data. Furthermore, without CO monitoring the Mums2Be Smokefree Service had to pause the voucher incentive scheme which is a proven excellent engagement tool (NHS Somerset, 2012; NHS Somerset SATOD Audit 2012).

3. The iCOquit monitor pilot

In April 2021, the service started the Bluetooth CO Monitor (iCOquit) pilot to support service users remotely to quit smoking and remain quit throughout their pregnancy and post-partum. The pilot lasted 12 months to enable comparison of routine quit and LTFU service data pre- and post-pilot, and to evaluate the value of the iCOquit monitor as experienced by service users (participants) and Stop Smoking Practitioners (practitioners). These mobile devices (N=150) were funded by Public Health Somerset County Council.

3.1 **Bluetooth iCOquit quit monitor**

The iCOquit is a personal Bluetooth CO monitor. Used alongside the free iCOquit application (App) for use on mobile devices, this personal CO monitor enables its users to self-manage their CO readings remotely, safely, and easily, and share their results and progress with their Stop Smoking Practitioner via text or WhatsApp. Portable, pocket-size, and with instant results, the iCOquit is ideal for remote CO monitoring (Bedfont Scientific, 2021)

3.2 **Design of the iCOquit monitor pilot**

A pragmatic design was used for the pilot. In case of a high loss to follow-up (LTFU) at 4 weeks resulting in the loss of iCOquit monitors, the design allowed 20 service users to receive a monitor for their 4-weeks quit CO validation, and other service users for their 12-weeks validation. Using quota sampling, all service users were invited by their Stop Smoking Practitioner to participate in the pilot. Each practitioner was issued with five monitors to offer to their service users eligible for 4-weeks CO validation, and additional monitors for those qualifying for 12-weeks CO validation. The pilot sample (N=58) comprised 20 (34%) service users who received their iCOquit monitors at 4-weeks, and 38 (66%) at 12-weeks for their CO validation.

Stop Smoking Practitioners home delivered the monitors with explanation of the instructions to the pilot participants. They were asked to send weekly CO readings via WhatsApp to their practitioners' The respective practitioners recorded the iCOquit data as part of the standard care pathway. The self-reported CO readings were verified by the Stop Smoking Practitioners through face-to-face measurement at 4- and 12-weeks.

The Mums2Be Smokefree Service Team Leader conducted weekly team meetings to monitor progress and ensure rapid response to any operational queries, challenges, and participant or practitioner recommendations.

Technical issues concerning the iCOquit monitors were shared with the supplier, Bedfont. Regular progress meetings continued during the pilot for joint resolution in response to operational challenges and recommendations. The Team Leader received regular feedback from Bedfont with resolutions to the issues raised. Meetings continue post pilot, with services users testing changes to the application, to ensure an improved operation for future users. Joint working remains essential for iCOquit functionality adjustments needed as a future integrated service offer.

4. The iCOquit monitor evaluation research

The service designed and undertook a 12-month evaluation of the pilot between April 2021 and April 2022.

4.1 Aims of the iCOquit monitor evaluation

To evaluate if the use of an iCOquit monitor enables service users to strengthen self-care skills to quit smoking and remain quit, throughout their pregnancy and post-partum when face-to-face support by Stop Smoking Practitioners are not available. And to evaluate if the iCOquit monitor enables Stop Smoking Practitioners to offer sustained support to strengthen the self-care quit skills of service users.

4.2 Objectives of the evaluation

The objectives of the evaluation are to:

a. Establish if the iCOquit monitor helps monitoring a quit attempt and leads to increased quits and reduced LTFU.

b. Assess the self-care value of the iCOquit monitor as experienced by the service users.

c. Identify recommendations for improving the use of iCOquit monitors to strengthen self-care skills as experienced by the service users.

d. Assess the value of and recommendations for the use of iCOquit monitors to offer sustained support to strength the self-care quit skills of service users as experienced by the Stop Smoking Practitioners.

4.3 **Design of the evaluation**

The Programme Manager and Evaluation Lead at the Southwest Academic Health Science Network, and the Service Manager: Healthy Lifestyle Services at Somerset County Council, were consulted for design of the evaluation.

Orem's Self-Care model, (Hartweg, 1991) with its focus on enabling patients (service users) and care agents (Stop Smoking Practitioners) to strengthen self-care skills, was used as the theoretical framework for the mixed-method evaluation research design. A structured outcome evaluation, through a mini survey with a nested qualitative component comprising semi-structured and unstructured questions, was conducted to evaluate the real-life value of the iCOquit monitor enabling the strengthening self-care skills to quit smoking and remain quit, throughout pregnancy and post-partum.

A brief semi-structured questionnaire was used to evaluate the value of the iCOquit monitor to enable self-care skills as experienced by the Stop Smoking Practitioners.

4.3.1 Study population and sample

4.3.1.1 Inclusion criteria

The purposive sampling included all adult service users (N=58) in the pilot and issued with an iCOquit monitor from the Mums2Be Smokefree Service at 4-weeks (n=20, 34%) or 12-weeks (n=38, 66%) pregnant for remote self-management of their CO validations since 1 April 2022, and who had reached 36 weeks pregnant or had not quit or were LTFU.

4.3.1.2 Sampling

All service users meeting the inclusion criteria (N=58) were invited by mobile phone to participate voluntarily in the evaluation research. An initial message was sent to them via WhatsApp by their Stop Smoking Practitioners:

"We are evaluating the iCOquit (blue tooth breath test) to see if it is a valuable resource for the service. I will send you a link via text to a short questionnaire. If you would complete it when you have time it would be really helpful with the redesign of our service?"

Those who confirmed their participation (n=51, 88%) received a second WhatsApp message once they reached 36 weeks of pregnancy or if they left the service before this point. The message contained a direct link to a digital evaluation questionnaire for anonymous completion.

"Dear {Forename},

Here is a link to a short questionnaire to help us evaluate the iCOquit Bluetooth monitor that you have been using through Mums2Be Smokefree. Your responses will help us decide if / how these are useful to our service users and whether they are a resource that we would like to continue to issue. Thank you again for completing this, https://www.smartsurvey.co.uk/s/A6XCOH/.

Kindest Regards the Mums2Be Smokefree Team."

After one week of the mini survey link being sent, a reminder was SMS was issued by the Stop Smoking Practitioners. As this was an anonymous survey, the reminder was sent to all the service users (n=51, 88%) who responded positively to the initial WhatsApp message.

"Dear {Forename},

I recently sent you an SMS asking if you would kindly complete a short questionnaire to help guide our service on its use of the iCOquit Bluetooth monitors. We still have a few outstanding and as this is anonymous, we are unable to see who has or has not completed it. Apologies if you have done so already, but if you have yet to do it, here is the link.

Thank you again for completing this, https://www.smartsurvey.co.uk/s/A6XCOH/. Kindest Regards the Mums2Be Smokefree Team."

Out of the total population (N=58), 51 (88%) confirmed their participation following the initial WhatsApp message and 29 (50%) completed the questionnaire. The reasons for declining participation (n=29, 50%) could not be investigated because of

anonymous completion of the on-line survey. All the Mums2Be Smokefree Stop Smoking Practitioners (N=5, 100%) completed a brief evaluation questionnaire.

4.3.1.3 Data collection tool

The Southwest Academic Health Science Network team recommended a mini survey with six structured questions that were assessed by the Service Manager: Healthy Lifestyle Services who made recommendations for some changes and the inclusion of semi-structured and unstructured questions. The final mixed-method mini survey questionnaire comprises 1 Likert scale, 3 multiple choice and 4 qualitative questions. Furthermore, a brief semi-structured questionnaire with three open-ended questions was used to evaluate the iCOquit monitor pilot as experienced by the Stop Smoking Practitioners.

It was agreed to sending participants a link to the digital survey which was anonymous. No personal identifying information was collected from the participants or practitioners to limit a negative impact on the response rate and honest responses to the questions.

4.3.1.4 Data Analysis

In addition to analysis of the evaluative data, the pilot sample quit outcomes were analysed first, followed by comparison of the quit rates and LTFU reported as routine service data during quarters 1 and 4 in 2020/21 (pre-pilot) and 2021/22 (post-pilot). Though iCOquit monitor use was the only change in service offer at the time, the effect of confounding variables was not analysed. Simple descriptive analysis of the quantitative data was undertaken and are presented in percentages and cluster bar

charts for ease of interpretation. The analysis was undertaken by the Mums2Be Smokefree Service Team Leader and validated by the Service Manager: Healthy Lifestyle Services.

The qualitative data were examined using thematic analysis to identify, analyse and report patterns (themes) within the data (Braun and Clarke, 2006). This process involved becoming familiar with the data, generating initial codes, searching for themes, reviewing the themes, defining, and naming the themes and subthemes, and producing the report. The findings from this evaluation research are presented according to the emerging themes with their respective sub-themes and substantiated by verbatim participant (service users) and practitioner (Stop Smoking Practitioners) quotes in *italics*. The thematic analysis was undertaken by the Service Manager: Healthy Lifestyles and validated by the Mums2Be Smokefree Service Team Leader.

4.3.1.5 **Ethics**

Ethics approval for the study was obtained from Somerset County Council.

5. Key Findings

The pilot sample quit outcomes and pre- and post-pilot comparative findings are summarised, followed by presentation of the quantitative evaluative findings according to each question of the mini survey. The qualitative findings are presented according to the themes with their respective sub-themes that emerged from the participant (service users) and practitioner (Stop Smoking Practitioners) data.

5.1 Quantitative findings summary: the pilot

5.1.1 Pilot quit outcomes

The age range of the pilot sample (N=58) was 18 to 30 years. They conducted between one and two iCOquit monitor readings leading up to their 4-weeks quit, and subsequently between two and four readings towards their 12-weeks quit. These exceeded the Mums2Be Smokefree Service standard of a minimum of two readings at 4-weeks and 12-weeks quit respectively. Face-to-face CO readings by Stop Smoking Practitioners at 4-weeks and 12-weeks quit verified accuracy of the remote iCO monitor readings submitted by the service users, no discrepancies were reported. Their quit rates for 4-weeks, 12-weeks and 36-weeks were 96.55% (n=56), 94.83% (n=55), and 94.83% (n=55) respectively; with a LTFU of 3.44% (n=2) at 4-weeks and 1.72% (n=1) at 12-weeks. Though iCOquit monitor use was the only change in service offer at the time, the effect of confounding variables was not analysed.

5.1.2 Pre- and post-pilot comparative outcomes

The comparative pre- and post-pilot findings suggest that, since integration of the iCOquit monitor, service user attendance of first appointments increased by 26.78% (n=105), with an increase in 4-weeks (15.35%, n=61) and 12-weeks quit rates (3.47%, n=55). Both 4- and 12-weeks CO validations increased by 100%, marked by 62.8% (n=130) of 4-weeks quits, and 67.88% (n=112) of 12-weeks quits. LTFU at 4-weeks decreased by 3.94% (n=7) and not quits at 4-weeks by 9.36% (n=24). There was a decrease of 4.16% (n=1) in LTFU at 12-weeks, and not quits at 12-weeks by 1.87% (n=5). Use of the voucher incentive scheme, offered to those who quit smoking, increased from 38 vouchers in 2020 to 353 in 2021.

5.2 Quantitative findings: the pilot evaluation

5.2.1 Participant demographics

It was not possible to determine the demographics of the evaluation sample due to the design of the digital survey questionnaire to ensure anonymity of and increase participation by the service users.

5.2.2 Question-1: I understand what I was being asked to do with the iCOquit

Nearly all the participants (93.1%, n=27) understood the instructions for use of the iCOquit monitor as explained by their Stop Smoking Practitioners. There were no reports of requests for improved or additional information.
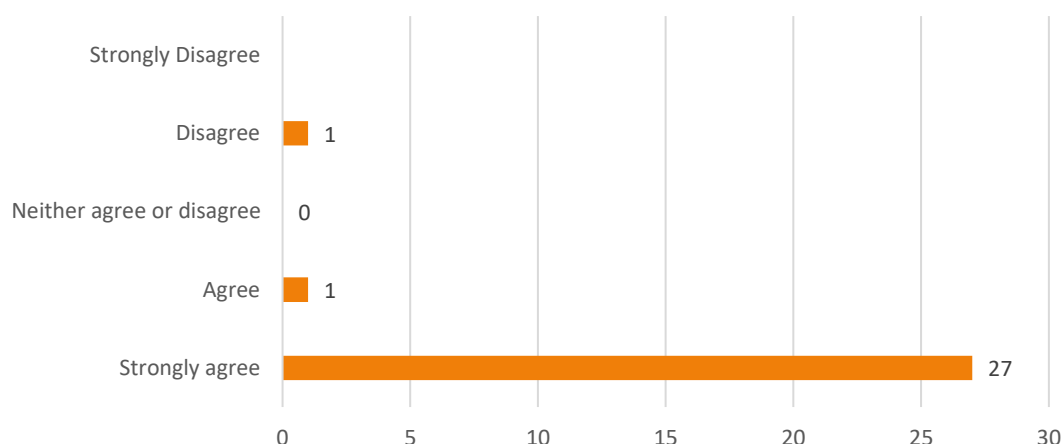

5.2.3 Question-2: At what stage did you find using the iCOquit most useful?

Over 40% of the participants (44.83%, n=13) found the iCOquit monitor useful throughout their entire quit attempt. Six (20.7%) found it useful in the early weeks, six, (20.7%) found it motivated them to quit, and four (13.8%) found the monitor most useful after they had been quit for a while. As the monitors were issued at various stages, this will affect the user response.

5.2.4 Question-3: How helpful do you feel the iCOquit has been to support you to sustain you're not smoking?

Nearly all the participants (93.1%, n=27) found the iCOquit monitor either very (55.2%, N=16) or somewhat helpful (41.4%, N=16) to quit and sustain their quit. Only one participant did not find the monitor at all helpful but did explain later in the survey that they could not connect it to their phone.
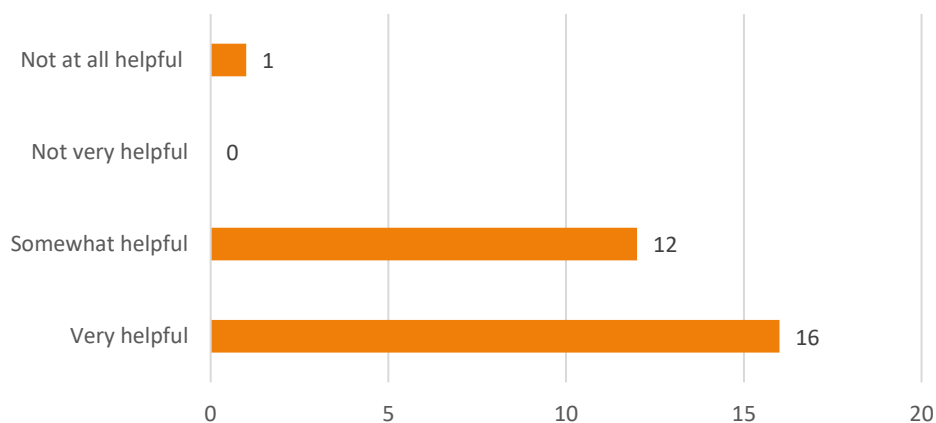
5.2.5 Question 4: In what (if any) way did you find the iCOquit useful to support you're not smoking?

Over half of the participants (51.72%, n=15) found seeing the iCOquit monitor results to be supportive of their quit. Motivation to quit and stay quit was another important benefit of the monitor (31.03%, n=9), followed by monitor efficiency (13.8%, n=4) in relation to access at home and not having to attend regular face to face appointments, and one participant found goal setting to be a useful support.
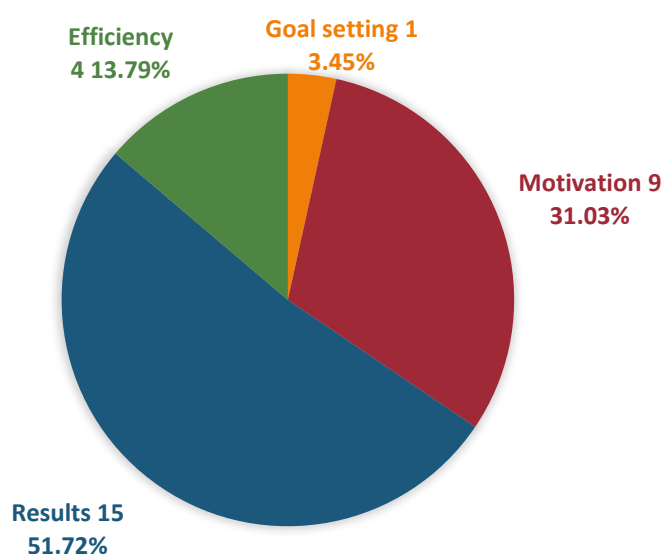
5.2.6 Question 5: Do you have any suggestions for improving the use of the iCOquit?

More than half of the participants (55%, n=16)) responded to this question with nine (56%) reporting that no improvements were needed. Seven (44%) reported that some improvement was required for the application (App) that links the iCOquit monitor to the participant's mobile phone.

5.2.7 Question 6: Do you have any other comments about your experience of using the iCOquit?

Fourteen participants (48%) responded to this question with three key themes, emerging from the findings as reported in section 5.3.

5.2.8 Question 7: If you are no longer engaging with the service, please could you explain why the service did not work for you and what may have helped you to continue engaging?

None of the participants responded to this question but several complimented the Mums2B Smokefree Service as reported in section 5.3.2.4.

5.3 Qualitative findings: the pilot evaluation

Three themes with their interconnected sub-themes emerged from the participant (service user) and practitioner data as shown below and presented in turn.

THEME	SUB-THEME
1. **Strengthening Self-Care Skills**	Ease of Self-Management
	Motivating Self-Monitoring
	Reinforcing Achievement
	Self-Empowerment
2. **Expanding Practitioner Support for Self-Care**	Increasing Service Reach and Access
	Enabling and Strengthening Sustained Service Support
	Person-centred Assessment
	Stop Smoking Practitioner Role
3. **Requiring Technological Advancement**	iCOquit App Log In
	iCOquit Monitor Connectivity

5.3.1 THEME-1: Strengthening Self-Care Skills

The participants and practitioners reveal that the Ease of Self-Management of the iCOquit monitor coupled with its value of Motivating Self-Monitoring, Reinforcing Achievement and Self-Empowerment enabled service users to strengthen their self-care skills to quit smoking and remain quit. Each of these interconnected sub-themes are described in turn.

5.3.1.1 Ease of Self-Management

Comments from the participants confirm that clear and simple operational instructions and explanations offered by the practitioners made it easy to use the iCOquit monitor. One participant mentioned the *"Straight forward and easy instructions"* and other stated that *"The Stop Smoking Practitioner explained very well what I had to do"*. Another participant indicated the ease of use and positive experience with the monitor by explaining *"I found the experience easy to use and I would recommend this device."*

Several participants reported satisfaction with their user experiences of the iCOquit monitor. Their range of comments include "*I think it's a very clever piece of kit", "Very easy to use", "Reading all levels of carbon monoxide", "The support is brilliant", "I love that it's all on your phone"*, and *"Nothing needs to be improved."*

Reports from the practitioners confirm the general ease of self-management of the iCOquit monitor by their clients. The few problems mentioned related to the technology and the App itself and not the use of the monitor. A practitioner explained that *"Clients* (service users) *report that the iCOquit are generally easy to use. Any issues*

appear to come from the technology/app itself rather than any problems with correct use".

Though service users do their own readings as part of self-care, they might forget to suit their readings to the service, The practitioner explained *"I do however have to do a monthly chase WhatsApp message to most of the clients to remind them to send me a photo of their recent reading, these have all come back low, so it is not that they are avoiding sending them, they simply forget."*

5.3.1.2 Motivating Self-Monitoring

Findings from the participants reveal repeated statements of the powerful value of the iCOquit monitor as a motivational tool to quit and remain quit and improve health. Several participants explained that the required submission of CO readings to their practitioners was motivating. They explained that *"Knowing that a reading had to be submitted was motivating. I didn't want to feel like I had failed"*, *"Knowing that if I smoke the iCOquit would detect an increase in my CO levels, and I have to send the readings to my advisor"* and *"Knowing that I had to submit my readings made me want to keep my levels low"*. Another stated that *"It kept me motivated knowing that I had to prove my results of not smoking. I really think it helped and its very clever."*

The ability to self-monitor CO readings at any time was reported as motivating by several participants. They explained that it *"Was nice to check on myself and family member the levels we were at early check-ups"*, *"It was motivating to see a result"*, *"It motivates you to keep a low carbon reading"*, and the readings *"Helped me notice how much CO was in my body and how much there isn't when you stop smoking."* Another

participant stated that *"It motivated me not to have a fag by monitoring it myself at home"*.

The immediate CO reading result function as a strong visual reminder of the health benefits and achievement of quitting. One participant said that the readings *"Motivated me to keep going and have a visual reminder of the immediate benefits of not smoking"*. Others explained the value of the reading by *"Seeing the impact smoking has on the body"* and that *"It was a reminder of the achievement."*

The iCOquit monitor was experienced by participants as enabling and motivating for self-monitoring to quit and remain quit. A participant explained that *"Having iCOquit connected to Bluetooth helps you keep on track of your levels. Gives motivation to stop"*. Referring to the monitor, others stated that *"It helped to keep me motivated in staying smoke free"* and that the monitor was a *"Great idea and helps to motivate you to stay quit."*

The statement of one of the participants summarises the overall value of the iCOquit monitor. *"Thank you for letting me be a part of this as it really helped me to quit whilst pregnant."*

5.3.1.3 Reinforcing Achievement

The participants reported that through self-care the iCOquit monitor reinforced their quit achievements. The monitor reinforced quitting as *"An effective way of showing results and that the quitting smoking is working to reduce carbon monoxide levels"*. A participant mentioned that *"It feels good to prove that I quit! So, it helped me"* and

another said that *"I love the fact you can see your score get lower. It feels like more of an achievement."*

5.3.1.4 **Self-Empowerment**

The participants indicated that by offering immediate readings and tracking of CO results, the iCOquit monitor empowered them to set realistic goals to quit and remain quit. Their statements highlight that *"It* (CO readings) *gave me periodic goals to reach which reduced the overwhelming feeling of quitting, small goals every few weeks broke it down for me"*, and *"It kept me from smoking because I knew I was breathing better and could see the results"*.

Several participants referred to the empowering effect of tracking the improvement of their personal results regularly. *"It was good to see the results getting less each time it was used"*, *"It was great to see the low numbers on the iCOquit after I had quit smoking compared to my partners high numbers when he was still smoking"*, *"It's good to check every week, as I personally think it gives more motivation to quit because when you see the results, only gives you determination to work down to 0."*

Some participants also mentioned that the CO readings resulted in determination to improve their quitting and a sense of pride about their progress. *"By being able to see where I started and the progress, I was making to the point I am at now was helpful. It made me try harder and want to get a better score come blow time"* and *"I loved the results of not having a cigarette, I was proud to show off my results."*

The practitioners also regarded the iCOquit monitor as empowering service users to take ownership of their quit attempt whilst also confirming a CO validate quit for data collection. *"I have found these an extremely useful tool to encourage and keep our clients smokefree, the clients like the idea of being able to check their CO, some have used it to prove to a partner that is still smoking the effect on their CO through second-hand smoke."*

5.3.2   THEME-2: Expanding Practitioner Support for Self-Care

The findings from the participants and practitioners illuminate the value of the iCOquit monitor for both service users and Stop Smoking Practitioners by Increasing Service Reach and Access, and by Enabling and Strengthening Sustained Service Support. Moreover, the findings reveal that the value of the monitor integrated with the important Stop Smoking Practitioner Role enabled sustained support to strengthen the self-care skills of service users to quit and remain quit.

5.3.2.1 Increasing Service Reach and Access

The participants reported that the iCOquit monitor increased the reach of and remote access to stop smoking services and support. One explained that *"The ICOQUIT was useful to help me quit smoking as it made it easier no need to go for appointments can do it from the ease of your own home making it much quicker and more efficient."* Others commented on the value of ease of access to quitting results and the service. *"I could check my levels at any time rather than just as an appointment"*, *"The ability to see how well you've done anytime you want to"*, and *"Knowing I could ask for patches etc when I needed them and regular phone calls"*.   Another participant explained the value of the monitor in expanding support by, and in reducing time

requirements for meetings with, a service practitioner. *"I didn't find it a support, but at least reduce arranging a meeting with Smokefree counsellors and therefore you are more flexible with your time. Again, the machine doesn't help you quit smoking; it's just kept you on the right track with the support".*

5.3.2.2 **Enabling and Strengthening Sustained Service Support**

The practitioners found the iCOquit monitor extremely useful by enabling and strengthening sustained support and CO readings for service users even though face-to-face contact was not taking place. The monitors proved particularly valuable for remote support and during staff absence, resulting in no face-to-face client contact and they allowed the continuation of the voucher incentive scheme. One participant highlighted the added value of the monitor in the context of COVID-19. *"iCOquit has proven useful when we have been unable to visit a client due to illness/Covid in the household."*

5.3.2.3 **Person-centred Assessment**

The practitioners suggested the integration of a person-centred assessment to identify the need and appropriate time for the use of an iCOquit monitor by each service user. There was a strong opinion that those who quit smoking since conception, or are in the first week with the service, do not require an iCOquit monitor. They raised several questions to guide service development. These include *"Do all clients need an iCOquit? Could the cost of issuing an iCOquit earlier in the quit attempt (potential loss if client becomes a LTFU) be outweighed by not providing one to every client* (service user)*?",* *"Could the Stop Smoking Practitioner make a professional judgement as to who to offer the device to and when?",* *"Is there a benefit in giving an iCOquit to a client that*

has quit easily with minimal support and stayed quit for 12 weeks in relation to the cost of the device?", "We know that clients who get to 4 weeks are more likely to stay engaged with the service through to 12 weeks so how useful is the device after this period? Especially now that maternity services are back to regular CO screening again."

Several practitioners felt that the iCOquit monitor should be issued at the earliest opportunity to service users who would benefit from them. They considered if it *"Would it be beneficial to look at giving an iCOquit to clients* (service users) *that are struggling to quit sooner (pre-4 weeks)? It seems more beneficial to give the iCOquit at an earlier stage so the client can see the improvement in their reading."* One practitioner stated, *"I have given more* (monitors) *out between 4-6 weeks to clients that are doing well and as motivation rather than waiting to 12 weeks which I felt was too late in their smokefree journey."*

5.3.2.4 Stop Smoking Practitioner Role

The participant statements reveal the value of the iCOquit monitor combined with the pivotal role of the Stop Smoking Practitioner in enabling sustained support to strengthen self-care skills for quitting. One explained that *"The combination of the ICOquit and an advisor* (practitioner) *is what it helped me to quit. Without the advisor I don't think it would have worked so well for me".* And another felt that *"It's not the machine* (monitor) *but our mindset that helps you quit, alongside the advisor's support"*

Several participants offered spontaneous comments about the importance of the Stop Smoking Practitioners in offering sustained support to quit and remain quit, and for broader healthy pregnancy outcomes. Two statements capture the reported

experiences shared by the participants. *"I still engage with my Stop Smoking Practitioner, and I couldn't have done this without her. It has been so much more than just the act of quitting smoking. Being able to talk about the pregnancy in general and just day to day life has made everything less stressful. I have recommended the service to many friends"* and *"I gave up smoking thanks to this great service."*

5.3.3 THEME-3: Requiring Technological Advancement

The participants and practitioners reveal the need for some technological advancement of the iCOquit Application (App) Log in and Monitor Connectivity to enable service users to strengthen self-care and Stop Smoking Practitioners to offer sustained support to quit and remain quit.

5.3.3.1 iCOquit App Log In

Though the participants reported general ease of iCOquit monitor use, they identified the need for improving the log in function of the App itself. Several reported periodic difficulties. *"I think the concept works well although I had issues with the App. There were numerous times I couldn't log in"*, *"The app didn't work on my phone, and I had to use my partner's phone"*, and *"The app was very inconsistent and froze a lot."*

These participant experiences were confirmed by the practitioners highlighting similar problems reported by service users they supported. *"I have only held a small caseload but have had a few issues where the App has stopped working and the client has tried to reinstall, but it has failed thus rendering the iCOquit useless. These have been a mixture of Android and iPhones."*

5.3.3.2   **iCOquit Monitor Connectivity**

Some participants mentioned the need for basic improvement to the connectivity of the monitor to strengthen the user experience. *"I couldn't get it to connect to my phone at all so it would be better if they were easier to use."*

Some practitioners also identified the need for improved connectivity. *"If a client changes their phone, they require another device as they cannot be linked to a second device."*

6. Discussion

Based on our literature search, this seems to be the first reported UK study on the evaluation of the iCOquit monitor as a tool to enable service users to strengthen self-care skills to quit smoking and remain quit, and to enable Stop Smoking Practitioners to offer sustained support to strengthen the self-care quit skills of service users.

The prevalence for smoking in pregnancy is estimated from the SATOD data that is routinely collected by maternity services. The target of 6% or below by 2022 was agreed in 2015 this is now unachievable and a new target of 4% or below by 2026 has been established (Action on Smoking and Health, 2021).

In Somerset SATOD was 10.5% at the end of 20/21 after seeing a reduction from the previous year of year 1.6% (NHS South, Central and West Commissioning Support Unit) This was 1% above the national average. The iCOquit monitors were introduced into the Mums2B Smokefree Service in April 2021, and since, Somerset has seen a reduction in SATOD of 0.5% to 10% (NHS South, Central and West Commissioning Support Unit). National figures ended the year at 9.1%. Though the iCOquit monitor use was the only

change in service offer at the time, the effect of confounding variables was not analysed.

The quit rates of the pilot sample, verified through face-to-face-CO readings by Stop Smoking Practitioners, for 4-weeks, 12-weeks and 36-weeks were 96.55% (n=56), 94.83% (n=55), and 94.83% (n=55) respectively; with a LTFU of 3.44% (n=2) at 4-weeks and 1.72% (n=1) at 12-weeks. The iCOquit monitor pilot resulted in an overall 26.78% (n=105) increase in service users attending a first appointment, 15.35% (n=61) increase in 4-weeks and 4.37% (n=55) at 12-weeks quit status, 9.36% (n=24) reduction in not quit at 4-weeks and 1.87 (n=5) % at 12-weeks, 3.94% (n=7) decrease in LTFU at 4-weeks and 4.16% (n=10) at 12-weeks, 100% increase in 4-weeks (n=130) and 12-weeks (n=112) CO validations. Furthermore, the use of the voucher incentive scheme increased from 38 vouchers issued in 2020 to 353 in 2021. A larger pilot sample, coupled with issuing of iCOquit monitors at the start of a quit attempt, would probably have resulted in a significant decrease in LTFU and not quits at 4-weeks and 12-weeks, and a further increase in vouchers issued as incentives to service users who quit.

The combined findings confirm the relevance of using Orem's Self-Care model (Hartweg, 1991) with its focus on enabling patients (service users) and care agents (Stop Smoking Practitioners) to strengthen self-care skills, as the theoretical framework for the mixed-method evaluation research design. The findings suggest that the iCOquit monitor enabled both the service users (participants) to strengthen their self-care skills and Stop Smoking Practitioners (practitioners) to offer sustained support to them, to quit smoking and remain quit.

Though the iCOquit monitors were issued at various stages for pragmatic reasons, over 40% (44.83%, n=13) of participants found the monitor useful throughout their entire quit attempt. The combined findings suggest that the participants would benefit from iCOquit monitors issued earlier in their quit attempt. The practitioners suggested the integration of a person-centred assessment to identify the need and appropriate time for the use of an iCOquit monitor by each service user. Monitors are now issued by practitioners within the first 3-4 weeks in line with the findings from the evaluation research.

Nearly all the participants (93.1%, n=27) found the iCOquit monitor either very (55.2%, n=16) or somewhat helpful (41.4%, n=16) to quit and sustain their quit. The ease of iCOquit monitor use as reported by participants (93.1%, n=27) and seeing the CO results (51.72%, n=15) coupled with it serving as a motivational tool (31.03%, n=9) during COVID-19 when home-based face-to-face support was not appropriate, strengthened self-care skills to quit and remain quit. Though reinstated, a reduced number of home visits remains the new service norm in line with service risk assessment. The monitor offered service users instant availability of self-managed CO readings and progress tracking monitor which reinforced their quit achievement and empowerment them to set realistic goals to quit and remain quit.

The participant and practitioner experiences highlight the value of the iCOquit monitor to sustain practitioner support for enabling self-care by users to quit and remain quit. By offering instant access to self-managed CO results and reducing time required for face-to-face appointments with practitioners, the monitor increased service reach and remote access for users. In addition, the monitor enabled and strengthened sustained

practitioner support and CO readings when face-to-face contact wat not offered. By issuing the iCOquit monitor, regular CO validation took place, to compliment the Stop Smoking Practitioner readings at 4, 12, and 36-weeks pregnant and 2 months post-delivery. Regular CO monitoring via the iCOquit monitor also allowed continuation of the voucher incentive scheme which is a proven excellent engagement tool (NHS Somerset, 2012 (NHS Somerset SATOD Audit 2012). The participants stressed that to enable sustained support to strengthen self-care skills for quitting, it is important to combine the stated values of iCOquit monitor with the pivotal role of the Stop Smoking Practitioner. Thus, in accordance with Orem's Self-Care model, the iCOquit monitor enables service users (patients) to strengthen their self-care skills to quit smoking and remain quit.

Though the participants and practitioners reported general ease of iCOquit monitor use, they identified the need for some technological advancement of the iCOquit App log in and monitor connectivity to mobile phones to enable service users to strengthen self-care and Stop Smoking Practitioners to offer sustained support to quit and remain quit. These challenges have been reported to the supplier of the monitors and advancements are in progress for testing by the service users.

Through integration of the iCOquit monitor, the Mums2Be Smokefree Service is now able to capture regular and more reliable CO validated data. Practitioners remain engaged with the service users not just through their face-to-face visits, phone calls and online support group, they now have regular CO readings being sent through by WhatsApp. They have reported that this has opened more conversation and improved service user relationships. Thus, in accordance with Orem's Self-Care model, the

iCOquit monitor enables practitioners (agents) to offer sustained support to strengthen the self-care skills of service users (patients) to quit smoking and remain quit.

The mini survey findings show that participants and practitioners experienced the value of the iCOquit in not only enabling and supporting a quit attempt but maintaining it. The cost of the monitor is therefore insignificant when examining the potential cost implications when a pregnant person continues to smoke in pregnancy. A cost benefit analysis would be helpful to leverage for a future budget to procure iCOquit monitors as part of a standard service offer to all users. Caution needs to be raised concerning the environmental impact as each monitor is for individual use, with battery life of 1 year or 500 tests, whichever comes first. The monitor can be recycled and placed in a battery bin or in home recycling. The battery needs removing for battery recycling, then the plastic casing of the monitor can be recycled with household plastics.

7. Recommendations

Several recommendations, recognised from the reported participant and practitioner experiences, are listed below.

a) Integrate the iCOquit monitor as a self-care enabling tool to all service users.
b) Introduce a person-centred iCOquit monitor needs assessment to determine at which point in the care pathway and for how long monitors should be issued.
c) Undertake a cost-benefit analysis of the iCOquit monitor by increasing quit rates and CO validations, and by decreasing LTFUs.

d) Advance the iCOquit monitor App and connectivity for improved remote reporting of CO readings.

e) Continue participatory monitoring and evaluation of service user and Stop Smoking Practitioner experiences of iCOquit monitors as part of a continuous improvement cycle.

8. Limitations

Based on the evaluative findings, it is probable that a larger pilot sample would have resulted in a significant decrease in LTFU and not quits at 4-weeks and 12-weeks. In addition, the iCOquit monitors were issued at various stages during the pilot with impact on the overall LTFU and quit rates. The findings suggest that service use access to a monitor at the start of a quit attempt is likely to substantially reduce LTFU and increase quit rates.

The 50% (n=29) participant response rate is encouraging but it was not possible to establish the reasons for the total population (N=58) not completing the anonymous digital survey. Though the sample size (n=29) is relatively small, the findings and recommendations already resulted in service improvement and could be of value to policies and practices in other settings towards enabling service users and Stop Smoking Practitioners to strengthen self-care skills to quit smoking and remain quit.

The mini digital survey was anonymous, when examining the App problems, it is not possible to analyse what type of phones were being used when the app failed. It would have been useful for the App developer to know this information to correct the errors. The Stop Smoking Practitioners have been able to support service users when

downloading the App and connecting the monitor. They have also been able to support those who have experienced issues with the App. The supplier of the iCOquit monitors have been available for support when required to resolve issues regarding the app.

Current discussions with both companies Bedfont and Intermedical regarding the concerns raised about the App failures are underway. Options are being explored to link the iCOquit monitor App to another Stop Smoking App for seamless support provision. The Mums2Be Smokefree service users will be testing all technological advancements to maximise digital service user support to quit and remain quit,

9. Conclusions

The combined findings from the mixed-method mini survey suggests that the iCOquit monitor enabled service users to strengthen self-care skills to quit smoking and remain quit throughout their pregnancy and post-partum when face-to-face support by Stop Smoking Practitioners were not available. And the monitor enabled Stop Smoking Practitioners to offer sustained support to strengthen the self-care quit skills of service users. The findings confirm the relevance of using Orem's Self-Care model as a theoretical framework for the evaluation research design with its focus on enabling patients (service users) and care agents (Stop Smoking Practitioners) to strengthen self-care quit skills.

The findings indicate that iCOquit monitor use resulted in increased service user engagement, increased 4-weeks, 12-weeks and 36-weeks quits, and a decrease in not quits and LTFUs. The participants (service users) and practitioners (Stop Smoking

Practitioners) reported the iCOquit monitor as a self-care enabling tool to motivate and maintain a quit status. The monitor enabled remote and regular CO validation by service users to compliment the practitioner readings. The iCOquit monitor enabled practitioners to offer remote motivation and sustain support for service users to quit and remain quit through self-care. In addition, the monitor offered regular and more reliable CO-validated data that enabled the Mums2Be Smokefree Service to resume the voucher incentive scheme, resulting in a significant increase in vouchers issued. The monitor strengthened practitioner engagement with their service users through regular CO readings being received by WhatsApp to monitor individual progress and offer immediate person-centred responses when indicated. The practitioners reported that the monitor opened more conversations and improved service user relationships and quit outcomes through expanded supported self-care without the need for seeing them face to face at every appointment. This will benefit the Service in the future with a new pathway that significantly reduces the amount of face-to-face contact with each service users.

Considering its reported value as a self-care enabling tool, the participants and practitioners recommended that the iCOquit monitor should be issued early on in a quit attempt. This recommendation has already been put into practice by pregnant persons now being issued and shown how to use the monitor at their 4-weeks face-to-face appointment. The requirement for technological advancement of the iCOquit App and connectivity of the monitor for improved remote reporting of CO readings are being addressed by the industry supplier for testing by the Service. As part of an embedded continuous improvement cycle, the Mums2Be Service is sustaining

participatory monitoring and evaluation of service user and Stop Smoking Practitioner experiences of the iCOquit monitors.

Despite some limitations, such as the small evaluation sample size and not being able to establish the reasons for the total population not completing the anonymous on-line survey, the findings from the evaluation research yielded several learnings and recommendations for strengthening the implementation of the iCOquit monitor. These findings could be of value to policies and practices in other settings towards enabling services users and Stop Smoking Practitioners to support and strengthen self-care skills to quit and remain quit.

"The combination of the ICOquit and an advisor (Stop Smoking Practitioner)

is what it helped me to quit"

(Service user, 2022)

Acknowledgements

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