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MISSION ABC: transforming respiratory care through one-stop multidisciplinary clinics – an observational study

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ABSTRACT

Objectives The Modern Innovative Solutions to Improve Outcomes in Asthma, Breathlessness and Chronic Obstructive Pulmonary Disease (COPD) (MABC) service aimed to enhance disease management for chronic respiratory conditions through specialist multidisciplinary clinics, predominantly in the community. This study assesses the outcomes of these clinics.

Design This study used a prospective, longitudinal, participatory action research approach.

Setting The study was conducted in primary care practices across Hampshire, UK.

Participants Adults aged 16 years and above with poorly controlled asthma or COPD, as well as those with undifferentiated breathlessness not under specialist care, were included.

Interventions Participants received care through the multidisciplinary, specialist-led MABC clinics.

Primary and secondary outcome measures Primary outcomes included disease activity, quality of life and healthcare utilisation. Secondary outcomes encompassed clinic attendance, diagnostic changes, patient activation, participant and healthcare professional experiences and cost-effectiveness.

Results A total of 441 participants from 11 general practitioner practices were recruited. Ninety-six per cent of participants would recommend MABC clinics. MABC assessments led to diagnosis changes for 64 (17%) participants with asthma and COPD and treatment adjustments for 252 participants (57%). Exacerbations decreased significantly from 236 to 30 after attending the clinics ($p<0.005$), with a mean reduction of 0.53 exacerbation events per participant. Reductions were also seen in unscheduled and out-of-hours primary care attendance, emergency department visits and hospital admissions (all $p<0.005$). Cost savings from reduced exacerbations and healthcare utilisation offset increased medication costs and clinic expenses.

Conclusions Specialist-supported multidisciplinary teams in MABC clinics improved diagnosis accuracy and adherence to guidelines. High patient satisfaction, disease control improvements and reduced exacerbations resulted in decreased unscheduled healthcare use and cost savings.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study was conducted in a real-world setting across multiple general practitioner practices, which enhances the external validity and generalisability of the findings to actual clinical practice.
⇒ The study followed participants for up to 12 months, allowing for an assessment of the sustained effects of the intervention over a meaningful timeframe.
⇒ The study's enrolment rate was 47% of invited participants, potentially introducing selection bias if those who responded to the invite were more motivated or likely to benefit from the clinics than non-responders.
⇒ The study over-represented older participants with asthma, limiting the generalisability of the findings to younger populations and highlighting the need for future studies to include a more diverse age range.

Trial registration number NCT03096509.

BACKGROUND

Asthma and chronic obstructive pulmonary disease (COPD) are highly prevalent and a significant cause of healthcare utilisation in the UK. They are significant drivers of acute care episodes.[1 2] Many patients, however, remain undiagnosed[3] and one approach for improving this is to identify patients with typical symptoms who may have asthma, COPD or an alternative diagnosis. For example, breathlessness is a common symptom in airways disorders; it affects 10% of the population, rising to a third in the elderly.[4] Even once confirmed, these disorders can remain uncontrolled; both COPD and asthma are associated with increased morbidity, lead to disabling symptoms that impact the patient's quality of life (QOL) and productivity and increases mortality risk. The

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National Review of Asthma Deaths, for example, identified areas for improvements in diagnosis, recognition of severity, access to care and use of personalised action plans to avoid unnecessary deaths.[5]

Integrated care programmes, often based in the community and aimed at improving outcomes in asthma and COPD, have however shown mixed results, with no consistent reductions in acute care episodes, improvements in self-management or cost-effectiveness.[6 7] Despite the variable evidence, the National Health Service (NHS) Long Term Plan is to integrate respiratory services around the patient, breaking down barriers between primary and secondary care.[8] There is, therefore, an urgent need to test new vertically integrated models of care and to assess their real-world impact and health economic benefit. The models are required to be comprehensive and better integrated into routine care to be successful.[9] In asthma and COPD, it would include the recognition of particularly high-risk patients, use multidisciplinary patient assessments with technology to diagnose comorbidities, identify alternative diagnoses, promote patient education and self-management, without the need for multiple frequent visits to specialists, within a cost-effective model.

The Modern Innovative SolutionsS to Improve Outcomes iN (MISSION) airways disease models of care combine these principles[10] and have improved outcomes in COPD,[11] but we now aimed to apply the methodology to patients with asthma, breathlessness and COPD in a large, single integrated project. We not only describe our assessment of the clinical and health economic impact of this approach in a broad range of high-risk patients but also assess whether those with exceptionally high use of unscheduled healthcare resources derived more benefit.

METHODS

Study design

Participatory action research methodology was used for study conduct, data collection and analysis. It aimed to evaluate the impact of the MISSION in Asthma, Breathlessness and COPD (ABC) (MABC) service primarily on disease outcomes. Secondary outcomes included measures of patient activation, productivity, medicines adherence and patient and healthcare professional (HCP) experience. We have described the protocol and study details previously,[12 13] and details of the intervention are publicly accessible (https://missionabc.uk).

Patient and public involvement

This study exemplifies participatory action research, involving patients as equal contributors to the knowledge creation process. Patients were fully engaged in all aspects of the study, including development, design, implementation and interpretation, facilitated by the Patient Research Ambassador initiative by the sponsor. Some patients also contributed to protocol writing.[13]

Patients and procedures

The clinics were arranged in 11 general practitioner (GP) practices in South-East Hampshire. Adults (≥16 years) with asthma, undifferentiated breathlessness and COPD were identified through electronic searches using the PRIMIS search tools (University of Nottingham, UK).[14] The selection criteria described previously[12] included patients with initial diagnoses of asthma and COPD or a 'case-finder' group with breathlessness but no diagnosis. There were no specific exclusion criteria, but the routinely recorded clinical data were reviewed to reconfirm suitability before inviting patients by letter to attend a clinic. All patients who attended an MABC clinic were invited to take part in the study with informed consent.

A team consisting of two secondary care respiratory nurse specialists, one physiotherapist, one respiratory physiologist, one administrator and two to three respiratory doctors, together with one or two HCPs from the primary care practice, delivered the clinics. Each participant underwent assessments that included spirometry (MicroLab 3500, CareFusion, UK), oscillometry (Tremoflo, Thorasys, Canada), measurement of fractional exhaled nitric oxide (NIOX Mino, Circassia, UK), disease control and comorbidity questionnaires (completed either before attending the clinic or on the day) and breathing control and inhaler technique. Each participant moved through a carousel of stations for each assessment. A written personalised self-management (or action) plan with inhaler technique information was given before participants left the clinic. Guideline-based treatment changes were made where necessary.[1 2] These assessments occurred alongside 'business-as-usual' activities at each surgery, that is, usual practice activity was not displaced.

All participants were subsequently discussed by the multidisciplinary team (MDT) and modifications made to the management plan if required. The outputs were either a discharge back to the GP (with an MABC summary and recommendations), referral to another specialty, referral to an MABC investigation clinic or a separate follow-up clinic for further MDT support as needed, for example, breathing retraining, dietician, self-management, smoking cessation and psychologist review. The MABC investigation clinic (delivered monthly) included a carousel assessment of investigations as required including echocardiography, CT scan, nasendoscopy and detailed body plethysmography. Participants were then referred for additional specialist care or discharged back to primary care. Thus, a comprehensive management plan was developed for each patient at the first clinic and modified where necessary at the MABC investigation clinic.[11] Participants considered to be at risk of further exacerbations or had difficulties in self-management were eligible for an e-platform monitoring solution. Monitor (Message Dynamics, Chertsey, UK) and CliniTouch Vie (Spirit Healthcare, Leicester, UK) were offered to these participants to monitor symptoms remotely for up to 3 months (the final choice determined by participant preference). Participants in Monitor received a call trigger every Monday and Thursday, and a specialist nurse triaged return calls. Patients were offered respiratory advice by

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telephone, and any concerns or second triggers were escalated to a duty respiratory consultant. Other health technologies included the myCOPD app (My mHealth, Bournemouth, UK) and the Flo-Tone Trainer (Clement Clarke International, Harlow, UK) to guide the use of inhalers. HCPs from each practice were invited to attend one of the three multidisciplinary education events or the MDT meetings.

Assessments at clinic and follow-up

Participant data were collected at baseline, and lung function tests were performed in line with recognised standards.[15] Participants completed questionnaires either at or before attending the first MABC clinic and at 3 and 6 months by postal return. The patient-reported outcome (PRO) measures initially included WPAI, EuroQol 5 Dimension (EQ-5D) and Short Form Health Survey Questionnaire-36 Item (SF-36) for health-related QOL and productivity, Asthma Control Questionnaire (ACQ) and COPD Assessment Test scores for asthma and COPD control, respectively, Adherence Starts with Knowledge-12 for attitude to medicines adherence and the Patient Activation Measure (PAM) Score for patient activation. A clinic satisfaction survey was given to each participant at the end of the first clinic. The research team collected longitudinal data on healthcare utilisation (eg, prescriptions, admissions, emergency department (ED) visits and unscheduled GP visits) from electronic medical records, collected separately for the 6-month and 12-month periods after attending the clinic. Unscheduled care events were defined as following: exacerbations—requiring a course of oral corticosteroids and/or antibiotics for an acute flare, unscheduled GP attendance—a non-elective visit to the practice during hours, out-of-hours GP attendance—a non-elective visit outside of standard working hours, ED attendance—visit to an ED and hospital admission.

Statistical and health economic analyses

Data were securely managed using Microsoft Access (Microsoft Corporation, Redmond, Washington, USA). Analyses aimed to examine how patient outcomes changed at 6 and 12 months after attending the MABC clinics by comparison with outcomes before attending the clinics. A Student's t-test and Mann-Whitney tests were used depending on distribution of data. A cohort of participants was defined as high service users when they were 2 SD above the mean for preclinic exacerbations and/or unscheduled GP visits and analysed similarly. Data are presented as mean (±SD) or median (IQR) for continuous variables or number (%) for categorical data. The significance threshold was 0.05, and SPSS (SPSS, Chicago, IL) was used for analyses.

Cost-effectiveness analyses from an NHS perspective were also conducted, comparing annual resource use before and after attending the MABC clinics. Standard NHS templates were used to cost for unscheduled and out-of-hours GP visits, hospital and ED visits and medicines costs and to calculate the cost of delivering the MABC service.[16 17] Costs for the e-platforms were agreed individually with each supplier. Results were presented as treatment costs, costs of unscheduled care and the average cost of an MABC clinic.

RESULTS

GP practices and eligible patients

The 11 GP practices were mixed in location (six large rural, five suburban) and deprivation (nine of the practices in the least or second least deprived quartiles by Index of Multiple Deprivation).[18] The average prevalence of COPD and asthma at baseline was 2.1% and 6.6%, respectively, in line with regional averages at that time (2.2% and 6.6%, respectively).[18] In total, 50 MABC clinics were held between September 2016 and July 2017. Electronic searches of 27 853 patient records identified 9505 potentially eligible patients, of which 974 (10%) remained eligible after manual confirmation and were invited to attend a clinic. Responses were received from 520 (53%), 474 (49%) attended consented to the study and 441 (45%) remained eligible for the analysis (figure 1).

Patient and HCP attendance

From 474 eligible patients who agreed to participate in the study, 20 had incomplete consent, 3 withdrew, a clinician withdrew 1, 5 did not attend further and 4 died before the end of the study. Therefore, 441 participants were included in the analyses. Following the first clinic, 199 (45%) patients attended just the MABC follow-up clinic, 91 patients (21%) were referred for further investigation at an investigation or MABC follow-up clinic and 151 (34%) returned to primary care (online supplemental table 1). Results from HCP education events are described in online supplemental table 2.

Confirmation of diagnoses and comorbidities

The primary diagnosis was confirmed in 88% and 79% of participants with COPD and asthma, respectively. The primary diagnosis was however changed in 47 and 17 of participants with asthma and COPD, respectively (table 1). Overall, 13% in the case-finder group were diagnosed with breathing pattern disorder (BPD), as were 3% with asthma. BPD was the primary post-review diagnosis in 16 participants and a concurrent diagnosis in 73 (33%) and 25 (18%) of participants with a post-review diagnosis of asthma and COPD, respectively. Nearly a third (32%) of participants in the case-finder category had alternative diagnoses to an airways disorder or BPD, while 31 (41%) participants were confirmed to have asthma. In total, 60 of the 380 participants (16%) had a fraction of exhaled nitric oxide (FeNO)≥40 ppb indicating eosinophilic airway inflammation.

In total, 44 additional diagnoses and comorbidities were made (online supplemental file 1), with 32 (73%) unrelated to a respiratory condition. Sinonasal disease, gastro-oesophageal reflux disease and bronchiectasis

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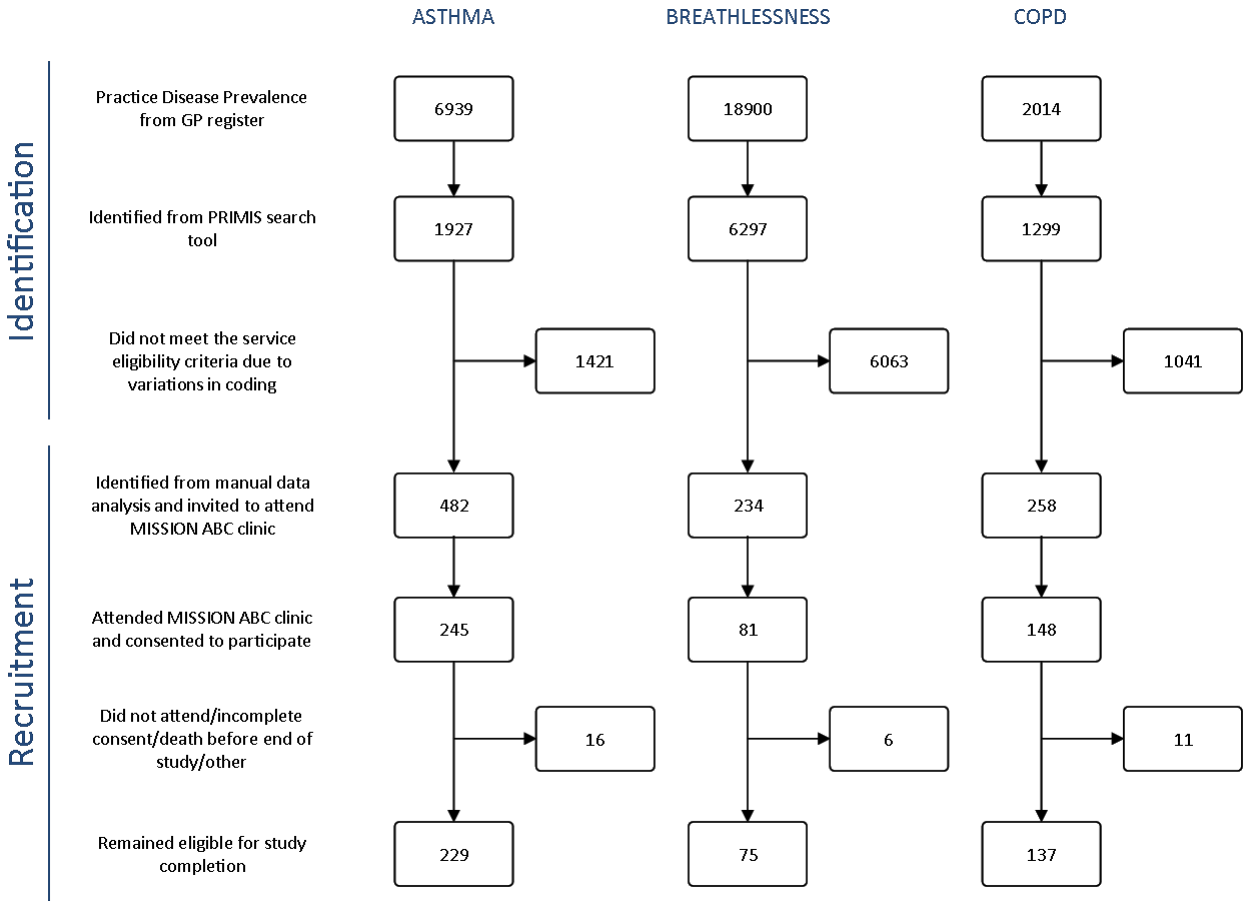

Figure 1 Patient identification, suitability and recruitment into the MABC study. COPD, chronic obstructive pulmonary disease; GP, general practitioner; MABC, Modern Innovative Solutions to Improve Outcomes in Asthma, Breathlessness and COPD.

were common, identified in 127 (29%) participants, including 73 (33%) participants with a post-MABC diagnosis of asthma and 25 (18%) with COPD.

Patient demographics

Post-review diagnosis data of lung function, smoking status and comorbidity are shown in online supplemental table 3, 229 were identified with asthma, 138 with COPD, 23 with asthma COPD overlap, 16 with BPD and 43 with other diagnoses. High service users did not differ significantly from the general cohort (online supplemental table 4).

Remote monitoring

In total, 41 participants (9%; 18 with asthma, 23 with COPD) were monitored remotely for 3 months using Message Dynamics (Message Dynamics, Chertsey, UK). The system triggered 172 events: 79 in asthma (mean 4.38 triggers per participant) and 93 in COPD (4.04 per participant). For 39 events (23%), definitive advice was given that would otherwise have required attendance at the GP practice; 96 triggers (56%) required a supportive discussion of self-management; 34 (20%) did not respond after triggering; 2 had planned reviews on the day of triggering;

Table 1 Changes in diagnoses following MABC clinic review

Preclinic		Post-MABC clinic primary diagnosis, n (%)				
Primary diagnosis	**Number**	**Asthma**	**COPD**	**ACO**	**BPD**	**Other**
Asthma	229	182 (79%)	12 (5%)	14 (6%)	6 (3%)	15 (7%)
Breathlessness	75	31 (41%)	6 (8%)	4 (5%)	10 (13%)	24 (32%)
COPD	137	8 (6%)	120 (88%)	5 (4%)	0	4 (3%)
Total	441	221 (50%)	138 (31%)	23 (5%)	16 (4%)	43 (10%)

Percentages expressed according to preclinic diagnosis as the denominator.
ACO, asthma COPD overlap; BPD, breathing pattern disorder; COPD, chronic obstructive pulmonary disease; MABC, Modern Innovative Solutions to Improve Outcomes in Asthma, Breathlessness and COPD.

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and 1 was an error. Technical difficulties meant the other e-solutions were not taken up by participants.

Patient-reported outcomes (PROs)

An excessive number of questionnaires impeded the flow of clinic, so the EQ-5D and SF-36 health-related QOL questionnaires were dropped after participant feedback. Participants with a post-MABC diagnosis of asthma had an improvement of 0.22 in mean ACQ Score (p=0.027), though the minimal clinically important difference is 0.5 (online supplemental table 5). There was no significant change in other PROs. Overall, 96% of participants reported they would recommend the clinic to family or friends (online supplemental table 6).

Unscheduled use of care

Exacerbations and unscheduled GP attendances were common acute events in this study, but all measures decreased significantly from baseline to month 6 (table 2). Just over half of participants (236; 54%) experienced at least one exacerbation in the 6 months before attending the MABC clinic, decreasing to 30 (7%) in the 6 months following clinic attendance (p<0.005), with a reduction in mean exacerbations of 0.53 per person. The reductions in unscheduled GP attendances and exacerbations were equivalent to one less event in 3 and 6 months, respectively. All unscheduled care events were reduced, ranging from overall 55.3% to 78.6% reductions. Data at 12-month follow-up was available in 200 participants, and a significant reduction in all unscheduled care use was maintained for all participants, though the magnitude of reductions per participant was even larger in asthma and COPD (online supplemental table 7), and were maintained in the high service users (online supplemental table 8).

High service users showed significantly larger reductions in exacerbations and unscheduled GP visits, with the magnitude in reductions generally double the main cohort (table 3).

Treatment costs and health economic analyses

In total, 252 participants (57%) had changes to their inhaled medicines (starting, stopping or switching) at the MABC clinic. Changes were more frequent in asthma (142; 64% of asthma cohort) than COPD (78; 57% of COPD cohort). For 6-month analyses, participants with a post-MABC diagnosis of asthma prescribed a corticosteroid-containing inhaler (either dual inhaled corticosteroid (ICS)–long-acting beta agonist (LABA) or ICS alone) increased from 181 (82%) before attending the clinic to 200 (91%) after attending the clinic. The mean number of prescribed corticosteroid-containing inhalers did not change significantly following the MABC clinic (6.86 (IQR 4–10)) per person before vs 6.64 (IQR 4–10) after). The number of short-acting beta agonist (SABA) inhalers prescribed was however significantly reduced from 7.00 per person (IQR 3–10) before to 5.40 (2–8) after (mean difference 23.5%, p<0.05) in all participants. Similarly,

Table 2 Change in healthcare utilisation in the 6 months before and after attending an MABC clinic

	Total events			Decrease in number of events per participant (p value)					
	Before	After	Decrease	Asthma	COPD	ACO	BPD	Other	Total
Participants*	429	419		218	135	23	14	39	429
Exacerbations	403	180	55.3%	0.50 (p<0.0001)	0.62 (p<0.0001)	0.40 (p=0.095)	0.57 (p=0.006)	0.49 (NS)	0.53 (p<0.0001)
Unscheduled GP attendances	732	268	63.4%	1.21 (p<0.0001)	0.93 (p<0.0001)	0.78 (p=0.053)	1.14 (p=0.006)	1.15 (p=0.005)	1.09 (p<0.0001)
Out-of-hours GP attendance	34	8	76.5%	0.06 (p=0.012)	0.08 (p=0.032)	Nil events	0.07 (NS)	0.01 (NS)	0.06 (p=0.001)
ED attendance	19	6	68.4%	0.03 (p=0.131)	0.08 (p=0.031)	Nil events	0.07 (NS)	0.05 (NS)	0.03 (p=0.042)
Hospital admissions	14	3	78.6%	0.01 (p=0.157)	0.08 (p=0.017)	Nil events	0.07 (NS)	0.05 (NS)	0.03 (p=0.028)

Values are mean decrease in the number of events per person between the two 6-month periods (p values from Student's t-test).
*Number of participants in whom all unscheduled care data was available.
ACO, asthma COPD overlap; BPD, breathing pattern disorder; COPD, chronic obstructive pulmonary disease; ED, emergency department; GP, general practitioner; MABC, Modern Innovative Solutions to Improve Outcomes in Asthma, Breathlessness and COPD.

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Table 3 Change in healthcare utilisation in the 6 months before and after attending an MABC clinic in participants with initial high usage

	Total events			Decrease in number of events per participant (p value)					
	Before	After	Decrease	Asthma	COPD	ACO	BPD	Other	Total
Participants	167	164		79	58	8	3	19	167
Exacerbations	266	109	59.0%	0.86 (p<0.0001)	1.14 (p=0.001)	0.63 (NS)	0.33 (NS)	0.89 (p=0.032)	0.94 (p<0.0001)
Unscheduled GP attendances	532	158	70.3%	2.58 (p<0.0001)	1.97 (p<0.0001)	1.25 (NS)	1.67 (NS)	2.05 (p=0.001)	2.22 (p<0.0001)

Values are mean decrease in the number of events per person between the two 6-month periods (p values from Student's t-test).
*Number of participants in whom all unscheduled care data was available.
ACO, asthma COPD overlap; BPD, breathing pattern disorder; COPD, chronic obstructive pulmonary disease; GP, general practitioner; MABC, Modern Innovative Solutions to Improve Outcomes in Asthma, Breathlessness and COPD.

participants with a post-MABC diagnosis of COPD GOLD group B or above[19] prescribed a LABA inhaler and/or long-acting anti-muscarinic antagonist increased from 104 (75%) to 115 (83%).

The mean cost of delivering the MABC clinics was £139.10 per participant, and substantial reductions in the costs of unscheduled healthcare provision for all participants at 6 and 12 months before and after attending the MABC clinic collectively offset an overall slight increase in treatment costs of medicines (table 4). The service was virtually cost neutral in the first 6 months, although high service users showed a 57% reduction (£638.36 per person) in costs. Furthermore, the MABC service reduced costs by 28% (£228.62 per person) at 12 months in all participants with follow-up data and by 74% (£1805.07 per person) in high service users. By 12 months, the overall costs decreased despite an increase in treatment costs which were again offset by reductions in unscheduled care costs. Incremental cost-effectiveness ratios for one exacerbation or unscheduled GP attendance prevented (events experienced by the majority of participants with asthma and COPD) were by 12 months, less than the cost of an MABC clinic (online supplemental table 9).

DISCUSSION

We met our primary outcome of delivering specialist-led multidisciplinary MABC clinics in a real-world setting, which led to significant reductions in unscheduled care over the subsequent 6 and 12 months compared with the preclinic period. The clinics were rated highly satisfactory by participants with poorly controlled asthma and COPD and a cohort with breathlessness without a formal diagnosis. We successfully tested technologies that helped support diagnosis, for example, FeNO was high in 16% of participants, and avoid unscheduled care in a small cohort of participants (Message Dynamics). The clinics were delivered alongside business-as-usual activity at each practice. Slightly increased prescription costs for guideline-based treatments were offset by the significant reductions in unscheduled healthcare use. Thus, even allowing for the cost of delivery of each clinic, MABC

Table 4 Mean costs of treatment and unscheduled healthcare use in the 6 and 12 months before and after the MISSION ABC service, including all participants and also stratified by high service users

	Pre and post 6 months				Pre and post 12 months			
	All participants (n=441)		High service users		All participants (n=200)		High service users	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Treatment costs	£253.95	£251.13	£253.95	£251.13	£281.37	£334.08	£281.37	£334.08
Exacerbations	£4.43	£1.06	£10.12	£1.95	£3.81	£1.67	£13.63	£6.82
Emergency department attendance	£12.60	£8.40	£76.09	£38.05	£39.95	£4.57	£213.05	£38.05
Unscheduled hospital visits	£72.18	£32.78	£445.27	–	£348.95	£45.46	£1606.13	–
Out-of-hours attendance	£1.42	£0.29	£3.33	£2.00	£0.84	£0.08	£3.72	£2.00
Unscheduled GP attendance	£129.20	£50.54	£338.83	£57.00	£129.20	£50.54	£316.67	£111.47
MISSION clinic cost	–	£139.10	–	£139.10	–	£139.10	–	£139.10
Total	£473.78	£483.31	£1127.58	£489.22	£804.12	£575.50	£2434.57	£629.51

Values are mean cost (£) per participant.
GP, general practitioner; MISSION ABC, Modern Innovative Solutions to Improve Outcomes in Asthma, Breathlessness and COPD.

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clinics were cost-effective at 6 months in high service users and all participants at 12 months with follow-up data. Those with very high baseline use of healthcare saw the most significant clinical and health economic benefits. The magnitude in reductions of unscheduled care events per person compare favourably to more expensive biologic therapies in severe asthma.[20] We now explore reasons for these observed benefits.

An individualised treatment approach including correct diagnosis, identifying comorbidities, optimising inhaled therapies and participant and HCP education to better support self-management[21–23] will have led to the clinical improvements in synergy.[24] While the primary diagnosis was unchanged in 79% and 88% of participants with asthma and COPD, respectively, one-fifth required further tests at the investigation clinic to clarify their diagnosis and comorbidities. For example, an additional 44 diagnoses were made; of which 73% were unrelated to an underlying respiratory disorder and BPD was identified frequently; as a primary diagnosis in 16 (4%), and as a comorbidity in 73 (17%) and 25 (6%) participants with a post-review diagnosis of asthma and COPD respectively. Pharmacological treatment was optimised in five ways: improving inhaler technique at each visit; emphasising the importance of adherence; prescription of guideline-recommended treatment (eg, resulting in increased prescriptions for ICS in patients with asthma); recommending an inhaler device suitable for each participant; and treating comorbidities. These clinical interventions accompanied by participant satisfaction with the clinics and HCPs satisfaction with education will have collectively contributed to the reduction in unscheduled care use and disease control markers, for example, the overall reduction in the prescription of SABA for all patients indicated less requirement for rescue inhalers (a recognised risk factor in asthma deaths[5]) and improved disease control, supported by improved mean ACQ scores.

We reviewed case records of 974 eligible patients in detail from a potential pool of 9505 and reviewed 474 patients (our aim was 500) but were limited by the complexities and challenges in organising clinics across many GP practices during specific time windows. This challenge also limited the number of practices able to provide 12-month follow-up data. It is possible that patients who responded to the invitation were more motivated and more likely to benefit from the clinics than those 500 patients who did not respond. The PAM scores for attending participants were, however, in the middle strata and not dominated by more engaged patients. The large numbers screened and subsequently excluded after detailed interrogation were due to known inaccuracies in practice coding which we have described previously[25]—reasons for exclusion varied from severe dementia, immobility and inability to provide informed consent. Disease prevalence based on online data also overestimated the number of patients likely to be eligible for the clinics, with 482/1927 (25%) for asthma, 234/6297 (4%) for case finding and 258/1299 (20%) for COPD. In addition, we acknowledge other potential limitations that may have led to bias: it was an observational study, there was no control group, the GP practices were heterogeneous, the clinics were multi-interventional and some questionnaires were removed to facilitate clinic flow.

We demonstrated reductions in a range of unscheduled care usage measures in participants in the case-finder group and participants with COPD In contrast, the largest reductions were seen in participants with asthma, including more than halving the number of exacerbations and out-of-hours visits to GPs. Scores for patients' activation, COPD control score and attitude around adherence did not change despite these reductions. There was however a signal for better disease control with significant reductions in use of reliever inhalers and an improvement in the ACQ Score (though it was less than the minimal clinically important difference). However, only about half the participant questionnaires were returned, resulting in missing data—a recognised issue in real-life studies, including those investigating respiratory interventions.[26 27] We reduced bias in our primary unscheduled care outcomes by using directly extracted data from GP practice records, with 200 participants still contributing data at 12 months. The introduction of the General Data Protection Regulations during follow-up also limited time-critical data from some practices. While this study achieved a high enrolment rate (47% of invited participants), older participants with asthma were over-represented – mean age 59 years, whereas nationally prevalence is highest at 16–30 years.[28] The COPD cohort was of the same mean age as the population (71 years).[29] Therefore, we cannot be sure the same results would be achieved in younger asthmatics; future studies should ensure the inclusion of younger patients.

The service was essentially cost neutral across all participants at 6 months; it was significantly cost-saving in high service users by 57% at 6 months and 74% at 12 months and by 28% for all participants at 12 months in whom data was available. We still demonstrated a cost benefit at 1 year, particularly in high-frequency users, despite data collection being restricted to 200 (of the original 441) participants. Missing data would expect to bias towards the null and so our findings remain meaningful. We restricted calculations of ICERS for events avoided to frequently occurring unscheduled care episodes, as the ICERS for a relatively uncommon preclinic occurrence, such as hospital admission, would have been non-generalisable. The ICERS for the frequent unscheduled care events avoided (exacerbations, GP attendances) were favourable, and by 12 months were less than the cost of the clinic. A future iteration of the clinic focusing on high service users could further increase MABC cost-effectiveness. The logistics of setting up MABC clinics to realise the benefits and cost-effectiveness is possible in most healthcare settings; they require good planning and project management to set up an MDT, organise the venue and equipment, patient identification, handling data and adequate funding and resource.

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In conclusion, this study is the first to show that a unique, vertically integrated and comprehensive 'carousel' care model improves outcomes in a range of poorly controlled respiratory patients, enhances HCP education and is satisfactory to patients. Substantial cost-savings in unscheduled care offset the cost of introducing the service, and the benefits are realised up to a year. The study involved many GP practices, and its low resource investment and implementation indicate the model could be extended to other local systems and other types of long-term conditions.

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