Health Economics Unit

NHS Midlands and Lancashire Commissioning Support Unit

Smarter Spending in Population Health

Using economic principles to set priorities for COPD resource allocation in Coventry Place

Health Economics Unit | Midlands Decision Support Network | The Strategy Unit

Contents

Introduction

This report summarises the outputs of the socio-technical allocation of resources (STAR) project undertaken by Coventry Place's long-term conditions respiratory programme and facilitated by the Health Economics Unit (HEU). The objective of this project was to support Coventry Place to set the priorities for the chronic obstructive pulmonary disease (COPD) pathway, focusing on the wider determinants of health.

The specific aims of this project were to:

1. Develop a common understanding of the COPD population, the COPD pathway (i.e., the interventions and programmes offered to prevent and treat COPD) and key challenges for COPD prevention and treatment in Coventry
2. Assess the relative value for money of the different interventions in the COPD pathway in Coventry
3. Create a priority list of pathway improvements (i.e., interventions or programmes) that can be implemented in Coventry Place.

This work builds on the work Coventry Place has undertaken with the creation of *The Integrated Chronic Obstructive Pulmonary Disease (COPD) Model for Coventry Place: Case for Change* (see the **appendices** for the full document). This document sets out the vision for COPD care in Coventry:

'Improved health and wellbeing for people in Coventry living with or at risk of developing chronic obstructive pulmonary disease.'

This report is designed for Coventry Place's respiratory programme to support its planning for the COPD pathway. It can be used to determine which pathway improvements should be taken forward given the available resources.

Recommendations

As a result of this project, it is recommended that the respiratory programme prioritises the following pathway improvements:

- Expansion of the virtual ward.
- Joint clinics in primary care with the current establishment of Respiratory Nurse Specialists.
- Targeting spirometry testing and improving diagnosis
- An education package for people with COPD.
- Education in schools against smoking and vaping.

The estimated savings from the virtual ward, £553,523.40 per year, could save enough to cover most of the additional cost of these improvements if the resource could be freed up.

These recommendations are explained in more depth in the **determining the next steps: setting priorities** section.

Socio-technical allocation of resources

STAR builds upon the principles of ‘cost-effectiveness analysis’ and ‘programme budgeting and marginal analysis’, combining a technical value-for-money analysis with extensive stakeholder engagement (Airoldi et al., 2014; The Health Foundation, n.d.).

The steps described in this report and the methods document in the appendices can be followed by those interested in applying STAR to other pathways.

By applying STAR, commissioners can:

- Engage all relevant stakeholders in the decision-making process for prioritising resources in a transparent and systematic way
- Identify the current pathways for preventing, diagnosing and treating people with COPD
- Identify and prioritise pathway improvements, drawing upon principles of allocative efficiency.

Smarter Spending in Population Health

This project forms a part of the HEU's 'Smarter Spending in Population Health' programme, which aims to support ICSs and Places to allocate resources more efficiently through scalable and systematic approaches to resource allocation, focusing on the wider determinants of health.

This programme has been supported by the **Midlands Decision Support Network (MDSN)** which has acted as an 'innovation incubator' and provided a significant proportion of the funding for the programme in 2022/23**.**

More resources on the Smarter Spending in Population Health programme and STAR can be found on the HEU's website **here**.

Running STAR in Coventry

The STAR process revolves around two decision conferences. These are workshops aimed at helping stakeholders arrive at a consensus on how to tackle a particular problem (Phillips, 2007). The first decision conference in Coventry focused on building a common understanding of the population for those at risk of developing COPD or already living with COPD, and understanding the relative value of all the COPD pathway components; that is, all the interventions currently offered in Coventry that are aimed at treating people with COPD. Summaries can be found in the **population** and **pathway** sections, respectively.

The second decision conference focused on highlighting the **main challenges** in the pathway and proposing ways in which it can be improved. This process was informed by a visual model of the value-for-money assessment of each suggested improvement in the pathway. The visual model is called an 'efficiency frontier'. The efficiency frontier can be found in the **value of the COPD pathway in Coventry** section.

Full information on the process that was followed in Coventry can be found in the **methods document** in the appendices.

Following the decision conferences, the HEU used evidence from published studies and data sources to visualise and summarise the effect that each of the prioritised pathway improvements could have on the COPD pathway. This information is summarised in the **improving the pathway** section.

Recommendations on which pathway improvements are likely to generate the most population health gain for the given cost and should be taken forward are also made in the **setting priorities** section.

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Attendees to the decision conferences

The STAR process relies on gathering insights from a broad range of stakeholders to provide their expert opinion on the local population and care provision. Their insight is used to create the efficiency frontier for the COPD pathway and to generate meaningful ways in which it can be improved.

The people who attended the decision conferences are outlined below:

Coventry and Rugby GP Alliance Ltd

Maisun Elftise, Coventry GP

Coventry and Warwickshire Partnership NHS Trust

Ankur Singh, Place Based Team Lead
Nikki Wise, Lead Nurse for Community Health and Wellbeing

Coventry City Council

Si Chun Lam, Population Health Management Analyst (Social Care)

Patient representatives

Colleen Badman
Marion Miller
Pam Arrowsmith
Vickie McKenzie

University Hospitals Coventry and Warwickshire NHS Trust

Charandeep Dehele, Respiratory Nurse Specialist Manager
Daniel Gilks, Associate Director of Finance
Dr Beatriz Lara, Respiratory Consultant
Emily Garratley, Operational Performance & Analytics Manager
Fay Raddan, RIPPLE Lead
Jodie Storrow, Lead for Community (COPD Nurse) & Respiratory Specialist Nurses
Lesley Terry, Head of Integration
Nicola Branch, COPD Clinical Nurse Specialist
Rachel Chapman, Consultant in Public Health
Sharon Crofts, Chaplain Team Leader and Bereavement Officer
Stuart Ennis, Clinical Exercise Physiologist
Valerie De Souza, Consultant in Public Health

The COPD population, pathway and main challenges

Population

By presenting the population figures in the first part of the decision conferences, we ensured that the attendees all had a common understanding of the population for whom they are making decisions and the levels at which they can intervene. For example, smoking cessation interventions might be targeted at those at risk of COPD, or the potential undiagnosed population with COPD might be the target of a case-finding intervention.

Figure 1 shows the QOF estimate of the total population of Coventry to be 417,871 people (Office for Health Improvement & Disparities, 2022).

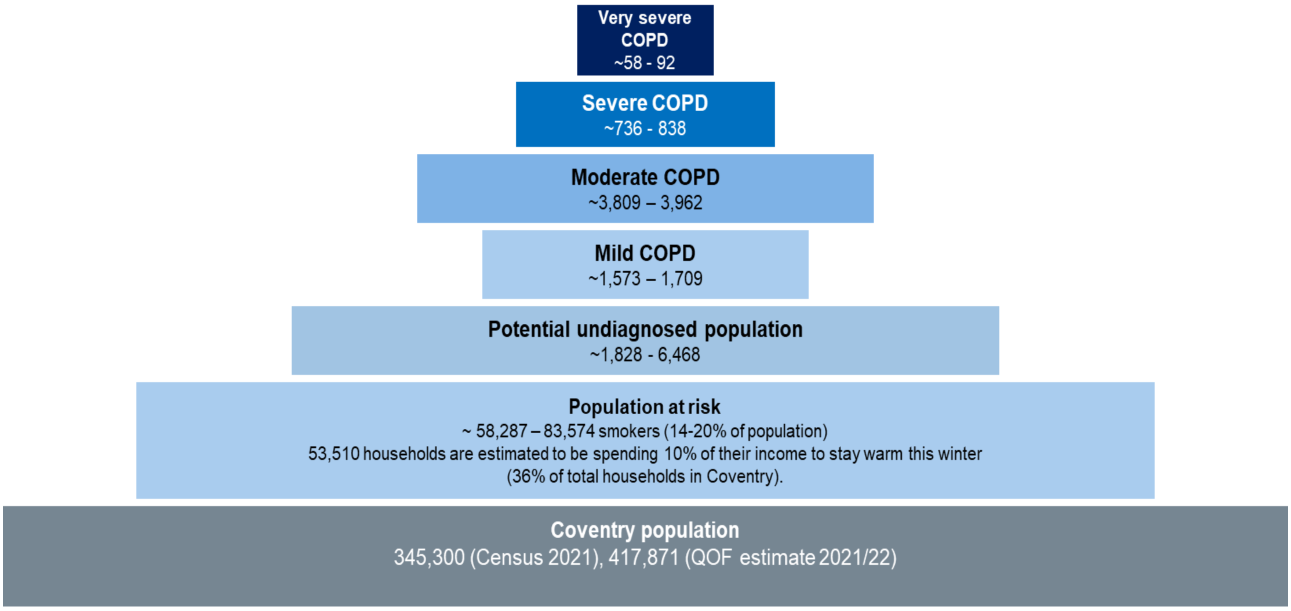

Figure 1 – Population pyramid in Coventry (sources are described in the appendices)

In terms of those at risk of COPD, the percentage of smokers is between 14 and 20% according to QOF estimates, equating to around 58,287–83,574 smokers (Office for Health Improvement & Disparities, 2022). There are potentially 6,468 people living with undiagnosed COPD in Coventry and 6,600 people with diagnosed COPD (Nacul et al., 2007; Office for Health Improvement & Disparities, 2022).

The COPD pathway

Next, participants were asked to assess the relative value of all the interventions and programmes (pathway improvements) in the COPD pathway. The interventions in the COPD pathway are outlined in Figure 2. This figure was presented to participants to ensure there was a common understanding of all the interventions available.

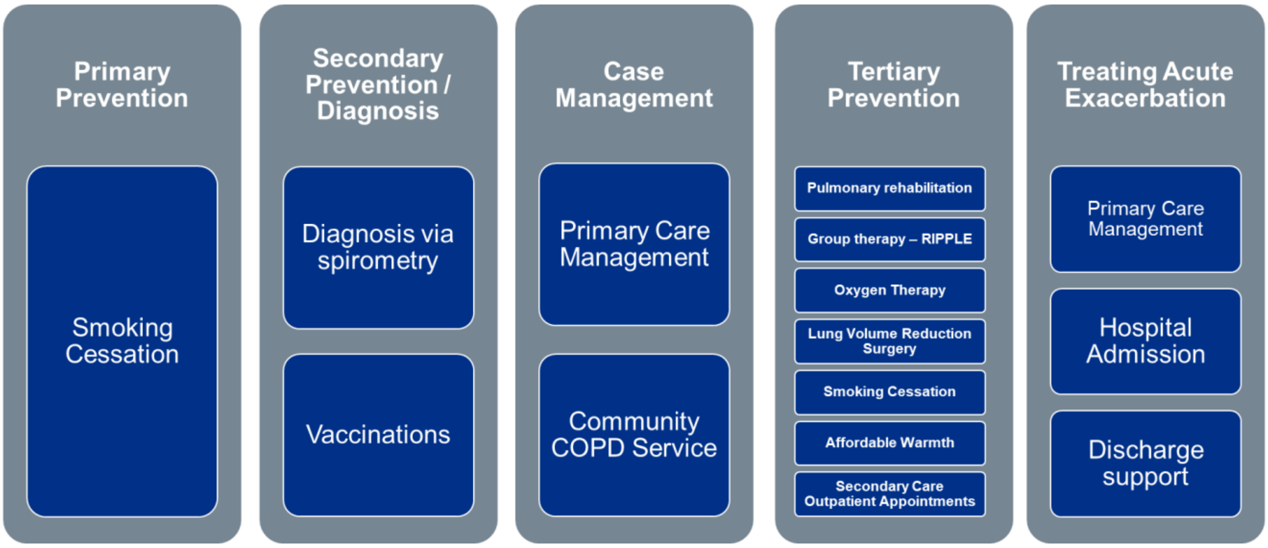

Figure 2 – The current care pathway for those living with and at risk of developing COPD

Valuing the current care pathway

Attendees were then asked to assess the relative benefit (value), in terms of length and quality of life, for all interventions and programmes in the pathway. This process is described in the **methods document** in the appendices. This assessment produced a 'benefit score', which is a key piece of evidence used to populate the efficiency frontier (see the **interpreting the efficiency frontier** section below). This process also helps attendees to think about comparing different interventions with each other and to consider the trade-offs between them; for example, some interventions may give people more health in the long term compared with others that have more immediate benefit. The discussions generated by this valuation process can be very beneficial in determining the key challenges, identifying the appropriate interventions to improve the pathway, and helping to build the efficiency frontiers (visual models of the interventions in the COPD pathway).

Participants rated the interventions in the pathway by plotting Post-it notes representing the interventions and programmes in the current care pathway on a visual analogue scale (VAS), a tool widely used in health economics (Parkin & Devlin, 2006). The scale and the scores assigned to each intervention are displayed in Figure 3 below. Attendees were given an information pack (which can be found in the **appendices**) which included information from published academic studies looking at the quality-of-life gain (in terms of quality-adjusted life years[1]) to inform the scoring process.

Smoking cessation as primary prevention (i.e., to stop people developing COPD in the first place) was given a score of 100 as the intervention deemed to give the most benefit in terms of health gain. A score of 0 indicates an intervention that gives no additional health gain compared with current care.

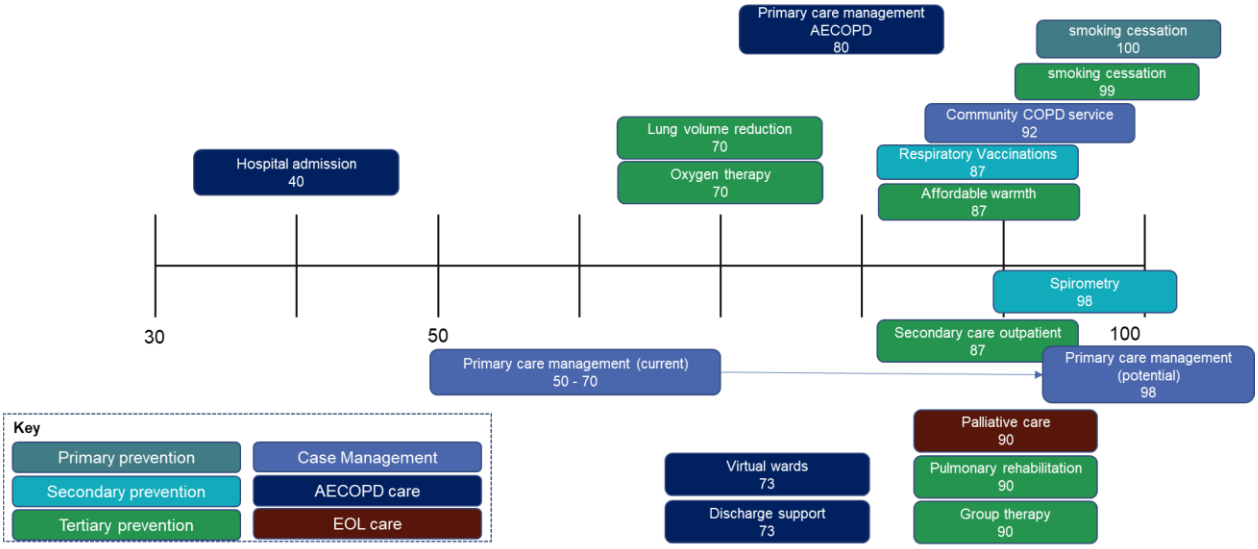

Figure 3 – Benefit scores of each of the interventions in the COPD pathway

[1] The quality-adjusted life year (QALY) is a summary outcome measure used to quantify the effectiveness of a particular intervention. QALYs combine the impact of gains in quality of life and in quantity of life (i.e., life expectancy) associated with an intervention (Drummond et al., 2015).

The value of the COPD pathway in Coventry

The benefit score derived from the VAS ratings was then combined with information on activity, costs and sources from the literature to build the efficiency frontier. This is a visual representation of the value for money of the COPD pathway in Coventry.

The methods and the data points are presented in the **methodology document** in the appendices.

Interpreting the efficiency frontier

The efficiency frontier is produced by triangles representing value for money for each intervention in the pathway. This allows us to visually compare the impact of different interventions and programmes across the whole pathway (e.g., spirometry and pulmonary rehabilitation). The y-axis shows the expected population health benefit for an intervention (the product of the number who benefit and the benefit score) compared with current care. The x-axis displays the estimated annual cost for an intervention.

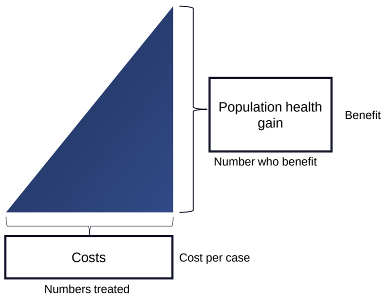

Figure 4 – Populating the efficiency frontier

STAR’s visual models are what makes it applied common sense. In the triangles below, we can see at a glance that the triangle on the right represents an intervention that is much more cost-effective than the intervention represented by the triangle on the left: as we increase spending, the benefits increase quickly for the triangle on the right but only slowly for the triangle on the left.

Figure 5 – Triangles showing low value for money (left) and high value for money (right)

The triangles are then ordered in a sequence according to their cost-effectiveness to display the ‘efficiency frontier’. This shows either where there are opportunities to spend the existing money in a different way to provide more value for money, or where additional investment will be best targeted. The purpose of the efficiency frontier is to help stakeholders think about how the care pathway for COPD ought to be developed. The aim is to move the curve to the left and upwards (as in the left-hand example in Figure 6), thus reducing costs and improving the population health benefit of the pathway (compared with the example on the right in Figure 6).

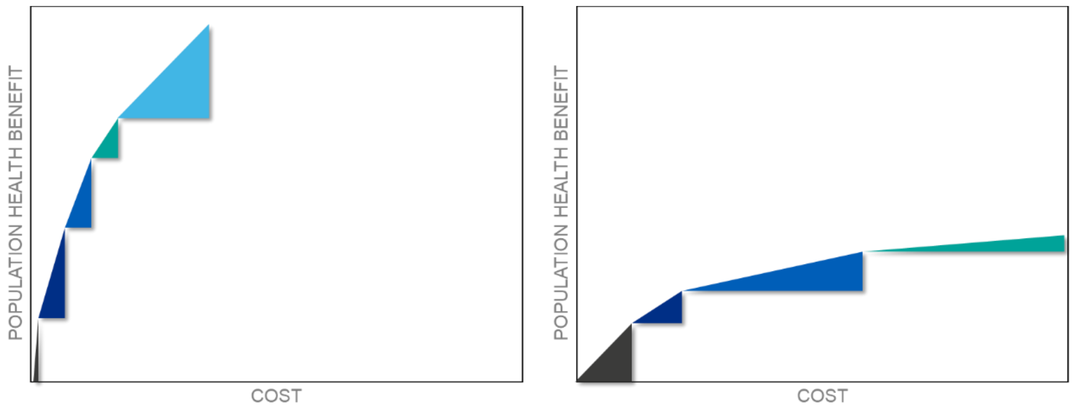

Figure 6 – Different efficiency frontiers with good (left) and bad (right) value for money

The efficiency frontier in Coventry

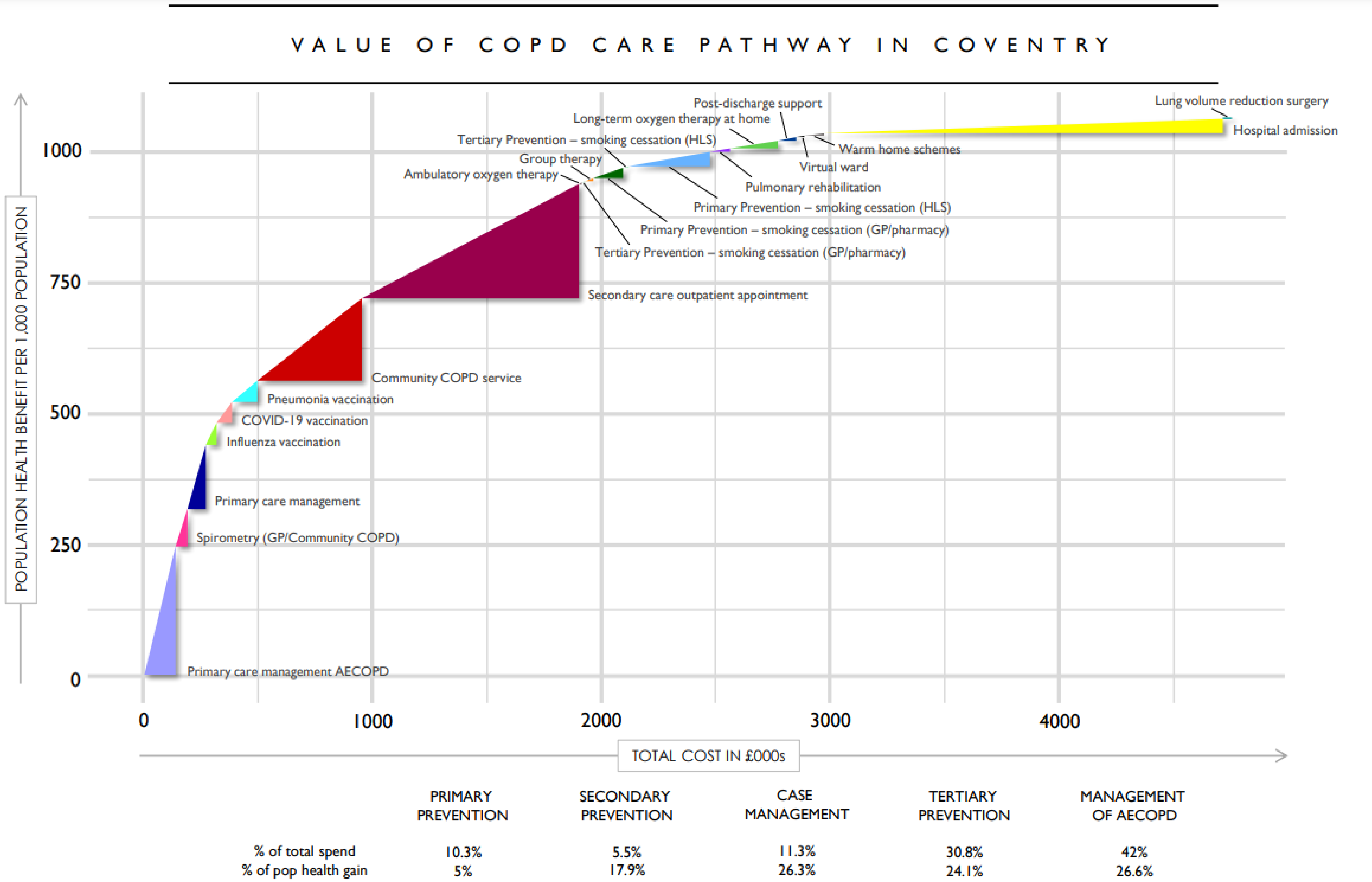

Figure 7 – The efficiency frontier for the COPD pathway in Coventry

Main challenges

By reflecting on the output from Figure 7 (efficiency frontier and value-for-money triangles along the COPD pathway) and considering the challenges identified by the stakeholders involved in the decision conference, we were able to select four main challenges as areas of focus:

- Improving primary care management
- Addressing difficulties in spirometry testing caused by the COVID-19 pandemic
- Stopping more people from smoking as primary prevention
- Helping people to realise the long-term benefits of lifestyle interventions and self-management.

Improving primary care management

The group highlighted that primary care should cover the whole of the population, although this is limited by capacity. Primary care teams therefore have a unique opportunity to optimise patient care all the way through a patient's disease journey; for example, through the provision of self-management plans or education on inhaler technique. Primary care is also the gateway to access almost all the other interventions in the pathway. Effective primary care management could have massive system- and population-level benefits, including reducing hospital admissions and resource use elsewhere in the system.

Addressing difficulties in spirometry testing caused by the COVID-19 pandemic

Spirometry testing is key to accessing many other services, such as pulmonary rehabilitation, where a referral requires a spirometry-confirmed diagnosis. Although spirometry offers good value for money, the number of people currently receiving spirometry testing remains low compared with pre-pandemic levels. During the COVID-19 pandemic, spirometry testing was stopped in primary care. The community COPD team started to deliver spirometry to make up for the gap, but they have now stopped this. However, primary care is struggling to restart the testing, as many testers have lost their accreditation and there is no money (or capacity) for them to undergo the relevant training again. At the time of writing, there are 720 people on the spirometry waiting list in Coventry.

Stopping more people from smoking as primary prevention

Although smoking cessation was given the highest relative value due to the long-term effects of quitting smoking – whether before or after someone develops COPD – the number of people who quit makes this intervention relatively expensive per quitter. This is especially true in GP- and pharmacy-led services, where the quit rate is 29% (see calculations in the appendices). The earlier in life an individual quits, the better, but ideally, we would aim to prevent smoking.

Helping people to realise the long-term benefits of lifestyle interventions and self-management

Whereas interventions like respiratory vaccinations have relatively short-term benefits (often only lasting a year), giving people the tools to self-manage their condition and help them to lead a healthy lifestyle is a more sustainable approach.

Improving the pathway

Addressing the main challenges

After discussing the main challenges, attendees were asked to identify pathway improvements that could address these challenges.

The pathway improvements that the attendees decided should be included in the STAR modelling exercise were:

- Joint clinics in primary care with respiratory nurse specialists
- Targeting spirometry testing and improving uptake
- Carer support
- Innovation in smoking cessation services
- Education package for people with COPD
- Targeted awareness campaign
- Education in schools against smoking and vaping
- Expansion of the virtual ward.

Pathway improvement: a definition

Here we have used the phrase ‘pathway improvement’ to mean the programmes and initiatives that were proposed in the decision conferences by the attendees as ways of improving the COPD pathway.

This could be a single intervention; for example, a pathway improvement looking to expand pulmonary rehabilitation would consist of only pulmonary rehabilitation. However, other pathway improvements may consist of multiple interventions; for example, the pathway improvement ‘improving signposting to services’ would consist of the signposting intervention itself as well as the expected increase in uptake of the services being signposted.

Joint clinics in primary care with respiratory nurse specialists

Current provision of care in primary care for people with COPD is variable. Helping general practice staff to develop specialist skills in COPD management could help to reduce this variability. Allowing the respiratory nurse specialists (RNSs) employed by University Hospitals Coventry and Warwickshire NHS Foundation Trust (UHCW) to hold joint clinics in general practices for patients' yearly reviews could help to do this as it would be an opportunity for the RNSs to share their specialist knowledge with practice staff. RNSs could also help to increase the capacity for primary care case management.

Targeting spirometry testing and improving uptake

In November 2022, there were 720 people on the waiting list for spirometry across the Coventry area. A theme of the discussions in the decision conferences was that there are several communities that do not engage with respiratory services. Therefore, one recommendation put forward during the decision conferences was to improve the accessibility of spirometry testing and target testing towards at-risk populations. Expanded spirometry testing capacity will lead to more tests being done, shorter waiting times for testing, and more people being diagnosed and treated.

Carer support

RIPPLE, a voluntary community support group, helps people with COPD to provide peer support to each other as well as giving them an opportunity to socialise. However, non-professional or informal carers play a large role in the care of people with COPD (Peña-Longobardo et al., 2015). There is currently no support for carers of people with COPD in Coventry. It was suggested that support for carers could be given alongside the peer support that is offered by RIPPLE.

Innovation in smoking cessation services

The more smokers who quit, the fewer people will develop COPD in the future. People with COPD who have quit smoking should experience fewer exacerbations and have improved symptoms. It was agreed that more can be done to stop people smoking across the board, either by increasing capacity in smoking cessation services (meaning more people can engage with smoking cessation services) or by changing the way in which smoking cessation services are delivered (meaning more of the people who currently engage with smoking cessation services will quit).

Education package for people with COPD

There is no significant education programme to help people with COPD manage their own condition in Coventry. This contrasts with diabetes care, where people can attend the DESMOND course (Gillett et al., 2010). A programme similar to DESMOND for diabetes, called SPACE for COPD, has been developed by the University of Leicester (University Hospitals Leicester NHS Trust, 2023). This self-management programme covers topics like information about medication, breathing control, exercise and nutritional advice.

Targeted awareness campaign

Despite its high prevalence, COPD is less well known compared with more common respiratory conditions such as lung cancer and asthma. This means people who may be experiencing symptoms of COPD may not recognise their symptoms and are therefore less likely to present to healthcare services. Similarly, people who do have COPD may not be aware of all the different services and treatments available to them. This is especially true of people who may not be interacting regularly with the healthcare system.

An awareness campaign could be targeted at communities where the expected prevalence of COPD is higher than the recorded prevalence. This could make people living in these areas more aware of the symptoms of COPD and the services available for new and existing patients.

Education in schools against smoking and vaping

More could be done to stop young people from smoking and vaping in the first place. NICE recommends school-based interventions as one way of achieving this though whole-school smoke-free policies and adult- and peer-led interventions (NICE, 2021). One such programme is the INTENT smoking prevention programme, which is aimed at adolescents who have never smoked prior to its delivery (University of Leeds, 2020). Introduction of the INTENT programme could lead to fewer young people taking up smoking.

Expansion of the virtual ward

The virtual ward is a time-limited service that allows a patient, through remote monitoring, to receive hospital-level care from the comfort of their own home.

UHCW is currently piloting a virtual ward for COPD patients following a hospitalisation for an acute exacerbation (Coventry and Warwickshire CCG, 2022). An expansion of this service could lead to system savings as people with an acute exacerbation of COPD would spend less time in hospital following an acute exacerbation.

Assessing the impact of the proposed pathway improvements

During this phase of the programme, the HEU outlined the expected change that could occur over a period of one year because of each pathway improvement and produced, where possible, a visualisation of the impact each one could have on the efficiency frontier, alongside summary statistics. Different scenarios have been included where there are multiple possibilities for implementing the pathway improvement, or where there is uncertainty around how the improvement could be implemented. The equations in this section have been developed using the guidance published by The Health Foundation and through consultation with subject matter experts (The Health Foundation, n.d.).

This piece of work can be used to demonstrate the potential impact of each improvement and to help the respiratory programme to determine which ones it should focus on.

To support this phase, information was taken from the literature review that was conducted as part of the programme (see the box below).

Understanding the impact of interventions on the COPD pathway

While there is a strong body of evidence in relation to clinical intervention options for COPD, via the **NG115 guidance**, evidence on interventions impacting wider determinants of health, such as behavioural, environmental and socio-economic interventions, is more limited.

Therefore, as part of the Smarter Spending in Population Health programme, an umbrella review (exploring previously published systematic literature reviews and network meta-analyses) was conducted to understand the impact of both the clinical interventions and those impacting the wider determinants of health on quality of life and healthcare resource use. A total of 64 publications were selected for the review. We examined the interventions found and identified their benefits in terms of the outcome reported.

In this phase of the programme, the information from this review has been used to estimate the numbers needed to treat (NNT) – that is, the number of people who need to receive an intervention in order for one good outcome to occur. For example, an NNT of 5 for hospital admissions means that five people need to be treated to avoid one hospital admission. This is explained further in the **developing the visualisations** section below.

The results of the umbrella review will be published separately.

Developing the visualisations

The source or estimation of each metric that was used in developing the visualisations of the impact each pathway improvement could have is explained in further detail in the table below. The exact numbers used for each metric can be found in the **data sources and calculations** section in the appendices.

Metric	Methods
Additional population health benefit due to pathway improvement **(PHB)**	This can be represented as: $$PHB_{j+k+i} = N_j \times B_j + N_i \times B_i + N_k \times B_k \;\ldots$$ Where j, I and k represent each intervention in the pathway improvement. Where N_j is the number of individuals who would benefit from the intervention j each year and B_j is the potential benefit in quality (and length) of life, assuming successful implementation, to the typical beneficiary (i.e., QALY gains), compared with current care. The benefit from intervention j consists of direct health benefit in terms of length and quality of life from the intervention itself as defined by participants in the decision conferences. In some cases, the pathway improvement may lead to a decrease in activity in another pathway component. In this case, the lost population health gain that would have been generated by this pathway component has been included in the calculation: $$PHB = N_j \times B_j - N_{l_i} \times B_i \;\ldots$$ Where N_l is the number of people who would now not be treated due to implementation of the pathway improvement.
Additional costs of pathway improvement **(N_tC)**	Where j, I and k represent each intervention in the pathway improvement. This can be represented as: $$N_tC = N_{t_j} \times C_j + N_{t_i} \times C_i + N_{t_k} \times C_k \;\ldots.$$

	Where N_{tj} is equal to the number of individuals who are expected to be treated by the intervention j within a given year and C_j is equal to the expected average cost of the intervention for treating one individual. It is assumed that costs apply to each person treated and that there is a linear relationship between costs and numbers treated.
Expected impact on healthcare resource use **(R)**	The expected impacts on healthcare resource use elsewhere in the COPD pathway (defined as 'pathway components' and including hospital admissions, GP appointments or acute exacerbations) for each pathway improvement have been calculated using numbers needed to treat (NNT) sourced from the literature review. When information was not available in the literature, it was assumed that the improvement would not have an impact on other pathway elements. NNT is an epidemiological measure of the number of patients it is necessary to treat to avoid one additional bad outcome. For example, having an NNT of five for a hospital admission would mean five people need to be treated to avoid one hospital admission. NNTs can be estimated from odds ratios, rate ratios and mean differences (Centre for Evidence-Based Medicine, n.d.; da Costa et al., 2012). Expected changes to the pathway have only been included if the literature review identified a paper outlining a statistically significant ($p < 0.05$) effect that can be used to estimate an NNT. We have modelled the latest timeframe in which the interventions are expected to have statistically significant effects on the rest of the pathway.

	Number who benefit ($N_{j,l,k...}$) from each intervention in the pathway improvement has then been divided by the relevant NNT: $$R_y = \frac{N_j}{NNT_y}$$ where Y is equal to the pathway component affected by the improvement (usually hospital admissions). Due to the different timescales that primary prevention will have on the COPD pathway (through reducing the number of people developing COPD) compared with other interventions, its effects on the rest of the pathway have not been included in the visualisations below.
Cost savings **(RC_v)**	The cost savings expected for each pathway improvement have been calculated by multiplying the expected impact on healthcare resource use by the estimated costs of each component, as defined in the **data sources for the efficiency frontier** section in the appendices. $$RC_{y+x+z} = R_y \times C_{vy} + R_x \times C_{vx} + R_z \times C_{vz....}$$ Where y, x and z represent the components impacted by the improvement, and C_v represents the cost of the pathway component in question. For example, the expected cost of a hospital admission is £2,222.25; if an intervention was expected to lead to 10 fewer hospital admissions, the cost saving would be £22,222.50.

Summarising the results

In each section below, summary statistics have been provided as additional pieces of evidence to support Coventry Place's respiratory programme in prioritising the pathway improvements and in influencing stakeholders and decision-makers to implement them.

The methods for calculating these summary statistics are provided in the table below.

Statistic	Definition
Total additional pathway cost	This is equal to the additional cost of the pathway improvement to the NHS minus the cost savings. It can be written as: $$N_t C - RC_v$$ This method can determine whether the improvement is likely to save money overall or incur additional costs. Negative numbers represent cost savings. **Primary prevention** For pathway improvements that will reduce the number of people expected to get COPD in the future, the cost saved has been estimated by multiplying the expected number of avoided cases of COPD by the expected cost of treating one person with COPD for a year. NNTs have been used to calculate the expected reduction in the number of people developing COPD in the future using the same methodology as outlined above. This has then been multiplied by the expected cost per person per year. This has been calculated as the probability that a person with COPD would receive each intervention in the current COPD pathway, multiplied by the estimated cost per person of each intervention. This is equal to £744.57.

	This figure has been subject to a sensitivity (scenario) analysis which is explained in the **discussion** section below.
Additional cost / additional population health ratio	This can be written as: $$\frac{N_t C - RC_v}{PHB}$$ This metric will help us understand the costs for each additional unit of population health gain. The lower the ratio, the better, with a negative ratio representing improvements which are both cost-saving and health-generating. A ratio of 1 would mean that one additional unit of population health benefit is generated for each unit of population health gain.
Cost ratio	This metric is calculated by dividing the cost saving by the additional cost of the pathway improvement. It can be written as: $$\frac{RC_v}{N_t C}$$ A ratio of 1 means that the improvement is cost-neutral (i.e., £1 saved for every £1 spent elsewhere in the pathway). A ratio of 1.1 means £1.10 is saved elsewhere in the pathway for every £1 spent on the improvement. Numbers below 1 represent interventions that are cost-incurring. This metric will help us understand the potential returns each improvement will likely give back to the system.
Timeframe	The timeframe in which the expected changes are due to be realised will differ depending on the particular pathway improvement. It is important to understand when these benefits are likely to be realised for financial and operational planning.

	Estimates of when the benefits are likely to be realised come from the literature. For example, if a study reports a reduction in hospital admissions after three years, we would expect the benefits to be realised 'after three years'.

Limitation of the modelling approach

The pathway improvements modelled below have been developed to support decisions on where best to allocate resources by looking at how each pathway improvement could affect the allocation of resources across the entire COPD pathway.

They are not meant to represent an accurate reflection of the costs and benefits of the COPD pathway pre- and post-improvement, nor do they represent a full economic evaluation.

Further work would be required to build these scenarios into business cases or to conduct a full economic evaluation.

Joint clinics in primary care with respiratory nurse specialists

Expected change

The literature review identified two papers looking at integrated care programmes, where community or secondary care providers join up with primary care colleagues to coordinate care together. Although the schemes were different in design from the plan suggested here, both studies suggested they were cost-effective ways of improving quality of life. However, neither paper suggested that there were any statistically significant changes in resource utilisation elsewhere in the pathway due to the improvement (Boland et al., 2015; Sørensen et al., 2017).

Scenarios

Here we model the impact of RNSs holding joint clinics in primary care on primary care case management. It is assumed that the joint clinics would replace primary care yearly reviews.

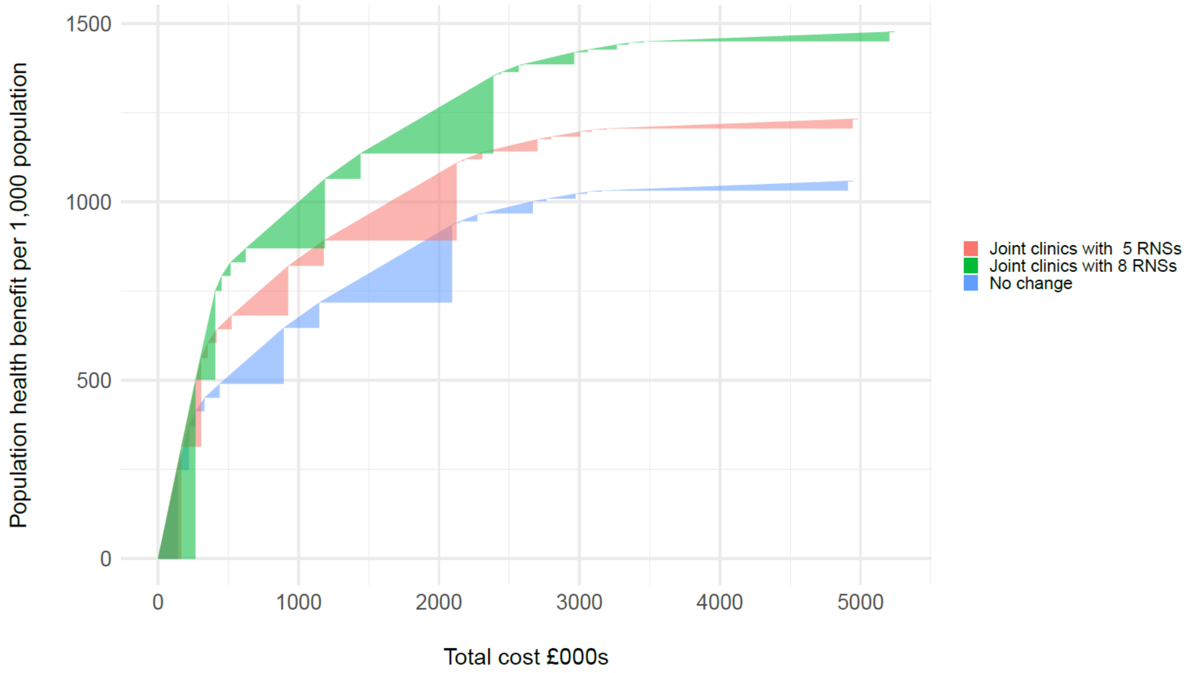

Figure 8 – Expected change in pathway due to introducing RNS joint clinics in primary care

There are two scenarios that could be used to implement this improvement:

1. Holding joint clinics with the current establishment of 5.6 RNSs (there are 5.6 full-time equivalent RNSs, but we assume that 0.6 of the RNS's time is spent on administrative duties and not on seeing patients)
2. Hiring an additional three RNSs so that one can be assigned to each of the eight primary care networks in Coventry Place. This would also mean that the capacity of the community COPD service could be expanded.

Both scenarios greatly increase the population health gain generated by the pathway. This is because they improve the relative health benefit score of primary care case management and, in the case of hiring an additional three RNSs, expand capacity in the community COPD service. However, both scenarios have cost implications. The additional cost of hiring the additional RNSs may make that scenario prohibitive.

The tables below summarise the outputs of modelling the two scenarios for registered nurses holding joint clinics.

Joint clinics with the current establishment of 5.6 RNSs

Metric	Total	Interpretation
Total additional pathway costs	£37,714.35	Once this improvement is fully implemented, it is not expected to be cost-saving. This is mainly due to the cost of the additional yearly reviews.
Additional cost / additional population health ratio	0.22	The pathway improvement would cost £0.22 for every additional unit of population health gain generated.
Cost ratio	0.56	The pathway improvement is not cost-saving. It would save £0.56 (due to reduction in community COPD service contacts) for every £1 spent.

Joint clinics with 8.6 RNSs (an additional 3 RNSs)

Metric	Total	Interpretation
Total additional pathway costs	£381,795.58	The pathway improvement has a large cost associated with it. This is due to the additional reviews in primary care and the cost of the additional RNSs.

Additional cost / additional population health ratio	0.85	The pathway improvement would cost £0.85 for every additional unit of population health gain generated.
Cost ratio	-1.05	The pathway improvement is cost-incurring. It would cost £1.05 (due to an increase in community COPD service capacity) for every £1 spent on the joint clinics.

Targeting spirometry testing and improving uptake

Expected change

We assume that the additional tests will lead to an earlier diagnosis while the cost of each test remains the same. Diagnosing someone early has been shown to reduce the rate of hospital admissions and acute exacerbations. After three years, Kostikas et al. (2020) report a hospitalisation rate of 73.52 per 100 person years (PY) in late-diagnosed COPD patients and 50.46 per 100 PY in early-diagnosed COPD patients.[2]

[2] Person years are a measurement of observation time per person and is often used as the denominator in incidence rates when, for varying periods, individuals are at risk of developing a disease, using a health service, or dying. Instead of using the number of people at the start of the observation period as the denominator, one can determine for each person the actual time at risk, from the beginning of the study period until the disease is detected, the person is lost to follow-up (i.e., moves out-of-province or dies), or the end of the study period.

Scenarios

We have modelled four different scenarios for how spirometry testing can be better targeted or how uptake can be improved. Different case-finding tools exist, such as the COPD diagnostic questionnaire (Johnson et al., 2021; Wright et al., 2015). Such tools can be used to target certain groups considered at risk of COPD and to indicate whether people go for spirometry. As the diagnosis rate that a case-finding strategy would achieve is not known, we looked at what the impact on the pathway would be if the diagnosis rate were doubled to 56.28%, the aim being to assess the impact of different ways of implementing an intervention aimed at diagnosing people with COPD.

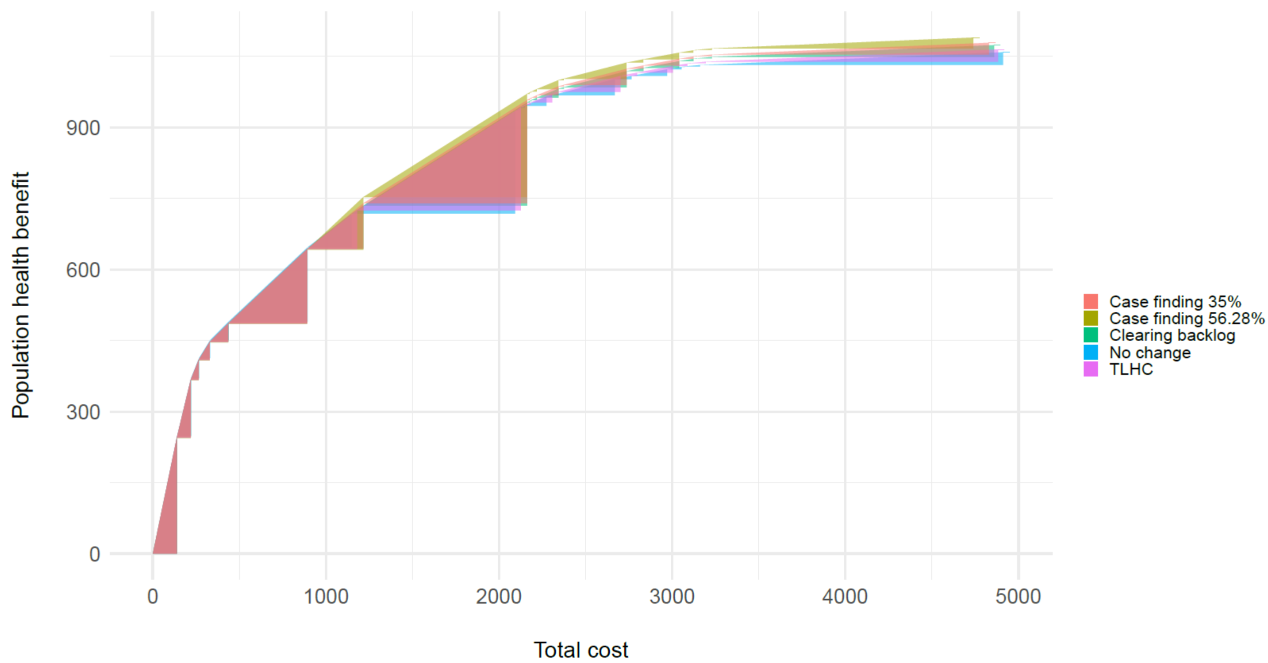

Figure 9 – Expected change to pathway due to targeting spirometry testing and improving uptake

The scenarios are:

1. **Increasing capacity to meet demand.** Here we look at the potential effect of increasing the supply of spirometry testing to meet the extra demand of 720 people, assuming it is sustained year on year.

2. **Improving the diagnosis rate to 56.28%.** According to data provided by UHCW and Coventry and Warwickshire ICB, an estimated 28.14% of spirometry tests lead to a diagnosis. Improving the diagnosis rate achieved would mean that fewer tests would be needed for each new diagnosis of COPD. Here we look at doing the same number of tests as in the ‘increasing capacity scenario’ (720) but assume that they were identified through a case-finding strategy.
3. **Improving the diagnosis rate to 35%.** This represents a more conservative estimate compared with the previous scenario of 56.28%.
4. **Expanding targeted lung health checks by testing patients with moderate emphysema.** Targeted lung health checks (TLHCs) are currently used to perform full lung function testing on patients identified as having severe emphysema by a CT scan. In 2023/24, tests will also be offered to patients with moderate emphysema. There is currently no provision of spirometry testing as part of this service expansion, but many of the patients with moderate emphysema will require it. There is an opportunity to add spirometry testing, supported by the respiratory physiology team at UHCW, alongside the TLHCs.

All these scenarios are expected to be cost-saving. This is largely because every 4.34 additional spirometry tests are expected to lead to one avoided hospital admission, assuming that testing leads to an early as opposed to a late diagnosis (see calculations in the appendices). Spirometry testing strategies should be designed to diagnose as many people as possible per test given, to make the testing as cost-effective as possible.

The tables below summarise the outputs of modelling the four scenarios of improving uptake for spirometry testing.

Increasing capacity to meet demand

Metric	Total	Interpretation
Total additional pathway costs	-£52,051.25	This scenario is cost-saving due to the estimated reduction in hospital admissions and primary care-managed acute exacerbations that an early diagnosis is expected to lead to compared with a late diagnosis.
Additional cost / additional population health ratio	-2.62	This scenario is cost-saving and health-generating. It would save £2.62 for each additional unit of population health gain it generates.
Cost ratio	1.74	This improvement is cost-saving. It is estimated to save £1.74 elsewhere in the pathway for every £1 spent on the testing.

Improving the diagnosis rate to 56.28%

Metric	Total	Interpretation
Total additional pathway costs	-£171,981.70	This scenario is cost-saving. It will incur fewer costs over the pathway than any other scenario for spirometry testing.
Additional cost / additional population health ratio	-4.33	This scenario is cost-saving and health-generating. It would save £4.33 for every additional unit of population health gain it generates.

Cost ratio	3.44	This scenario is expected to be cost-saving. It is estimated to save £3.44 elsewhere in the pathway for every £1 spent on spirometry testing.

Improving the diagnosis rate to 35%

Metric	Total	Interpretation
Total additional pathway costs	-£80,713.57	This scenario is expected to lead to a large enough reduction in hospital admissions and primary care-managed AECOPDs to be cost-saving.
Additional cost / additional population health ratio	-3.27	This scenario is cost-saving and health-generating. It is estimated to cost £3.27 for every additional unit of population health gain generated.
Cost ratio	2.15	This scenario is cost-saving. It is estimated to save £2.15 elsewhere in the pathway for every £1 spent on spirometry testing.

Expanding targeted lung health checks

Metric	Total	Interpretation
Total additional pathway costs	-£26,258.27	This scenario is expected to lead to a large enough reduction in hospital admissions and primary care-managed AECOPDs to be cost-saving.

Additional cost / additional population health ratio	-2.58	This scenario would save £2.58 for every additional unit of population health gain it generates.
Cost ratio	1.72	This scenario is cost-saving. It would save £1.72 elsewhere in the pathway for every £1 spent on spirometry testing.

Carer support

Expected change

Carers will be able to provide better support to those they care for.

No sources in the literature were identified that suggested improving carer support would impact elsewhere on the pathway.

Scenario

The RIPPLE group currently provides support for around 60 people living with COPD in Coventry. Carers could attend sessions alongside those they are caring for, or separate sessions could be organised. It was suggested that a Facebook group could also help to foster peer learning and support among carers.

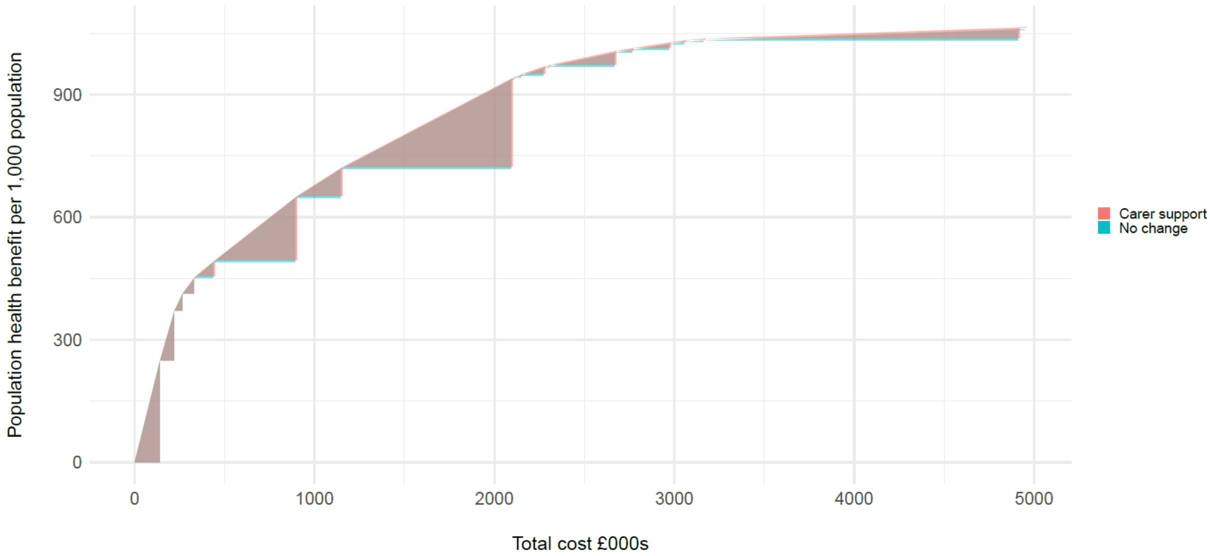

Figure 10 – Expected change to pathway due to carer support through RIPPLE

As the carer groups only reach a small number of people, this improvement is likely to have only a minimal impact on the pathway. As it is not expected to lead to changes in other pathway elements, it is not expected to be cost-saving. Offering the carer support groups to more people could improve the overall benefit associated with the carer support groups.

The table below summarises the expected results of providing carer support groups alongside the current peer support offering.

Metric	Total	Interpretation
Total additional pathway costs	£10,080	As carer support is not expected to lead to any changes in other pathway components, it is not expected to be cost-saving.
Additional cost / additional population health ratio	2.1	It is expected that carer support would cost £2.10 for every additional unit of population health gain it generates.

Cost ratio	N/A	As carer support is not expected to lead to any changes in other pathway components, it is not possible to calculate a cost ratio as the numerator would be 0.

Innovation in smoking cessation services

Expected change

People with COPD who stop smoking are less likely to have acute exacerbations and require a hospital admission (Au et al., 2009; Godtfredsen, 2002). Au et al. (2009) found a statistically significant reduction in exacerbation rates among veterans in the US who were ex-smokers compared with current smokers (hazard ratio [HR]: 0.78, 95% CI: 0.75–0.87), but the results were only statistically significant after someone had quit for 10 years or more (HR: 0.65, 95% CI: 0.58–0.74). Godtfredsen et al. (2002) found a statistically significant reduction in hospitalisations among ex-smokers compared with quitters in a Danish population, with an average follow-up of 14 years (HR: 0.57, 95% CI: 0.33–0.99).

Similarly, people are less likely to develop COPD if they quit smoking. According to a cohort study in the Netherlands, the incidence of COPD was 19.7/1,000 PY (95% CI: 18.1–21.4) among current smokers and 8.3/1,000 PY (95% CI: 7.6–9.1) among former smokers, with a maximum follow-up time of 25 years (Terzikhan et al., 2016).

Scenarios

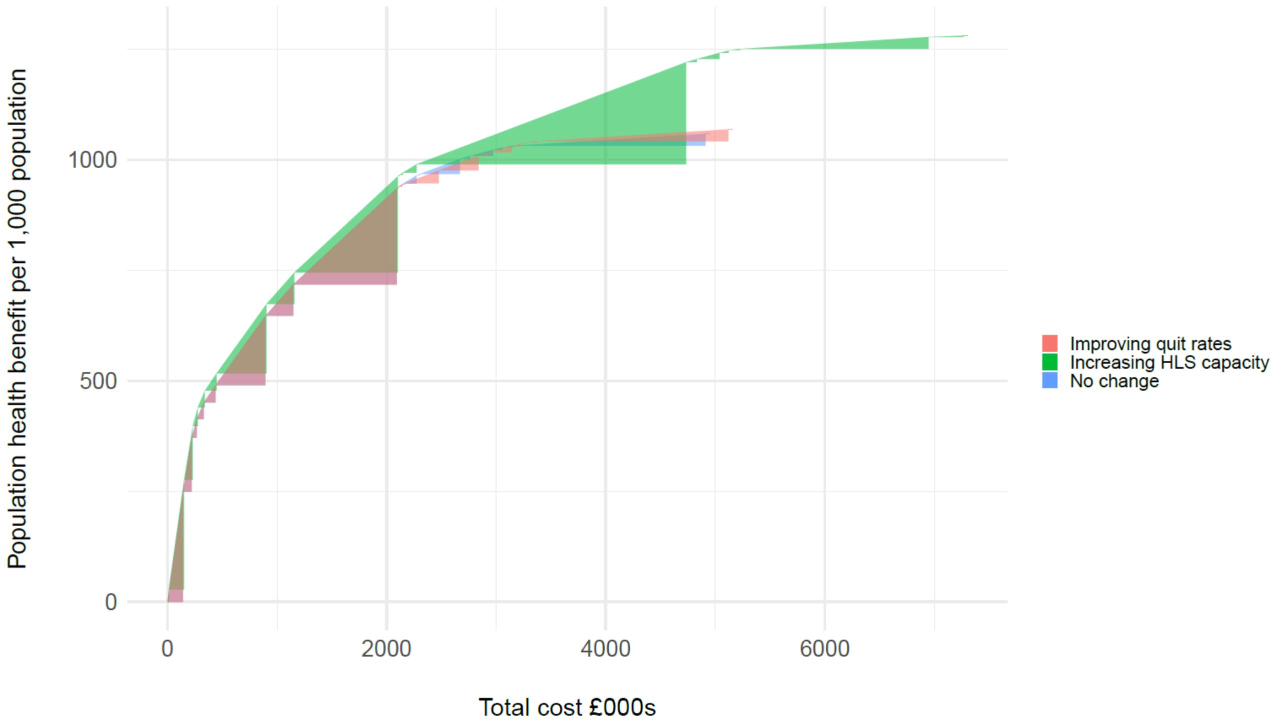

Figure 11 – Expected change to pathway due to innovation in smoking cessation services

Scenario A: Increasing capacity in the Healthy Lifestyles service

This scenario looks at the effect of reaching more smokers with the stop smoking services, assuming that the quit rate is the same as for the current provision. According to QOF, in 2020/21, 15.6% (65,188 people) of the adult population of Coventry registered with a GP smoked. This means that to reach the NICE target of 5% of smokers setting a quit date, 3,259 extra smokers would have to set a quit date, up from 1,459 in 2021/22 (Office for Health Improvement & Disparities, 2022).

Here we assume the extra 2,070 people setting a quit date occurs in the Healthy Lifestyles service as opposed to the GP-led services and that the extra capacity only targets people aged 45 and over, in line with the Terzikhan et al. (2016) study.

Scenario B: Improving quit rates from GP- and pharmacy-led services

GP- and pharmacy-led smoking cessation services account for 45.85% of all quit dates set in Coventry. However, 43% of people who set a quit date in the Healthy Lifestyles service quit after 12 weeks in 2021/22, compared with 29% in GP- and pharmacy-led services (see calculations in the **appendices**). It is assumed that this is because of the additional behavioural therapy that people receive in the Healthy Lifestyles service. This scenario looks at increasing quit rates in GP- and pharmacy-led services to 43%, as in the Healthy Lifestyles service, by including behavioural support alongside nicotine replacement therapy.

Allen Carr Easyway (not modelled)

In August 2022, NICE recommended the Allen Carr Easyway (ACE) method for supporting people to quit smoking. This method is a multicomponent programme which includes group cognitive behaviour and relaxation therapies without pharmacotherapy (NICE, 2022).

In the decision conferences, the ACE method was suggested as a way of improving smoking cessation services. However, according to a recent study of 620 people in Oxfordshire, the ACE method had a quit rate of 27.7% at four weeks (Frings et al., 2020). This is less than the current quit rates of both GP- and pharmacy-led services (29%) and the Healthy Lifestyles service (43.03%) Therefore we have not taken this scenario forward to the modelling. Another paper looking at the ACE method gave a quit rate of 38% at four weeks (Keogan et al., 2019). However, that study had a much smaller sample size (n = 151) and is less reliable for effect size estimation.

Both scenarios modelled are estimated to greatly improve the population health benefit of the pathway but also have large cost implications associated with them. The cost savings to the COPD pathway are not expected to make up for the cost of the pathway improvements. The cost savings to the COPD pathway are relatively low, because many people need to be treated per year to avoid hospital admissions (23.32 people with COPD) and acute exacerbations (16.24 people with COPD). However, there is uncertainty over the cost savings associated with the number of cases of COPD each scenario would avoid. This is subject to a sensitivity analysis, which can be found in the discussion section. It should also be noted that stopping someone from smoking brings wider benefits to the individual's health (and therefore the health system) outside of the COPD pathway; however, these benefits are out of scope of this project.

Increasing capacity in the Healthy Lifestyles service

Metric	Total	Interpretation
Total additional pathway costs	£1,372,001.46	This scenario has a large cost implication associated with it. Considering only the benefits that this will bring to the COPD pathway, the cost savings account for only a fraction of the cost of the scenario.
Additional cost / additional population health ratio	9.80	This scenario is expected to cost £9.80 for every additional unit of population health gain it generates.
Cost ratio	0.08	This scenario is not cost-saving. It would save £0.08 elsewhere in the COPD pathway for every £1 spent.

Improving quit rates in GP- and pharmacy-led services

Metric	Total	Interpretation
Total additional pathway costs	£189,477.75	This scenario is not cost-saving. The extra number of quitters is not large enough to avoid any further acute exacerbations or hospital admissions, so the cost savings are minimal.
Additional cost / additional population health ratio	18.59	This scenario would cost £18.59 for every additional unit of population health gain it generates for the COPD pathway.
Cost ratio	0.04	This scenario is not cost-saving. It would save £0.04 elsewhere in the COPD pathway for every £1 spent.

Education package for people with COPD

Expected change

An education programme would help people to understand and self-manage their own condition better (NICE, n.d.).

No papers looking at healthcare resource use for the SPACE programme (and education package for people with COPD developed by the University Hospitals of Leicester NHS Trust) were identified. A meta-analysis, conducted as part of the NICE guidance looking at self-management interventions, showed there was no other statistically significant impact on hospital admissions, acute exacerbations, or other elements of the COPD pathway. It did suggest there was a statistically significant mean difference in the length of stay of patients who had a self-management plan versus those who did not ($p = 0.04$). However, this meta-analysis was skewed by the inclusion of one study with a mean length of stay of

18.60 days in the self-management arm and 24.80 days in the control arm, far above that in Coventry (5.98 days) so it has not been included in the modelling.

Scenario

Here we model what it would look like for newly diagnosed patients to undergo the SPACE for COPD package. As SPACE is likely to be relatively cheap per person, the cost implication of expanding the programme is relatively small compared with not introducing it, for the extra benefit it would generate.

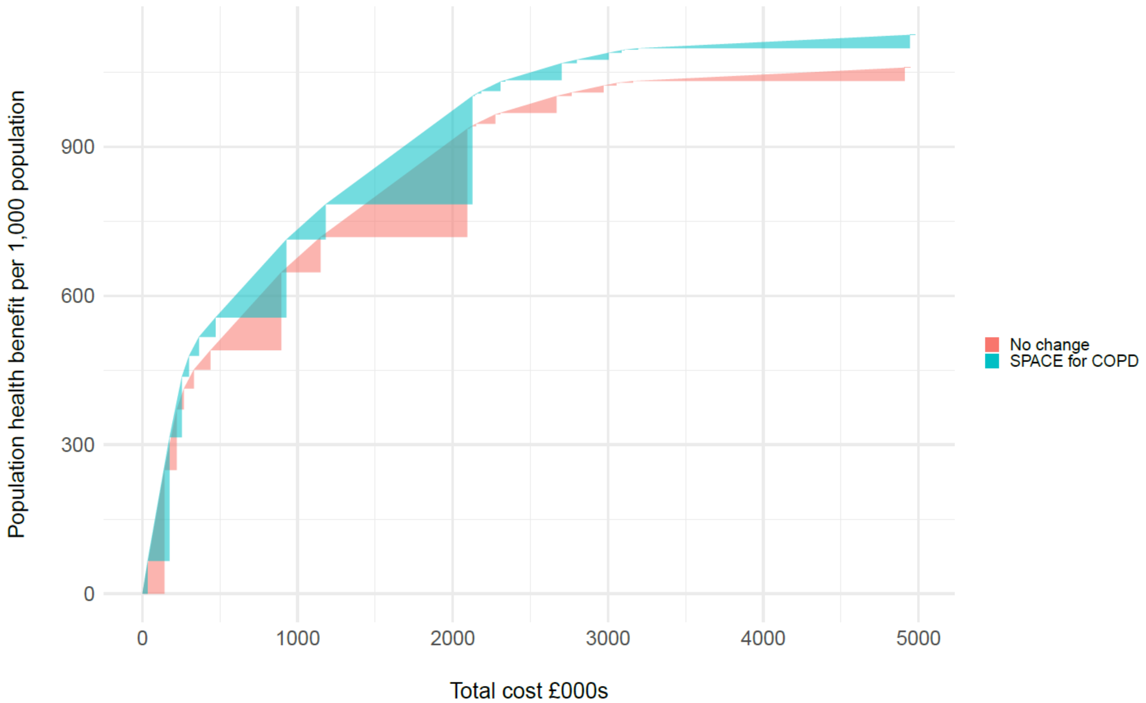

Figure 12 – Expected impact of introducing the SPACE programme for people who are newly diagnosed with COPD

The table below summarises the results of modelling the impact of the SPACE programme.

Metric	Total	Interpretation
Total additional pathway costs	£33,250.50	The education package is cost-incurring as there are no expected cost savings elsewhere in the pathway.
Additional cost/ additional population health ratio	0.51	The education package would cost £0.51 for every additional unit of population health gain it generates.
Cost ratio	N/A	As the education package is not expected to lead to any changes in other pathway components, it is not possible to calculate a cost ratio as the numerator would be 0.

Targeted awareness campaign

Expected change

It is assumed that the main benefit of the targeted awareness campaign would be a doubling of the number of people referred to pulmonary rehabilitation (PR) services and 25% more people coming forward for spirometry testing.

We assume the effects of more spirometry testing as a result of this improvement would be the same as those modelled above for the improvement **increasing the capacity of spirometry**.

The literature review identified one Cochrane review looking at the impact of PR in people who had an exacerbation of COPD (Puhan et al., 2016). That study suggested that PR had a positive effect on hospital readmission rates compared with usual post-exacerbation care after nine months (odds ratio [OR]: 0.44, 95% CI: 0.21–0.91). No relevant papers were identified which looked at changes in healthcare resource use, such as PR in a community setting versus usual care, in a wider population of COPD patients. Therefore, we assume that the effect of PR in the general population would be the same as that reported in the Puhan et al. review.

Scenario

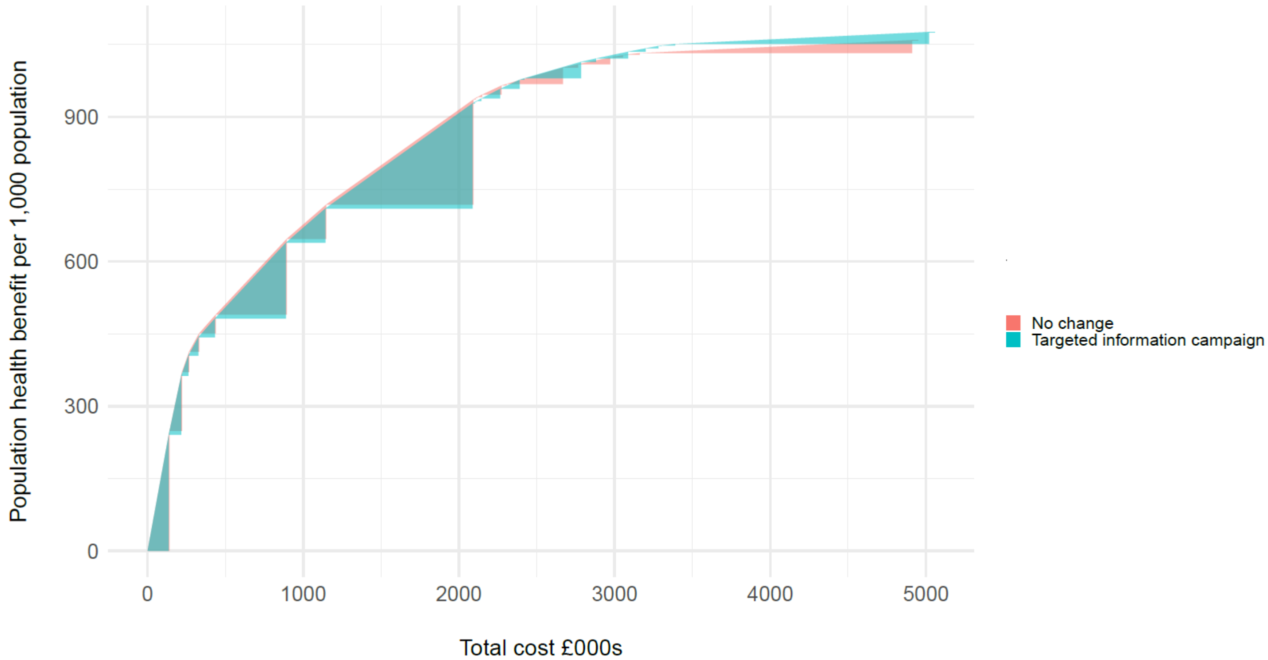

Figure 13 – Expected impact of a targeted awareness campaign

Based on the **assumptions** around increased activity in spirometry services and PR services, it is not expected that a targeted information campaign would be cost-saving once the improvement is fully implemented. A targeted awareness campaign may lead to increased activity in spirometry testing and PR, but there is substantial uncertainty around how much additional activity would be generated. It is important that the cost implications for the services towards which the campaign aims to point people are considered should this improvement be commissioned.

Metric	Total	Interpretation
Total additional pathway costs	£143,628.89	It is not expected that the targeted information campaign would be cost-saving.
Additional cost / additional population health ratio	5.76	The targeted information campaign is expected to cost £5.76 for each additional unit of population health gain it generates.
Cost ratio	0.46	The targeted information campaign is not expected to be cost-saving. It is estimated to save £0.46 elsewhere in the pathway for every £1 spent.

Education in schools against smoking and vaping

Expected change

This intervention has been tested in three studies, including a cluster randomised controlled trial, and has shown positive effects on smoking initiation in schools (Conner et al., 2019).

As people who do not smoke are much less likely to develop COPD than those who do (Terzikhan et al., 2016), fewer people would be expected to develop COPD or experience severe COPD symptoms.

Scenario

As the only impact of this pathway improvement would be on primary prevention, we have not created a visualisation for this scenario.

Assuming every school in Coventry receives the programme, it can be expected that this would avoid 102 cases of COPD for every year that the programme runs (see appendices). However, it is not expected that this will make the programme cost-saving in the long run, based on the expected yearly cost of an avoided case of COPD of £744.57. Note that this number is subject to a sensitivity analysis, which can be found in the discussion section.

It should also be noted that stopping someone smoking also has wider benefits outside of the COPD pathway, including reducing the risk of a wide range of other diseases, saving money, and reduction in second-hand smoke for others; however, these benefits are out of scope of this piece of work.

Metric	Total	Interpretation
Total additional pathway costs	£107,938.78	The cost savings due to the number of COPD cases avoided are not expected to make this campaign cost-saving.
Additional cost / additional population health ratio	1.10	Education against smoking and vaping in schools is expected to cost £1.20 for every additional unit of population health gain it generates.
Cost ratio	0.41	Education against smoking and vaping in schools is not cost-saving. It would save £0.41 for every £1 spent due to cases of COPD avoided.

Expansion of the virtual ward

Expected change

A 2017 Cochrane review showed virtual wards to be comparable with current practice in terms of readmission to hospital (Gonçalves-Bradley et al., 2017). That paper suggested a reduction in length of stay of around seven days for patients, and this is supported by a more recent paper which suggests a length of stay two days less than expected, with a median length of stay of one day (Echevarria et al., 2018).

Scenario

Here we have modelled the expected impact of including everyone who is eligible on the virtual ward. It is assumed that patients with a DECAF score of 0 or 1 (approximately 50% of patients) are eligible (Echevarria et al., 2018).

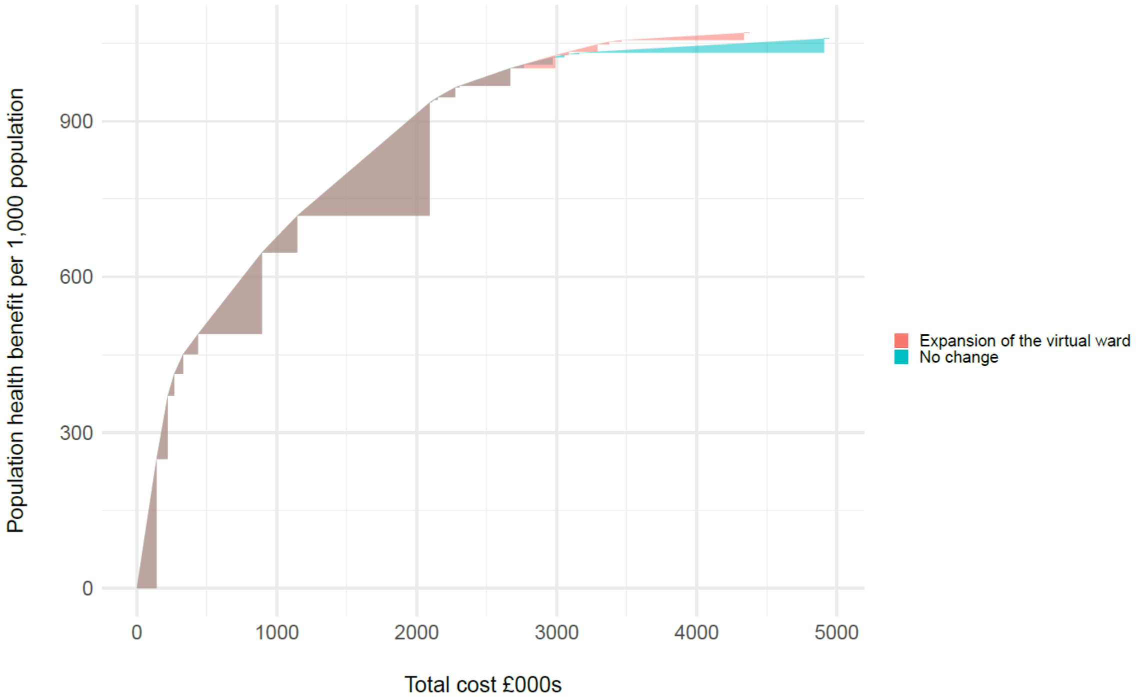

Figure 14 – Expected impact of introducing the virtual ward to the pathway

As can be seen in the table below, the virtual ward is cost-saving overall. This is because it is expected to be cheaper to treat someone on the virtual ward rather than in hospital. It also improves the value as people get treated in home rather than the hospital. However, the number of home visits required (estimated at 7.1 hours of visits per person) would put extra demand on the community COPD service, and this needs to be accounted for in the expansion (Echevarria et al., 2018).

The table below summarises modelling the impact of virtual wards.

Metric	Total	Interpretation
Total additional pathway costs	-£553,523.40	The virtual ward is expected to be cost-saving. This is because it is estimated to cost £1,628.01 less to care for someone on a virtual ward than in hospital following an acute exacerbation.
Additional cost / additional population health ratio	-22.30	The virtual ward is expected to be cost-saving and health-generating. It is estimated to save £22.30 for every additional unit of population health gain it generates.
Cost ratio	2.72	The virtual ward would save £2.72 due to reduced spend on hospital admissions for every £1 spent on the virtual ward.

Determining the next steps: setting priorities

Using the results of the modelling for decision-making

This section outlines how Coventry Place can use this information to determine the priorities for its respiratory programme in 2023/24.

The modelling approach outlined in the previous sections produces three outputs which can be used for ranking the pathway improvements and priority-setting:

- **Cost / population health benefit.** Prioritising pathway improvements using this measure will help to ensure that the improvements taken forward will produce the most health within the given available budget. The lower the ratio, the better, with a negative ratio representing improvements which are both cost-saving and health-generating. The ratio for each pathway improvement is, in and of itself, meaningless; it only has meaning in comparison to the cost/population health ratios of other pathway improvements.
- **Cost ratio.** Prioritising in this way can determine the pathway improvement that will offset the most costs elsewhere in the system. The bigger the ratio, the better.
- **Total additional pathway cost.** Like looking at the cost ratio, this method can determine whether the pathway improvement is likely to save money overall or incur additional costs. Negative numbers represent a cost saving.

We recommend that priority-setting of the pathway improvements is done based upon cost/population health ratio. Using this method will ensure the most efficient allocation of resources based on cost per unit of population health gain, therefore improving the value for money of the pathway.

A ranking of the pathway improvements by their cost/population health ratio is displayed in the table below. Where improvements have multiple scenarios, the scenarios have been displayed separately.

Ranking	Pathway improvement (scenario)	Cost / population health ratio
1	Expansion of the virtual ward	-22.30
2	Targeting spirometry testing and improving uptake (improving the diagnosis rate to 56.28%)	-4.33
3	Targeting spirometry testing and improving uptake (improving the diagnosis rate to 35%)	-3.27
4	Targeting spirometry testing and improving uptake (increasing capacity to meet demand)	-2.62
5	Targeting spirometry testing and improving uptake (expanding TLHCs)	-2.58
6	Joint clinics in primary care (with current establishment of 5.6 RNSs)	0.22
7	Education package for people with COPD	0.51
8	Joint clinics in primary care (with 8.6 RNSs)	0.85
9	Education in schools against smoking and vaping	1.10
10	Carer support	2.1
11	Targeted awareness campaign	5.76

12	Innovation in smoking cessation services (increasing capacity in Healthy Lifestyles service)	9.80
13	Innovation in smoking cessation services (improving quit rates in GP- and pharmacy-led services)	18.59

Recommendations

Based on the results presented in the table above, it is recommended that Coventry Place invest in the pathway improvements that have the best cost/population health ratio. This will ensure the investment leads to the most health generated per pound spent. Where more than one scenario for the pathway improvement is cited, the scenario with the best cost/population health ratio has been suggested. It is recommended to focus on the following five pathway improvements:

- **Expansion of the virtual ward.** The expansion of the virtual ward is a national priority. This improvement is expected to lead to a large cost saving as it is less expensive to treat someone at home, through the virtual ward, than in a hospital. It would be expected to save £553,523.40 per year if 50% of all hospital admissions for an acute exacerbation were treated through the virtual ward.
- **Targeting spirometry testing and improving diagnosis.** Expanding the capacity in spirometry testing is key to overcoming the **difficulties in spirometry testing following the COVID-19 pandemic**. All the scenarios modelled here are expected to be cost-saving. The better the diagnosis rate, the more cost-effective spirometry testing will be.
- **Joint clinics in primary care (current establishment of 5.6 RNSs).** This improvement is the most cost-effective approach for addressing the **importance of primary care**. It is expected to cost an estimated additional £86,463.72 per year. Hiring an extra three RNSs is estimated to generate the most additional population health benefit of any scenario suggested in this report. However, the additional cost

that this would incur, and the expected shortage of RNSs to hire, mean that using the current establishment of nurses would be more cost-effective.

- **Education package for people with COPD.** This pathway improvement would help people to realise the **long-term benefits of lifestyle interventions** by supporting people with COPD to better manage their own condition. It is expected to cost an additional £33,250.50.
- **Education in schools against smoking and vaping.** This improvement would help to **stop more people from smoking as primary prevention.** This improvement is expected to cost an additional £183,884.92 per year.

Investing in all these recommended improvements would have an estimated yearly budget impact (sum of the additional costs of the pathway improvement) of £727,362.34 or £693,212.69 dependent on whether spirometry testing is carried out is part of the targeted lung health checks.

That said, expected savings from the virtual ward (£553,523.40 per year) would be enough to cover most of these additional costs. For these recommendations to be carried out, the capacity and resource available to the community COPD service should be considered carefully; both the virtual ward and the joint clinics involve their input. From a financial point of view, the challenge is being able to release the savings from the virtual ward into other parts of the system.

Discussion

This report can help Coventry Place's respiratory programme to set priorities for its COPD programme in an evidence-based way, in the knowledge that it has taken a robust and transparent approach to doing so.

One thing to bear in mind is that the exact value of primary prevention in the reduction of COPD cases is not known. Here we have used the expected cost within a calendar year, as one year was the relevant timeframe for budget planning. However, stopping someone from developing COPD will have benefits beyond the one-year timeframe.

According to one study in the US, the average life expectancy for someone diagnosed with COPD is 17.2 years (Shavelle et al., 2009). This would make the expected cost saved due to an avoided case of COPD £12,806.60 (the expected yearly cost of an avoided case of COPD of £744.57 × 17.2). Over the same timeframe, increasing capacity in the Healthy Lifestyles service would save an estimated £328,724.77 and have a cost/population health ratio of -2.35. This would make it the second most cost-effective pathway improvement after the virtual ward. However, as these cost savings would only be realised in the long term, it would be difficult to free up these savings to invest elsewhere.

Similarly, it is to be noted that different examples of the STAR approach use different methods for valuing the individual health gain generated by the improvements. Elsewhere, for example, The Health Foundation has weighted the quality of life of individuals with different severities of eating disorders and calculated the proportion of patients who would deteriorate, stay the same or recover with and without receiving each intervention, and the resulting average incremental quality of life gain (The Health Foundation, 2012). However, here we have used the same method as Airoldi et al. (2014): assessing each improvement on the visual analogue scale, as described in the **methods document**. The Airoldi et al. method was chosen in part because it encourages participants to think about the principle of 'relativity' in relation to the interventions and improvements; that is, directly comparing the health gains associated with each intervention. Also, the need to value a large number of interventions meant that the Health Foundation method would not have been practical in the time available. It is possible that using different methods to generate the individual health gain generated by each intervention and improvement would give a different emphasis to the results.

Limitations

There are some limitations that should be kept in mind when interpreting this work.

There is a lack of available data in the literature looking at the impact on healthcare resource use as a result of the pathway improvements. In most cases, the literature review only identified impacts on urgent care (hospitalisations and exacerbations). The impacts of improvements on other elements of the pathway, such as primary care usage or uptake of services like PR, are not known.

Similarly, it was not possible to evidence the potential capital or programme costs that may be involved in the development of the pathway improvements within the timeframe of this project. These may affect the cost/population health ratio if they were included.

Pharmacological treatments were out of scope of this project and therefore the costs do not include the cost of pharmacotherapies for standard COPD (such as the cost of inhalers).

The scenarios presented here are high-level scenarios that were identified in the decision conferences. When it comes to implementation, the exact nature and effect of the scenarios may vary. It is important that an evaluation of the programmes to be taken forward is commissioned so their effects can be monitored.

Appendix

1. The Integrated Chronic Obstructive Pulmonary Disease (COPD) Model for Coventry Place: Case for Change

220318 COPD Coventry Case for Cl

2. Methodology document

HEU STAR framework - Coventr

3. Data sources for the efficiency frontier

Primary prevention

Smoking cessation

Healthy Lifestyles service

Metric	Total	Source
Relative benefit score	100	Agreed upon by stakeholders in the first decision conference.

Number treated: **Number of people setting a quit date**	790	Healthy Lifestyles team.
Number who benefit: **Successful quitters – 12 weeks**	340	Healthy Lifestyles team.
Cost per person **Cost per individual who set a quit date**	£458.87	NHS Digital submission plus data from HLS.

Other smoking cessation services e.g. GP/Pharmacy/Other

Metric	Total	Source
Relative benefit score	100	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people setting a quit date**	669	Healthy Lifestyles team.
Number who benefit: **Successful quitters – 12 weeks**	194	Healthy Lifestyles team.
Cost per person: **Cost per individual who set a quit date**	£186.60	NHS Digital submission plus data from HLS.

Secondary prevention and diagnosis

Spirometry testing

Spirometry in GP practices

Metric	Total	Source
Relative benefit score	98	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given a spirometry test**	728	QOF 2019/20.
Number who benefit: **Number of people diagnosed with COPD following a spirometry test**	2,587	Data for GP-led spirometry taken from the business case for 2022 (2,120); numbers for secondary care provided by UHCW.
Cost per person: **Cost of spirometry test**	£97.85	Overhead costs including training, oversight and audit have been calculated pro rata based on the percentage of activity expected in Coventry compared with elsewhere.

Respiratory vaccinations

COVID-19 vaccinations

Metric	Total	Source
Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of vaccinated COPD patients**	4,297	Estimate. Data is not available on COVID-19 vaccinations for COPD patients. The Health Inequalities Improvement Dashboard suggests that, by end of March 2022, 67.3% of people with a respiratory condition in Coventry and Warwickshire ICS had received two doses of a COVID-19 vaccination. This assumes that the rate is the same among COPD patients in Coventry alone.
Number who benefit: **Number of avoided acute exacerbations**	434.24	Assumed same as influenza vaccination.
Cost per case: **Cost of vaccination**	£15	ICS / Reference Costs.

Pneumonia vaccinations

Metric	Total	Source
Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of vaccinated COPD patients**	3,576	According to the **Pneumococcal Polysaccharide Vaccine (PPV) coverage report** for England, April 2020 to March 2021, uptake of PPV vaccine for chronic respiratory patients is 56%. This assumes the same rate among patients in Coventry based on QOF COPD population of 6,385 in 2020/21.
Number who benefit: **Number of acute exacerbations avoided**	447	Main benefit is reduction in flare-ups (alongside avoiding someone getting a disease). Therefore, used expected number of hospital admissions avoided and assumed they would be evenly distributed in the population. According to a Cochrane review, the number of patients needed to treat to prevent a patient from experiencing an exacerbation is eight (Walters et al., 2017).
Cost per case: **Cost of vaccination**	£30	ICS / Reference Costs. Assumed cost of vaccination is the same as the market prices.

Influenza vaccinations

Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given an influenza vaccination**	4,773	QOF 2020/21.
Number who benefit: **Number of acute exacerbations avoided**	482.33	Assumed the patient expected event rate is 0.24 and also only one acute exacerbation avoided per person.
Cost per case: **Cost of vaccination**	£9.58	2021/22 Item of service cost.

Case management

Primary care case management

Metric	Total	Source
Relative benefit score:	60	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients with COPD who have had a review**	2,036	QOF register for 2020/21.
Number who benefit:	2,036	Literature / Elicitation.

Number of patients with COPD who have had a review		
Cost per case: **Cost of GP review**	£39.23	PSSRU 2021/22.

Community COPD service case management

RESTART and ROCKET

Metric	Total	Source
Relative benefit score:	92	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of contacts for case management**	1,711	Service manager community COPD service UHCW.
Number who benefit: **Number of hospital admissions avoided**	1,711	Coventry DC1 workshop output.
Cost per case: **Total cost of service**	£266	Contract value from UHCW and number of contacts.

Tertiary prevention

Pulmonary rehabilitation

Metric	Total	Source
Relative benefit score:	90	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of accepted**	213	The Atrium.
Number who benefit: **Number who complete the course**	79	ICS / Place.
Cost per case: **Cost per person of PR Programme**	£455	The Atrium.

Group therapy

Metric	Total	Source
Relative benefit score:	90	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients with COPD seen by RIPPLE**	60	Provided by Simon Betteridge, Head of Compassionate Community Development; estimated that the full number of people seen in a calendar year that will be supported is 50–60 across the year.

		Numbers had to be restricted during COVID so recent figures would not be a good reflection of capacity.
Number who benefit: **Number of patients with COPD seen by RIPPLE**	60	Literature / Elicitation.
Cost per case: **Cost of providing RIPPLE for one year for one patient**	£500	Provided by Simon Betteridge.

Oxygen therapy

Ambulatory oxygen therapy

Metric	Total	Source
Relative benefit score:	70	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given AOT**	38	Breathing Space Contract Monitoring Report for 2021/22. Baywater Healthcare, the provider of oxygen services in Coventry.
Number who benefit: **Number of people given AOT**	38	Literature / Elicitation.

Cost per case: **Cost per patient**	£388.21	ICS / Reference Costs.

Long-term oxygen therapy

Metric	Total	Source
Relative benefit score:	70	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given LTOT**	196	Baywater Healthcare, the provider of oxygen services in Coventry.
Number who benefit: **Number of people given LTOT**	196	Assumed that everyone benefits.
Cost per case: **Cost of providing LTOT for one year**	£1,051	ICS / Place.

Lung volume reduction

Metric	Total	Source
Relative benefit score:	70	Agreed upon by stakeholders in the first decision conference.
Number treated:	5	ICS/Place.

Number of patients undergoing LVR		
Number who benefit:	4	Literature / Elicitation. 80% of total; according to the BLF, 20% of people say they do not receive any benefit from LVR.
Cost per case: **Mean cost of LVR**	£7,241	ICS / Reference Costs.

Smoking cessation

Healthy Lifestyles service

Metric	Total	Source
Relative benefit score:	99	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people setting a quit date**	67	Peter Kent (Healthy Lifestyles team).
Number who benefit: **Successful quitters – 12 weeks**	29	Healthy Lifestyles team.

Cost per case: **Cost per individual who set a quit date with COPD**	£458.87	Costs of smoking cessation services were sourced from NHS Digital return. Costs are divided into cost of pharmacotherapies and service costs. The Healthy Lifestyles service offers counselling and nicotine replacement therapy (NRT), whereas the GP and pharmacy services only provide NRT. Therefore, we assume the cost of NRT is spread between all those who set a quit date in the two services. 90% of the service costs have been spread across those quitting in the Healthy Lifestyles service due to the counselling. It is assumed that 10% of the service costs relate to the GP and pharmacy-led services.

Other smoking cessation services (GP/pharmacy/other)

Metric	Total	Source
Relative benefit score:	90	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people setting a quit date**	57	Assumed that the percentage of people with COPD undertaking the course is the same in GP practices and pharmacies as it is in the Healthy Lifestyles service.
Number who benefit:	17	Assumed same quit rate among people with COPD as in those without COPD.

Successful quitters – 12 weeks		
Cost per case: **Cost per patient setting a quit date**	£186.60	Costs of smoking cessation services were sourced from NHS Digital return. Costs are divided into cost of pharmacotherapies and service costs. The Healthy Lifestyles service offers counselling and NRT, whereas the GP and pharmacy services only provide NRT. Therefore, we assume the cost of NRT is spread between all those who set a quit date in the two services. 90% of the service costs have been spread across those quitting in the Healthy Lifestyles service due to the counselling. It is assumed that 10% of the service costs relate to the GP and pharmacy-led services.

Affordable warmth: warm home schemes

Metric	Total	Source
Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given support**	32	Provided by Jenny Bowker, Act On Energy affordable warmth officer. NOTE: figures are for 2021/22. Demand expected to be higher in 2022/23.
Number who benefit:	32	Provided by Jenny Bowker.

Number of people given support		
Cost per case: **Cost of scheme in 2021/22**	£2,763	Average cost across all schemes. Assumed the benefit of each scheme is the same (i.e., the same improvement in warmth).

Secondary care outpatient attendance

Metric	Total	Source
Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of outpatient appointments offered**	2,509	SUS / Estimate.
Number who benefit: **Number of outpatient appointment attendances that were attended**	2,509	SUS / Estimate.
Cost per case: **Mean cost per appointment**	£377.07	SUS / Estimate.

Management of acute exacerbations

Primary care management

Metric	Total	Source
Relative benefit score:	80	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients receiving 12 or 13+ 5mg prednisolone prescription**	3,115	e-pact 2021/22.
Number who benefit: **Number of patients receiving 12 or 13+ 5mg prednisolone prescription**	3,115	e-pact 2021/22.

Cost per case: **Cost of GP-managed acute exacerbation**	£45.19	According to Maisun Elftise, GP in Coventry, a patient whose AECOPD is managed in primary care will be seen by the GP and given a rescue pack (prednisolone 5mg tablets, nebuliser vial and a nebuliser). According to **BNF**, the NHS tariff for prednisolone per pack of 28 tablets is £0.79, a Nebuliser vial (500mg/2ml) costs £2.87 and a **single use nebuliser pack** costs £2.30 . Assuming that the AECOPD would take the same amount of time as a GP appointment (£39.23 according to the **PSSRU**), that would make the estimated cost of managing a AECOPD in primary care £45.19

Hospital admission

Metric	Total	Source
Relative benefit score:	40	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of AECOPD admissions**	680	SUS.
Number who benefit: **Number of AECOPD admissions**	680	Literature / Elicitation.
Cost per case: **Mean cost of hospital admission for acute exacerbation**	£2,573	ICS / Reference Costs.

Discharge support

Metric	Total	Source
Relative benefit score:	73	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people admitted for acute exacerbation of COPD**	311	Service manager, community COPD service UHCW.
Number who benefit: **Number of expected avoided hospital admissions due to**	69	Literature / Elicitation.

discharge support scheme after 12 months		
Cost per case: **Cost per patient of providing discharge support**	£266.39	Contract value from UHCW and number of contacts.

Virtual ward

Metric	Total	Source
Relative benefit score:	73	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients with COPD on the virtual ward**	20	Number provided by UHCW (07/10/22). Number of people included on virtual ward to date.
Number who benefit: **Number of people who were included on the virtual ward**	20	Literature / Elicitation.
Cost per case: **Median cost of hospital admission for acute exacerbation**	£944.79	Activities are equivalent to those reported by Echevarria et al. (2018).

4. Sources for population health statistics

This section provides details on the sources that were used to create the tables in section 3.

1. **Total number of people with COPD registered with a GP in Coventry:** **https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data/2019-20**
2. **COPD population by severity level:** There is no publicly available dataset that allows us to understand the distribution of severity scores for people with COPD. One study published in the journal *Scientific Reports* uses the mean and frequency distribution of FEV1% predicted scores to predict patients' severity. This method has been used here based on a mean FEV1% of 68.9% and the estimated prevalence of COPD in Coventry. **https://www.nature.com/articles/srep31893#:~:text=In%20England%2C%20the%20prevalence%20of,by%20more%20women%20developing%20COPD**
3. **Estimated undiagnosed population:** Nacul et al. estimated that in 2007, the true prevalence of COPD in the country was 3.1%. This estimate is the difference between QOF register prevalence and this expected true prevalence. **https://pophealthmetrics.biomedcentral.com/articles/10.1186/1478-7954-5-8**
4. **Estimated number of smokers:** Lower estimate: QOF register – estimated smoking prevalence among people over the age of 18 in Coventry in 2020/21 **https://fingertips.phe.org.uk/search/QOF#page/3/gid/1/pat/167/par/E38000251/ati/7/are/M86039/iid/91280/age/188/sex/4/cat/-1/ctp/-1/yrr/1/cid/4/tbm/1**
5. **Total population registered with a GP in Coventry:** QOF register – numbers of people on GP practice lists in 2020/21 **https://qof.digital.nhs.uk/**.

5. Assessing the impact of the proposed improvements: data sources and calculations

Joint clinics in primary care with respiratory nurse specialists

Current establishment

Metric	Value	Definition and source
Pathway improvement		
Benefit score **(B)**	Improved score of current reviews: 38 Benefit score of additional reviews: 98	The benefit score defined in the decision conference for the potential of primary care case management was 98. We assume that this potential will be met through the joint clinics. The score used in the original efficiency frontier was the midpoint of the range: 60. Where the RNSs are joining existing yearly reviews, the benefit would be the additional benefit that RNSs would give to primary care case management. We assume that the RNSs will allow primary care case management to operate at the top of that range so would lead an additional benefit of 38 (98 – 60). Where additional yearly reviews would be held, the full score of 98 has been used.

Cost of the improvement (C)	Additional cost to current reviews: £12.75 / Cost of additional reviews: £51.98	According to a GP working in Coventry (Maisun Elftise), a review will take around 15 minutes. The cost of a band 6 nurse specialist is £51 per hour, according to **PSSRU**. (Burns & Jones, 2021b). Therefore, the cost of community nurse involvement is £12.75 per appointment (51/4). In 2021/22 there were 2,036 yearly reviews conducted in Coventry. Assuming all of these are now covered by the community nurse, the additional cost would be £12.75. For additional yearly reviews on top of this, the cost of a yearly review would have to be factored in. Current cost of a review in primary care is £39.23 according to **PSSRU** (Burns & Jones, 2021a). So the cost of the additional reviews would be £51.98.
Number treated (N_t)	3,200	If five nurses held one 4-hour clinic per week for 40 weeks, with 15-minute appointments. Assuming no DNAs (did not attends). 5 × 40 × (4/0.25) = 3,200 This would mean an additional 1,164 primary care yearly reviews.

Number who benefit **(N)**	3,200	Assumed everyone benefits.
Additional costs of pathway improvement	£86,463.72	Additional cost of current review × current number of yearly reviews + additional number of yearly reviews × cost of additional yearly reviews. (12.75 × 2,036) + (1,164 × 51.98)
Pathway effects		
Reduction in number treated in the community COPD service **(R)**	183	There were 1,712 contacts by the RNS team in 2021/22. As this scenario would mean nurses' capacity has reduced by 4 hours per week, assuming a 37.5-hour week, they will miss 1,712 × (4/37.5) = 183 appointments. The estimated cost per patient is estimated at £266.39, and the benefit score attributed to the community COPD service was 92 (see **data sources for the efficiency frontier** section).
Additional population health gain	174,604	Improved score of current reviews × current number of yearly reviews + benefit score of additional reviews × number of estimated additional reviews – reduction in the number treated in the community

		COPD service × benefit score of community COPD service. (38 × 2036) + (1,164 × 98) – (183 × 92)
Cost savings	£48,749.37	183 × 266.39

Hiring three additional nurses

Metric	Value	Description
Pathway improvement		
Benefit score **(B)**	Improved score of current reviews: 38 Benefit score of additional reviews: 98	The benefit score defined in the decision conference for the potential of primary care case management was 98. We assume that this potential will be met through the joint clinics. The score used in the original efficiency frontier was the midpoint of the range: 60. Where the RNSs are joining existing yearly reviews, the benefit would be the additional benefit that RNSs would give to primary care case management. We assume that the RNSs will allow primary care case management to operate at the top of that range so would lead an additional benefit of 38 (98 – 60).

		Where additional yearly reviews would be held, the full score of 98 has been used.
Cost of the improvement (C)	Additional cost to current reviews: £12.75 / Cost of additional reviews: £51.98	In 2021/22 there were 2,036 yearly reviews conducted in Coventry. Assuming all of these are now covered by community nurse, the additional cost would be £12.75. For additional yearly reviews on top of this, the cost of a yearly review would have to be factored in. Current cost of a review in primary care is £39.23 according to PSSRU. So the cost of the additional reviews would be £51.98 (Burns & Jones, 2021a).
Number treated (N_t)	5,120	If eight nurses held one 4-hour clinic per week for 40 weeks, with 15-minute appointments. Assuming no DNAs. 8 × 40 × (4/0.25) = 5,120
Number who benefit (N)	5,120	Assumed everyone benefits.
Additional costs of pathway improvement	£186,265.32	(2,036 × 12.75) + (3,084 × 51.98)
Pathway effects		

Increase in number treated in the community COPD service	734	Assuming five RNSs saw 1,712 patients in a year without any joint clinics and 1,529 in a year with joint clinics (1,712 – 183). Each RNS would be able to have 305.8 contacts per year alongside their joint clinics. This means they would be able to see 2,446.4 people per year, or 734.4 more than the baseline year (1,712). The estimated cost per patient is estimated at £266.39 and the benefit score attributed to the community COPD service was 92 (see **data sources for the efficiency frontier** section).
Additional population health gain	447,128	Number of additional patients treated in the community COPD service + benefit score of the community COPD service + Improved score of current reviews × current number of yearly reviews + benefit score of additional reviews × number of estimated additional reviews. (734 × 92) + (2,036 × 38) + (3,084 × 98)
Cost savings	-£195,530.26	266.36 × 734 Number is negative as represents costs incurred.

Targeting spirometry testing and improving uptake

Increasing capacity to meet demand

Metric	Value	Description
Pathway improvement		
Cost of spirometry test **(C)**	£97.85	Based on ICB investment case. Used in the creation of the original efficiency frontier.
Benefit score **(B)**	98	Score given to spirometry testing in the decision conferences.
Number treated: Additional number given a spirometry test **(N_t)**	720	The number of additional spirometry tests required to clear the backlog.
Number who benefit: Number of people diagnosed with COPD **(N)**	203	The people who benefit are those who get a diagnosis of COPD and can therefore be put on the right treatment pathways. In the community COPD service in 2021/22, 28.14% of spirometry tests led to a diagnosis of COPD. 720 × 0.2814 = 202.61
Additional costs of pathway improvement	£70,452	Number of additional spirometry tests × cost of spirometry test. 720 × 97.85

Additional population health gain	19,894	Number of people diagnosed × benefit score. 203 × 98
Pathway effects		
Predicted reduction in COPD hospital admissions: NNT	47	NNT = 1/absolute risk reduction (ARR). ARR = control event rate – experiment event rate. After three years, Kostikas et al. (2020) report a hospitalisation rate of 73.52 per 100 person years (PY) in late-diagnosed COPD patients and 50.46 per 100 PY in early-diagnosed COPD patients. ARR = 0.7352 – 0.5046 = 0.2306 NNT = 1/0.2306= 4.34 Predicted reduction in COPD hospital admissions: 203/4.34 = 46.77 per year. A hospital admission has a unit cost of £2,572.80.
Predicted reduction in AECOPDs managed in primary care	35	After three years, Kostikas et al. (2020) report an exacerbation rate in late-diagnosed COPD patients of 108.94 per 100 PY and 57.23 per 100 PY in early-diagnosed COPD. ARR = 1.0894 – 0.5723 = 0.5171/3 = 0.1724 NNT = 1/0.1724 = 5.80

		Predicted reduction in AECOPDs managed in primary care = 203/5.80 = 35. An AECOPD managed in primary care has a unit cost of £45.19.
Cost savings	£122,503.25	Number of AECOPD managed in primary care avoided × cost of primary care-managed AECOPD + number of hospital admissions avoided × cost of hospital admission. (35 × 45.19) + (47 × 2,572.80)

Improving the diagnosis rate: case-finding with a 56.28% diagnosis rate

Metric	Value	Description
Pathway improvement		
Cost of spirometry test (C)	£97.85	Based on ICB investment case. Used in the creation of the original efficiency frontier.
Benefit score (B)	98	Score given to spirometry testing in the decision conferences.
Number treated: Additional number given a spirometry test (N_t)	720	The number of additional spirometry tests required to clear the backlog.
Number who benefit: Number of people	405	Assumed 56.28% diagnosis rate. 720 × 0.5628 = 405.22

diagnosed with COPD (N)		
Additional costs of pathway improvement	£70,452	Number of additional spirometry tests × cost of spirometry test. 720 × 97.85
Additional population health gain	39,690	Number of people diagnosed with COPD × benefit score. 405 × 98
Pathway effects		
Predicted reduction in COPD hospital admissions: NNT	93	Predicted reduction in COPD hospital admissions: 405/4.34 = 93.18 per year. A hospital admission has a unit cost of: £2,572.80.
Predicted reduction in AECOPDs managed in primary care	70	Predicted reduction in AECOPDs managed in primary care = 405/5.80 = 69.83. An AECOPD managed in primary care has a unit cost of £45.19.
Cost savings	£242,433.70	Reduction in AECOPDs managed in primary care × cost of primary care-managed AECOPD + reduction in hospital admissions × cost of hospital admission. (70 × 45.19) + (93 × 2,572.80)

Improving the diagnosis rate: case-finding with a 35% diagnosis rate

Metric	Value	Description
Pathway improvement		
Cost of spirometry test (C)	£97.85	Based on ICB investment case. Used in the creation of the original efficiency frontier.
Benefit score (B)	98	Score given to spirometry testing in the decision conferences.
Number treated: Additional number given a spirometry test (N_t)	720	The number of additional spirometry tests required to clear the backlog.
Number who benefit: Number of people diagnosed with COPD (N)	252	Assumed 35% diagnosis rate. 720 × 0.35 = 252
Additional costs of pathway improvement	£70,452	Number of additional spirometry tests × cost of spirometry test. 720 × 97.85
Additional population health gain	24,696	Number of people diagnosed × benefit score. 252 × 98
Pathway effects		

Predicted reduction in COPD hospital admissions: NNT	58	Predicted reduction in COPD hospital admissions: 252/4.34 = 58.06 per year. A hospital admission has a unit cost of £2,572.80
Predicted reduction in AECOPDs managed in primary care	43	Predicted reduction in AECOPDs managed in primary care = 252/5.80 = 43.45. An AECOPD managed in primary care has a unit cost of £45.19.
Cost savings	£151,165.57	Reduction in AECOPDs managed in primary care × cost of primary care-managed AECOPD + reduction in hospital admissions × cost of hospital admission. (43 × 45.19) + (58 × 2,572.80)

Targeted lung health checks

Metric	Value	Description
Cost of spirometry test **(C)**	£97.85	Based on ICB investment case. Used in the creation of the original efficiency frontier.
Benefit score **(B)**	98	Score given to spirometry testing in the decision conferences.
Number treated: Number given a spirometry test	371	The TLHC team is expecting to do no more than 480 scans in 2023/24 for both Coventry and Rugby patients.

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(N_t)		According to ONS, in 2018 Coventry had a population of 366,785 and Rugby had a population of 107,194 (ONS, n.d.), so between the two areas 77.38% of the population live in Coventry. Assuming the number of tests split between the two areas is in line with this, 371.44 tests would be for Coventry residents. It is expected the number of tests for Coventry and Rugby patients would drop off after the first year once the backlog is cleared.
Number who benefit: **Number of additional people diagnosed with COPD** **(N)**	104	Assuming the same diagnosis rate as in the baseline year (28.14%). 371 × 0.2814 = 104.40
Additional costs of pathway improvement	£36,302.35	Number of additional spirometry tests × cost of spirometry test. 97.85 × 371
Additional population health gain	10,192	Number of people diagnosed × benefit score. 104 × 98
Pathway effects		

Predicted reduction in COPD hospital admissions: NNT	24	Predicted reduction in COPD hospital admissions: 104/4.34 = 23.96 per year. A hospital admission has a unit cost of £2,572.80
Predicted reduction in AECOPDs managed in primary care	18	Predicted reduction in AECOPDs managed in primary care = 104/5.80 = 17.93. An AECOPD managed in primary care has a unit cost of £45.19.
Cost savings	£62,560.62	Reduction in AECOPDs managed in primary care × cost of primary care-managed AECOPD + reduction in hospital admissions × cost of hospital admission. (24 × 2,572.8) + (18 × 45.19)

Carer support

Metric	Value	Description
Cost of carer support	£168	Assumed that it would take three hours a week to plan and run the support group and one hour a week to manage the Facebook group over 40 weeks. Assuming a band 7 counsellor undertakes this, the cost is £63 an hour according to PSSRU. Total cost is £10,080; assuming 60 people are treated, that would be £168 per person.

Benefit score **(B)**	80	80 was the score that was given for self-care interventions. Have assumed that the benefit of carer support is like that of being able to self-manage someone’s condition.
Number treated: Number attending support groups **(N_t)**	60	Assumed that carer support will be done off the back of the initial peer support group. Therefore, number of people receiving the intervention will be the same. Assumed that the number of people attending the support groups remain the same.
Number who benefit **(N)**	60	Assumed everyone benefits.
Additional costs of pathway improvement	£10,080	Number of people attending support groups × cost per person. 60 × 168
Additional population health gain	4,800	Number of people attending support groups × benefit score. 60 × 80

Innovation in smoking cessation services

Increasing capacity in the Healthy Lifestyles service

Metric	Value	Description
Pathway improvement		

Cost of smoking cessation for Healthy Lifestyles (C)	£458.87	Estimated cost per person setting a quit date used in the creation of the original efficiency frontier.
Primary prevention		
Benefit score (B)	100	The relative benefit score given in the decision conferences.
Number treated: Number of additional people setting a quit date (N_t)	2,868	3,259 additional smokers would have to set a quit date to reach the 5% NICE target. Assumed 12% already have COPD and therefore would be for tertiary prevention: 3,259 – (3,259 × 0.12) = 2,867.92
Number who benefit: Number of additional people quitting (N)	1,234	There was a 43.03% 12-week quit rate in the Healthy Lifestyles service in 2021/22. Assumed the quit rate will remain the same. 0.4303 × 2,868 = 1,234.10
Tertiary prevention		
Benefit score (B)	99	Benefit score attributed to tertiary prevention smoking cessation in the decision conference.
Number treated: Additional number of	391	Assumed 12% of people treated have COPD already. This assumption has been confirmed with the Healthy Lifestyles team.

people setting a quit date **(N_t)**		3,259 × 0.12 = 391.08
Number who benefit: Number who quit **(N)**	168	There was a 43.03% quit rate in the Healthy Lifestyles service in 2021/22. Assumed the quit rate will remain the same. 0.4303 × 391 = 168.25
Additional costs of pathway improvement	£1,495,457.33	Cost of Healthy Lifestyles smoking cessation service × number of people setting quit dates. 458.87 × (391 + 2,868)
Additional population health gain	140,032	Benefit score (primary prevention) × number of people setting a quit date (primary prevention) + benefit score (secondary prevention) × benefit score (secondary prevention). (100 × 1,234) + (99 × 168)
Pathway effects		
Reduction in hospitalisations **(R)**	7	NNT = (1 – (PEER × (1 – HR))) / ((1 – PEER) × (PEER) × (1 – HR)) Godtfredsen et al. (2002) reported a HR of 0.57. In 2021/22 there were 680 hospital admissions for COPD in 6,385 people.

		Therefore, the patient expected event rate is 10.65 per 100 people (680/6385 × 100). NNT = (1 – (0.1065 × (1 – 0.57))) / ((1 – 0.1065) × (0.1065) × (1 – 0.57)) = 23.32 Reduction in hospitalisations = 168/23.32 = 7.20. A hospital admission has a unit cost of £2,572.80.
Reduction in primary care-managed AECOPD **(R)**	10	In 2021/22 there were an estimated 3,115 primary care-managed AECOPDs for 6,385 people with COPD. Therefore, the expected event rate is 48.79 per 100 people (3,115/6,385 × 100). Au et al. (2009) reported a HR of 0.78. NNT = (1 – (0.4879 × (1 – 0.78))) / ((1 – 0.4879) × (0.4879) × (1 – 0.78)) = 16.24 Reduction in primary care-managed AECOPDs = 168/16.24 = 10.34. An AECOPD managed in primary care has a unit cost of £45.19.
Reduction in number of people developing COPD per year **(R)**	141	NNT = 1/absolute risk reduction (ARR) ARR = control event rate – experiment event rate Terzikhan et al. (2016) reported an incidence of COPD of 19.7/1,000 PY in current

		smokers and 8.3/1,000 PY in former smokers. ARR = 0.197 – 0.083 = 0.114 NNT = 1/0.114 = 8.77 Reduction in number of people developing COPD = 1,234/8.77 = 140.72. This is expected to save £744.57 per case avoided per year.
Cost savings	£123,455.87	Number of hospital admissions avoided × cost of hospital admission + number of primary care-managed AECOPDs × cost of primary care-managed AECOPD + number of cases of COPD avoided × expected cost per year of treating someone with COPD. (7 × 2,572.80) + (10 × 45.19) + (141 × 744.57)

Improving quit rates from GP- and pharmacy-led services

Metric	Value	Description
Pathway improvement		
Additional cost of smoking cessation for GP-led services (C)	£272.27	Cost per person setting estimated at £186.60 in GP-led services and £458.87 in the Healthy Lifestyles led service, so the extra cost is £458.87 – £186.60.

		The extra cost is due to the counselling that someone would receive on the Healthy Lifestyles service.
Primary prevention		
Benefit score (B)	100	The relative benefit score given in the decision conferences.
Number treated: Number of people setting a quit date (N_t)	669	Additional number of people accessing GP-led services remains the same. See **data sources for the efficiency frontier**.
Number who benefit: Number of additional people quitting (N)	94	There was a 43.03% quit rate in the Healthy Lifestyles service in 2021/22. There was an average 29% quit rate in GP- and pharmacy-led services. Assuming these services would have the same quit rate as the Healthy Lifestyles service, it would increase the quit rate by 14.03%. 669 × 0.1403 = 93.86
Tertiary prevention		
Benefit score (B)	99	Benefit score attributed to tertiary prevention smoking cessation in the decision conference.

Number treated: Additional number of people setting a quit date **(N_t)**	57	Assuming the number treated stays the same as the baseline year. As shown in the **data sources for the efficiency frontier**.
Number who benefit: Additional number who quit **(N)**	8	There was a 43.03% quit rate in the Healthy Lifestyles service in 2021/22. There was an average 27% quit rate in GP-led services. Assuming these services would have the same quit rate as HLS services, it would increase the quit rate by 14.03%. 57 × 0.1403 = 8.00
Additional costs of pathway improvement	£197,668.02	Cost of smoking cessation service × number of people setting quit dates. 272.27 × (669 + 57)
Additional population health gain	10,192	Benefit score (primary prevention) × number of people setting a quit date (primary prevention) + benefit score (secondary prevention) × benefit score (secondary prevention). (100 × 94) + (8 × 99)
Pathway effects		

Reduction in hospitalisations **(R)**	0	NNT = (1 – (PEER × (1 – HR))) / ((1 – PEER) × (PEER) × (1 – HR)) Godtfredsen et al. (2002) reported a HR of 0.57. In 2021/22 there were 680 hospital admissions for COPD in 6,385 people. Therefore, the patient expected event rate is 10.65 per 100 people (680/6385 × 100). NNT = (1 – (0.1065 × (1 – 0.57))) / ((1 – 0.1065) × (0.1065) × (1 – 0.57)) = 23.32 Reduction in hospitalisations = 8/23.32 = 0.34. A hospital admission has a unit cost of £2,572.80.
Reduction in primary care-managed AECOPD **(R)**	0	In 2021/22 there were an estimated 3,115 primary care-managed AECOPDs for 6,385 people with COPD. Therefore, the expected event rate is 48.79 per 100 people (3,115/6,385 × 100). Au et al. (2009) reported a HR of 0.78. NNT = (1 – (0.4879 × (1 – 0.78))) / ((1 – 0.4879) × (0.4879) × (1 – 0.78)) = 16.24 Reduction in primary care-managed AECOPD = 8/16.24 = 0.49.

		An AECOPD managed in primary care has a unit cost of £45.19.
Reduction in number of people developing COPD per year **(R)**	11	Reduction in number of people developing COPD = 94/8.77 = 10.71. This is expected to save £744.57 per case avoided per year.
Cost savings	£8,190.27	Number of cases of COPD avoided × expected cost per year of treating someone with COPD. 11 × 744.57

Education package for people with COPD

Metric	Value	Description
Cost of SPACE programme per person **(C)**	£45.67	Costs for the SPACE programme are not publicly available. Therefore, we have used the real-world costs outlined in a paper looking at DESMOND (a similar programme for diabetes) (Gillett et al., 2010). Total costs include:

		Trainer time	£28,470	Based on 7.5-hour day for a band 6 AFC at £52 an hour (£390 per day) (Burns & Jones, 2021b). One educator per course for one day per course; assumed average of 10 patients per course. Each patient would attend the course once. Would have to do 73 courses to cover all 728 patients. 73 × 390 = 28,470
		Starter pack	£3,258.00	£250 starter pack, £3.90 per participant and £200 for additional materials.
		Training costs	£1,400	Confirmed by DESMOND team per educator (assumed one educator).

<table>
<tr><td></td><td></td><td><table><tr><td>Course admin</td><td>£122.50</td><td>3.5 hours per course at Band 4 (£20,821 per year including costs).</td></tr><tr><td>Total</td><td colspan="2">£33,250.50</td></tr></table>Cost per person = £33,250.50/728 = £45.67</td></tr>
<tr><td>Benefit score
(B)</td><td>90</td><td>Score assigned to such a programme in the decision conference.</td></tr>
<tr><td>Number treated: Number of people enrolled in SPACE per year
(N_t)</td><td>728</td><td>The number of prospective SPACE patients is estimated by the number of people diagnosed with COPD in baseline year, which is estimated to be 728, assuming all of them are expected to be enrolled to SPACE.
Assumed the rate is the same.</td></tr>
<tr><td>Number who benefit
(N)</td><td>728</td><td>Assumed everyone benefits.</td></tr>
<tr><td>Additional costs of pathway improvement</td><td>£33,250.50</td><td>Cost of SPACE programme × number of people enrolled in SPACE programme.
45.67 × 728</td></tr>
<tr><td>Additional population health gain</td><td>65,520</td><td>Benefit score × number of people enrolled in SPACE programme.
728 × 90</td></tr>
</table>

Targeted awareness campaign

Metric	Value	Description
Pathway improvement		
Cost of awareness campaign per person treated **(C)**	£76.76	No information is available on what the cost of the campaign would be. Therefore, we have assumed that there would be one band 7 health promotion project manager hired to run the campaign at £56,011 (salary + on costs) (PSSRU) as well as a budget of £10,000 for communications and engagements. This has then been divided by the total number of people expected to be treated as per below. (56,011 + 10,000) / (647 + 213) = £76.76
Spirometry testing		
Cost of spirometry test	£97.85	Based on ICB investment case. Used in the creation of the original efficiency frontier.
Benefit score **(B)**	98	Score given to spirometry testing in the decision conferences.
Number treated: Additional number given	647	Here we assume that the targeted campaign leads to 25% more people coming forward for spirometry testing than in the baseline year. 2,587 × 0.25 = 646.75

a spirometry test **(N_t)**		
Number who benefit: Number of people diagnosed with COPD **(N)**	182	In the community COPD service in 2021/22, 28.14% of spirometry tests led to a diagnosis of COPD. 646.75 × 0.2814 = 181.99
Pulmonary rehabilitation		
Cost per person **(C)**	£455	Cost provided by the Atrium.
Benefit score **(B)**	90	Score given in the decision conference.
Number treated: Number of additional accepted referrals **(N_t)**	213	Assumed the information campaign doubles the number of people seen in PR services. 213 people were seen in **the baseline year**.

Number who benefit: Additional number who complete the course (N)	79	Assumed the information campaign doubles the capacity in PR services. 79 people completed the PR course in the baseline year.
Additional costs of pathway improvement	£266,237.55	Cost of targeted awareness campaign × number of people doing spirometry testing and PR + cost of spirometry testing × number of people tested + cost of PR × number of accepted referrals for PR. (76.76 × (213 + 647)) + (97.85 × 647) + (455 × 213)
Additional population health gain	24,946	Benefit score (spirometry) × number of additional people diagnosed + benefit score (PR) × number of people completing course. (98 × 182) + (90 × 79)
Pathway effects		
Spirometry testing		
Predicted reduction in COPD hospital admissions: NNT	42	Predicted reduction in COPD hospital admissions: 182/4.34 = 41.94 per year. A hospital admission has a unit cost of £2,572.80.

Predicted reduction in AECOPDs managed in primary care	94	After three years, Kostikas et al. (2020) report an exacerbation rate in late-diagnosed COPD patients of 108.94 per 100 PY and 57.23 per 100 PY in early-diagnosed COPD. ARR = 1.0894 – 0.5723 = 0.5171 NNT = 1/0.5171= 1.93 Predicted reduction in AECOPDs managed in primary care = 182/1.93 = 94.30. An AECOPD managed in primary care has a unit cost of £45.19.
Pulmonary rehabilitation		
Reduction in hospital admissions **(R)**	4	NNT = (1 – (PEER × (1 – OR))) / ((1 – PEER) × (PEER) × (1 – OR)) According to Puhan et al. (2016), the OR is 0.66. In 2021/22 there were 680 hospital admissions for COPD in 6,385 people. Therefore, the patient expected event rate is 10.65 per 100 people (680/6,385 × 100). NNT = (1 – (0.1065 × (1 – 0.44)))/ ((1 – 0.1065) × (0.1065) × (1 – 0.44)) = 17.65. Number of hospital admissions avoided = 79/17.65 = 4.48. A hospital admission has a unit cost of £2,572.80.
Cost savings	£122,608.66	Reduction in hospital admissions (spirometry) × cost of hospital admission + number of AECOPDs

		managed in primary care avoided (spirometry) × cost of primary care-managed AECOPD + reduction in hospital admissions (PR) × cost of hospital admission. (42 × 2,572.80) + (94 × 45.19) + (4 × 2,572.80)

Education in schools against smoking and vaping

Metric	Value	Description
Cost per person of programme **(C)**	£5.78	According to INTENT, the course costs £205 per smoker prevented. The cost of preventing 897 pupils from smoking would be 205 × 897 = £183,884.92. To get the cost per person treated we divide that by the number treated: 183,885 / 31,814 = 5.78.
Benefit score **(B)**	100	Score given to primary prevention smoking cessation in the decision conference.
Number treated: Number of school children in Coventry **(N_t)**	31,814	There are 31,814 school-aged (11–18) children in Coventry according to the ONS in 2018.
Number who benefit: Avoided	977	According to INTENT, children are 25.6% less likely to smoke due to their programme.

smokers and vapers **(N)**		According to NHS Digital (2022), 3% of school-aged children smoke and 9% vape in the country. Assumed someone either smokes or vapes. So an estimated 12% of school-aged children currently smoke in Coventry. Here we assume the risk of developing COPD from vaping is the same as from smoking. Therefore, it can be expected that, due to the INTENT programme, 3.07% (0.12 × 0.256) of children would avoid smoking. 31,814 × 0.0307 = 976.69
Additional costs of pathway improvement	£183,884.92	Cost of INTENT programme per person × number of school children in county. 5.78 × 31,814
Additional population health gain	97,700	Number of avoided smokers and vapers × benefit score. 977 × 100
Pathway effects		
Number of avoided cases of COPD	102	NNT = 1/absolute risk reduction (ARR) ARR = control event rate – experiment event rate Terzikhan et al. (2016) reported the incidence of COPD in current smokers was 19.7/1,000 PY and 8.3/1,000 PY in former smokers. ARR = 0.197 – 0.083 = 0.114 NNT = 1/0.114 = 8.77

		Number of expected avoided cases of COPD per year: 897/8.77 = 102.28. This is expected to save £744.57 per case avoided per year.
Cost savings	£75,946.14	Number of cases of COPD avoided × expected cost per year of treating someone with COPD. 102 × 744.57

Expansion of the virtual ward

Metric	Value	Description
Pathway improvement		
Cost of virtual ward per person **(C)**	£944.79	Cost of virtual ward used in original efficiency frontier. This cost assumes that: • the cost of the virtual ward software itself is negligible • each person would spend one day in hospital (at an average cost of £582.69 based on hospital admission data) • each patient would have 7.1 hours of specialist nursing visits at a cost of £51 per hour (Burns & Jones, 2021b; Echevarria et al., 2018). 0 + 582.69 + (51 × 7.1) = 944.79
Benefit score	73	Score used in the decision conference.

(B)		
Number treated: Number of patients eligible for the virtual ward **(N_t)**	340	It is assumed that patients with a DECAF score of 0 or 1 (approximately 50% of patients) are eligible (Echevarria et al., 2018). There were 680 hospital admissions in 2021/22.
Number who benefit **(N)**	340	Assumed everyone benefits.
Additional costs of pathway improvement	£321,228.60	Number of people treated on virtual ward × cost of virtual ward. 340 × 944.79
Additional population health gain	24,820	Benefit score × number of people treated on virtual ward. 73 × 340
Pathway effects		
Number of hospital admissions replaced by virtual ward	340	There would be 340 normal hospital admissions for the people who would be ineligible for the virtual ward. A hospital admission has a unit cost of £2,572.80.
Cost savings	£874,752	Number of hospital admissions replaced by virtual ward × the cost of a hospital admission. 340 × 2,572.80

6. Information pre-pack

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