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 Gloucestershire ICS

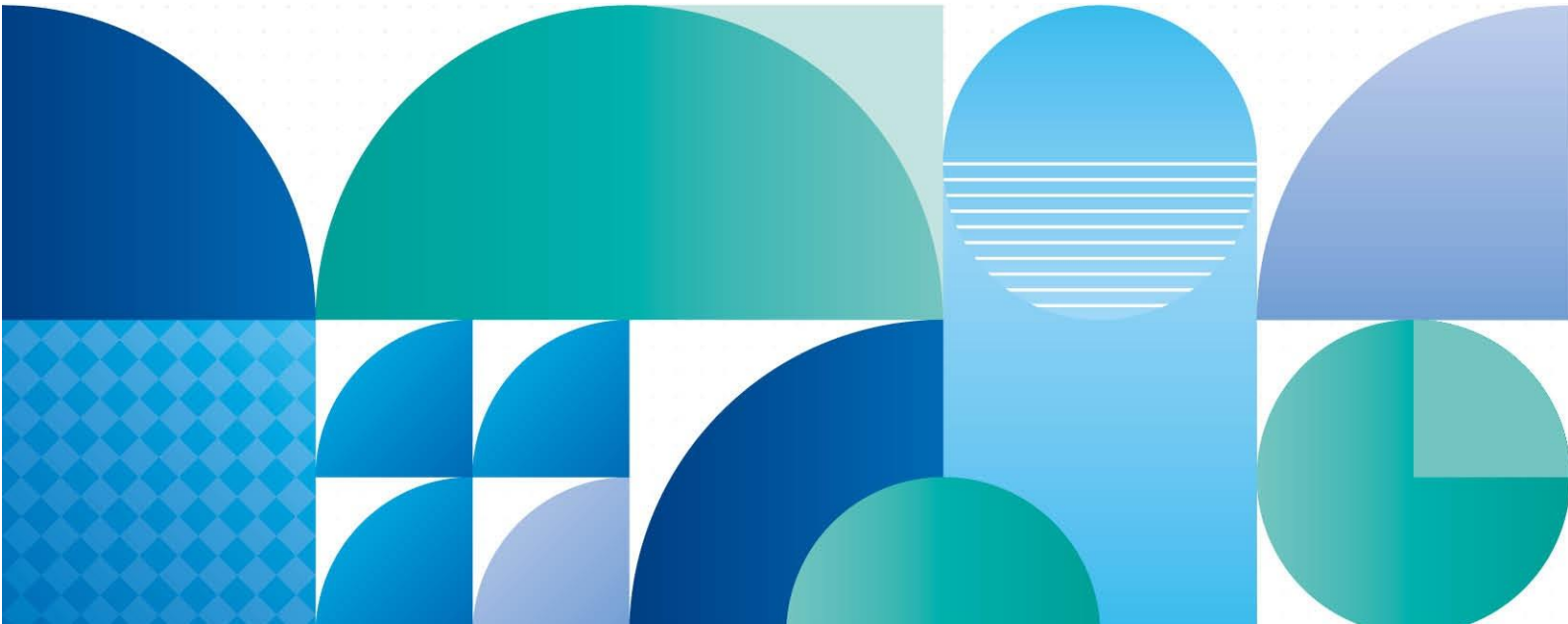

Table of Contents

Introduction

This report summarises the outputs of the Socio-Technical Allocation of Resources (STAR) project undertaken by Gloucestershire Integrated Care System's (ICS's) Programme Development Group, facilitated by the Health Economics Unit (HEU). The objective of this project was to support Gloucestershire ICS 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 and understand the COPD pathway (i.e., the interventions and programmes offered to prevent and treat COPD).
2. Identify the key opportunities for improving COPD prevention and treatment in Gloucestershire.
3. Assess the relative value for money of the different interventions in the COPD pathway in Gloucestershire.
4. Create a priority list of the pathway improvements (i.e., interventions or programmes) that can be implemented in Gloucestershire.

This report is designed for the respiratory programme to support its planning for the COPD pathway. It should be used by Gloucestershire's respiratory programme to inform investment decisions, budget planning and programme plans. It is also possible that implementing these schemes could free up resources that can be used to meet other priorities.

Recommendations

It is recommended that Gloucestershire ICS invest in the pathway improvements that have the best cost/population health ratio, as this will ensure the investment leads to the most health generated per pound spent. It is recommended that the ICS focus on the following interventions:

- More effective use of the virtual ward
- Improving uptake to Mindsong and KiActiv
- Proactive case finding to identify cases of COPD
- Very brief advice for tobacco dependency
- Increasing uptake of pulmonary rehabilitation (online offering)

If implemented as described, these pathway improvements are expected to be cost saving. They are estimated to save £1.04m net per year and lead to a 12.4% percentage point increase to population health. The recommendations are explained in more depth in the **determining the next steps 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.
- Create a common understanding of the current pathways for preventing, diagnosing and treating people with COPD in England.
- Identify and prioritise pathway improvements drawing upon principles of allocative efficiency.

Smarter Spending in Population Health

This project forms a part of 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 Gloucestershire

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 Gloucestershire focused on building a common understanding of the population for those at risk of developing COPD or already living with COPD as well as the relative value of all COPD pathway components; that is, all the interventions currently offered in Gloucestershire 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 Gloucestershire** section.

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

Following the decision conferences, 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.

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 of the COPD pathway and to generate meaningful ways it can be improved. The people who attended the decision conferences are outlined below:

A patient representative

Gloucestershire County Council

- Dino Motti — Public Health Consultant
- Lynette Bishop — Principal Public Health Analyst

Gloucestershire ICB

- Alan Thomas — Lay Member and Patient/Public representative
- Alice Brixley — Project Manager for Tobacco Dependency, Social Prescribing and Creative Health
- Amy Critchley — Programme Manager, Respiratory CPG
- Bronwyn Barnes — Head of Locality Development
- Carol Stonham — Senior Respiratory Nurse Practitioner
- Chris Trout — Finance and Information Lead, Business Intelligence
- Douglas Forbes — Project Manager, Respiratory CPG
- Gemma Artz — Programme Director, Clinical Programmes
- Gina Mann — Service Improvement Manager, Respiratory CPG
- Graham Mennie — GP Respiratory Lead
- Hannah Gorf — Commissioning Development Manager for Social Prescribing and Creative Health
- Neil Penny — Health and Social Care Commissioning Manager
- Sian Williams — ICS Clinical Lead, Community Pharmacy Integration

Gloucestershire Health and Care NHS Foundation Trust

- Angela Stonham — Respiratory Clinical Team Lead
- Des Gorman — Deputy Director, Strategy and Partnerships
- Esther Mitchell — Community Manager for the Long-term Conditions Service
- Elizabeth Mount — Integrated Respiratory Practitioner and Co-Lead for Gloucestershire Respiratory Service

Gloucestershire Hospitals NHS Foundation Trust

- Angela Wilkins — General Manager
- Charity Gladstone — Matron, Cardiology and Respiratory
- Charles Sharp — Consultant in Respiratory Medicine
- Simon Lanceley — Director of Strategy and Transformation
- Stacey Webb — Assistant General Manager for Cardiology and Respiratory
- Zoe Stoneley — Health Improvement Manager

St Catherine's Surgery, Cheltenham

- Richard Tilson — General Practitioner

Mythe Medical Practice

- Lisa Healey — Nurse Practitioner

Attendees to the decision conferences (continued)

Mindsong

- Karen Lawton — Chief Executive Officer

PeoplePlus

- Jane Burns

ELCOM

- Simon Holmyard — Vice President of Public Sector Sales

Health Economics Unit/Strategy Unit (facilitating)

- James de Lacy — Senior Consultant
- Jack Ettinger — Senior Health Economist
- Sophie Hodges — Client Service Manager
- Luca Ricci-Pacifici — Consultant

The COPD population, pathway and main challenges

Population

The aim of the first part of the decision conferences was to ensure the attendees all had a common understanding of the population for whom they are making decisions and the different risk segments in the ICS.

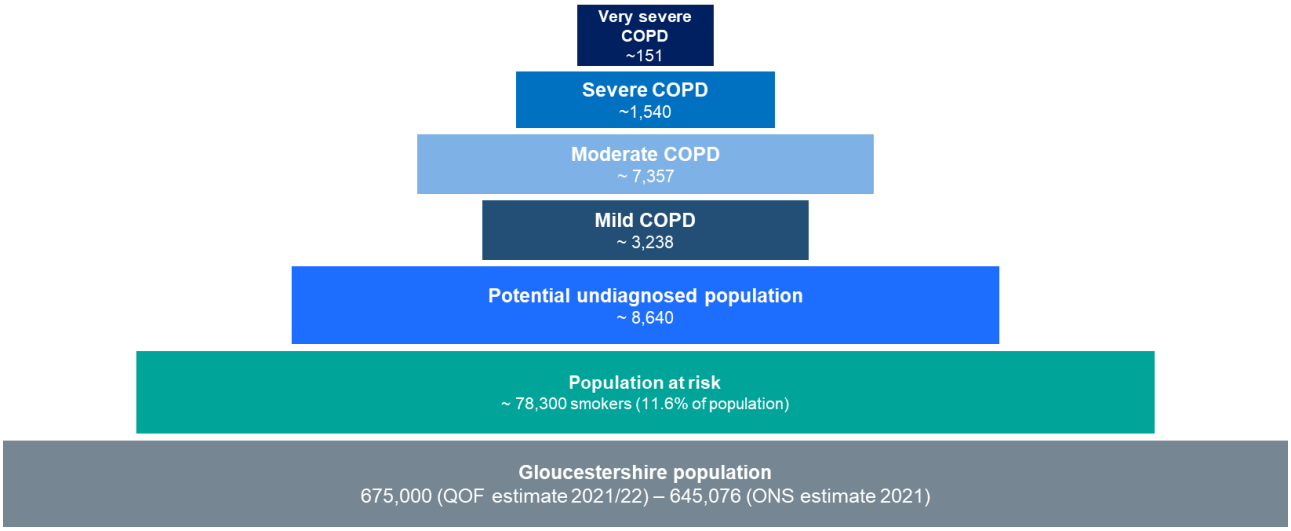

Figure 1 – Population pyramid in Gloucestershire ICS (sources are described in the appendices)

As shown in Figure 1, the total population of Gloucestershire is 675,000 people. In terms of those at risk of COPD, the percentage of smokers in the ICS is 11.6% which equates to around 78,300 smokers. There are potentially 8,640 people living with undiagnosed COPD in the county and 12,286 people with diagnosed COPD (Nacul et al., 2007; Office for Health Improvement and 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.

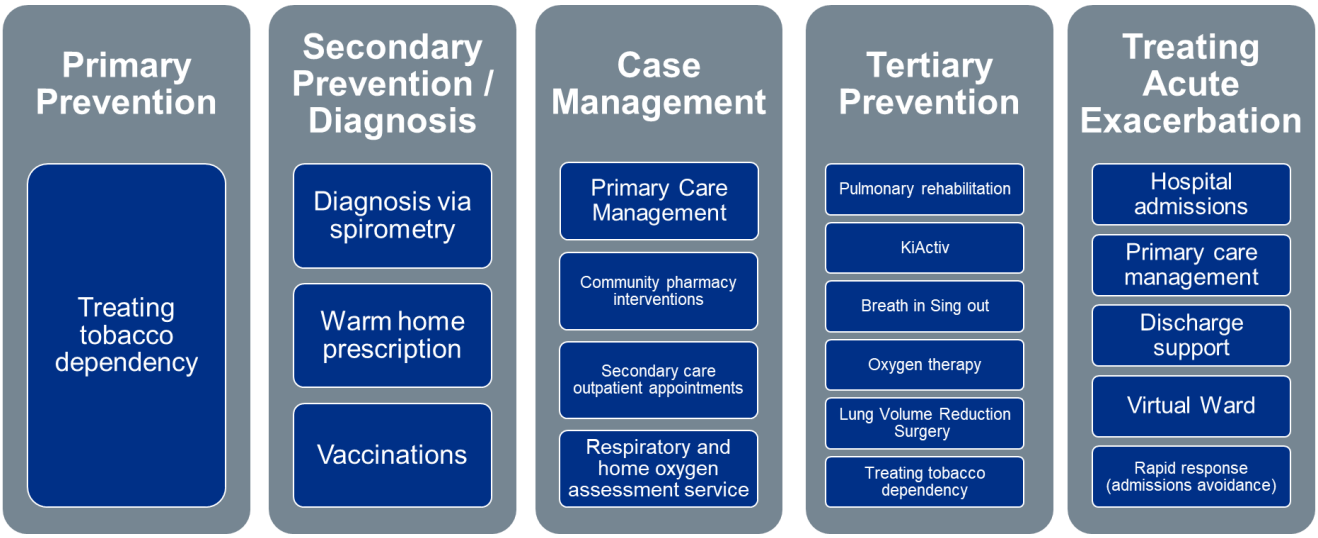

Figure 2 – The current care pathway for those living with and at risk of developing COPD

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 using a visual analogue scale (VAS). 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 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 and identifying the appropriate interventions to improve the pathway, as well as in 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, 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.

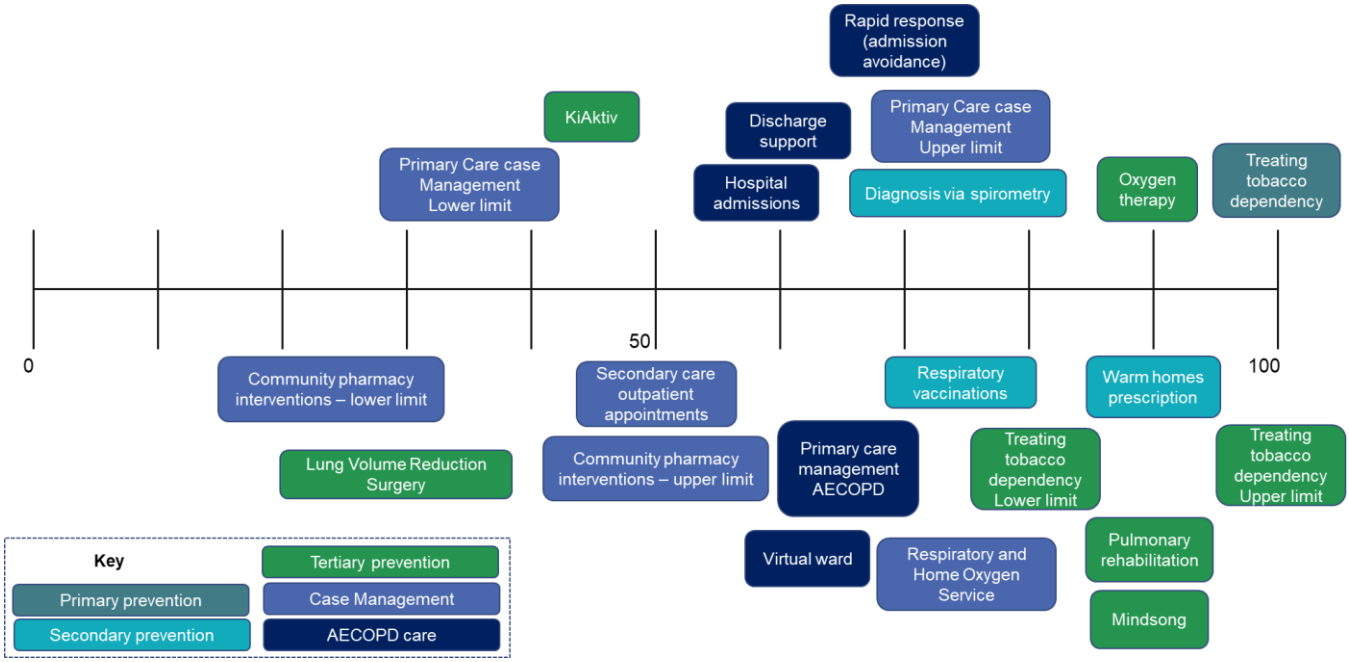

Figure 3 – Benefit scores of each of the interventions in the COPD pathway

The value of the COPD pathway in Gloucestershire

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 Gloucestershire.

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

[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).

Interpreting the efficiency frontier

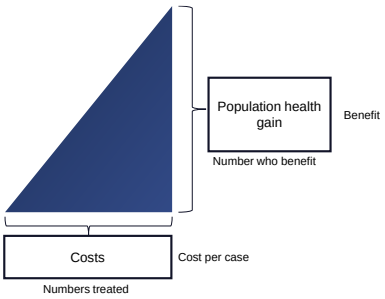

Figure 4 – Populating the efficiency frontier

The efficiency frontier is produced by triangles of value for money for each intervention in that 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 5 – Triangles showing low value for money (left) and high value for money (right)

In the triangles above, we can easily see 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.

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 (represented in Figure 6a), thus reducing costs and improving the population health benefit of the pathway (compared with the curve in Figure 6b).

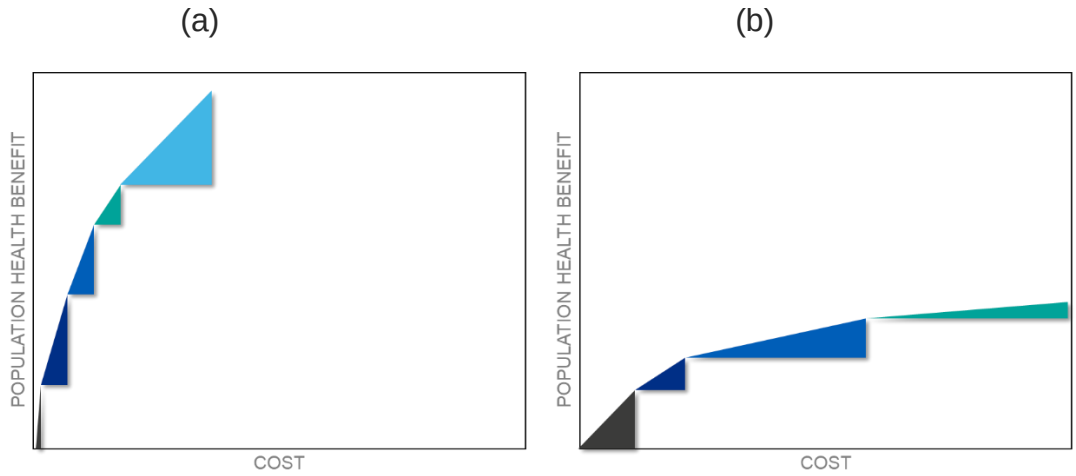

Figure 6 – Different efficiency frontiers with good (a) and bad (b) value for money

The efficiency frontier in Gloucestershire

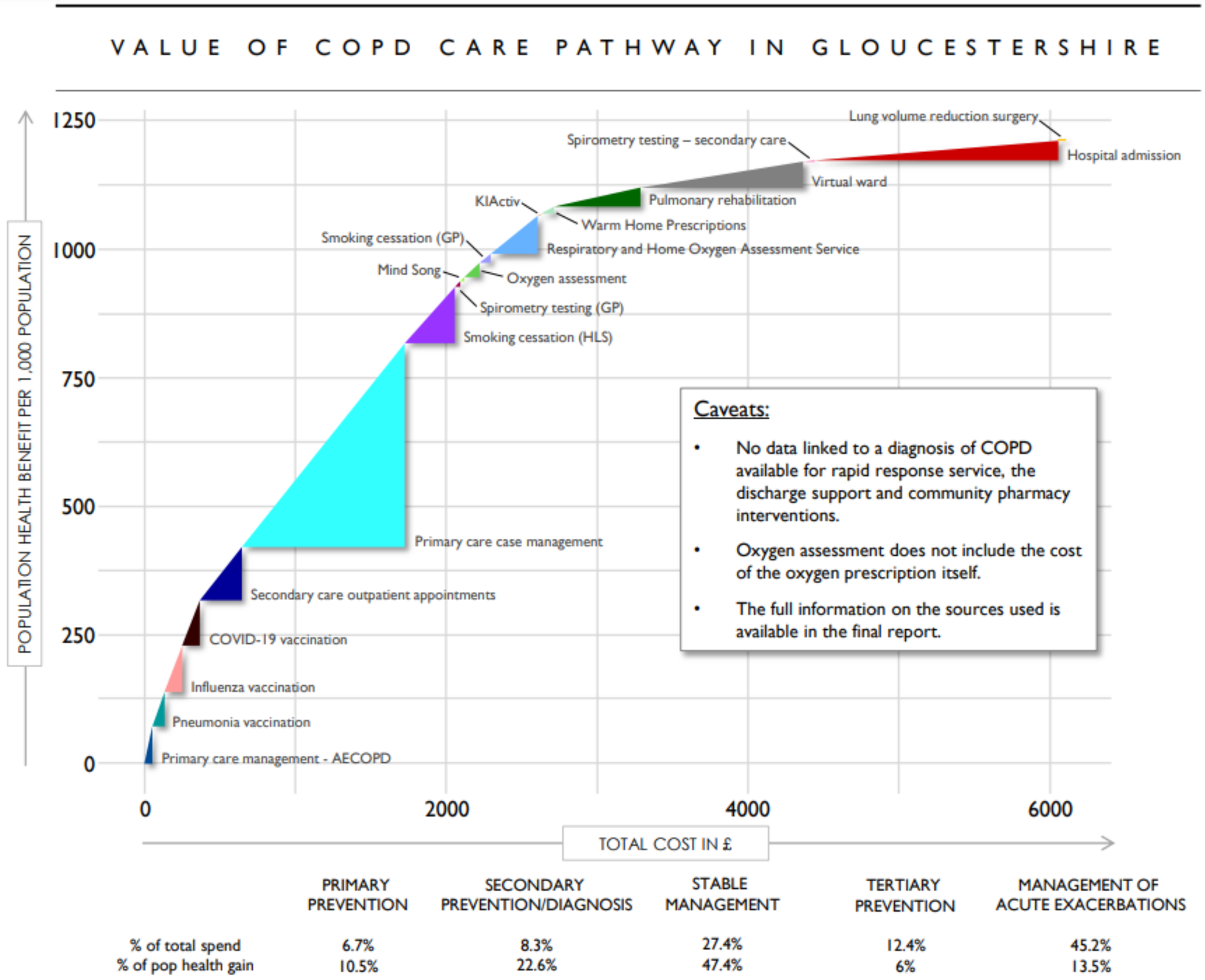

Figure 7 – The efficiency frontier for the COPD pathway in Gloucestershire

Main opportunities

By reflecting on the efficiency frontier (Figure 7) and through considering the challenges identified by the stakeholders involved in the decision conference, four main areas of focus were identified by our stakeholders:

1. More proactive and earlier interventions in primary care.
2. Creation of an alliance with responsibilities for treating tobacco dependency and advocating for tobacco control.
3. Enhancing the role of social prescribing and awareness of tertiary prevention services.
4. Managing acute exacerbations more efficiently.

More proactive and earlier interventions in primary care

Many of the highest value interventions in the **efficiency frontier** are delivered in primary care. This is because primary care interventions are relatively cheap per person compared to acute services and can reach many more people. However, there is variability in the care offered in primary care. Some clinicians working in primary care may have experience or training in respiratory conditions and therefore are able to provide better advice and guidance, for example on inhaler technique. Improving the quality of primary care management could help the ICS to intervene earlier in a patient's disease pathway.

Similarly, as shown in the **population pyramid** above, there are potentially 8,640 people living in Gloucestershire with undiagnosed COPD. Until these people get a diagnosis of COPD, they will be unable to access many of the services that can help improve their condition. There is also evidence that an early diagnosis helps to reduce hospital admissions (Kostikas et al., 2020b). It is in the ICS's interest to proactively find people with undiagnosed COPD and get them on the correct treatment pathway earlier to avoid the negative consequences of a late diagnosis.

Creation of an alliance with responsibilities for treating tobacco dependency and advocating for tobacco control

There is more that can be done to help people to quit smoking and stop them smoking in the first place. However, there are some activities which are outside of the respiratory programmes remit. For example, implementing smoking prevention initiatives in schools and introducing tobacco control measures and legislation. However, the group discussed setting up an alliance which could advocate for the things outside their direct control and implement pathway improvements that are within their direct control.

Enhancing the role of social prescribing and improving uptake and completion rates for tertiary prevention services

There are many services available to patients with COPD that have been proven to improve their quality of life, physical and mental wellbeing and reduce hospital admissions, such as pulmonary rehabilitation (PR), KiActiv – a personalised online physical activity

course – and Mindsong's Breathe in and Sing out groups. However, there is not widespread knowledge of these services among clinicians and even when patients do attend these services they do not always complete them.

This is of particular concern for PR, which is widely regarded as the best non-pharmacological intervention for people with COPD (Bolton et al., 2013). For example, of the 4,074 people who have a recorded MRC score of 3+ in 2021/22, only 15% of them attended a PR course. Of those attending, the completion rate for PR services is estimated at 67%[2] (Office for Health Improvement and Disparities, 2022).

Managing acute exacerbations more efficiently

Gloucestershire ICS is in the lowest quartile nationally in terms of the total non-elective bed days per 100,000 population (NHS England, n.d.). However the management of acute exacerbations still accounts for 45.2% of the total spend in the COPD pathway.

Treating people outside of hospital is beneficial for the patient. It reduces the risk of hospital acquired infections and allows them to be treated closer to home. It is also beneficial for the health system. Doing more to keep people out of hospital could free up resource that can be used elsewhere.

[2] No data on PR completion rates is available. This estimate was given by a respiratory nurse working at Gloucester Health and Care NHS Foundation Trust in the decision conferences.

Improving the pathway

Addressing the main opportunities

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

The pathway improvements that the attendees decided should be taken forward for consideration are summarised in the graphic below and then explained in more detail.

More proactive and earlier interventions in primary care	• Psychological support for patients • Multi-professional team (MPT) management of patients • Increase uptake of pneumonia vaccinations • Proactive case finding.
Creation of an alliance with responsibilities for treating tobacco dependency and advocating for tobacco control	• Increasing uptake to smoking cessation services • Vaping as a harm reduction pilot • Very brief advice (VBA) for tobacco dependency.
Enhancing the role of social prescribing and awareness of tertiary prevention services	• Avoiding fuel poverty • Improving PR services • Improving uptake to Mindsong and KiActiv.
Managing acute exacerbations more efficiently	• More effective use of the virtual ward • Acute assessment hubs for emergency attendance avoidance.

Figure 8 – Pathway improvements set out to meet the main challenges

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 such as expanding/introducing pr. Oher pathway improvements may consist of multiple interventions. For example, the pathway improvement ‘improving signposting to services’ would consist of signposting to a service as well as the expected increase in uptake of that service.

More proactive and earlier interventions in primary care

Psychological support for patients

Anxiety and depression are among the main co-morbidities for people living with COPD. However, treatment tends to focus on the physical symptoms and it can be difficult to access psychological support (Ma et al., 2020). Increasing the number of people being referred to Improving Access to Psychological Therapies (IAPT) services would help to improve physical and mental wellbeing as well as reducing the burden on hospital admissions and outpatient attendances (Gruber et al., 2022). Anxiety and depression can make it more difficult for someone to manage their COPD symptoms. For example, if someone is too anxious to exercise, their condition will deteriorate. This could lead to a lower quality of life and increased healthcare resource use. Psychological treatments may reduce healthcare resource use as people are better able to manage their own condition (Gruber et al., 2022).

IAPT services provide evidence-based treatments for people with depression and anxiety disorders, and co-morbid long-term physical health conditions (The National Collaborating Centre for Mental Health, 2023). In 2021/22, only 3,630 people with a recorded long-term condition were referred to IAPT services in Gloucestershire (Clinical audit and specialist care team – NHS Digital, 2022). Yet some sources indicate that the prevalence of anxiety in people living with COPD is around 50%. The rate of depression ranges from 10% to 42% in stable patients and up to 86% in patients with acute exacerbations (Ma et al., 2020).

The challenge here would be to get people to attend treatment sessions and training professionals to meet the expanded demand (Thornicroft, 2018).

Multi-professional team (MPT) management of patients

Currently in Gloucestershire, case management (or care co-ordination) can happen in one of three places: primary care, secondary care outpatients at Gloucester Hospitals NHS Foundation Trust or the Home Oxygen and Respiratory Service (HORS) at

Gloucestershire Community Health and Care NHS Foundation Trust. This means services do not always appear to be integrated.

Similarly, there is variability in the quality of care offered by primary care case management. If a patient's yearly review is conducted by a primary care clinician with a specialist interest in respiratory diseases, a patient will receive detailed advice and guidance. A primary care clinician without that specialist interest will not be able provide the same level of advice .

One way of overcoming this issue would be to embed an MPT team into each primary care network (PCN) in Gloucestershire. It was discussed in the decision conference that the MPT could upskill primary care clinicians on the management of COPD patients, therefore improving the quality of primary care case management. The aim of this service would be to improve the quality of primary care case management by supporting primary care clinicians to conduct more beneficial annual reviews, including medicine optimisation and symptom management advice.

Increase uptake of pneumonia vaccinations

As noted by the patient representatives that attended the decision conferences, a respiratory infection, such as pneumonia, is one of the last things you want if you already have COPD. It is estimated that 97.47% of people with COPD in Gloucestershire had their influenza vaccinations in the baseline year of 2021/22 and 96.05% had their COVID-19 vaccinations. However, only an estimated 60% of people had their pneumonia vaccinations (see data sources in **the appendices**). Therefore, more can be done to improve the number of people with COPD who take up a pneumonia vaccination.

Proactive case finding

Undiagnosed COPD cases can be found by opportunistic case detection involving screening people at higher risk of developing COPD during routine primary care visits. There is limited additional resource to conduct more spirometry tests beyond those already planned. Currently the percentage of spirometry tests that lead to a diagnosis of COPD is 7.33% (see data sources in **the appendices**). Improving this rate would improve the value for money generated by spirometry testing.

Given that high-risk smokers – defined as current smokers and those who have quit within the last five years (Tindle et al., 2018) – are one of the most prominent at-risk groups for developing COPD (Office for Health Improvement and Disparities, 2022), undiagnosed COPD cases are likely to be more prevalent among this group than the general population.

Based on available data sources and a literature review, we suggest that a **three-stage process** could be a cost-effective way to find undiagnosed COPD cases:

1. Identify high-risk smokers through risk stratification.
2. Screen them with a clinically validated questionnaire (COPD diagnostic questionnaire, CDQ).
3. Administer diagnostic spirometry testing for those with a CDQ score of 16.5 and above.

High-risk smokers can be identified via primary care databases that register people's smoking status. A few selection criteria based on age, smoking history and other demographics might also be applied to identify those at higher risk of having undiagnosed COPD.

To further refine the target population for diagnostic spirometry testing, we can use the CDQ as a cost-effective case-finding strategy, as suggested by the literature review (Johnson et al., 2021; Wright et al., 2015). According to Johnson et al.(2021), administering the CDQ during routine primary care visits (to community pharmacies, GPs or community centres) at five-year intervals is the most cost-effective case-finding strategy.

Creation of an alliance with responsibilities for treating tobacco dependency and advocating for tobacco control

Increasing uptake of smoking cessation services

Stopping people from smoking, whether they have COPD or not, was regarded in the decision conferences as the best thing you can do for someone's health. There are an estimated 78,300 smokers in Gloucestershire (see the **population pyramid above**). In 2021/22, an estimated 1,882 people set a quit date (2.4% of the smoking population). Of these people, 67.27% of them quit after four weeks (see data sources in **the appendices**).

Increasing the number of people with and without COPD accessing smoking cessation services could greatly improve the value of the COPD pathway.

Vaping as a harm reduction pilot

The long-term harms of e-cigarettes is not known, however their use is likely to be substantially less harmful than smoking tobacco (McNeil et al., 2022; NICE, 2023). One review by Public Health England suggested that e-cigarettes could be 95% less harmful than smoking in the long-term.(Public Health England, 2015) In some areas, like Northamptonshire, vapes are offered in smoking cessation services as a 'harm reduction' approach to treating tobacco dependency. Only the first month is paid for by the NHS (NEL WP admin, 2020).

Although the evidence surrounding the potential health benefits of vaping over smoking is growing, the long-term effect is not known. Therefore, this could be done as a pilot that is evaluated to help build the evidence base around vaping as a harm reduction approach. The Healthy Lifestyle Service would also work with people to ensure addiction to the vape is reduced.

Very brief advice for tobacco dependency

Staff in general practice could be mandated to offer 'very brief advice' (VBA) to people with COPD as part of their yearly reviews. This can increase the likelihood that a smoker will go on to engage with a smoking cessation service and successfully quit smoking (Stead et al., 2008)

The National Centre for Smoking Cessation and Training (NCSCT) online module is one recognised training module available for staff. It teaches them how to give VBA on smoking cessation.

Enhancing the role of social prescribing and awareness of tertiary prevention services

Avoiding fuel poverty

For people with COPD, a home that is kept above 18 degrees Celsius has been shown to improve respiratory related quality of life and may reduce hospital admissions (Osman et al., 2008, 2010).

Currently there is a 'warm home on prescription' pilot with Gloucester City Homes which looks to support people with respiratory conditions, such as COPD. This pilot aims to improve the energy efficiency of homes so people can better afford to keep warm.

Should this scheme prove to be successful, a wider rollout could bring benefits to patients and the health system.

Improving PR services

In 2021/22, an estimated 600 people accessed the PR service at Gloucestershire Health and Care NHS Foundation Trust (see data sources in the appendices). Currently all people with an MRC score of three and above are eligible for the PR service. This means of the 4,074 people with an MRC score of three and above, only 14.73% of people attend a PR course (Office for Health Improvement and Disparities, 2022).

In the decision conference, it was mentioned that this could be an accessibility issue as well as a capacity issue. Not everyone is able to travel to the hospital twice a week between 9am and 5pm to attend a PR course. Similarly, the HORS only has a limited amount of capacity to take on more people.

Looking at online PR options and moving PR services to community venues could help to improve the number of people undertaking PR.

Improving uptake to Mindsong and KiActiv

Mindsong offer a 'Breath in Sing out course' for people with chronic lung conditions. KiActiv offers a digital activity hub for patients who are referred by primary, community and secondary care. These services offer many of the same benefits as PR (including improving physical activity, helping people to manage their own condition and, in the case of Mindsong, allow people to socialise). These services could be an option for people for whom PR is inappropriate.

Furthermore, it was discussed in the decision conferences that these services are not yet at capacity, so it is possible to increase the number of people engaging with them without increasing costs. Currently only a minority of general practice staff know these services exist and most referrals are either self-referrals or come from secondary care.

Managing acute exacerbations more efficiently

More effective use 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.

According to Gloucestershire ICS, there were 827 patients with COPD included on the virtual ward in the baseline year 2021/22. 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.

Acute assessment hubs for emergency attendance avoidance

There are currently two PCNs that run acute assessment hubs. The aim of these hubs is to avoid emergency department attendances. They would have benefits to the system, through a reduction in emergency attendances and to patients as more patients are able to be treated closer to home.

Assessing the impact of the proposed pathway improvements

During this phase of the programme, HEU outlined the expected change that could occur over a period of one year because of each pathway improvement. We 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.

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

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 pathway improvements: literature review

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 impacts 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 the benefit 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 five for hospital admissions means five people would 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 methods used in developing the visualisations of the impact each improvement could have on the COPD pathway are explained in further detail in the table below. The exact numbers, calculations and assumptions used for each pathway improvement can be found in the **data sources and calculations** section in the appendices.

Metric	Methods
Additional population health benefit (PHB) due to pathway improvement	This can be represented as: $$PHB_{j+k+i} = N_j \times B_j + N_i \times B_i + N_k \times B_k \ ...$$ Where j, I and k represent each intervention in the pathway improvement. Where Nj is the number of individuals who would benefit from the intervention j each year and Bj 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 improvement 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.
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 the number of individuals expected to be treated by intervention j within a given year, and C_j is the expected average cost of the intervention per 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 components. NNT is an epidemiological measure representing the number of patients it is necessary to treat to avoid one additional bad outcome. For example, an NNT of 5 for a hospital admission would mean that 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 effect ($p < 0.05$) that can be used to estimate an NNT. We have modelled the latest timeframe in which the improvements are expected to have statistically significant effects on the rest of the pathway. Number who benefit ($N_{j,I,k...}$) 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 for the effects that primary prevention will have on the COPD pathway (through reducing the number of people developing COPD) compared with other pathway improvements, its effects on the rest of the pathway have not been included in the visualisations below but have been included in the **summary statistics**.
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 improvement, 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 £2,855.05. If a pathway improvement was expected to lead to 10 fewer hospital admissions, the cost saving would be £28,550.50.

Summarising the results

In each section below, summary statistics have been provided as additional pieces of evidence to support Gloucestershire'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 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 cases of COPD avoided 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 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 £496.38. 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 interventions that are both cost-saving and health-generating. A ratio of 1 would mean it costs £1 to generate one additional unit of population health gain.
Cost ratio	This metric is calculated by dividing the cost saving by the additional cost of the improvement. It can be written as: $$\frac{RC_v}{N_t C}$$ A ratio of 1 means 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 under consideration. It is important to understand when these benefits are realised for financial and operational planning. Estimates of when the benefits are likely to be realised come from the literature. For example, a study reports a reduction in hospital admissions after three years; we would expect the benefits to be realised 'after three years'.

Impact of the pathway improvements

More proactive and earlier interventions in primary care

Psychological support for patients

Expected change

One relevant paper was sourced from the literature review.

An evaluation of IAPT services by the London School of Economics used routinely collected hospital utilisation data (the Secondary Usage Services Dataset) to look at the effect of IAPT services on outpatient attendances and inpatient admissions for people with three long-term conditions (COPD, diabetes and cardiovascular disease). They found a 13% decrease in inpatient non-elective admissions and a 14% reduction in outpatient attendances after 12 months for people with COPD compared to a matched control group (Gruber et al., 2022).

Scenarios

NHS Digital's data collection only reports on the number of people with long-term conditions who are accessing IAPT services, not people with COPD. Therefore, the number of people with COPD accessing services is not known.

Here (Figure 9) we estimate what affect it would have on the COPD pathway if 10%, 25% or 50% of people with COPD in Gloucestershire living with anxiety or depression were referred to IAPT services. There is no data available on the proportion of people living with COPD and co-morbid anxiety and/or depression in Gloucestershire so we assume the rate is 50%, in line with the reported prevalence in Ma et al. for anxiety (Ma et al., 2020).

The reduction in hospital admissions expected to be avoided due to IAPT services is not expected to offset the cost of providing those services. Although it is expected to be generate benefit, there are substantial costs associated.

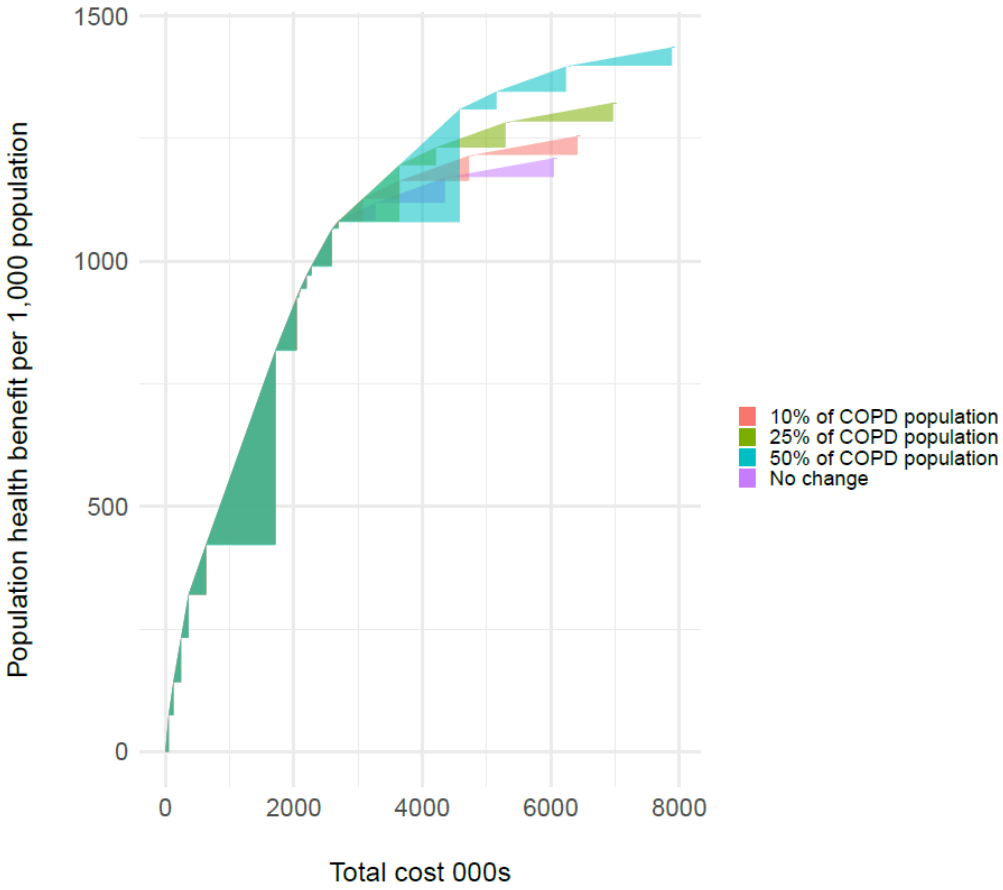

Figure 9 – Expected impact of psychological support for patients

Metric	Total	Interpretation
Total additional pathway costs	10%: £366,864.34 25%: £917,844.64 50%: £1,835,822.88	There are significant costs associated with increasing IAPT capacity.
Additional cost/additional population health ratio	7.97	This pathway improvement is expected to cost £7.97 for every additional unit of population health it generates.
Cost ratio	0.03	This pathway improvement is not cost-saving. It is estimated to save £0.03 elsewhere in the pathway for every £1 spent on the intervention.

Multi-professional management of patients

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.

Although the schemes were different in design from the plan suggested here, both studies suggested integrated care programmes 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 look at embedding specialists in the PCNs with the highest number of people with COPD (Forest of Dean PCN – 1,552, St Paul's PCN – 1,032 and Gloucester inner city – 754) (Office for Health Improvement and Disparities, 2022). All the scenarios are expected to be health generating but are not expected to be cost saving and there are no savings expected in the rest of the pathway.

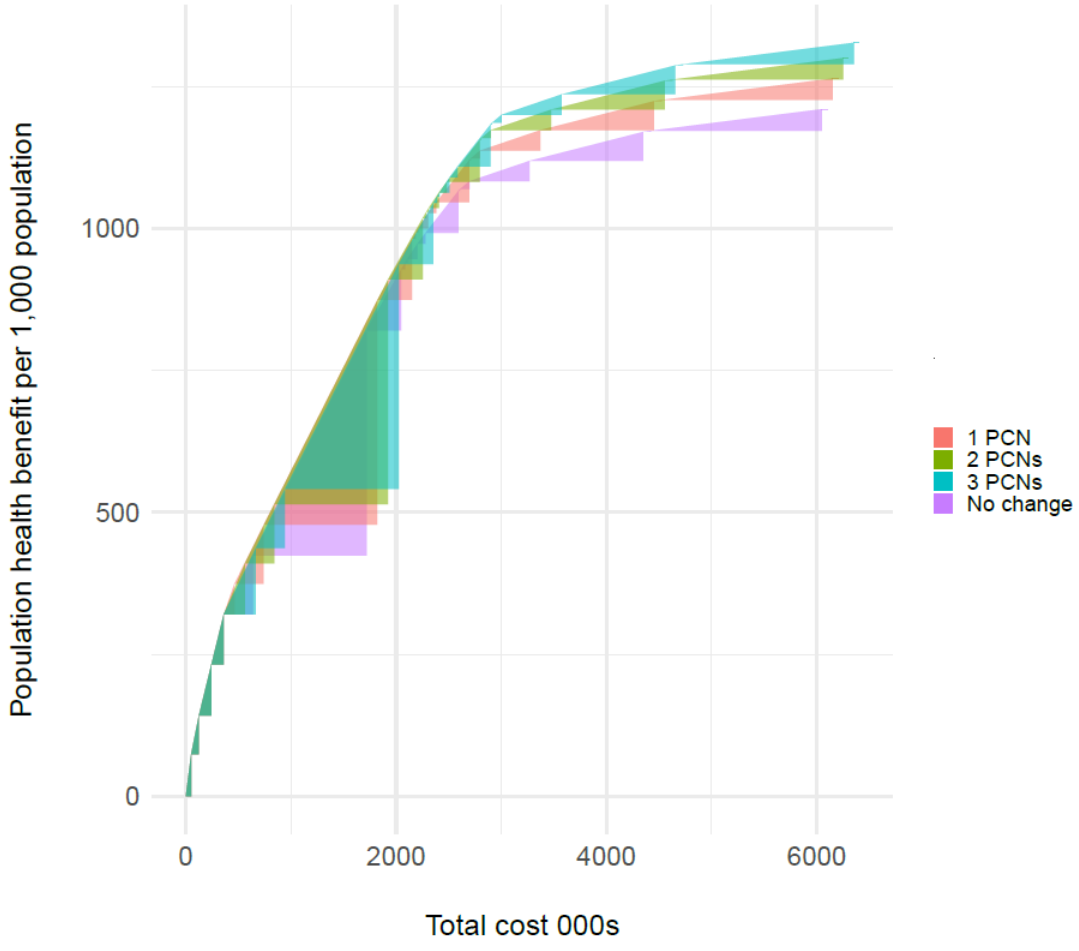

Figure 10 – Expected impact of multi-professional management of patients

Metric	Total	Interpretation
Total additional pathway costs	1 PCN: £101,559 2 PCNs: £203,118 3 PCNs: £304,677	There are no expected savings for this pathway improvement.
Additional cost/additional population health ratio	1 PCN: 1.87 2 PCNs: 2.25 3 PCNs: 2.61	The cost/population health ratio is dependent on the population each MPT team covers.
Cost ratio	N/A	There are no expected savings for this pathway improvement.

Increase uptake of pneumonia vaccinations

Expected change

It was highlighted in the decision conferences that a pneumonia vaccination for people with COPD can lead to fewer acute exacerbations. According to a Cochrane Review, the number of patients needed to treat to prevent one patient from experiencing an exacerbation is eight (Walters et al., 2017). No papers identified in the literature review looked at the number of hospital admissions avoided due to pneumonia vaccinations in people with COPD.

Scenario

Here we model what it would look like if pneumonia vaccination coverage was expanded to 90% of patients with COPD. The overall impact on the pathway is small, as the number of people it is expected to benefit is small (only an estimated 456 people will not have an acute exacerbation due to the increase in coverage). Although the improvement is not expected to be cost saving here, the additional cost is expected to be just £16,082.18. At a cost of, £2,490.88 per admission, 6.46 hospital admissions would need to be avoided to

make this improvement cost saving.

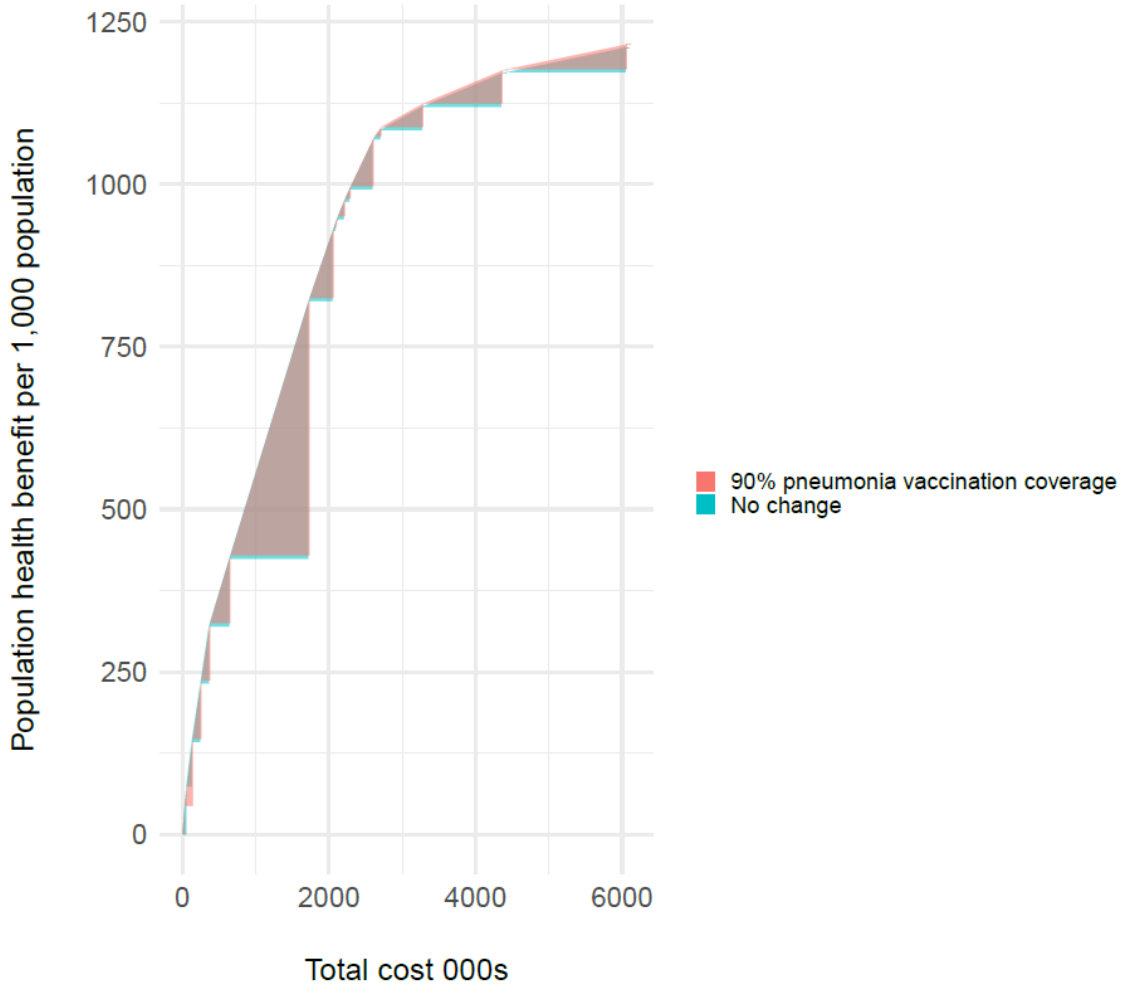

Figure 11 – Expected impact of increasing uptake of pneumonia vaccinations

Metric	Total	Interpretation
Total additional pathway costs	£16,082.18	This pathway improvement is not expected to save enough money to make it cost saving.
Additional cost/additional population health ratio	0.47	This pathway improvement is expected to cost £0.47 for every additional unit of population health gain it generates.

Cost ratio	0.56	This pathway improvement is estimated to save £0.56 for every additional £1 spent on it.

Proactive case finding

Expected change

We assume that this pathway improvement will lead to two positive changes along the care pathway:

- An earlier diagnosis of COPD compared with no case detection
- A higher diagnosis rate compared with conventional case detection screening without using the CDQ.

Earlier diagnosis of COPD allows opportunities for early interventions, such as programmes for smoking cessation and pharmacotherapy to reduce symptoms, both of which can reduce the risk of exacerbations and hospitalisations and improve quality of life and other long-term health outcomes (Decramer et al., 2011; Kostikas et al., 2020). However, early diagnosis would require regular screening, and Johnson and colleagues (2021) recommended that the best practice frequency of screening was to be once every five years.

A higher diagnosis rate will save NHS resources used for spirometry testing as well as reducing the logistical burden of healthy and low-risk patients who might otherwise be tested unnecessarily. According to Wright et al. (2015), targeted case detection using clinically validated questionnaires (e.g., CDQ) can identify one patient with moderate severity COPD (GOLD-2) for every two screened (equivalent to 50%), which is substantially higher than the current estimated diagnostic rate of 7.3% in Gloucestershire.

Scenarios

Here we model two scenarios:

- The most optimistic scenario: 80% of the potential-at-risk population are contacted for the CDQ survey and 50% of them complete it. 70% of people completing the survey and who meet the CDQ score of 16.5 (56.6%) come forward for testing and the diagnosis rate is improved from the current level (7.3%) up to 50% as stated in Wright et al.
- The most pessimistic scenario: 80% of the potential-at-risk population are contacted for the CDQ survey and 20% of them complete it. 70% of people completing the

survey and who meet the CDQ score of 16.5 (56.6%) come forward for testing and the diagnosis rate stays at the current level of 7.3%.

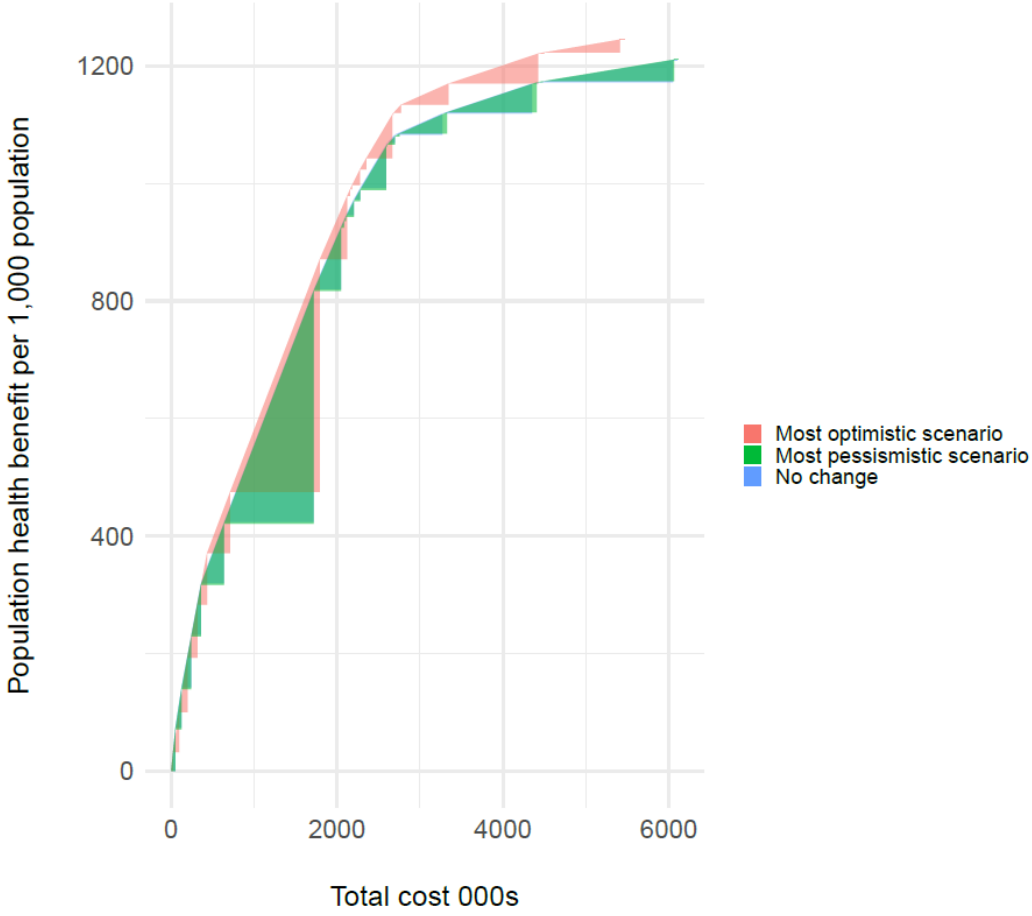

Figure 12 – Expected impact of more proactive case finding

The cost-effectiveness of this pathway improvement is largely dependent on the diagnosis rate from the spirometry testing. The most pessimistic scenario is virtually indistinguishable from the current pathway in Figure 13 as it would only lead to an additional 73 cases of COPD being diagnosed. However, the most optimistic scenario is expected to be cost saving and health generating. It is reasonable to assume the diagnoses rate from case-finding would improve upon the current rate as several the tests undertaken currently would also be conducted to monitor lung function in people who are already diagnosed with COPD. This means the 7.3% diagnosis rate is likely an underestimate. That said, the diagnosis rate, should be monitored should this improvement be adopted.

Metric	Total	Interpretation
Total additional pathway costs • **Most optimistic scenario** • **Most pessimistic scenario**	 -£639,803 £12,919	The additional pathway costs are dependent on the depends on the diagnosis rate of the spirometry tests and how many people complete the survey.
Additional cost/additional population health ratio • **Most optimistic scenario** • **Most pessimistic scenario**	 -6.87 2.36	In the most optimistic scenario, this pathway improvement would save £6.87 for every additional unit of population health gain it generates. In the most pessimistic scenario it would cost £2.36 for every additional unit of population health gain it generates.
Cost ratio • **Most optimistic scenario** • **Most pessimistic scenario**	 7.30 0.77	In the most optimistic scenario, this pathway improvement would save £7.30 elsewhere in the pathway for every £1 on the case-finding. In the most optimistic scenario, this pathway improvement would save £0.77 elsewhere in the pathway for every £1 on the case-finding.

Creation of an alliance with responsibilities for treating tobacco dependency and advocating for tobacco control

Increasing uptake of smoking cessation services

Expected change

If more people were to engage with smoking cessation services in the county, it is likely that more people would quit smoking. For this to happen the following steps would be required:

- More people would need to be referred to smoking cessation services.
- The capacity of the smoking cessation services would need to be expanded to deal with this increase in referrals.

Stopping people with COPD from smoking through smoking cessation programmes can impact the rate of exacerbations and hospital admissions for the individuals involved (Au et al., 2009; Godtfredsen, 2002). Au et al. found a reduction in exacerbation rates in 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 when individuals had quit for 10 years or more (HR 0.65, 95% CI 0.58–0.74). Godtfredsen et al. found a statistically significant reduction in hospitalisations among ex-smokers compared with quitters in a Danish population, with an average follow-up time of 14 years (HR 0.57, 95% CI 0.33–0.99).

In terms of primary prevention (i.e., stopping people from smoking before they develop COPD), it is expected that stopping more people smoking will lead to a reduction in the number of people developing COPD. According to Terzikhan et al., among a cohort of 14,619 participants in the Netherlands, the incidence of COPD was 19.7/1000 person years (95% CI 18.1–21.4) among current smokers, and 8.3/1000 person years (95% CI 7.6–9.1) among former smokers, with a maximum follow-up time of 25 years (Terzikhan et al., 2016).

Scenarios

The additional number of people that can be reached to engage with smoking cessation services is not known. Therefore, we model what it would look like if double the number of people set quit dates in the existing Healthy Lifestyle Service.

Whether or not someone who engages with the smoking cessation service has COPD is not known. Therefore, we will assume that the increase in smoking cessation services is for primary prevention only. This means we are unable to map its impact on the COPD pathway as the only effect would be as primary prevention.

The number of cases of COPD expected to be averted is not expected to be cost saving when you look at the expected cost savings over a one-year period. However, this number is subject to a sensitivity analysis in the **discussion** section.

Metric	Total	Interpretation
Total additional pathway costs	£323,059.56	This pathway improvement is not expected to avert enough cases of COPD to be cost-effective.
Additional cost/additional population health ratio	3.00	This pathway improvement would cost £3.00 for every additional unit of population health gain it generates.
Cost ratio	0.02	This pathway improvement is estimated to save £0.02 for every £1 spent on it due to averted cases of COPD.

Vaping as a harm reduction pilot

Expected change

No papers in the literature review were identified which look at the risk of developing COPD in tobacco smokers compared to vaping. As vaping is a new phenomenon, there is a lack of long-term studies looking at its use. That said, it is likely that it is substantially better for someone's health than smoking tobacco (NICE, 2023). Here we assume the effect on the risk of developing COPD associated with replacing cigarettes with a vape is equivalent to that of quitting smoking altogether.

Scenarios

Here we look at two scenarios:

- If the Healthy Lifestyle Service was to offer vapes/e-cigarettes for one month to people who do not successfully quit smoking after four weeks to help them reduce their tobacco dependency.
- As e-cigarettes could be a scalable intervention, we also look at the impact of offering e-cigarettes to 10% of the smoking population (excluding e-cigarette smokers) in Gloucestershire for one month.

Although some people engaging with the smoking cessation/substitution service have COPD, we do not know the proportion, making it difficult to estimate the impact of smoking

cessation/substitution services on secondary and tertiary prevention. Therefore, we conservatively assume that the increase in smoking cessation services is for primary prevention. This means we are unable to map its full impact on the COPD pathway as the only effect would be as primary prevention.

The low cost of the vapes makes this scenario markedly more cost-effective than increasing capacity in the current smoking cessation service, assuming moving to vaping has the same effect on risk as not smoking.[3] However, as stated, the long-term effects of vaping are not known. For this pathway improvement to be cost neutral, it would have to avoid one case of COPD for every 13.42 vapes prescribed (based on a one-month cost of vapes of £37 and the expected cost of treating someone with COPD for one year at £496.38). In the current scenario, it is estimated that one case of COPD is avoided for every 87.72 vapes that are prescribed (see **calculations** in the appendices).

Metric	Total	Interpretation
Total additional pathway costs • Non quitters • 10% of all smokers	£13,687.10 £245,532.18	This pathway improvement is not expected to be cost saving due to the number of cases of COPD it could avert.
Additional cost/additional population health ratio • Non quitters • 10% of all smokers	0.32 0.33	This pathway improvement would cost £0.32 or £0.33 for every additional unit of population health gain generated.
Cost ratio	0.15	This pathway improvement is estimated to save £0.15 for every £1 spent in either scenario.

[3] This assumption is not certain as there is no long-term evidence looking at vaping and its reduction on risk of developing COPD is not known. However, as some sources estimate there is an estimated 95% reduction in harm from vaping compared to cigarette smoking (Public Health England, 2015), this assumption seems reasonable. As this pathway improvement is not recommended, any changes to this would not influence the recommendations below.

VBA for tobacco dependency

Expected change

If staff were to provide VBA to smokers with COPD, this would likely expand the number of people setting quit dates and make those that do more likely to quit.

A meta-analysis pooling the results of 17 trials suggested that the provision of brief advice was associated with a statistically significant increase in the rate of quitting, by 66%, compared with no advice (risk ratio 1.66, 95% CI 1.42–1.94) (Stead et al., 2008).

As above, stopping people with COPD from smoking can impact the rate of exacerbations and hospital admissions for the individuals involved (Au et al., 2009; Godtfredsen, 2002).

Scenario

Here we model what it would look like for general practice staff offering VBA on smoking cessation to people with COPD as part of their yearly review. As can be seen in Figure 13 below, the effect on the overall pathway is minimal. The VBA and no change scenarios are virtually indistinguishable. This is because it is expected to lead to only 144 extra quitters. That said, as it is a cheap intervention, it appears to be essentially cost neutral.

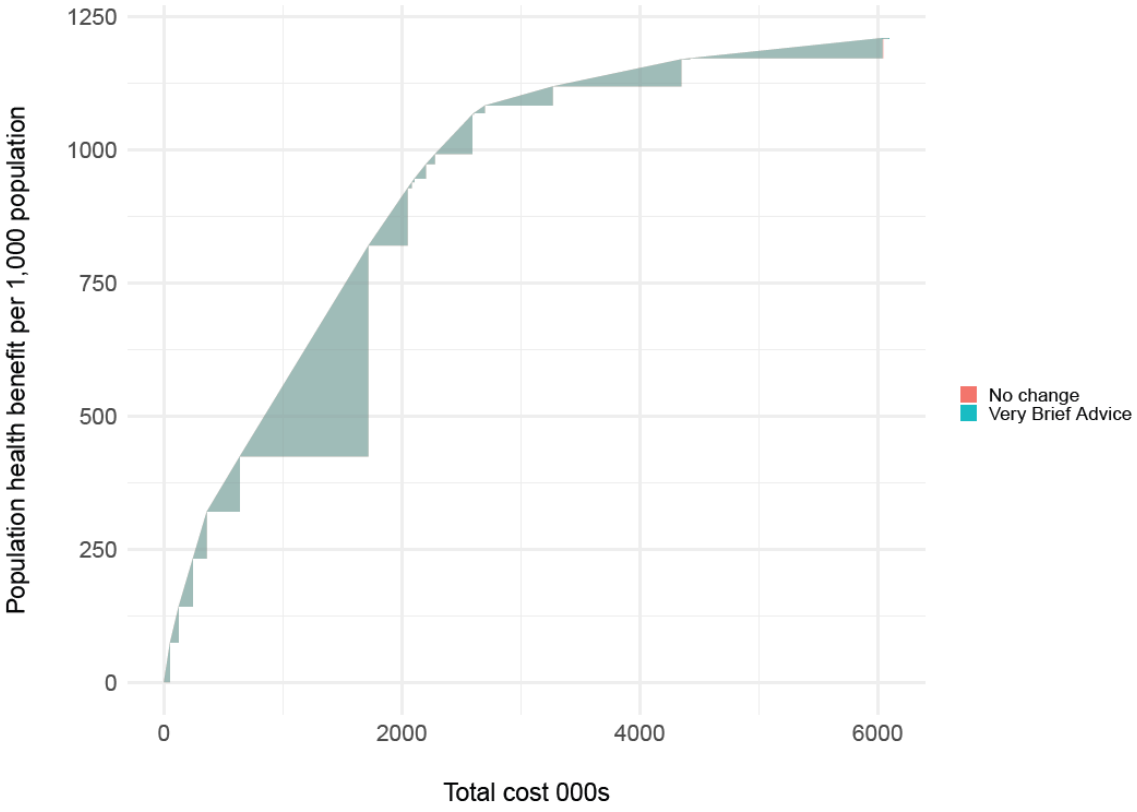

Figure 13 – Expected impact of offering VBA for tobacco dependency

Metric	Total	Interpretation
Total additional pathway costs	-£399.21	This pathway improvement is effectively cost neutral.
Additional cost/additional population health ratio	-0.03	This pathway improvement would save £0.03 for each additional unit of population health gain generated.
Cost ratio	1.06	This pathway improvement is estimated to save £1.06 for every £1 spent.

Enhancing the role of social prescribing and awareness of tertiary prevention services

Avoiding fuel poverty

Expected change

Expanding the budget available for warm home on prescription schemes could help to meet the increased demand for affordable warmth schemes brought about by the cost-of-living crisis.

No statistically significant pathway effects for warm home on prescription schemes, such as that offered in Gloucestershire, were found in the literature. One randomised controlled trial of warm home schemes conducted in Aberdeen suggested a small, non-statistically significant, decrease in the number of hospital admissions for people living with COPD who were given home energy efficiency improvements. However, the study also noted that patients may be unlikely to take up the schemes (Osman et al., 2010).

Scenarios

As the number of people who would be eligible for warm home on prescription schemes is not known, we model what a 10%, 25% and 50% increase in uptake would look like.

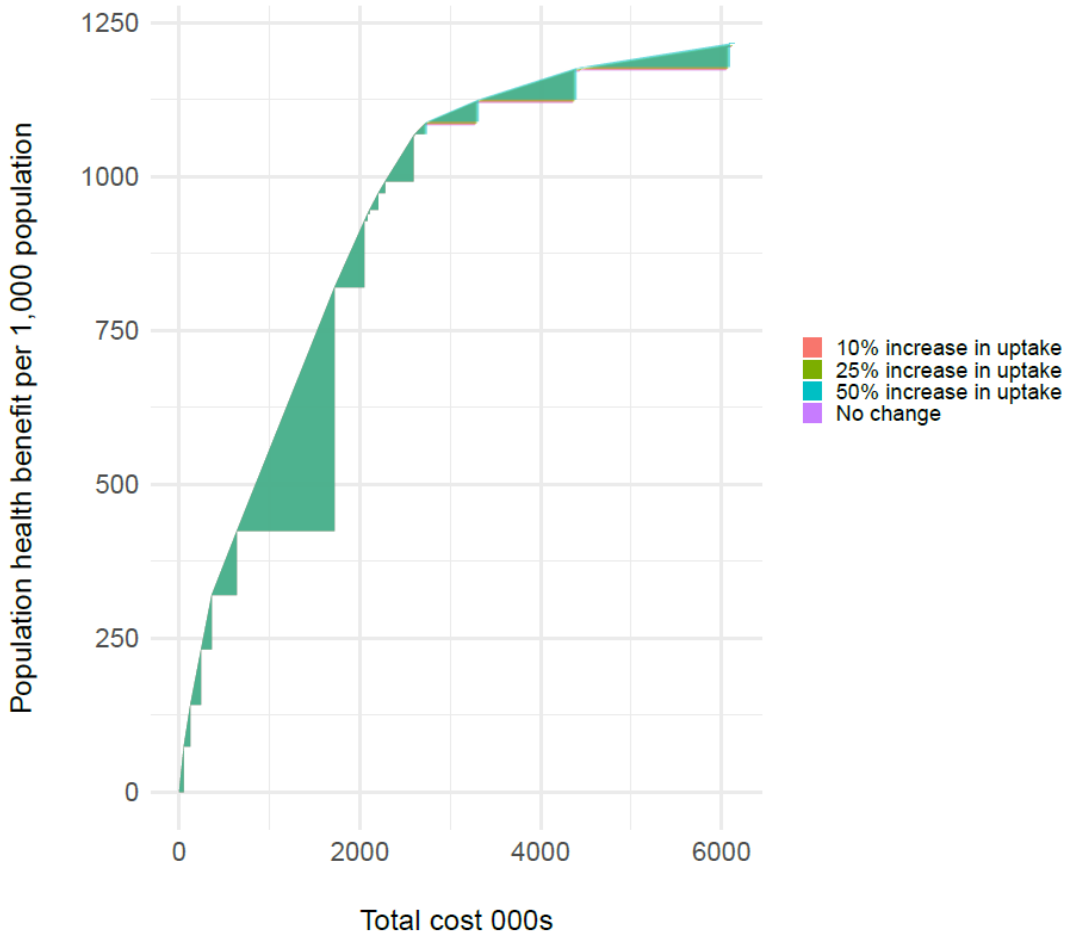

Figure 14 – Expected impact of warm home on prescription schemes

Although we assume that no hospital admissions will be avoided by this scheme, as we do not have statistically significant results to say the scheme will reduce hospital admissions, we will include how many hospital admissions would have to be avoided to make this intervention cost-effective.

Even a 50% increase in uptake will only have a small effect on the COPD pathway as the number of people that would benefit is relatively small (75). Therefore, as can be seen in Figure 14, these scenarios are virtually indistinguishable from each other. As we cannot expect a reduction in hospital admissions, the pathway improvement is expected to be cost incurring.

Metric	Total	Interpretation
Total additional pathway costs • **10% increase in uptake** • **25% increase in uptake** • **50% increase in uptake**	£9,000 £22,800 £45,000	There are no expected cost savings from this pathway improvement so it is cost incurring.
Additional cost/additional population health ratio	6.67	This pathway improvement is estimated to cost £6.67 for every additional unit of population health gain it generates.
Cost ratio	n/a	This pathway improvement is not expected to create any savings

Improving PR services

Expected change

A Cochrane Review suggested that PR had a positive effect on hospital readmission rates compared with usual post-exacerbation care after nine months (OR 0.44, 95% CI 0.21–0.91) (Puhan et al., 2016). No relevant papers were identified that looked at changes in healthcare resource use, such as PR in a community setting versus usual care in a wider population of COPD. Therefore, we assumed the effect of PR in the general population to be the same as that reported in the Puhan et al. study.

Scenarios

Here we model three scenarios to help inform the design of PR services in Gloucestershire:

- Improving uptake 50% through the HORS.
- Improving uptake 50% through introducing online courses. The studies referenced in the NICE guidance looking at the online PR offering of the myCOPD app suggest that it was not inferior to face-to-face care for PR. Therefore, we assume the effects and completion rates are the same.(National Institute for Health and Care Excellence (NICE), 2022)
- Improving uptake by 50% and completion rates from 67% to 87% in the PR services offered by the HORS.

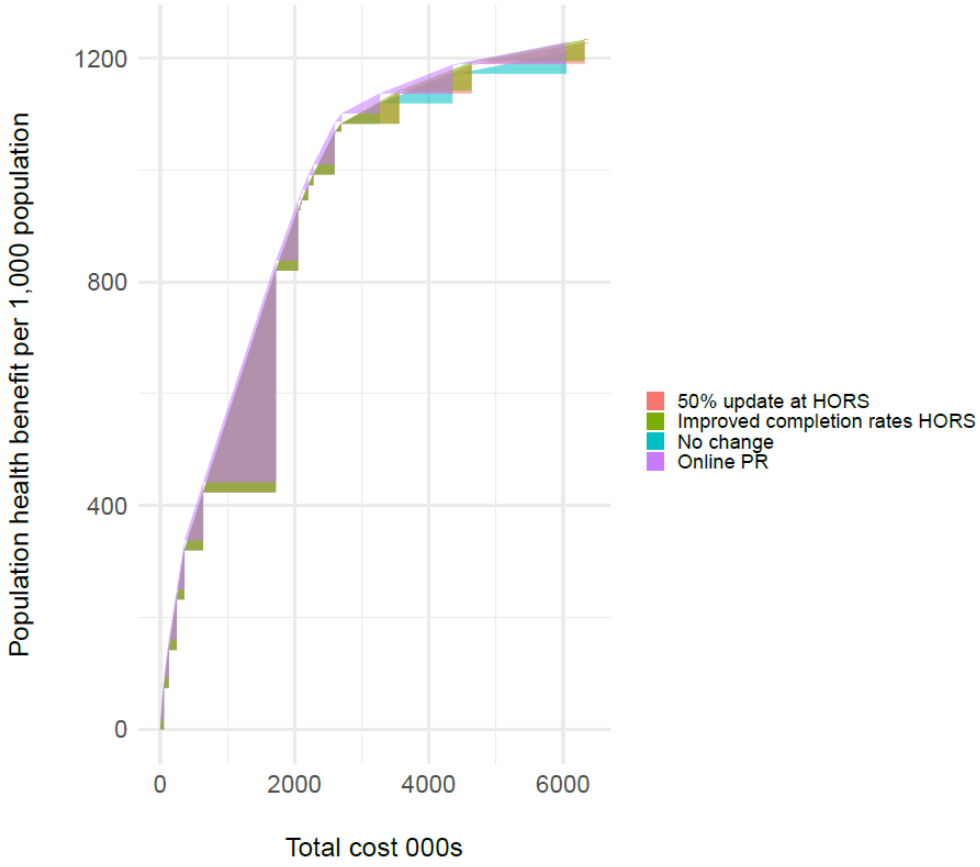

Figure 15 – Expected impact of improving PR services

All three scenarios are health generating. However, as PR is estimated to be relatively expensive per person in the HORS service (£954.00), the HORS scenarios are likely to incur significant costs. The online offering, as it is expected to be much less expensive per person (£10.24), is effectively cost neutral. It would have to cost £49.82 per person before the intervention is expected to be cost incurring. The online offer would also be easy to scale up.

Metric	Total	Interpretation
Total additional pathway costs • Improving uptake through the standard route • Improving uptake through an online offering	£271,254.72 -£11,874.28	The cost of the scenarios which require face-to-face care are expected to have significant cost burdens. The online offering could

• Improving completion rates in the current services.	£266,272.92	be cost saving as the costs of delivering PR are cheaper.
Additional cost/additional population health ratio • Improving uptake through the standard route • Improving uptake through an online offering • Improving completion rates in the current services.	 15.07 -0.66 11.34	
Cost ratio • Improving uptake through the standard route • Improving uptake through an online offering • Improving completion rates in the current services.	 -0.05 4.87 0.07	

Improving uptake to MindSong and Kiactiv

Expected change

KiActiv

One prospective cohort study, conducted in Copenhagen, was identified in the literature review as looking at the impact of physical activity on hospital admissions in people with COPD. In this study, subjects reporting low, moderate or high physical activity had a lower risk of hospital admission for COPD during the follow-up period than those who reported very low physical activity (incidence rate ratio 0.72, 95% confidence interval, 0.53 to 0.97) (Garcia-Aymerich et al., 2006).

Mindsong

One literature review looked at randomised controlled trials of structured singing training of at least four weeks. The review included three papers. The review reported low to very low-quality evidence that singing is safe and improves physical health, but not dyspnoea or respiratory-specific quality of life. However, the three studies included had small sample sizes and the authors note that larger, more long-term studies are required. No papers were identified which looked at the impact on resource use elsewhere in the COPD pathway (McNamara et al., 2017).

Scenarios

Here we model what it would look like if Mindsong was running at capacity and KiActiv (which, as an online platform can accommodate many more users) had their capacity expanded by 100%.

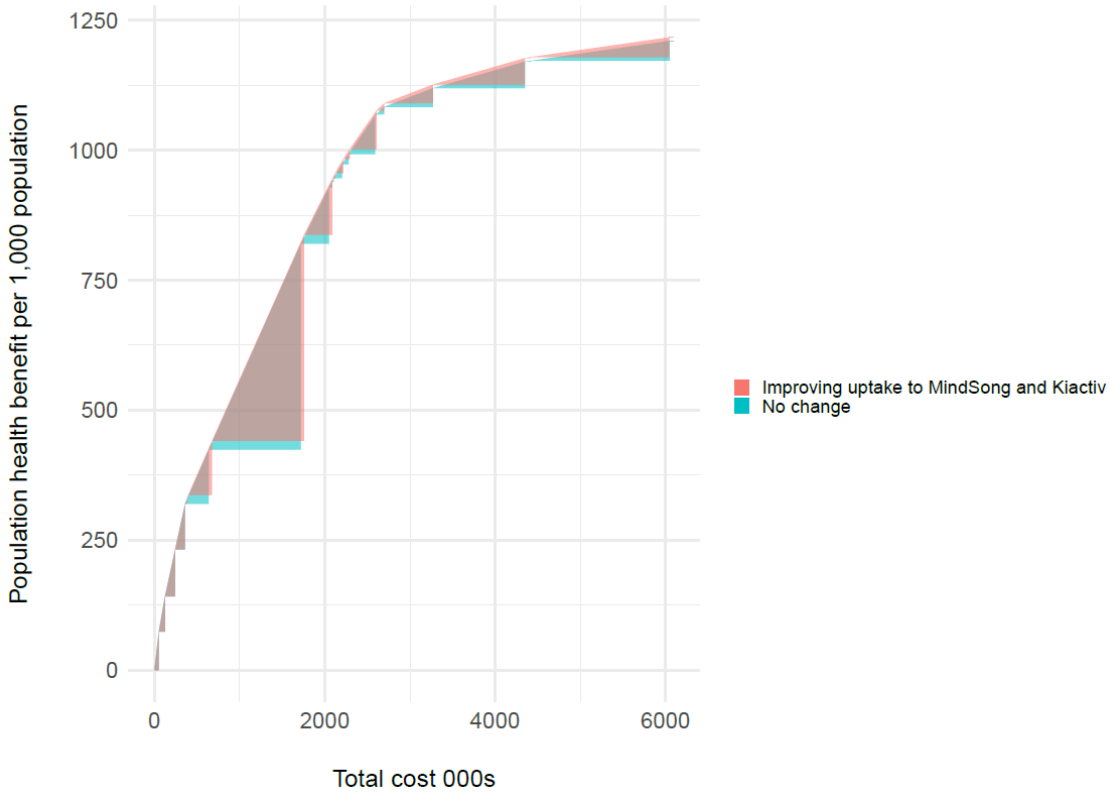

Figure 16 – Expected impact of improving uptake to Mindsong and KiActiv

The additional number of people that this improvement is expected to benefit is relatively small (102 people), but as the cost is assumed to be 0, it is cost-effective as it is health generating. The number of people using both services should be maximised to get as much benefit out of them for the associated costs.

Metric	Total	Interpretation
Total additional pathway costs	-£2,490.88	It is expected that this improvement would lead to one hospital admission avoided.
Additional cost/additional population health ratio	-0.39	This improvement would have £0.39 for every additional unit of population health gain generated.
Cost ratio	N/A	As there are no costs associated with the improvement it is not possible to calculate a cost ratio.

Managing acute exacerbations more efficiently

More effective use 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 of two days less than expected, with a median length of stay of one day (Echevarria et al., 2018).

Scenario

Here we model the expected impact of including the remaining eligible people admitted to hospital 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).

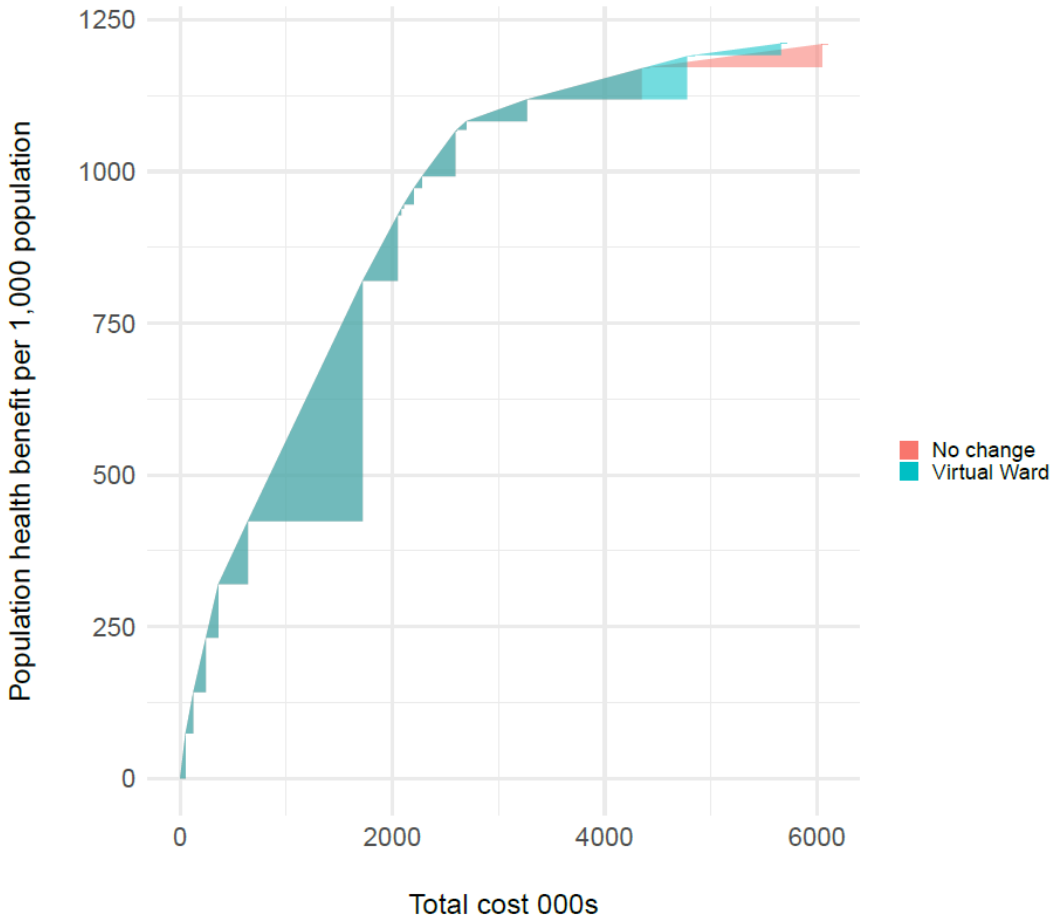

Figure 17 – Expected impact of more effective use of the virtual ward

Treating a patient on the virtual ward is expected to cost 52.49% of the cost of treating an acute exacerbation through a hospital admission alone so will save money (see **data sources** in the appendices).

Metric	Total	Interpretation
Total additional pathway costs	-£385,821	This pathway improvement is expected to be cost saving as it is cheaper to treat someone on a virtual ward rather than in a hospital bed.
Additional cost/additional population health ratio	-19.09	This pathway improvement is estimated to save £19.09 for every one unit of population health gain it generates.
Cost ratio	1.91	This pathway improvement is expected to save £1.91 for every £1 spent.

Acute assessment hubs for emergency department avoidance

Expected change

No papers were identified in the literature review which looked at acute assessment hubs or similar interventions. Therefore, we are unable to assess the impact of this intervention on the COPD pathway. However, learning can be taken from the acute respiratory infection hubs developed during the COVID-19 pandemic (NHS England, 2022; Rasheed et al., 2021). These hubs aim to support people with acute respiratory needs, treat them closer to home and keep people out of the hospital.

One such hub in Dudley is staffed by either two GPs or one GP and an Advanced Nurse Practitioner, providing urgent same day appointments, two reception staff and a hub manager. It is mainly staffed by locum GPs. Assuming the Advanced Nurse Practitioner is a band 7, the two-reception staff are band 4 and the hub manager is a band 6, the estimated running cost of the acute assessment hubs (excluding capital costs and assuming prescription costs would not vary dependent on where the patient is treated) would be £2,452.50 a day. This would mean approximately one hospital admission (at a cost of £2,490.88) would have to be avoided per day to make the hub cost saving to the system.

Determining the next steps: setting priorities

Using the results of the modelling for decision-making

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

- **Ranking interventions by cost/population health ratio.** Prioritising in this way will help ensure that the pathway improvements taken forward will produce the most health within the given available budget. The lower the ratio, the better, with a negative ratio representing interventions that 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 on the cost/population health ratio. Using this method will ensure the most efficient allocation of resources based on cost per unit of population health gain, thereby improving the value for money of the pathway.

A ranking of the pathway improvements by their cost/population health ratios is displayed in the table below. Where the modelled improvements include multiple scenarios with different outcomes, the scenarios have been displayed separately.

Ranking	Pathway improvement (scenario)	Cost/population health ratio
1	More effective use of the virtual ward	-19.09

2	Proactive case finding (most optimistic scenario)	-6.87
3	Improving uptake to Mindsong and KiActiv	-0.39
4	VBA for tobacco dependency	-0.03
5	Increasing uptake of PR (online offering)	-0.66
6	Vaping as a harm reduction pilot	0.32
7	Improving uptake of pneumonia vaccinations	0.47
8	MPT management of patients (1 PCN)	1.87
9	MPT management of patients (2 PCNs)	2.25
10	Proactive case finding (most pessimistic scenario)	2.36
11	MPT management of patients (3 PCNs)	2.61
12	Increasing uptake of smoking cessation services	3.00
13	Avoiding fuel poverty	6.67
14	Psychological support for patients	7.97
15	Increasing uptake of PR (improving completion rates in the current services)	11.34
16	Increasing uptake of PR (improving uptake through the standard route)	15.07

Discussion

This report identifies the priority interventions to include in Gloucestershire's respiratory programme. It discussed the approach used which includes a series of decision conferences (facilitated workshops), as well as a technical element that selects and ranks the interventions in order of value for money/cost-effectiveness along an efficiency frontier. The visual output makes decisions on resource allocation easy to interpret. The STAR approach provides a robust and systematic way to prioritising resources.

An **umbrella review** identified clinical interventions and those impacting the wider determinants of health on quality of life and healthcare resource use. Following on from this, stakeholders in a decision conference identified **four main opportunities** and 12 pathway improvements which can address those opportunities.

To create a visual understanding of the current care pathway, information on health benefits were drawn out during the decision conferences. Numbers needed to treat as well as numbers who benefit are derived from the literature or activity data. Costs were derived from various sources, such as national datasets. The information collected throughout the process was used to generate the value for money triangles and efficiency frontier which represents the top ranked interventions of best value for money.

Recommendations

Scenario analysis was performed on the interventions to understand the impact of different ways of implementing each of the interventions. Five interventions were prioritised depending on the expected ratio of costs to population health benefit. These five interventions were:

- **More effective use 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.
- **Improving uptake to Mindsong and KiActiv:** As these services are not currently running at capacity, there is an opportunity to expand the number of people that are treated by them without increasing costs.
- **Proactive case finding:** Identifying people earlier in their disease pathway will mean that they can get treatment quicker and reduce hospital admissions. Finding ways to improve the diagnosis rate from spirometry is key to making this a cost-effective intervention to limit the number of tests needed.
- **VBA for tobacco dependency:** Even though this improvement is only expected to lead to a small number of additional people quitting (144) per year, it is inexpensive for clinicians to offer this advice, making it cost-effective.

- **Increasing uptake of PR (online offering):** PR is clinically one of the best things to do to improve the quality of life of someone with COPD. Online PR courses offer an inexpensive and scalable way to increase the number of people with COPD who undertake PR.

This output should be used by Gloucestershire's respiratory programme to inform investment decisions, budget planning and programme plans. It is also possible that implementing these schemes could free up resources that can be used to meet other priorities. All six of these pathway improvements are expected to be cost saving. They are estimated to cost £538,131.38 in total and lead to cost savings of £1,578,520.10. This is largely due to the reduction in hospital admissions estimated due to proactive case findings (due to earlier diagnoses of COPD) and the reduction in costs of hospital admissions for acute exacerbations when they are treated on the virtual ward.

To see how robust the recommendations are, a scenario analysis was conducted for the majority of the pathway improvements. In addition, sensitivity analysis was conducted on the inputs to two specific improvements: looking at case finding and the expected cost savings from primary prevention smoking cessation. These were chosen in particular as there was a possibility that the results could change based on different cost inputs.

In the case finding improvement, only the costs of the intervention and the expected cost savings were included. The additional costs of treating additional cases of COPD identified were not considered. For this intervention, we modelled two different scenarios: the most optimistic and the most pessimistic where the diagnosis rate and the number of people engaging with case finding varies. If the expected cost of treating someone with COPD for one year (£496.38 as described in the **summarising the results** section) was included, in the most optimistic scenario this would have an associated additional cost of £616,007 per year and £36,235.74 in the most pessimistic scenario (plus the additional drug costs which are out of scope of this piece of work as described in the **methods document**). That said, even when including these additional costs, case finding would still be recommended. The expected number of hospital admissions avoided due to these earlier diagnoses means the scenario would still save £23,796.27 a year in the most optimistic scenario and £49,154.97 in the most pessimistic scenario.

The exact value of primary prevention (increasing the uptake of smoking cessation services and vaping as a harm reduction pilot) resulting in the reduction of COPD cases is not known. Here we have calculated the expected cost within a calendar year since this was the relevant timeframe for budget planning. However, COPD prevention strategies 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 £8,537.74 over the patients lifetime (the expected yearly cost of an avoided case of COPD of £496.38 × 17.2). Using this figure, increasing capacity in the smoking cessation service would save £110,990.62 a year with a cost/population health ratio of 2.03.. Similarly, the cost-effectiveness of vaping as a harm reduction pilot would save £759,858.86 per year if it was given to 10% of the smoking population with a cost/population health ratio of -0.63.

Limitations

There are some limitations to the approach taken.

Different examples of the STAR approach use different methods for valuing the individual health gain generated by the interventions. Here we have used the method used by Airoldi et al. (assessing each intervention on the VAS as described in the **methods document**) (Airoldi et al., 2014). This method has the advantage of being cognitively simple to understand and allowed us to compare more than 20 interventions in the available time.

Elsewhere, The Health Foundation have taken a different approach to modelling; for example, they weighted the quality of life of patients with different severities of eating disorders and calculated the proportion of patients who would deteriorate, stay the same or, to varying degrees, recover, and the resulting average quality of life (The Health Foundation, 2012). The large number of interventions needing to be valued here 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 bearing on the results.

There is a lack of available data in the literature regarding the impact on healthcare resource use of the pathway improvements. In most cases, the literature review only identified impacts on urgent care (hospitalisations and exacerbations). The impact of improvements on other elements of the pathway 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 ratios if they were included.

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

The pathway improvements modelled above 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. Further work would be required to build these scenarios into business cases or to conduct a full economic evaluation.

Appendix

1. Methodology document

STAR method document One Glou

2. Information pack for attendees

SSPH Decision Conference Particip

3. Data sources for the efficiency frontier

Smoking cessation

GP practices

Metric	Total	Source
Relative benefit score	100	Score given in decision conference one.
Number treated: **Number of people setting a quit date**	367	Data provided by Public Health Gloucestershire.
Number who benefit: **Number of people quitting after 4 weeks**	188	
Cost per person **Cost per person setting a quit date**	£206.59	NHS digital smoking cessation data for 2019/20. Assume 10% of the total service cost expenditure for smoking cessation is attributable to the GP led services.

Healthy Lifestyle Service

Metric	Total	Source
Relative benefit score	100	Score given in decision conference one.
Number treated: **Number of people setting a quit date**	1515	Data provided by Public Health Gloucestershire.
Number who benefit: **Number of people quitting after 4 weeks**	1078	Assumed that the percentage of people with COPD who undertake the smoking cessation programme is equivalent to the percentage of people with COPD in the population (prevalence 1.9%).
Cost per person **Cost per person setting a quit date**	£217.75	NHS digital smoking cessation data for 2019/20. Assume 10% of the total service cost expenditure for smoking cessation is attributable to the GP led services.

Case management

Primary care case management

Metric	Total	Source
Relative benefit score	35 – 75	Score given in decision conference one.
Number treated: **number of people receiving yearly reviews**	7,209	Quality and Outcomes Framework (QOF) 2021/22. Assumed everyone benefits.
Number who benefit: **number of people receiving yearly reviews**	7,209	
Cost per person	£150.00	QOF reference.

HORS

Metric	Total	Source
Relative benefit score	70	Score assigned to upper limit of primary care case management in decision conference one.
Number treated: **Number of contacts**	983	All contacts that aren't for PR or oxygen assessments.
Number who benefit: **Number of contacts**	983	Assumed everyone benefits.
Cost per contact	£318.00	Cost per contact in the HORS according to data provided by Gloucestershire ICS.

Respiratory vaccinations

Pneumonia

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: **Number of vaccinated COPD patients**	7,295	60% estimate of people with COPD in Gloucestershire who have been given the pneumonia vaccination. 12,158 people with COPD in Gloucestershire in 2021/22 according to the QOF. (Office for Health Improvement & Disparities, 2022)Estimate agreed upon in the decision conference.
Number who benefit: **Number of avoided acute exacerbations**	912	Assumed that the benefit for people with COPD is avoided acute exacerbations. According to a Cochrane Review, the number of patients needed to treat to prevent a patient from experiencing an exacerbation is 8 (Walters et al., 2017).
Cost per person **Cost of vaccination**	£10.06	Provided by Gloucestershire ICS.

Influenza

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: **Number of vaccinated COPD patients**	11,851	Provided by Gloucestershire ICS.
Number who benefit: **Number of avoided acute exacerbations**	1,197	Assumed that those with COPD who benefit are those that avoid an acute exacerbation. According to a pooled estimated in a recent Cochrane Review, on average, people receiving a flu vaccine had 0.37 fewer exacerbations than people receiving a placebo (Kopsaftis et al., 2018). This means that 9.90 people would need to be treated to avoid one additional exacerbation.
Cost per person **Cost of vaccination**	£10.06	Provided by Gloucestershire ICS.

COVID-19

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: **Number of vaccinated COPD patients**	11,678	Provided by Gloucestershire ICS. Number of people receiving two doses of COVID-19 vaccination.
Number who benefit: **Number of avoided acute exacerbations**	1180	Assumed that the number of avoided acute exacerbations is the same as the influenza jab.
Cost per person **Cost of vaccination**	£10.06	Provided by Gloucestershire ICS.

Spirometry testing

GP practices

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: **Number of people given spirometry test**	2,005	System one data from Gloucestershire. According to Gloucestershire system one data, 117 had a spirometry test after a confirmed diagnosis of COPD and 30 had a spirometry test before a confirmed diagnosis. This is because clinicians are using spirometry to confirm a diagnosis.
Number who benefit: **Number of patients with diagnosis of COPD confirmed using spirometry**	147	
Cost per person **Cost of spirometry test**	£17.37	

Secondary care

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: **Number of people given spirometry test**	423	Number pulled from the secondary users services (SUS) database using procedure code E932. SQL code available on request.
Number who benefit: **number of patients with diagnosis of COPD confirmed using spirometry**	31	Assumed the same diagnosis rate as in primary care.
Cost per person **Cost of spirometry test**	£174.39	Average cost of OPA appointment with a procedure code for spirometry. SQL code available on request.

Warm home on prescription

Metric	Total	Source
Relative benefit score	90	Score given in decision conference one.
Number treated: **Number of people given support**	150	Gloucestershire community housing website all people with 'chronic lung condition' including COPD. Assumed everyone benefits.
Number who benefit: **Number of people given support**	150	
Cost per person	£600.00	Provided by Gloucestershire ICS.

Lung volume reduction surgery (LVRS)

Metric	Total	Source
Relative benefit score	20-40	Score confirmed in decision conference.
Number treated: **Number of people undergoing LVRS**	5	Extracted from SUS database using procedure code E546. Rounded to nearest 5 for low number suppression. SQL code available on request.
Number who benefit: **Number of people benefitting from LVRS**	4	80% of total; according to the Asthma and Lug UK, 20% of people say they do not receive any benefit from LVR.
Cost per person **Cost per operation**	£9,804.33	Average cost of operation pulled from SUS database. SQL code available on request.

PR

Metric	Total	Source

Relative benefit score	90	Score given in decision conference one.
Number treated: **Number of people starting the course**	600	Estimate agreed in the decision conference.
Number who benefit: **Number of people receiving discharge assessment**	400	Estimate agreed in the decision conference.
Cost per person	£954.00	Cost per patient in the HORS according to data provided by Gloucestershire ICS.

Oxygen Assessment

Metric	Total	Source
Relative benefit score	90	Score given in decision conference one.
Number treated: **Number of contacts for oxygen assessment**	301	Data provided by Angela Stonham, Respiratory Clinical Lead for the Gloucestershire Respiratory Service.
Number who benefit: **Number of contacts for oxygen assessment**	301	
Cost per person	£318.00	Cost per contact. Data provided by the HORS according to data provided by Gloucestershire ICS. NOTE: cost of assessment only, not oxygen prescription.

KiActiv

Metric	Total	Source
Relative benefit score	45	Score given in decision conference one.
Number treated: **Number of people**	96	Data provided by KiActiv. Between July 2021 and July 2022, two sets of invitation

		letters were sent from the NHS Gloucestershire PR pathway and, as a result, 145 people contacted KiActiv Health. 96 people enrolled. An unusually high level of people (30) were unable to enrol as they did not have the correct equipment.
Number who benefit: **Number completing the course**	62	Data provided by KiActiv. 62 (65%) people completed their 12-week programme.
Cost per person	£160.55	Data provided by Gloucestershire ICS. Based on contract value.

Mindsong

Metric	Total	Source
Relative benefit score	90	Score given in decision conference one.
Number treated: **Number of people attending Mindsong courses**	80	Provided by Commissioning Development Manager: Social Prescribing and Creative Health for Gloucestershire ICS. Assumed everyone benefits.
Number who benefit: **Number of people attending Mindsong courses**	80	
Cost per person attending Mindsong courses	£284.00	Provided by Commissioning Development Manager: Social Prescribing and Creative Health for Gloucestershire ICS.

Community pharmacy interventions

Metric	Total	Source
Relative benefit score	37.5	Score given in decision conference one.
Number treated: **Number of people attending Mindsong courses**	No data available.	

Number who benefit: **Number of people attending Mindsong courses**	
Cost per person attending courses	

Secondary Care Outpatient Appointments

Metric	Total	Source
Relative benefit score	50	Score given in decision conference one.
Number treated: **Number of people attending outpatient appointments**	2,084	Sourced from SUS. Number of outpatient appointments attended by people with a previous hospital admission for COPD for their first appointment or a structured review. SQL code available on request.
Number who benefit: **Number of people attending outpatient appointments**	2,084	Assumed everyone benefits.
Cost per person outpatient appointment	£133.60	Sourced from SUS. Cost per outpatient appointments attended by people with a previous hospital admission for COPD for their first appointment or structured review. SQL code available on request.

Virtual ward

Metric	Total	Source
Relative benefit score	62	Score given in decision conference one.
Number treated: **Number of people with COPD on the virtual ward**	827	Number provided by Gloucestershire ICS.
Number who benefit:	827	

Number of people attending on the virtual ward		
Cost per person attending courses	£1,307.38	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 £1,218.13 based on hospital admission data) • Each patient would have maximum of seven calls of 15 minutes (1 hour 45 minutes in total) of specialist nursing visits at a cost of £51 per hour (£89.25 in total). 0 + 1,218.13 + 89.25 = 1,307.38

Hospital admissions

Metric	Total	Source
Relative benefit score	59	Score given in decision conference one.
Number treated: **Number of people admitted to hospital**	652	Pulled from the 2021/22 admitted patient care dataset in SUS using the same strategy as PHE Fingertips (activity). Activity data rounded.
Number who benefit: **Number of people admitted to hospital**	652	Upper estimate using the COPD code (J44) in any position. SQL code available on request.
Cost per person attending courses	£2,490.88	Average cost of a hospital admission in Gloucestershire according to SUS. SQL code available on request.

Rapid response

Metric	Total	Source
Relative benefit score	70	Score given in decision conference one.
Number treated:	No data available.	

Number of people given support	
Number who benefit: **Number of people given support**	
Cost per person attending courses	

Primary care-managed AECOPD

Metric	Total	Source
Relative benefit score	55	Score given in decision conference one.
Number treated: **Number of people with an acute exacerbation**	1,134	Number of occurrences in Gloucestershire primary care dataset of the following codes in 2021/22: • 195951007 |Acute exacerbation of chronic obstructive airways disease (disorder) • 1751000119100 |Acute exacerbation of chronic obstructive airways disease with asthma (disorder)| • 847091000000104 |Acute non-infective exacerbation of chronic obstructive pulmonary disease (disorder)| • 106001000119101 |Chronic obstructive lung disease co-occurrent with acute bronchitis (disorder)|.
Number who benefit: **Number of people with an acute exacerbation**	1,134	Assumed everyone benefits.
Cost per person	£45.19	According to Maisun Elftise, a 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.

4. Sources for population health statistics

The below 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 Gloucestershire**. Sourced from the Office for Health Improvement and Disparities 'Fingertips' Dashboard. Data is sourced from the Quality and Outcomes Framework (QOF). (Office for Health Improvement & Disparities, 2022)
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 Gloucestershire. (McLean et al., 2016)
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. (Nacul et al., 2007)
4. **Estimated number of smokers:** Lower estimate: QOF register – estimated smoking prevalence among people over the age of 18 in Gloucestershire in 2020/21.
5. **Total population registered with a GP in Gloucestershire:** QOF register – numbers of people on GP practice lists in 2020/21

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

More proactive and earlier interventions in primary care

Psychological support for patients in primary care

Metric	Value	Description
Cost per person of programme (C)	£ 616.99	Cost of IAPT services is broken down into three parts: • Cost of the assessment • Cost of low intensity treatment • Cost of high intensity treatment. **Cost of assessment** Assumed each patient referred will receive an initial 30-minute assessment by a band 5 psychological wellbeing practitioner (£41 per hour – £20.50 per session) (Burns & Jones, 2021a; *Psychological Wellbeing Practitioner*, 2022; The National Collaborating Centre for Mental Health, 2023) **Cost of low intensity treatment** It is assumed low intensity treatment is conducted by a band 5 PWP (Clinical audit and specialist care team - NHS Digital, 2022; The National Collaborating Centre for Mental Health, 2023). Low intensity treatment can be delivered in one of three ways: • Six weeks non-facilitated self-help with a short phone call of no longer than five minutes every week (total cost £20.50) • Six sessions of individual guided self-help for people with generalised anxiety disorder (GAD) lasting a maximum of 30 minutes (£123) • Six weekly psychoeducational group sessions lasting 2 hours for 12 people (£41).

		The proportion of people who undertake each kind of low intensity treatment is unknown, therefore we assume people are allocated equally between them. Expected cost = probability of treatment x cost = £61.50. **Cost of high intensity treatment** High intensity is conducted by a high intensity therapist (band 7) at cost of £65 per hour. It consists of 12 – 15 weekly sessions lasting one hour here we have used 13.5 as a mid-point. £65 x 13.5 = £877.50. **Expected cost per patient.** 37% of patients receive low intensity treatment, 29% receive high intensity treatment and 34% receive both (The National Collaborating Centre for Mental Health, 2023). Expected cost per patient = 20.5 + (0.37 x 184.5) + (0.29 x 877.50) + (0.34 x 877.50 + 0.34 x 184.5) = £616.99
Benefit **(B)**	75	Score given to psychological support in the decision conferences.
Number treated: **Number of additional people attending IAPT sessions** **(Nt)**	10%: 614 25%: 1536 50%: 3072	There are 12,286 people with diagnosed COPD in Gloucestershire (Office for Health Improvement and Disparities, 2022). It is assumed 50% of them have anxiety and/or depression. 10% of eligible people referred = 12286 x 0.5 x 0.1 = 614.3. 25% of eligible people referred = 12286 x 0.5 x 0.25 = 1535.75. 50% of eligible people referred = 12286 x 0.5 x 0.5 = 3071.5.
Number who benefit **(N)**	10%: 614 25%: 1536 50%: 3072	Assumed everyone benefits.

Additional costs of pathway improvement	10%: £378,831.86 25%: £947,696.64 50%: £1,895,393.28	614 x 616.99 = 378,831.86 1536 x 616.99 = 947,696.64 3072 x 616.99 = 1,895,393.28
Additional population health gain	10%: 46,050 25%: 115,200 50%: 230,400	75 x 614 = 46,050 75 x 1536 = 115,200 75 x 3072 = 230,400
Pathway effects		
Number of hospital admissions avoided	10%: 4 25%: 10 50%: 20	An estimated 5% of people with COPD in Gloucestershire had a hospital admission in 2021/22 (see data sources for the original efficiency frontier). According to Gruber et al. there was a 13% decrease in inpatient non-elective admissions compared to matched cohort for people receiving IAPT services. This means an expected 0.65% of people (0.13 x 0.05) referred to IAPT services do not have a hospital admission who would have had one otherwise. 10%: 614 x 0.0065 = 3.99 25%: 1536 x 0.0065 = 9.98 50%: 3072 x 0.0065 = 19.97 The average cost of a hospital admission in Gloucestershire is £2,490.88.
Number of outpatient attendances avoided	10%: 15 25%: 37 50%: 73	An estimated 17% of people with COPD in Gloucestershire had an outpatient appointment in 2021/22 (see data sources for the original efficiency frontier). According to Gruber et al. psychological support leads to a reduction in outpatient appointments of 14% after 12 months. This would mean 2.38% of people (0.17 x 0.14) referred to IAPT services would not have

		an outpatient appointment who would have had one otherwise. 10%: 614 x 0.0238 = 14.61 25%: 1536 x 0.0238 = 36.57 50%: 3072 x 0.0238 = 73.11 The average cost of an outpatient appointment in Gloucestershire is estimated at £133.60.
Cost savings	10%: £11,967.52 25%: £29,852 50%: £59,570.40	(15 x 133.60) + (4 x 2490.88) (37 x 133.60) + (10 x 2490.88) (73 x 133.60) + (20 x 2490.88)

Multi-professional management of patients

Metric	Value	Description
Additional cost per person of the yearly review **(C)**	1 PCN: £65.44 2 PCNs: £78.61 3 PCNs: £91.28	It is assumed that each MPT team consists of: • Respiratory consultant for three hours per month at a cost of £123 per hour • Respiratory nurse specialist (band 6) for 4 hours per week at a cost of £51 per hour • High intensity therapist (band 7) for 4 hours per week at a cost of £65 per hour • Practice nurse for 12 hours per week at a cost of £42 per hour. This is based on a conference abstract from Ali et al. and agreed with a respiratory consultant in Gloucestershire.(Ali et al., 2019) Costs are sourced from the PSSRU (Burns & Jones, 2021). Monthly cost of: (3x123)+(4x4x51)+(4x4x65)+(12x4x42) = £4,241. An MPT co-ordinator (band 4) would also need to be hired to run the meetings at a cost of £50,667 including on costs for the year.(Burns & Jones, 2021b) Therefore, the cost of each MPT for a year would be (4241x12) + 50667= £101,559.

		The cost per person is: Forest of Dean PCN: 101559/1552 = 65.44 Above + St Paul's PCN: (101559x2)/(1552+1032)= 78.61 Above + Gloucester inner city: (101559x3)/(1552+1032+754) = £91.28.
Additional benefit **(B)**	35	In the decision conferences, the score assigned to current primary care case management was 55. The score assigned to MPT covered appointments in the decision conference was 90. Therefore, the additional benefit is 35.
Number treated: **Number of additional people attending yearly reviews in areas covered by MPT** **(Nt)**	1 PCN: 1,552 2 PCNs: 2,584 3 PCNs: 3,338	Assumed everyone in the PCNs covered benefited from the specialist advice for staff and patients given by the MPT. (Forest of Dean PCN – 1,552, St Paul's PCN – 1,032 and Gloucester inner city – 754) (Office for Health Improvement & Disparities, 2022).
Number who benefit **(N)**	1 PCN: 1,552 2 PCNs: 2,584 3 PCNs: 3,338	Assumed everyone benefits.
Additional costs of pathway improvement	1 PCN: £101,559 2 PCNs: £203,118 3 PCNs: £304,677	
Additional population health gain	1 PCN: 54,320 2 PCNs: 90,440 3 PCNs: 116,830	1552 x 35 2584 x 35 3338 x 35

Increase uptake of pneumonia vaccinations

Metric	Value	Description
Cost per person of vaccination (C)	£10.06	Cost used in the original **efficiency frontier**.
Benefit (B)	75	Benefit score agreed in the decision conferences.
Number treated: number of people given a vaccination (Nt)	3,647	There are 12,158 people with COPD in Gloucestershire (Office for Health Improvement and Disparities, 2022). 60% (7,295) of patients a year are estimated to have had a pneumonia vaccination in 2021/22. An extra 30% (3,647) would need to be vaccinated to reach 90%.
Number who benefit: Number of people who do not exacerbate because of vaccination. (N)	456	Assumed that the benefit for people with COPD is avoided acute exacerbations. According to a Cochrane Review, the number of patients needed to treat to prevent a patient from experiencing an exacerbation is 8 (Walters et al., 2017). 3647 / 8 = 455.86
Additional costs of pathway improvement	£36,688.82	3,647 x 10.06
Additional population health gain	34,200	456 x 75
Pathway effects		

Number of primary care-managed AECOPD avoided	456	Assumed that the benefit for people with COPD is avoided acute exacerbations. According to a Cochrane Review, the number of patients needed to treat to prevent a patient from experiencing an exacerbation is 8 (Walters et al., 2017). 3647/8 = 455.86 The unit cost for a primary care-managed AECOPD is £45.19.
Cost savings	£20,606.64	456 x 45.19

Proactive case finding

Most optimistic scenario

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£40.95	Costs are defined as the following: • **Identifying smokers:** 24 days a year for a band 6 analyst to identify and send update to high-risk people at £55 an hour: £9,900 (55 × 7.5 × 24) (Burns & Jones, 2021) • **Responding to queries**: 0.2 FTE × NHS band 6 annual salary: 41.9 weeks (1,573 hours) per year, 37.5 hours per week: £17,303 • **Survey administration costs:** £5 per survey (6,264 × 5) = £31,320 • **Number of tests completed:** unit cost of spirometry test is assumed to be £17.37 as used in the original efficiency frontier (2,482 × 17.37) = £43,112.34. Total cost: £101,645 Per-person cost: £101,642/ 2,482 = £40.95.
Benefit score (B)	75	Benefit score attributed to spirometry testing in the decision conferences.
Number treated: Number of people tested (Nt)	2,482	Assumes that, of the 78,300 potentially at-risk people, 20% of them are contacted with the survey, 80% are reached and 50% of them complete it.

		(78300 × 0.2 x 0.8) x 0.5 = 6,264 Then 70% of those people come forward for testing, the same response rate as a recent breast screening programme and that 56.6% of participants score about 16.5 on the CDQ (Johnson et al., 2021; NHS Digital, 2019). 6,264 × 0.7 × 0.566 = 5,357.10
Number who benefit: **Number of people diagnosed with COPD** **(N)**	1,241	Assume 50% diagnosis rate.
Additional population health benefit	93,075	Number of people diagnosed with COPD × benefit score. 1,241 × 75
Additional costs of pathway improvement	£101,645	See cost of improvement row above.
Pathway effects		
Predicted reduction in COPD hospital admissions	286	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: 1241/4.34 = 285.94 per year.

		A hospital admission has a unit cost of £2,490.88.
Predicted reduction in AECOPDs managed in primary care	643	After three years, Kostikas et al. report an exacerbation rate of 57.23 per 100 PY in early diagnosed COPD patients and 108.94 per 100 PY in late diagnosed COPD patients. ARR = 1.0894 – 0.5723 = 0.5171 NNT = 1/0.5171= 1.93 Predicted reduction in AECOPDs managed in primary care = 1241/1.93 = 643.01. The unit cost for a primary care-managed AECOPD is £45.19.
Cost savings	£741,448.85	Number of avoided hospital admissions × cost of a hospital admission + number of avoided primary care-managed AECOPDs × cost of primary care-managed AECOPD. (2490.88 x 286) + (643 × 45.19)

Most pessimistic scenario

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£57.38	Costs are defined as the following: • **Identifying smokers:** 24 days a year for a band 6 analyst to identify and send update to high-risk people at £55 an hour: £9,900 (55 × 7.5 × 24) (Burns & Jones, 2021) • **Responding to queries**: 0.2 FTE × NHS band 6 annual salary: 41.9 weeks (1,573

		hours) per year, 37.5 hours per week: £17,303 • **Survey administration costs:** £5 per survey (2,506 × 5) = £12,530 • **Number of tests completed:** unit cost of spirometry test is assumed to be £17.37 as used in the **original efficiency frontier** (993 × 17.37) = £17,248.41. Total cost: £56,981.41 Per-person cost £56,981.41/ 993 = £57.38.
Benefit score **(B)**	75	Benefit score attributed to spirometry testing in the decision conferences.
Number treated: **Number of people tested** **(Nt)**	993	Assumes that of the 78,300 potentially at-risk people, 20% are contacted each year and 80% of those contacted are reached. Of those reached, 20% complete the survey. (78,300 × 0.8 × 0.2) × 0.2 = 2,506 Then 70% of those people come forward for testing, the same response rate as a recent breast screening programme and that 56.6% of participants score about 16.5 on the CDQ(NHS Digital, 2019). 2506 × 0.7 × 0.566 = 993
Number who benefit: **Number of people diagnosed with COPD** **(N)**	73	Assume 7.33% diagnosis rate. 993 × 0.0733 = 72.79
Additional population health benefit	5,475	Number of people diagnosed with COPD × benefit score. 75 X 73

Additional costs of pathway improvement	£56,981.41	See cost of pathway improvement above.
Pathway effects		
Predicted reduction in COPD hospital admissions	17	Predicted reduction in COPD hospital admissions: 73/4.34 = 16.82 per year. A hospital admission has a unit cost of £2,490.88.
Predicted reduction in AECOPDs managed in primary care	38	Predicted reduction in AECOPDs managed in primary care = 73/1.93 = 37.82. The unit cost for a primary care-managed AECOPD is £45.19.
Cost savings	£44,062.18	Number of avoided hospital admissions × cost of a hospital admission + number of avoided primary care-managed AECOPDs × cost of primary care-managed AECOPDs. (17 × 2490.88) + (38 × 45.19)

Creation of an alliance with responsibilities for treating tobacco dependency and advocating for tobacco control

Increasing uptake of smoking cessation services

Doubled capacity in smoking cessation services

Metric	Value	Description
Pathway improvement		
Cost of improvement ©	£217.75	Cost of smoking cessation programmes used in the original efficiency frontier.
Benefit score (B)	100	Benefit score attributed to primary prevention smoking cessation in the decision conference.

Number treated: **Number of additional people setting a quit date** **(Nt)**	1515	1,515 people set a quit date in the Healthy Lifestyle Service in 2021/22 (see the **original efficiency frontier**). Therefore, we assume this is the number required to double the number of people referred to smoking cessation services.
Number who benefit: **Number who quit** **(N)**	1,078	Assuming the same quit rate for primary prevention as the original efficiency frontier of 71.16%.
Additional population health gain	107,800	1078 x 100
Additional costs of pathway improvement	£329,512.50	1515 x 217.15
Pathway effects		
Reduction in number of people developing COPD	13	NNT = 1/absolute risk reduction (ARR) ARR = control event rate – experiment event rate Terzikhan et al. (2016) reported incidences of COPD of 19.7/1000 PY in current smokers and 8.3/1000 PY in former smokers. ARR = 0.0197 – 0.0083 = 0.0114 NNT = 1/0.114 = 87.72 Reduction in number of people developing COPD = 1078/87.72 = 12.92. This is expected to save £496.38 per case avoided per year.
Cost savings	£6,452.94	Number of cases of COPD avoided × expected cost of treating someone with COPD for a year. 13 x 496.38

Vaping as a harm reduction pilot

Scenario 1: Offering vapes to people who do not quit through the Healthy Lifestyle Service

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£37	Additional cost of a vape per person for one month sourced from https://vapable.com/how-much-does-vaping-cost.
Benefit score (B)	95	Benefit score attributed to vaping as harm reduction in the decision conference.
Number treated: Number of additional people setting a quit date (Nt)	437	1515 people set quit dates in the Healthy Lifestyle Service in 2021/22. 1,078 quit meaning vapes would be offered to the remaining 437.
Number who benefit: Number who quit (N)	437	Assumed that everyone takes up the offer.
Additional population health gain	41,515	437 x 95
Additional costs of pathway improvement	£16,169	437 x 37
Pathway effects		
Reduction in number of people developing COPD	5	NNT = 1/absolute risk reduction (ARR). ARR = control event rate – experiment event rate. Terzikhan et al. (2016) reported incidences of COPD of 19.7/1000 PY in current smokers and 8.3/1000 PY in former smokers.

		ARR = 0.0197 – 0.0083 = 0.0114 NNT = 1/0.114 = 87.72 Reduction in number of people developing COPD = 437/87.72 = 4.98. This is expected to save £496.38 per case avoided per year.
Cost savings	£2,481.90	5 x 496.38

Scenario 2: 10% of the smoking population

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£37	Additional cost of a vape per person for one month.
Benefit score (B)	95	Benefit score attributed to vaping as harm reduction in the decision conference.
Number treated: Number of additional people setting a quit date (Nt)	7,830	There are an estimated 78,300 smokers in Gloucestershire.
Number who benefit: Number who quit (N)	7,830	Assumed that everyone takes up the offer.
Additional population health gain	743,850	7830 x 95
Additional costs of pathway improvement	£289,710	7830 x 37

Pathway effects		
Reduction in number of people developing COPD	89	NNT = 1/absolute risk reduction (ARR). ARR = control event rate – experiment event rate. Terzikhan et al. (2016) reported incidences of COPD of 19.7/1000 PY in current smokers and 8.3/1000 PY in former smokers. ARR = 0.0197 – 0.0083 = 0.0114 NNT = 1/0.114 = 87.72 Reduction in number of people developing COPD = 7830/87.72 = 89.26. This is expected to save £496.38 per case avoided per year.
Cost savings	£44,177.82	89 x 496.38

VBA for tobacco dependency

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£1	The cost of the NCST training module is free. Providing VBA is free and it could be given as part of a yearly review.
Benefit score (B)	90	The benefit score given to tertiary smoking prevention in the decision conferences as part of the original efficiency frontier.
Number treated: Number who have yearly reviews (Nt)	7,209	The number of people who had a yearly review in 2021/22, according to the QOF register and used in the original efficiency frontier.
Number who benefit:	144	Stead et al. (2008) suggested that a further 1–3% additional people would quit due to a VBA intervention. Taking the mid-point of an extra 2% of people quitting, that would mean 243 of the 7,209

Number additional who quit **(N)**		people who receive yearly reviews would quit smoking as a result of the VBA intervention.
Additional population health gain	12,960	Benefit score × additional number who quit. 90 × 144
Additional costs of pathway improvement	£7,209	Cost per person × number who have yearly reviews. 1 × 7209
Pathway effects		
Reduction in hospitalisations	3	NNT = (1 – (PEER × (1 – HR))) / ((1 – PEER) × (PEER) × (1 – HR)) Where PEER represents the predicted event rate and HR represents the Hazard Ratio Godtfredsen et al. (2002) reported a HR of 0.57. In 2021/22 there were 652 hospital admissions for COPD among 12,286 people. Therefore, the patient expected event rate is 5.3 per 100 people (652/12286). NNT = (1 – (0.053 × (1 – 0.57))) / ((1 – 0.053) × (0.053) × (1 – 0.57)) = 45.28. Reduction in hospitalisations = 144/45.28 = 3.18. A hospital admission has a unit cost of £2,490.88.
Reduction in primary care-managed AECOPDs	3	In 2021/22 there were an estimated 5,234 primary care-managed AECOPD among 15,328 people with COPD. Therefore, the expected event rate is 9.2 per 100 people (1134/12286 × 100). Au et al. (2009) reported a HR of 0.78. NNT = (1 – (0.092 × (1 – 0.78))) / ((1 – 0.092) × (0.092) × (1 – 0.78)) = 53.31. Reduction in primary care-managed AECOPD = 143/53.31 = 2.68. The unit cost for a primary care-managed AECOPD is £45.19.
Cost savings	£7,608.21	Cost of hospital admission × expected reduction in hospital admissions + number of primary care-

		managed AECOPDs avoided × cost of primary care-managed AECOPD. (2,490.88 × 3) + (3 × 45.19)

Enhancing the role of social prescribing and awareness of tertiary prevention services

Avoiding fuel poverty

Metric	Value	Description
Cost of improvement (C)	£600.00	Average cost of warm home schemes used in the original efficiency frontier.
Benefit (B)	90	Benefit score assigned to warm home schemes in the decision conferences.
Number additional treated (Nt)	10%: 15 25%: 38 50%: 75	An estimated 150 people were given support in 2021/22.
Number additional who benefit (N)	10%: 15 25%: 38 50%: 75	Assumed everyone benefits.
Additional population health gain	10%: 1,350 25%: 3420 50%: 6,750	15 x 90 38 x 90 75 x 90
Additional costs of pathway improvement	10%: £9,000 25%: £22,800 50%: £45,000	15 x 600 38 x 600 75 x 600

Improving PR services

Improving uptake through the standard route

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£954.00	Cost used in the creation of the original **efficiency frontier**.
Benefit score (B)	90	Benefit score assigned to PR in the decision conference.
Number treated: Number of accepted referrals (Nt)	300	There were an estimated 600 people attending PR courses in the 2021/22 period.
Number who benefit: Number of people completing the course (N)	200	An estimated 67% of people completed PR courses. This number was estimated in the decision conference.
Additional population health gain	18,000	Number who benefit × benefit score. 200 × 90
Additional costs of pathway improvement	£286,200	Number treated × cost of improvement. 300 × 954.00
Pathway effects		

Reduction in hospitalisations	6	NNT = (1 – (PEER × (1 – OR))) / ((1 –PEER) × (PEER) × (1 – OR)) Puhan et al. gave an odds ratio of 0.44 for a reduction in hospital admissions. In 2021/22 there were 652 hospital admissions for COPD among 12,286 people. Therefore, the patient expected event rate is 5.3 per 100 people (652/12286). NNT = (1 – (0.053 × (1 – 0.44))) / ((1 – 0.053) × (0.053) × (1 – 0.44)) = 34.52. Number of hospital admissions avoided = 200/34.52 = 5.79. A hospital admission has a unit cost of £2,490.88.
Cost savings	£14,945.28	2490.88 x 6

Improving uptake through an online offering

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£10.24	According to the NICE guidance, the unlimited licence plan has an annual cost of £0.25 per person registered with a GP in the region (NICE, 2022). There are 12,286 people with COPD in Gloucestershire so the total cost would be £3,071.50. The cost per person undertaking PR would be: 10.24 (3071.5/300).
Benefit score (B)	90	Benefit score assigned to PR in the decision conference.
Number treated: Number of accepted referrals (Nt)	300	There were an estimated 600 people attending PR courses in the 2021/22 period.

Number who benefit: **Number of people completing the course** **(N)**	200	An estimated 67% of people completed PR courses. This number was estimated in the decision conference.
Additional population health gain	18,000	Number who benefit × benefit score. 200 × 90
Additional costs of pathway improvement	£3,071.50	300 × 0.25
Pathway effects		
Reduction in hospitalisations	6	NNT = (1 – (PEER × (1 – OR))) / ((1 –PEER) × (PEER) × (1 – OR)) Puhan et al. gave an odds ratio of 0.44 for a reduction in hospital admissions. In 2021/22 there were 652 hospital admissions for COPD among 12,286 people. Therefore, the patient expected event rate is 5.3 per 100 people (652/12286). NNT = (1 – (0.053 × (1 – 0.44))) / ((1 – 0.053) × (0.053) × (1 – 0.44)) = 34.52 Number of hospital admissions avoided = 200/34.52 = 5.79. A hospital admission has a unit cost of £2,490.88.
Cost savings	£14,945.28	2490.88 x 6

Improving completion rates in the current service

Metric	Value	Description
Pathway improvement		
Cost of improvement **(C)**	£954.00	Cost used in the creation of the original **efficiency frontier**.

Benefit score (B)	90	Benefit score assigned to PR in the decision conference.
Number treated: Number of accepted referrals (Nt)	300	There were an estimated 600 people attending PR courses in the 2021/22 period.
Number who benefit: Number of a people completing the course (N)	261	An estimated 67% of people completed PR courses. This number was estimated in the decision conference.
Additional population health gain	23,490	Number who benefit × benefit score. 261 × 90
Additional costs of pathway improvement	£286,200	Number treated × cost of improvement. 300 × 954.00
Pathway effects		
Reduction in hospitalisations	8	NNT = (1 – (PEER × (1 – OR))) / ((1 –PEER) × (PEER) × (1 – OR)) Puhan et al. gave an odds ratio of 0.44 for a reduction in hospital admissions In 2021/22 there were 652 hospital admissions for COPD among 12,286 people. Therefore, the patient expected event rate is 5.3 per 100 people (652/12286). NNT = (1 – (0.053 × (1 – 0.44))) / ((1 – 0.053) × (0.053) × (1 – 0.44)) = 34.52 Number of hospital admissions avoided = 261/34.52 = 7.56. A hospital admission has a unit cost of £2,490.88.
Cost savings	£19,927.04	2490.88 x 8

Improving uptake to Mindsong and KiActiv

Metric	Value	Description
Pathway improvement		
Cost of improvement **(C)**	£0	At the decision conference, it was discussed that the current Mindsong and KiActiv can be expanded with no additional cost as they are not currently running at capacity.
Benefit score **(B)**	KiActiv: 45 Mindsong: 90	Scores given in the decision conferences.
Number treated: **Number starting the course**. **(Nt)**	KiActiv: 96 Mindsong: 40	KiActiv: 96 people started the course between July 2021 and July 2022. According to Mindsong, they can take an extra 40 people without incurring additional costs.
Number who benefit: **Number completing the course**. **(N)**	KiActiv: 62 Mindsong: 40	Data provided by KiActiv suggests that 65% of people complete the programme.
Additional population health gain	6,390	62 x 45 + 40 x 90
Additional costs of pathway improvement	£0	No expected additional costs.
Pathway effects		

Reduction in hospitalisations from KiActiv	1	NNT = (1 – (PEER × (1 – IRR))) / ((1 – PEER) × (PEER) × (1 – IRR)) Garcia-Aymerich et al. give an incidence rate ratio of 0.72. In 2021/22 there were 652 hospital admissions for COPD among 12,286 people. Therefore, the patient expected event rate is 5.3 per 100 people (652/12286). NNT = (1 – (0.053 x (1 – 0.72))) / ((1-0.053) x (0.053) x (1- 0.72)) = 70.10 62 / 70.10 = 0.88 A hospital admission has a unit cost of £2,490.88.
Cost savings	£2490.88	1 x 2,490.88

Managing acute exacerbations more efficiently

More effective use of the virtual ward

Metric	Value	Description
Pathway improvement		
Cost of virtual ward per person **(C)**	£1,307.38	This is the cost of the virtual ward used in the original efficiency frontier.
Benefit score **(B)**	62	Score used in the decision conference.
Number treated: Number of patients eligible for the virtual ward **(N_t)**	326	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 652 hospital admissions in 2021/22 not included on the virtual ward.

Number who benefit (N)	326	Assumed everyone benefits.
Additional costs of pathway improvement	£426,205.88	Number of people treated on virtual ward × cost of virtual ward. 326 x 1307.38
Additional population health gain	20,212	Benefit score × number of people treated on virtual ward. 62 × 326
Pathway effects		
Number of hospital admissions replaced by virtual ward	326	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 £2,490.88.
Cost savings	£812,026.88	Number of hospital admissions replaced by virtual ward × the cost of a hospital admission. 326 x 2,490.88

6. References

Airoldi, M., Morton, A., Smith, J. A. E., & Bevan, G. (2014). STAR - People-powered prioritization: A 21st-century solution to allocation headaches. *Medical Decision Making*, *34*(8). https://doi.org/10.1177/0272989X14546376

Ali, A., Khan, T., Ahmed, J., Sesan, A., Mougdil, H., Makan, A., Mawaid, A., & Ibrahim, J. (2019). The multidisciplinary team (MDT) management of chronic obstructive pulmonary disease in the community (2019). *American Journal of Respiratory and Critical Care Medicine*, *199*(9). https://www.library.sath.nhs.uk/research/2020/02/17/the-multidisciplinary-team-mdt-management-of-chronic-obstructive-pulmonary-disease-in-the-community-2019/

Au, D. H., Bryson, C. L., Chien, J. W., Sun, H., Udris, E. M., Evans, L. E., & Bradley, K. A. (2009). The Effects of Smoking Cessation on the Risk of Chronic Obstructive Pulmonary Disease Exacerbations. *Journal of General Internal Medicine*, *24*(4), 457–463. https://doi.org/10.1007/s11606-009-0907-y

Boland, M. R. S., Kruis, A. L., Tsiachristas, A., Assendelft, W. J. J., Gussekloo, J., Blom, C. M. G., Chavannes, N. H., & Rutten-van Mölken, M. P. M. H. (2015). Cost-effectiveness of integrated COPD care: the RECODE cluster randomised trial. *BMJ Open*, *5*(10), e007284. https://doi.org/10.1136/bmjopen-2014-007284

Bolton, C. E., Bevan-Smith, E. F., Blakey, J. D., Crowe, P., Elkin, S. L., Garrod, R., Greening, N. J., Heslop, K., Hull, J. H., Man, W. D.-C., Morgan, M. D., Proud, D., Roberts, C. M., Sewell, L., Singh, S. J., Walker, P. P., & Walmsley, S. (2013). British Thoracic Society guideline on pulmonary rehabilitation in adults: accredited by NICE. *Thorax*, *68*(Suppl 2), ii1–ii30. https://doi.org/10.1136/thoraxjnl-2013-203808

Burns, A., & Jones, K. (2021a). *Unit Costs of Health and Social Care 2021: 1. Services*. https://www.pssru.ac.uk/pub/uc/uc2021/services.pdf

Burns, A., & Jones, K. (2021b). *Univt Costs of Health and Social Care 2021: IV. Hospital Based Healthcare Staff*. https://www.pssru.ac.uk/pub/uc/uc2021/hospitalbased.pdf

Clinical audit and specialist care team - NHS Digital. (2022). *Physchological therapies: annual report on the use of IAPT services England 2021/22* . Digital.Nhs.Uk. https://digital.nhs.uk/data-and-information/publications/statistical/psychological-therapies-annual-reports-on-the-use-of-iapt-services/annual-report-2021-22

Decramer, M., Miravitlles, M., Price, D., Román-Rodríguez, M., Llor, C., Welte, T., Buhl, R., Dusser, D., Samara, K., & Siafakas, N. (2011). New horizons in early stage COPD – Improving knowledge, detection and treatment. *Respiratory Medicine*, *105*(11), 1576–1587. https://doi.org/10.1016/j.rmed.2010.12.015

Echevarria, C., Gray, J., Hartley, T., Steer, J., Miller, J., Simpson, A. J., Gibson, G. J., & Bourke, S. C. (2018). Home treatment of COPD exacerbation selected by DECAF score: a non-inferiority, randomised controlled trial and economic evaluation. *Thorax*, *73*(8), 713–722. https://doi.org/10.1136/thoraxjnl-2017-211197

Garcia-Aymerich, J., Lange, P., Benet, M., Schnohr, P., & Anto, J. M. (2006). Regular physical activity reduces hospital admission and mortality in chronic obstructive pulmonary disease: a population based cohort study. *Thorax*, *61*(9), 772–778. https://doi.org/10.1136/thx.2006.060145

Godtfredsen, N. S. (2002). Risk of hospital admission for COPD following smoking cessation and reduction: a Danish population study. *Thorax*, *57*(11), 967–972. https://doi.org/10.1136/thorax.57.11.967

Gonçalves-Bradley, D. C., Iliffe, S., Doll, H. A., Broad, J., Gladman, J., Langhorne, P., Richards, S. H., & Shepperd, S. (2017). Early discharge hospital at home. *Cochrane Database of Systematic Reviews*, *2021*(7). https://doi.org/10.1002/14651858.CD000356.pub4

Gruber, J., Lordan, G., Pilling, S., Propper, C., & Saunders, R. (2022). *The impact of mental health support for the chronically ill on hospital utilisation: evidence from the UK*. https://cep.lse.ac.uk/pubs/download/dp1840.pdf

Johnson, K. M., Sadatsafavi, M., Adibi, A., Lynd, L., Harrison, M., Tavakoli, H., Sin, D. D., & Bryan, S. (2021). Cost Effectiveness of Case Detection Strategies for the Early Detection of COPD. *Applied Health Economics and Health Policy*, *19*(2), 203–215. https://doi.org/10.1007/s40258-020-00616-2

Kostikas, K., Price, D., Gutzwiller, F. S., Jones, B., Loefroth, E., Clemens, A., Fogel, R., Jones, R., & Cao, H. (2020a). Clinical impact and healthcare resource utilization associated with early versus late COPD diagnosis in patients from UK CPRD database. *International Journal of COPD*, *15*. https://doi.org/10.2147/COPD.S255414

Kostikas, K., Price, D., Gutzwiller, F. S., Jones, B., Loefroth, E., Clemens, A., Fogel, R., Jones, R., & Cao, H. (2020b). Clinical Impact and Healthcare Resource Utilization Associated with Early versus Late COPD Diagnosis in Patients from UK CPRD Database . *International Journal of Chronic Obstructive Pulmonary Disease*, *Volume 15*, 1729–1738. https://doi.org/10.2147/COPD.S255414

Ma, R.-C., Yin, Y.-Y., Wang, Y.-Q., Liu, X., & Xie, J. (2020). Effectiveness of cognitive behavioural therapy for chronic obstructive pulmonary disease patients: A systematic review and meta-analysis. *Complementary Therapies in Clinical Practice*, *38*, 101071. https://doi.org/10.1016/j.ctcp.2019.101071

McLean, S., Hoogendoorn, M., Hoogenveen, R. T., Feenstra, T. L., Wild, S., Simpson, C. R., Mölken, M. R. Van, & Sheikh, A. (2016). Projecting the COPD population and costs in England and Scotland: 2011 to 2030. *Scientific Reports*, *6*. https://doi.org/10.1038/srep31893

McNamara, R. J., Epsley, C., Coren, E., & McKeough, Z. J. (2017). Singing for adults with chronic obstructive pulmonary disease. *Cochrane Database of Systematic Reviews*, *2019*(2). https://doi.org/10.1002/14651858.CD012296.pub2

McNeil, A., Brose, L., East, K., Robson, D., Simonavicius, E., & Taylor, E. (2022, September). *Vaping substantially less harmful than smoking, largest review of its kind finds*. Kcl.Ac.Uk. https://www.kcl.ac.uk/news/vaping-substantially-less-harmful-than-smoking-largest-review-of-its-kind-finds

Nacul, L. C., Soljak, M., & Meade, T. (2007). Model for estimating the population prevalence of chronic obstructive pulmonary disease: Cross sectional data from the health survey for England. *Population Health Metrics*, *5*. https://doi.org/10.1186/1478-7954-5-8

National Institute for Health and Care Excellence (NICE). (2022). *myCOPD for managing chronic obstructive pulmonary disease [MTG68]*. https://www.nice.org.uk/guidance/mtg68

NEL WP admin. (2020). *Northamptonshire backs e-cigarettes as way to stop smoking*. Northamptonshirehcp.Co.Uk. https://northamptonshirehcp.co.uk/2020/03/https-www-northamptonshirehcp-co-uk-2020-03-northamptonshire-to-stop-smoking/

NHS Digital. (2019). *Proportion of women taking up breast screening invitations falls*. Digital.Nhs.Uk. https://digital.nhs.uk/news/2019/proportion-of-women-taking-up-breast-screening-invitations-falls

NHS England. (n.d.). *Model Health System*. Model.Nhs.Uk. Retrieved February 22, 2023, from https://model.nhs.uk/

NHS England. (2022). *Combined adult and paediatric Acute Respiratory Infection (ARI) hubs (previously RCAS hubs)*. https://www.england.nhs.uk/wp-content/uploads/2022/10/BW2064-combined-adult-paediatric-ari-hubs-october-22.pdf

NICE. (2023). *Tobacco: preventing uptake, promoting quitting and treating dependence*. Nice.Org.Uk. https://www.nice.org.uk/guidance/ng209/chapter/recommendations-on-treating-tobacco-dependence

Office for Health Improvement & Disparities. (2022). *Fingertips: Public Health Profiles*. https://fingertips.phe.org.uk/search/COPD#page/4/gid/1/pat/15/par/E92000001/ati/167/are/E38000251/iid/93792/age/1/sex/4/cat/-1/ctp/-1/yrr/1/cid/4/tbm/1

Osman, L. M., Ayres, J. G., Garden, C., Reglitz, K., Lyon, J., & Douglas, J. G. (2008). Home warmth and health status of COPD patients. *The European Journal of Public Health*, *18*(4), 399–405. https://doi.org/10.1093/eurpub/ckn015

Osman, L. M., Ayres, J. G., Garden, C., Reglitz, K., Lyon, J., & Douglas, J. G. (2010). A randomised trial of home energy efficiency improvement in the homes of elderly COPD patients. *European Respiratory Journal*, *35*(2), 303–309. https://doi.org/10.1183/09031936.00187708

Psychological wellbeing practitioner. (2022). Prospects.Ac.Uk.

Public Health England. (2015, August). *E-cigarettes around 95% less harmful than tobacco estimates landmark review*. Gov.Uk.

Rasheed, R., Salako, B., Odutola, O., & Shanthakumaran, Y. (2021). 19 Establishment of acute respiratory hub (ARH) service during COVID-19 pandemic. *Abstracts*, A7.3-A8. https://doi.org/10.1136/leader-2021-FMLM.19

Shavelle, R., Strauss, D., Paculdo, Kush, & Mannino, D. M. (2009). Life expectancy and years of life lost in chronic obstructive pulmonary disease: Findings from the NHANES III Follow-up Study. *International Journal of Chronic Obstructive Pulmonary Disease*, 137. https://doi.org/10.2147/COPD.S5237

Sørensen, S. S., Pedersen, K. M., Weinreich, U. M., & Ehlers, L. (2017). Economic Evaluation of Community-Based Case Management of Patients Suffering From Chronic Obstructive Pulmonary Disease. *Applied Health Economics and Health Policy*, *15*(3), 413–424. https://doi.org/10.1007/s40258-016-0298-2

Stead, L. F., Bergson, G., & Lancaster, T. (2008). Physician advice for smoking cessation. In L. F. Stead (Ed.), *Cochrane Database of Systematic Reviews*. John Wiley & Sons, Ltd. https://doi.org/10.1002/14651858.CD000165.pub3

Terzikhan, N., Verhamme, K. M. C., Hofman, A., Stricker, B. H., Brusselle, G. G., & Lahousse, L. (2016). Prevalence and incidence of COPD in smokers and non-smokers: the Rotterdam Study. *European Journal of Epidemiology*, *31*(8), 785–792. https://doi.org/10.1007/s10654-016-0132-z

The Health Foundation. (n.d.). *STAR: a tool for commissioners*. Available from: Https://Www.Health.Org.Uk/Funding-and-Partnerships/Programmes/Star-a-Tool-for-Commissioners.

The Health Foundation. (2012). *Learning Report: Looking for Value in Hard Times*.

The National Collaborating Centre for Mental Health. (2023). *The Improving Access to Psychological Therapies Manual*. https://www.england.nhs.uk/wp-content/uploads/2018/06/the-nhs-talking-therapies-manual-v6.pdf

Thornicroft, G. (2018). Improving access to psychological therapies in England. *The Lancet*, *391*(10121), 636–637. https://doi.org/10.1016/S0140-6736(17)32158-X

Tindle, H. A., Stevenson Duncan, M., Greevy, R. A., Vasan, R. S., Kundu, S., Massion, P. P., & Freiberg, M. S. (2018). Lifetime Smoking History and Risk of Lung Cancer: Results From the Framingham Heart Study. *JNCI: Journal of the National Cancer Institute*. https://doi.org/10.1093/jnci/djy041

Walters, J. A., Tang, J. N. Q., Poole, P., & Wood-Baker, R. (2017). Pneumococcal vaccines for preventing pneumonia in chronic obstructive pulmonary disease. *Cochrane Database of Systematic Reviews*, *2019*(3). https://doi.org/10.1002/14651858.CD001390.pub4

Wright, D., Twigg, M., & Thornley, T. (2015). Chronic obstructive pulmonary disease case finding by community pharmacists: a potential cost-effective public health intervention. *International Journal of Pharmacy Practice*, *23*(1), 83–85. https://doi.org/10.1111/ijpp.12161