

Smarter Spending in Population Health

Using economic principles to set priorities for COPD resource allocation in Birmingham and Solihull ICS

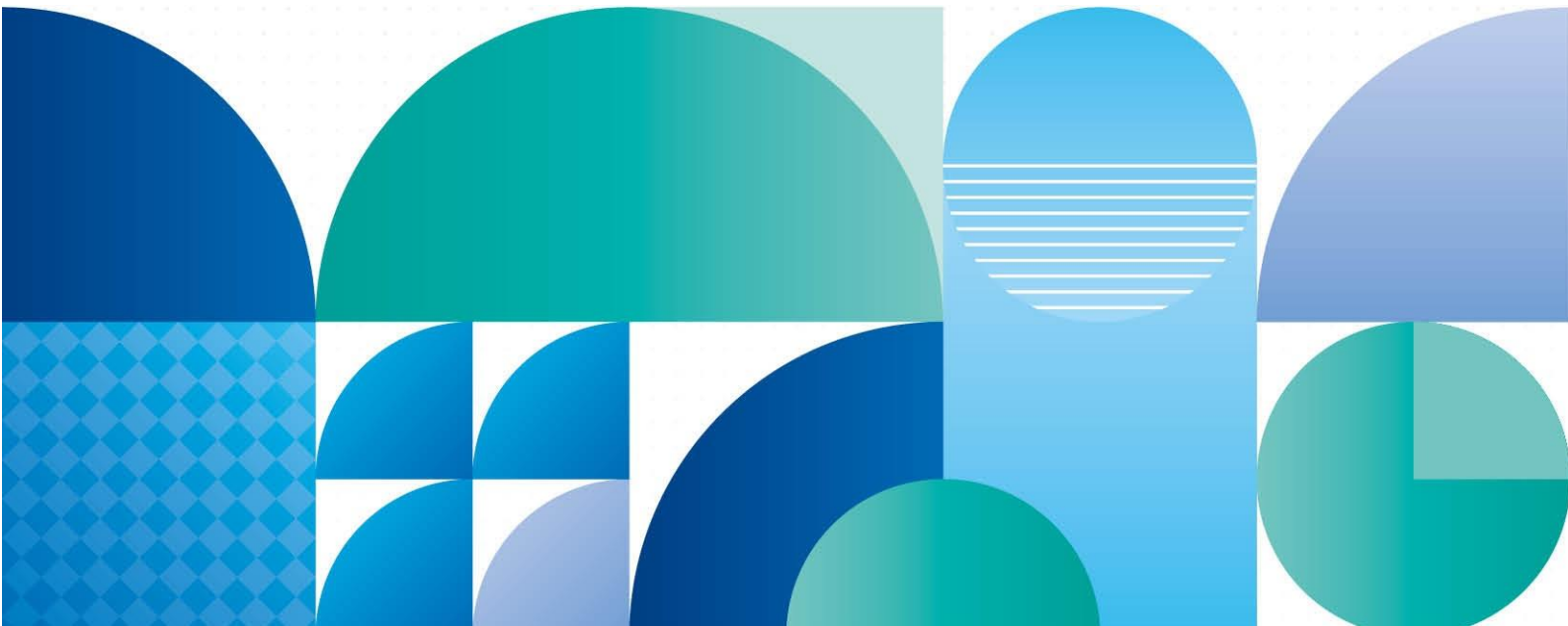


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Introduction

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

This report is designed to support the respiratory steering group with planning for the COPD pathway. It can be used to determine which pathway improvements should be taken forward in consideration of the available resources.

Recommendations

Based on the STAR methodology applied in this project, it is recommended that the respiratory steering group prioritises the following pathway improvements:

- Making use of the virtual ward to support early discharge
- Expanding spirometry testing
- Introducing the [myCOPD](#) app
- Increasing uptake of smoking cessation services (tertiary prevention: [Quit with Bella](#) app)
- Promoting respiratory services within localities through social prescribing (physical activity).

If these were all implemented as described, they would be expected to save £1,798,053.49 per year and lead to a 52.46% increase in population health.

Socio-Technical Allocation of Resources

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

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

By applying STAR, commissioners can:

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

Smarter Spending in Population Health

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

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

More resources on the Smarter Spending in Population Health Programme and STAR can be found on the HEU's website [here](#).

Running STAR in Birmingham and Solihull

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 Birmingham focused on building a common understanding of the population for those at risk of developing COPD or already living with COPD and understanding the relative value of all the COPD pathway components. This covers all the interventions currently offered in Birmingham and Solihull that are aimed at treating people with COPD. Summaries are 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 Birmingham and Solihull](#) section.

Full information on the process that was followed in Birmingham and Solihull can be found in the [methods document](#) in the appendices.

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

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

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 in which it can be improved. The people who attended the decision conferences are outlined below:

Birmingham and Solihull ICB

- Richard Mendelsohn Medical Director for Long Term Conditions, Prevention and Population Health Management
- Carol Watson Senior Integration Manager – Respiratory and CKD
- Nasema Akhtar Project Manager, Executive Office – PMO
- Richard Wilson Chief Analyst
- Stephen Taggart Head of Business Intelligence
- Mark Dasgupta Clinical Director, Medicines Management and Optimisation
- Kim Silvester System Improvement Partner
- Heather Moorhouse Director of Finance
- Lizanne Harland Head of Contracting
- Elizabeth Nalwadda Clinical Prioritisation Manager
- Mitalee Pisavadia Clinical Prioritisation Officer
- Inderpal Jandu Interim Head of Central Improvement Unit (CIU)

Birmingham City Council

- Rebecca Howell-Jones Public Health Consultant
- Rachel Emmerich Public Health Programme Senior Officer

University Hospital of Birmingham

- Simon Gompertz Consultant Respiratory Physician and Clinical Service Lead for Respiratory Medicine
- Clara Green Consultant Respiratory QE
- John Singh Respiratory Consultant
- Paul Cockwell Consultant Physician

Birmingham Community Healthcare NHS Foundation Trust

- Hailey Williamson Respiratory Physiotherapist
- Amy Iche Clinical Service Lead – Respiratory

Health Economics Unit/Strategy Unit (facilitating)

- Sophie Hodges Client Service Manager
- Jack Ettinger Senior Health Economist
- Phil Bucknall Senior Consultant
- Luca Ricci Pacifici Consultant
- Bethany Taylor Consultant
- Lydia Hextell Consultant
- Marya Mobeen Research Assistant

The COPD population, pathway and main challenges

Population

The aim of the first part of the decision conferences was to ensure that the attendees all had a common understanding of the population for whom they are making decisions and an understanding of the levels at which they can intervene. For example, smoking cessation interventions would be targeted at those at risk of COPD.

As shown in Figure 1 below, the total population of Birmingham and Solihull is 1.2 million people. In terms of those at risk of COPD, the percentage of smokers in the ICS is 15.3%, equating to around 240,183 smokers. There are potentially people living with undiagnosed COPD in the ICS (Nacul et al., 2007). In 2021/22, there were 23,473 people with diagnosed COPD (Office for Health Improvement & Disparities, 2022).

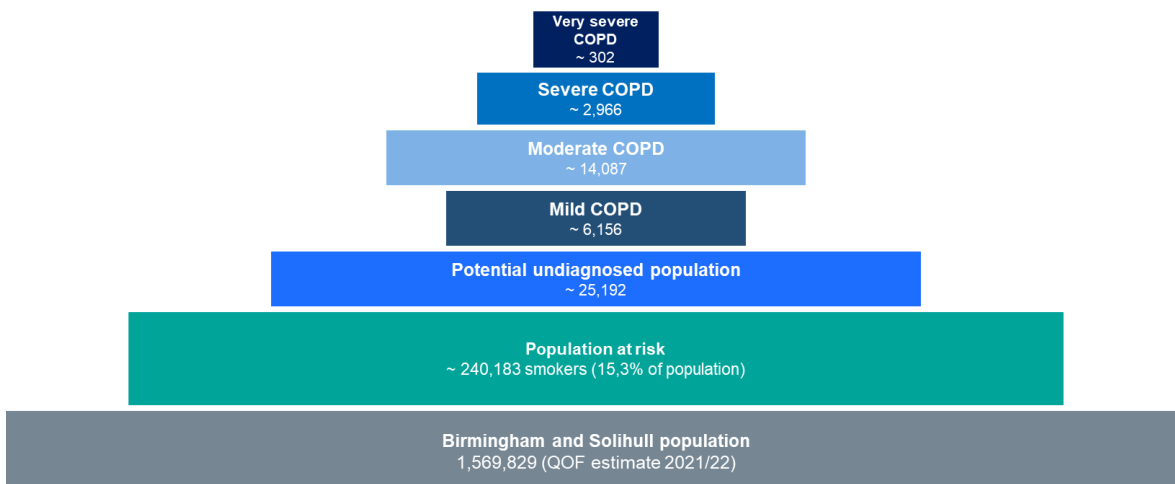


Figure 1 – Population pyramid in Birmingham and Solihull ICS (sources are described in the appendices).

The COPD pathway

Next, participants were asked to assess the relative value of all the interventions and programmes (pathway improvements) in the COPD pathway. The interventions in the

COPD pathway are outlined in Figure 2. This figure was presented to participants to ensure there was a common understanding of all the interventions available.

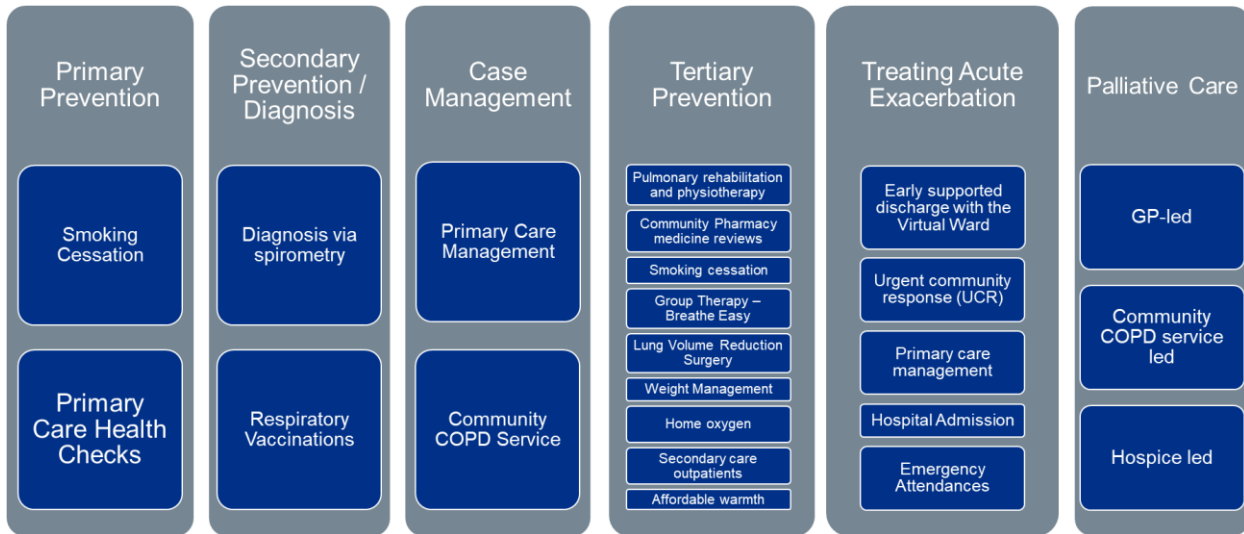


Figure 2 – The current care pathway for those living with and at risk of developing COPD.

Valuing the current care pathway

Attendees were then asked to assess the relative benefit (value), in terms of length and quality of life, for all interventions and programmes in the pathway. This process is described in the [methods document](#) in the appendices.

This assessment produced a 'benefit score', which is a key piece of evidence used to populate the efficiency frontier (see the [interpreting the efficiency frontier](#) section below). This process also helps attendees to think about comparing different interventions with each other and to consider the trade-offs between them. For example, some interventions may provide more benefit in the long term compared with others which offer more immediate benefit. The discussions generated by this valuation process can help to determine the key challenges and identify the appropriate interventions to improve the pathway, as well as helping to build the efficiency frontier (the visual model of the interventions in the COPD pathway).

Participants rated the interventions in the pathway by plotting Post-it notes (representing the interventions and programmes in the current care pathway) on a visual analogue scale (VAS), a tool widely used in health economics (Parkin & Devlin, 2006). The scale and the scores assigned to each intervention are displayed in Figure 3 below. Attendees were given an information pack (which can be found in the [appendices](#)) which included

information from published academic studies looking at the quality-of-life gain (in terms of quality-adjusted life years¹) to inform the scoring process.

In Figure 3, 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 offer the most health gain. A score of 0 indicates an intervention that gives no additional health gain compared with current care.

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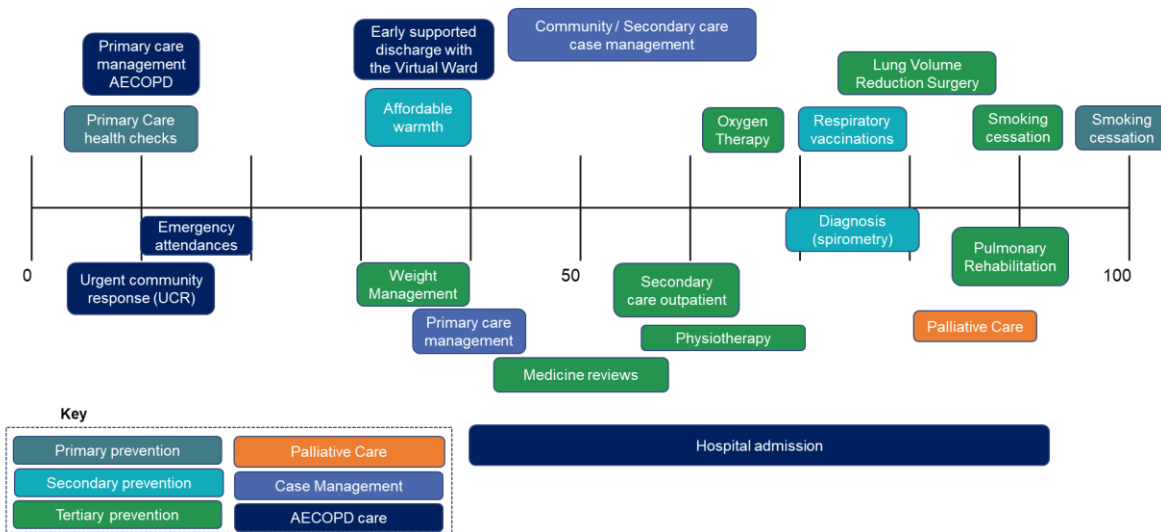


Figure 3 – Benefit scores of each of the interventions in the COPD pathway.

The value of the COPD pathway in Birmingham and Solihull

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

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

The methods are presented in the [methodology document](#) in the appendices.

Interpreting the efficiency frontier

The efficiency frontier is made up of triangles representing the value for money of each intervention in that pathway (Figure 4). This allows us to visually compare the impact of different interventions and programmes across the whole pathway (e.g., spirometry and pulmonary rehabilitation). The y-axis shows the expected population health benefit for an intervention (the product of the number who benefit and the benefit score) compared with current care. The x-axis displays the estimated annual cost for an intervention.

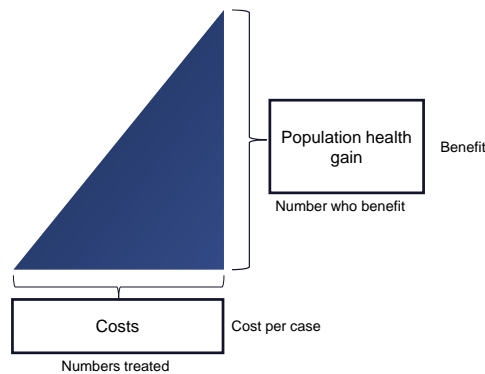


Figure 4 – Populating the efficiency frontier.

STAR’s visual models are what makes it applied common sense. In Figure 5 below, we can see at a glance that the triangle on the right represents an intervention that is much more cost-effective than the intervention represented by the triangle on the left: as we increase spending, the benefits increase quickly for the triangle on the right but only slowly for the triangle on the left.



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

The triangles are then ordered according to their value for money 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).

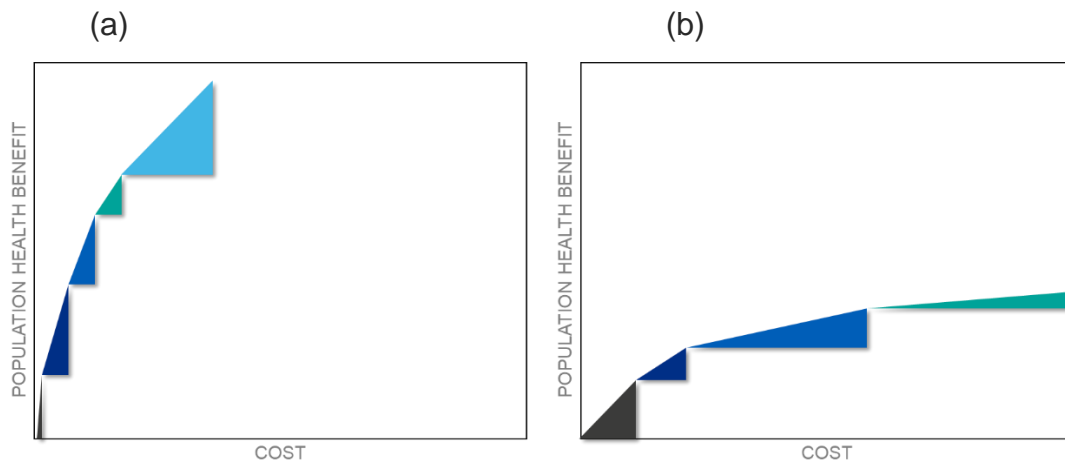


Figure 6 – Different efficiency frontiers with good (a) and bad (b) value for money.

The efficiency frontier in Birmingham and Solihull

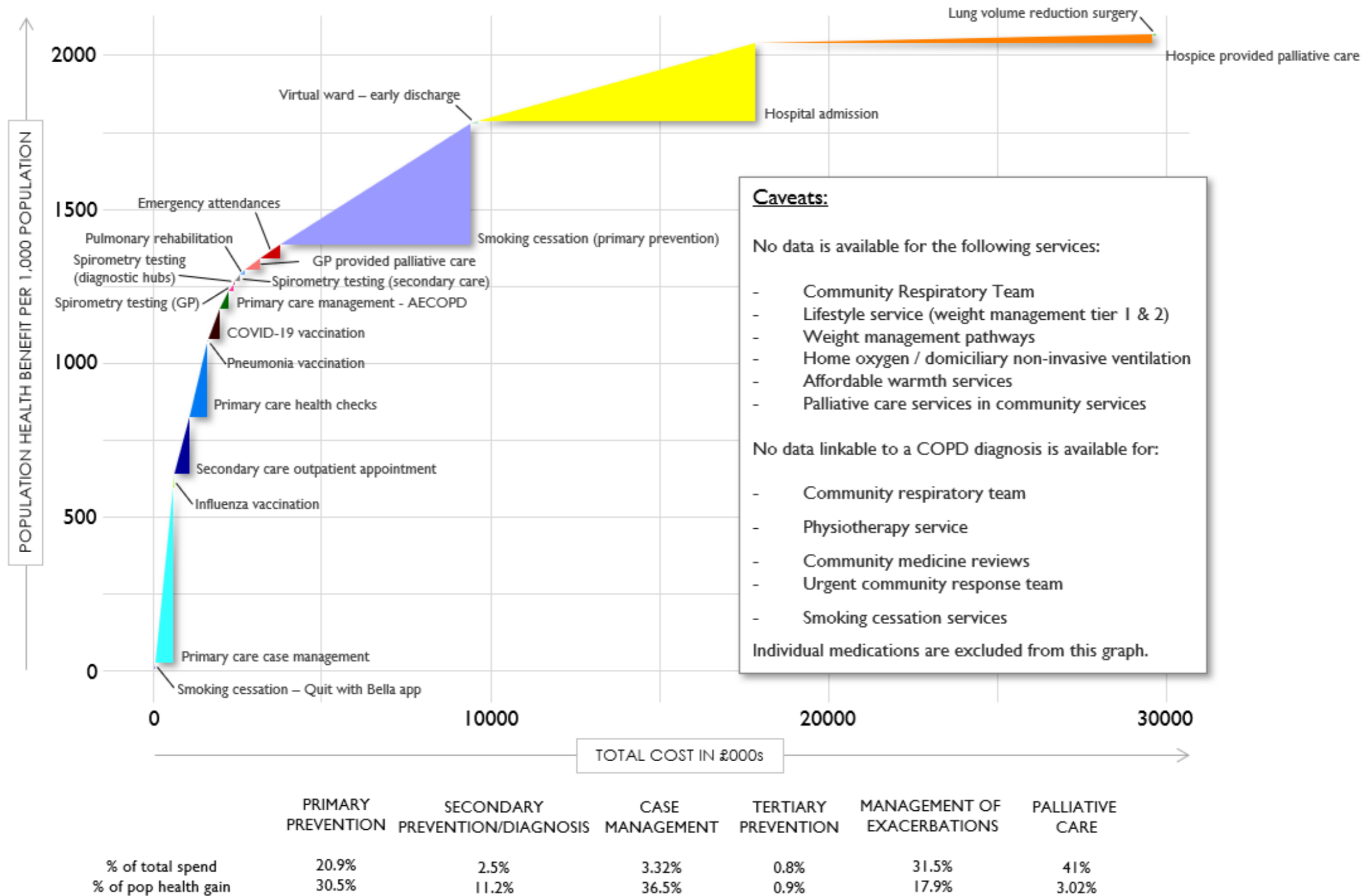


Figure 7 – The efficiency frontier for the COPD pathway in Birmingham and Solihull.

Priority areas

The ICS's respiratory steering group held an away day in October 2022 during which they developed a list of priority areas for improving the health and management of people with respiratory disease. These priority areas are:

- Prevention of COPD and promotion of healthier communities
- Accurate diagnosis
- Support and education for clinicians
- Living well
- Dying well
- National priorities.

Prevention of COPD and promotion of healthier communities

Because COPD is a chronic disease, reducing the risk of developing COPD is the best way for individuals to maintain as high a quality of life as possible. For those who already have COPD, reducing the risk of infected exacerbation and proper use of effective support services for patients are key to promoting healthier lifestyles.

This could be done alongside population health mapping to identify inequalities and population needs so that interventions can be targeted.

Accurate diagnosis

Accurate and quality-assured diagnostics are essential to the management of patients with respiratory disease and reducing the risk of exacerbation. The earlier someone can be diagnosed, the earlier they can begin the correct management plan.

The starting point is to increase uptake of screening tests. This was recognised as a significant challenge. A spirometry testing van had been trialled in the past but it was not recognised as the best solution based on the number of patients reached. Looking at inequality and deprivation indexes, it was seen that COPD patients were living in the most deprived area of the system footprint. This might suggest that case-finding activity should be focused on patients living in the most deprived decile.

More generally, high-risk smokers can be identified via primary-care databases which register people's smoking status. A few selection criteria based on age, smoking history and other demographics might also be applied to identify those more likely to have undiagnosed COPD.

There is an ambition to commission an ICS-wide community-based screening model, aligned with the Community Diagnostic Centre, across the six locality footprints (North, East, Central, South, West and Solihull). It would serve as a conduit between primary care

and acute services, focusing on the identification and fast-tracking of patients with unstable asthma and COPD.

It would identify patients earlier through a specialist diagnostic service, benefiting both the patient and the economy by implementing appropriate therapies at the earliest possible point.

Support and education for clinicians

Not all clinicians, and especially those in primary care who are not respiratory specialists, are aware of all the services available to people with COPD in Birmingham and Solihull. Similarly, not all clinicians are aware of the latest guidance on COPD management. Birmingham and Solihull ICS plans to implement a robust training programme to upskill clinical teams to deliver high-quality respiratory care. This programme could be supplemented by helping clinicians to understand the wide range of services, both inside and outside of healthcare, that can be beneficial to people with COPD.

Living well

Because COPD is a chronic illness, people living with it need to be supported to self-manage their condition and learn how to live with it. Birmingham and Solihull ICS plans to develop a clear set of pathways to support patients at each point of contact and intervention.

Dying well

Palliative care services are less well developed for patients with chronic disorders compared with those who have malignant disease. Communication problems can be compounded by a mismatch in expectations between patients and healthcare providers on prognosis and other issues. Most patients want more information about their illness to facilitate participation in decision-making.

Development of clinical and social support systems to improve palliative care processes for patients and carers could have big benefits for people with COPD who are in their last years of life.

National priorities

The expansion of the virtual ward as early discharge support for respiratory exacerbations is a national priority. It aims to treat patients closer to home and to reduce the resources needed for their care in the hospital setting.

The virtual ward is currently being trialled at University Hospitals Birmingham. The expansion of this ward could have wide system benefits.

Improving the pathway

Addressing the key priorities

After discussing the priority areas and reflecting on the efficiency frontier presented in Figure 7, attendees were asked to identify pathway improvements that could address these key priorities.

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

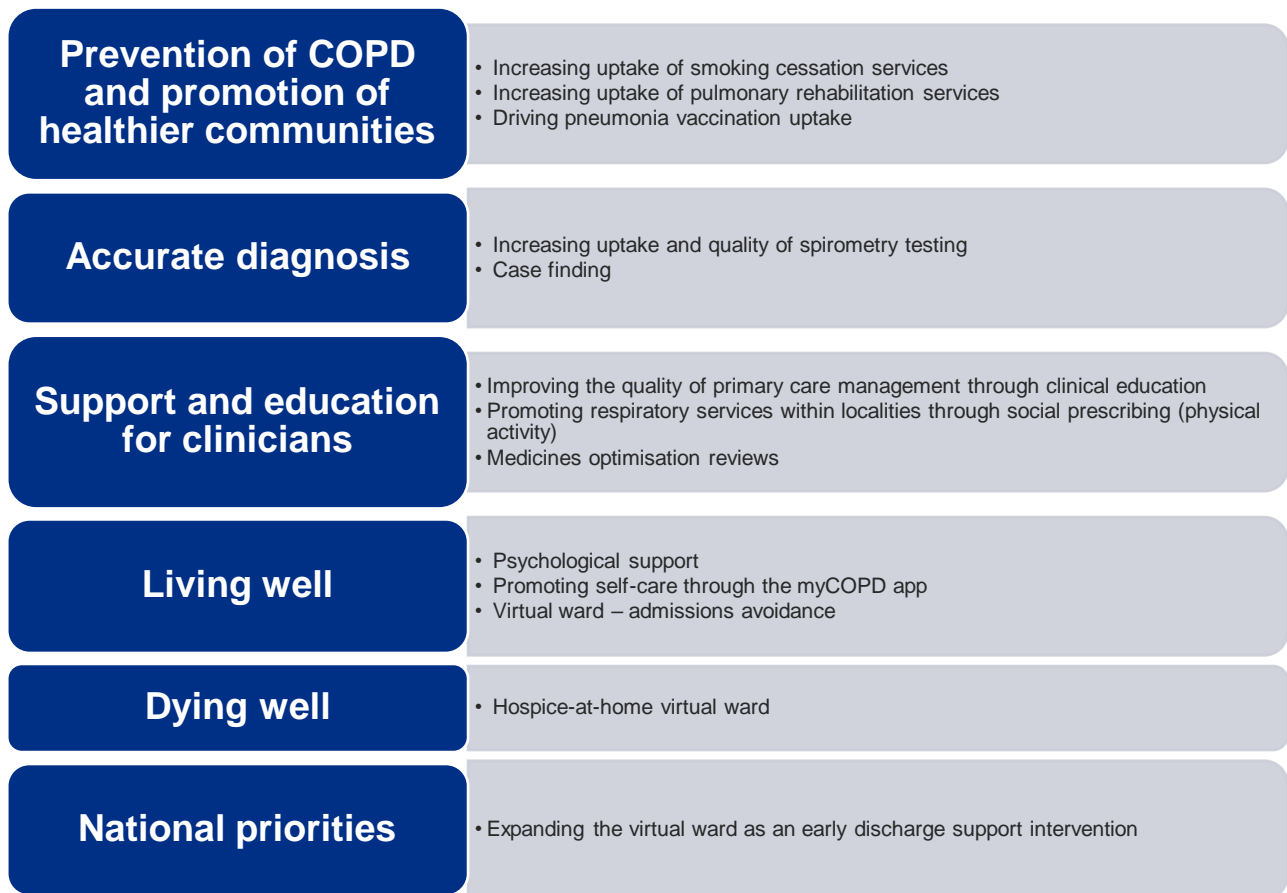


Figure 8 – Pathway improvements set out to meet the main challenges.

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.

A pathway improvement can be a single intervention such as pulmonary rehabilitation. However, other pathway improvements may consist of multiple interventions; for example, ‘improving signposting to services’ would consist of the signposting intervention itself as well as offering increased capacity to improve uptake of the services being signposted to.

Prevention of COPD and promotion of healthier communities

Increasing uptake of smoking cessation services

Smoking is one of the leading causes of COPD (NICE, n.d.). According to estimates, there are 240,183 smokers in Birmingham and Solihull, representing 15.3% of the population.

In 2021/22 13,649 people set a quit date – 5.7% of the smoking population. Of these, 28.5% quit after four weeks (see data sources in the [appendices](#)). Improving the number of people who take up and complete smoking cessation services would help to reduce the number of people who develop COPD.

Increasing uptake of pulmonary rehabilitation services

Pulmonary rehabilitation (PR) is widely regarded as one of the best things that someone with COPD can do to improve their quality of life (Bolton et al., 2013).

In the decision conferences it was discussed that getting people onto PR services early would help to ensure they get the education on how to manage their breathlessness and maintain their physical health. Current referral criteria limit PR services to people with an MRC score of 3+. This could be lowered to allow earlier intervention.

Only an estimated 51% of people complete PR (see data sources in [the appendices](#)). This means around two people need to be treated for one person to benefit. Improving this number would make PR a more cost-effective intervention.

Driving pneumonia vaccination uptake

According to data provided by the ICS, approximately 4.4% of patients with COPD had a pneumonia vaccination in 2021/22. According to the Health Inequalities Dashboard from

NHS England, an estimated 26% of patients with any respiratory condition had their flu jab and 56.6% of people had two doses of COVID-19 vaccination in December 2022.

Improving the number of people who have respiratory vaccinations is the best way to reduce the number of people who have an infective exacerbation of COPD. This is also one of the key aims of the Core20PLUS5 programme, a national approach to reducing health inequalities (NHS England, n.d.).

Accurate diagnosis

Increasing uptake and quality of spirometry testing

Diagnostics is a critical step in the COPD management process. Spirometry tests can be administered by clinical practices, diagnostic hubs and in secondary care. Numbers suggest that administering those tests in hubs and practices is cheaper compared with secondary care and that increasing the activity will improve the value for money generated by this intervention.

It was discussed how much more effective it would be to have a tiered approach, distinguishing simpler cases from more complex situations. A simpler diagnostic pathway administered by upskilled staff could increase the diagnostic potential of practices. The critical aspect in the lower tier would be to provide accurate training that leads to robust testing. This would be done through a stronger network of trained professionals to enhance peer support, keep staff engaged and support their training, and review techniques at definite intervals. There would need to be more work at primary care level to create such a network, increase know-how, and link staff and professionals. The same approach would be ideal in rural communities, where access to healthcare is more complex and primary care plays a crucial role in terms of case-finding.

Case-finding

The pathway improvement above does not look at improving the diagnosis rate from spirometry testing. Undiagnosed COPD cases can be found by opportunistic case detection involving screening people at higher risk of developing COPD during routine primary care visits. However, 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 26.94% (see data sources in the [appendices](#)). Improving this rate would improve the value for money generated by spirometry testing.

As high-risk smokers (defined as current smokers and those who have quit within five years; Tindle et al., 2018) are one of the most prominent at-risk groups for developing COPD (Office for Health Improvement & Disparities, 2022), undiagnosed COPD cases are likely to be more prevalent among this group than among 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 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 which 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 (Johnson et al., 2021; D. Wright et al., 2015).

To further refine the target population for diagnostic spirometry testing, we can use the CDQ as a cost-effective case-finding strategy, suggests the literature review (Johnson et al., 2021; D. 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.

Support and education of clinicians

Improving the quality of primary care management through clinical education

Current provision of care in primary care for people with COPD is variable. Helping general practice staff to develop specialist skills in COPD management could help to reduce this variability. Education to the primary care sector will be offered through the ICS's training hub.

Promoting respiratory services within localities through social prescribing – physical activity

There are many services that could be beneficial for people with COPD. These could be flagged to patients through text messages from their GPs and even through the myCOPD app.

As smoking cessation services and PR services are modelled elsewhere, here we focus on the creation of a physical exercise programme that allows people with long-term conditions to increase their activity levels.

Medicines optimisation reviews

The appropriate or inappropriate use of rescue therapies, inhalers and other medications can make a big difference in the quality of life for someone with COPD and in the cost of medications to the health system (Gormley et al., 2021).

NICE guidelines recommend progression to triple therapy in patients with persistent breathlessness and exacerbation despite other therapies. However, triple therapy is over-prescribed in clinical practice and used in lower-risk patients who are not frequent

exacerbators. More can be done in Birmingham and Solihull to ensure triple therapy is appropriately prescribed (Wright et al., 2022).

Living well

Psychological support

Anxiety and depression are among the main comorbidities 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).

The Improving Access to Psychological Therapies (IAPT) services provide evidence-based treatments for people with depression and anxiety disorders and comorbid 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 Birmingham (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% and that the rate of depression ranges from 10 to 42% in stable patients and may be up to 86% in patients with acute exacerbations (Ma et al., 2020).

Increasing the number of people being referred to IAPT services could help to improve physical and mental wellbeing as well as reducing the burden on hospital admissions and outpatient attendances (Gruber et al., 2022).

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

Promoting self-care through the myCOPD app

Currently in Birmingham and Solihull, there is no offer of an online tool to help people self-manage their COPD. The myCOPD app is a smartphone application to support self-management for people at any stage of COPD. It provides education on inhaler use, help with self-management, prescription assessments and symptom tracking, and provides access to a six-week PR course.

Healthcare professionals can also use the app to communicate with patients. It can be used as a way of signposting people to local services (National Institute for Health and Care Excellence, 2022). The focus here is on myCOPD as a self-management tool; therefore, we have not included the online PR offer or the signposting functionality available through the app in the scenario below.

Virtual ward: admissions avoidance

Currently the virtual ward is only offered to people as part of an early supported discharge following a hospital admission for an acute exacerbation. In the decision conference, it was suggested that the virtual ward could be offered to people who are at high risk of a hospital

admission or ‘frequent flyers’. This could be a way of avoiding people going to hospital in the first place.

Dying well

Expanding palliative care offer through hospice-at-home virtual ward

In the decision conferences it was discussed that there are no set pathways for patients with COPD in their last months and years of life. Similarly, it was discussed that a minority of people with COPD receive palliative care and that patients with COPD tend to receive less adequate palliative care than their counterparts with other long-term conditions (Curtis, 2008). The main reasons for inadequate palliative care are poor patient–physician communication about palliative and end-of-life care and the uncertainty in predicting prognosis for patients with COPD.

Therefore, proactive tools and approaches to palliative care are required for patients with later-stage COPD and their carers. Virtual wards are being set up for frail patients and there is an opportunity to extend the virtual wards service to later-stage as well as end-of-life COPD patients. This could prove to be an efficient way of expanding the palliative care offering rather than expanding expensive hospice care or relying on GP capacity.

National priorities

Expanding the virtual ward as an early discharge support intervention

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

According to Birmingham and Solihull ICS, there were 308 patients with COPD included on the virtual ward between February 2022 and February 2023 (see data sources in the [appendices](#)). An expansion of this service could lead to system savings as people would spend less time in hospital following an acute exacerbation.

Assessing the impact of the proposed pathway improvements

During this phase of the programme, the HEU outlined the expected change that could occur over a period of one year because of each pathway improvement. Where possible, a visualisation of the impact each one could have on the efficiency frontier was also

produced, 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 help the respiratory programme team 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 number 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 pathway 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. These formulae were adapted from those in the work of Airoidi et al. (2014) in discussion with external experts.

Metric	Methods
Additional population health benefit due to pathway improvement (PHB)	<p>This can be represented as:</p> $PHB_{j+k+i} = N_j \times B_j + N_i \times B_i + N_k \times B_k \dots$ <p>Where <i>j</i>, <i>l</i> and <i>k</i> represent each intervention in the pathway improvement.</p>

	<p>Where N_j is the number of individuals who would benefit from the intervention j each year and B_j is the potential benefit in quality (and length) of life, assuming successful implementation, to the typical beneficiary (i.e., QALY gains), compared with current care.</p> <p>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.</p>
<p>Additional costs of pathway improvement (N_tC)</p>	<p>Where j, l and k represent each intervention in the pathway improvement.</p> <p>This can be represented as:</p> $N_t C = N_{t_j} \times C_j + N_{t_i} \times C_i + N_{t_k} \times C_k \dots$ <p>Where N_{t_j} 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.</p> <p>It is assumed that costs apply to each person treated and that there is a linear relationship between costs and numbers treated.</p>
<p>Expected impact on healthcare resource use (R)</p>	<p>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 NNTs 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.</p> <p>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.</p>

	<p>We have modelled the latest timeframe in which the improvements are expected to have statistically significant effects on the rest of the pathway.</p> <p>Number who benefit ($N_{j,l,k...}$) from each intervention in the pathway improvement has then been divided by the relevant NNT:</p> $R_y = \frac{N_j}{NNT_y}$ <p>Where y is equal to the pathway component affected by the improvement (usually hospital admissions).</p> <p>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.</p>
<p>Cost savings (RC_v)</p>	<p>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.</p> $RC_{y+x+z} = R_y \times C_{vy} + R_x \times C_{vx} + R_z \times C_{vz}...$ <p>Where y, x and z represent the components impacted by the improvement, and C_v represents the cost of the pathway component in question.</p> <p>For example, the expected cost of a hospital admission is £2,855.05. If a pathway improvement was expected to lead to ten fewer hospital admissions, the cost saving would be £28,550.50.</p>

Summarising the results

In each section below, summary statistics have been provided as additional pieces of evidence to support the Birmingham and Solihull 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
<p>Total additional pathway cost</p>	<p>This is equal to the additional cost of the pathway improvement minus the cost savings. It can be written as:</p> $N_t C - RC_v$ <p>This method can determine whether the improvement is likely to save money overall or incur additional costs.</p> <p>Negative numbers represent cost savings.</p> <p><i>Primary prevention</i></p> <p>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.</p> <p>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.</p> <p>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 £1,243.93.</p> <p>This figure has been subject to a sensitivity (scenario) analysis, which is explained in the discussion section below.</p>
<p>Additional cost / additional population health ratio</p>	<p>This can be written as:</p> $\frac{N_t C - RC_v}{PHB}$ <p>This metric will help us understand the costs for each additional unit of population health gain.</p> <p>The lower the ratio, the better, with a negative ratio representing an intervention that is both cost-saving and health-generating. A ratio of 1 would mean it costs £1 to generate one additional unit of population health gain.</p>

<p>Cost ratio</p>	<p>This metric is calculated by dividing the cost saving by the additional cost of the improvement. It can be written as:</p> $\frac{RC_v}{N_t C}$ <p>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.</p> <p>This metric will help us understand the potential returns each improvement will likely give back to the system.</p>
<p>Timeframe</p>	<p>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.</p> <p>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'.</p>

Impact of the pathway improvements

Prevention of COPD and promotion of healthier communities

Increasing uptake of smoking cessation services

Expected change

Increasing the number of people referred to smoking cessation services is expected to lead to more people, both with and without COPD, quitting smoking.

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 ten 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. (2016), among a cohort of 14,619 participants in the Netherlands, the incidence of COPD was 19.7/1,000 person years (95% CI 18.1–21.4) among current smokers, and 8.3/1,000 person years (95% CI 7.6–9.1) among former smokers, with a maximum follow-up time of 25 years.

Scenarios

The additional number of people that can be reached to engage with smoking cessation services is not known. Therefore, we model four scenarios that can help to inform decisions about which areas to prioritise:

Primary prevention

1. Double the number of people without COPD setting quit dates through the smoking cessation service.
2. Double the number of people without COPD setting quit dates with the Quit with Bella app.

Tertiary prevention

3. Achieve 100% of people with COPD who smoke setting quit dates through smoking cessation services (an estimated 34.9% of people with spirometry-confirmed COPD still smoke (Shahab et al., 2006)).
4. Achieve 100% people with COPD who smoke setting quit dates with the Quit with Bella app.

As can be seen in Figure 9 below, both expanding access through the smoking cessation programme and the Quit with Bella app are likely to increase population health due to more people quitting smoking.

However, the smoking cessation programme has a much larger cost associated with it. The smoking cessation service would cost an estimated £73,282.78 for every avoided hospital admission if it were targeted at people with COPD, and £127,649.17 to avoid one additional case of COPD if it were targeted at those at risk of developing COPD. Use of the Quit with Bella app would cost £3,694.33 for every avoided hospital admission and £4,997.85 to avoid one additional case of COPD (see data sources in the [appendices](#)).

Similarly, as increasing the capacity of the Quit with Bella app would not require hiring significant numbers of staff, it is the most scalable option for getting more people to quit smoking.

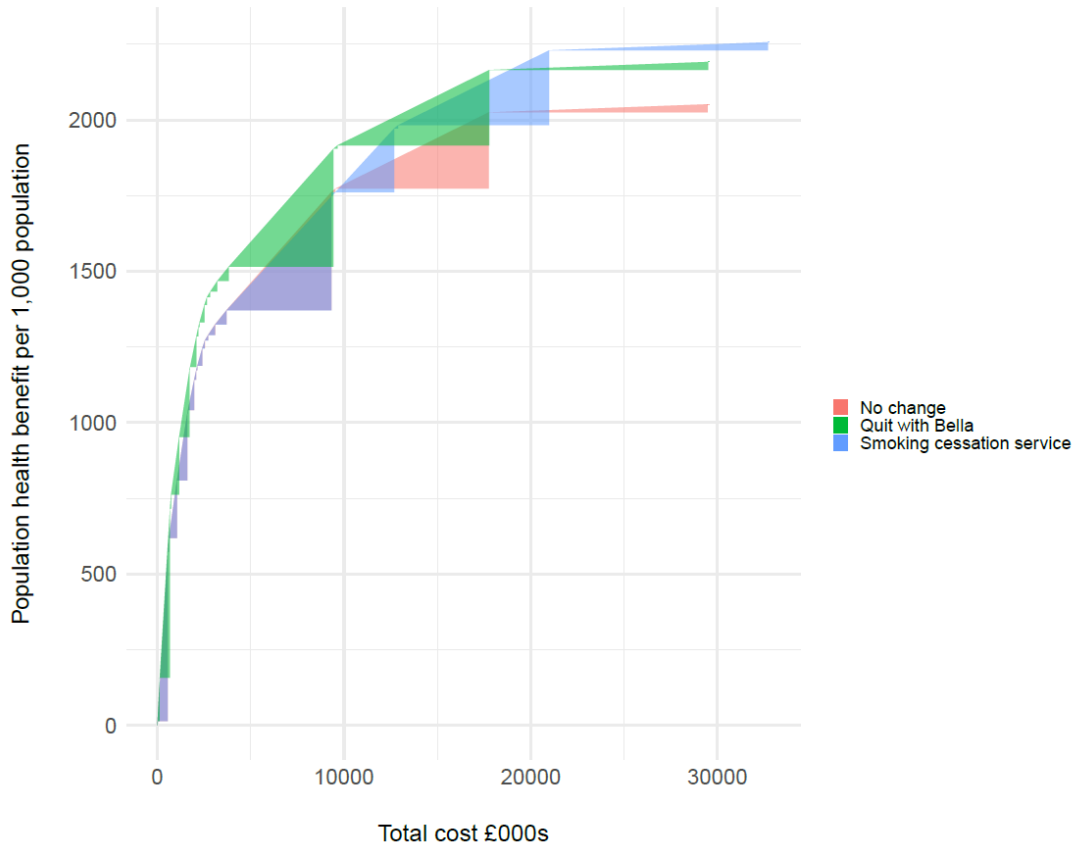


Figure 9 – Expected change due to tertiary prevention scenarios.²

Metric	Total	Interpretation
Total additional pathway costs		None of the scenarios proposed are expected to avoid enough cases of COPD (primary prevention) or acute exacerbations (tertiary prevention) to be cost-saving. This is partly because approximately
Primary prevention		
1. Smoking cessation service	£5,561,830	
2. Quit with Bella	£7,507.84	
Tertiary prevention		

² NOTE this graph displays only the tertiary prevention scenarios for the reasons described in the 'developing the visualisations' section.

3. Smoking cessation service	£3,250,791.65	three people in both services need to set a quit date to get one additional quitter.
4. Quit with Bella	£33,474.41	
Additional cost / additional population health ratio		The Quit with Bella app is expected to cost a lot less to generate each additional unit of population health than the smoking cessation service. Tertiary prevention smoking cessation with the Quit with Bella app is expected to cost £0.23 for every additional unit of population health gain, versus £15.43 in the current smoking cessation service.
Primary prevention		
1. Smoking cessation service	14.26	
2. Quit with Bella	0.54	
Tertiary prevention		
3. Smoking cessation service	15.43	
4. Quit with Bella	0.23	
Cost ratio		
Primary prevention		
1. Smoking cessation service	0.01	
2. Quit with Bella	0.25	
Tertiary prevention		
4. Quit with Bella	0.71	

Increasing uptake of pulmonary rehabilitation 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 (odds ratio [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 two scenarios to help the ICS prioritise where to focus to improve PR services:

- Doubling the number of people with an MRC score of 3+ who start PR courses.
- Improving the completion rates for PR services to 75%.

As can be seen in Figure 10, the impact of PR on the overall value of the pathway is relatively small. This is because the number of people it could reach is relatively small. Doubling the number of people undertaking the course would lead to an additional 499 people at an estimated cost of £346 per person.

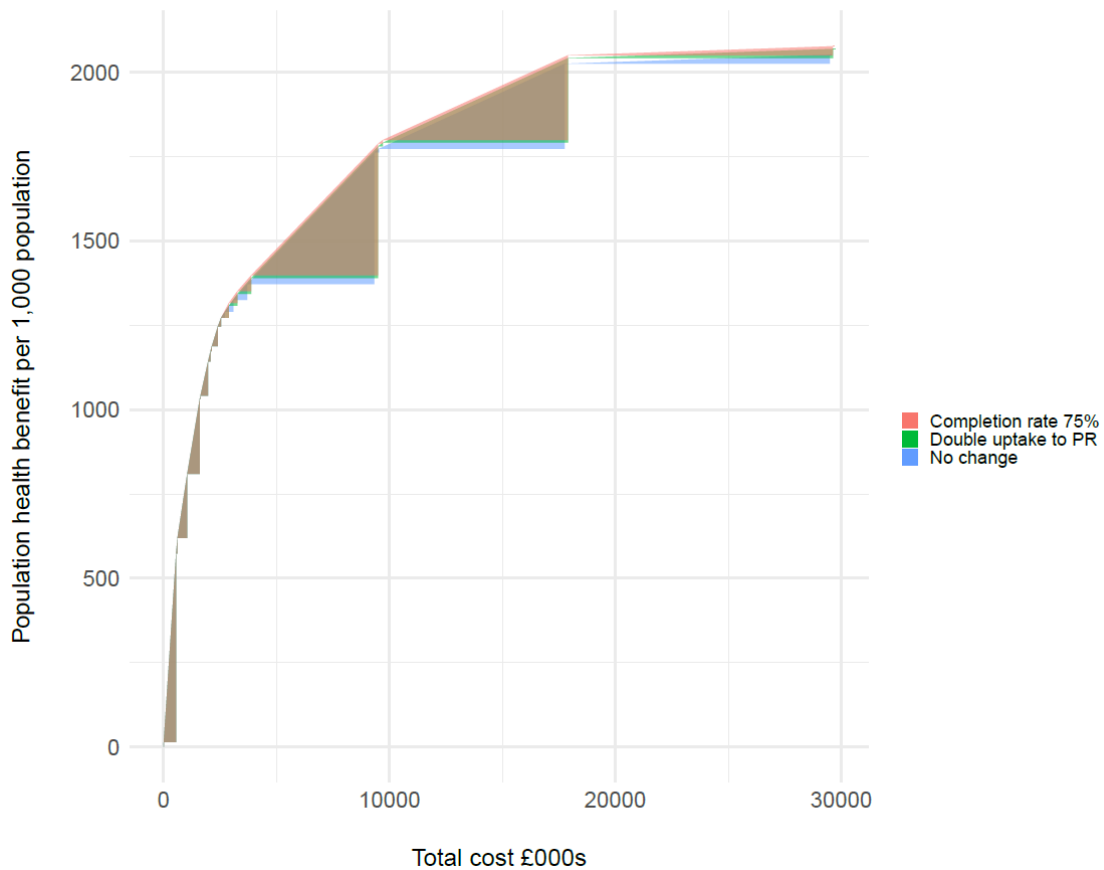


Figure 10 – Expected change due to increasing uptake of pulmonary rehabilitation services

Metric	Total	Interpretation
Total additional pathway costs <ul style="list-style-type: none"> - Double people starting course - Improving completion rate to 75% 	<ul style="list-style-type: none"> £155,217.84 £145,254.32 	Neither scenario is expected to offset enough hospital admissions to be cost-saving
Additional cost / additional population health ratio <ul style="list-style-type: none"> - Double people starting course - Improving completion rate to 75% 	<ul style="list-style-type: none"> 6.87 4.36 	With the current completion rate, PR is expected to cost £6.87 for every additional unit of population health gain. With a 75% completion rate, it would be £4.36.
Cost ratio <ul style="list-style-type: none"> - Double people starting course - Improving completion rate to 75% 	<ul style="list-style-type: none"> 0.11 0.16 	With the current completion rate, PR is expected to save £0.11 elsewhere in the pathway for every £1 spent. With a 75% completion rate, that would be £0.16.

Driving pneumonia vaccination uptake

Expected change

It is assumed that the benefit for people with COPD of a pneumonia vaccination is avoiding acute exacerbations. According to a Cochrane review, the NNT to prevent a patient from experiencing an exacerbation is eight (Walters et al., 2017).

Scenarios

Here we look at what it would look like if 90% of the total population of COPD was covered with pneumonia vaccinations, an increase from the estimated 4.4% in the baseline year (see data sources in the [appendices](#)).

In the current COPD pathway, pneumonia vaccination was the sixth best intervention in the pathway in terms of value for money, but only reached a small proportion of the target population. Although this improvement is not expected to be cost-saving, it would lead to a large increase in population health gain, as can be seen in Figure 11 below.

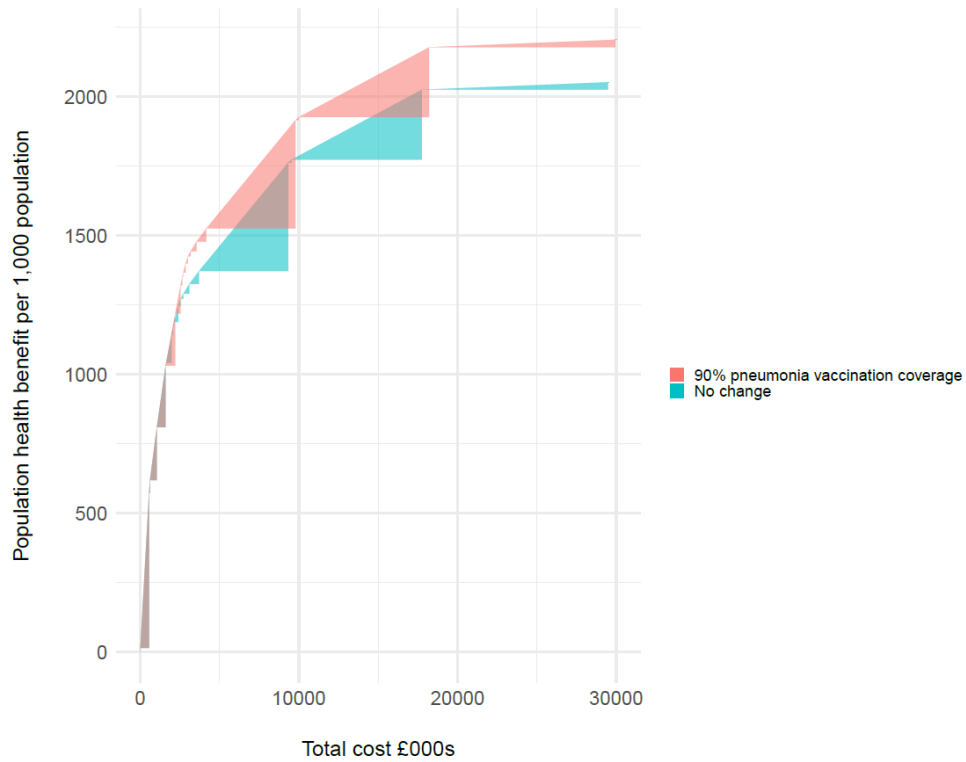


Figure 11 – Expected change due to increasing pneumonia vaccination.

Metric	Total	Interpretation
Total additional pathway costs	£489,077.91	The number of avoided acute exacerbations is not expected to offset the costs of this pathway improvement.
Additional cost / additional population health ratio	2.60	Increasing the number of pneumonia vaccinations is estimated to cost £2.60 for every additional unit of population health gain.
Cost ratio	0.19	This pathway improvement is expected to cost £0.19 for every additional £1 spent.

Accurate diagnosis

Increasing uptake and quality of spirometry testing

Expected change

We assume that extra tests lead to an early diagnosis of COPD, as opposed to a late diagnosis. Earlier diagnosis of COPD brings 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 as well as improving quality of life and other long-term health outcomes (Decramer et al., 2011; Kostikas et al., 2020).

Scenarios

To help focus the priorities around spirometry testing, we model two different scenarios:

- Doubling the number of tests done in primary care – via a PCN model.
- Expanding the Respiratory Diagnostic Hubs (RDHs) to cover all six localities (up from two).

Both scenarios are expected to be cost-saving due to the reduction in hospital admissions associated with earlier diagnoses. Doubling the number of tests in primary care is expected to provide slightly better value for money as it has a higher estimated diagnosis rate (26.94 vs 22.8%; see data sources in the [appendices](#)).

There are a few uncertainties in this estimation. As the true cost of delivering a spirometry test is not known, we have assumed the cost is the same whether the test is delivered in primary care or the RDHs. Similarly, whether the diagnoses are ‘true diagnoses’ or not is unknown. Both these factors would affect the relative cost-effectiveness of each intervention.

The most important predictor of cost-effectiveness in spirometry is the number of tests that need to be conducted to identify one additional case of COPD. Currently, in primary care 3.7 tests need to be done for every additional case of COPD identified, compared with 4.4 tests in the RDHs.

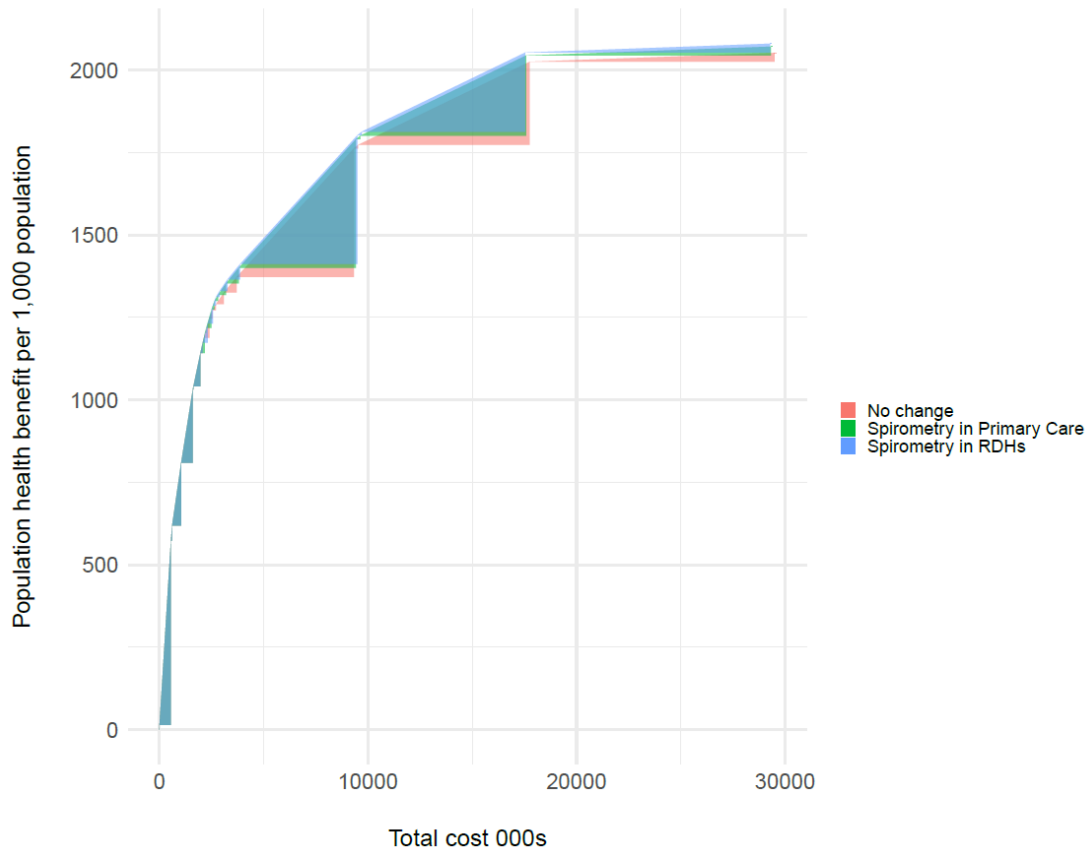


Figure 12 – Expected change due to increasing uptake and quality of spirometry testing.

Metric	Total	Interpretation
Total additional pathway costs <ul style="list-style-type: none"> - Doubling tests in primary care - Expanding RDHs 	<p>-£134,400.68</p> <p>-£163,742.59</p>	Both scenarios are expected to be cost-saving.
Additional cost / additional population health ratio <ul style="list-style-type: none"> - Doubling tests in primary care - Expanding RDHs 	<p>-4.38</p> <p>-3.76</p>	Expanding spirometry tests through the RDHs is expected to save £3.76 for every unit of population health gain it generates, versus £4.38 for the doubling of tests in primary care.
Cost ratio <ul style="list-style-type: none"> - Doubling tests in primary care 	2.23	Expanding spirometry tests through the RDHs would save £1.89 for every £1

- Expanding RDHs	1.89	spent, compared with £2.23 in primary care.
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Support and education of clinicians

Improving the quality of primary care management through clinical education

Expected change

It is assumed that the benefit of educating primary care staff in COPD care is that it would improve the relative benefit score of primary care management from 40 to 55 (in line with that of the community-provided case management services; see data sources in the [appendices](#)).

No papers were identified in the literature review that suggested educating primary care staff would impact other components of the COPD pathway, such as hospital admissions.

Scenarios

Here we look at all patients' yearly reviews being undertaken by a clinician who has undergone the training programme. We assume that this leads to an increase in the health benefit generated by the yearly review that patients receive. This is because clinicians will be able to give better advice on self-management, as well as prescribe more appropriate medication.

As can be seen in Figure 13 below, this pathway improvement would greatly improve the population health benefit of the pathway without a need to increase capacity. It would only benefit those already interacting with primary care, however.

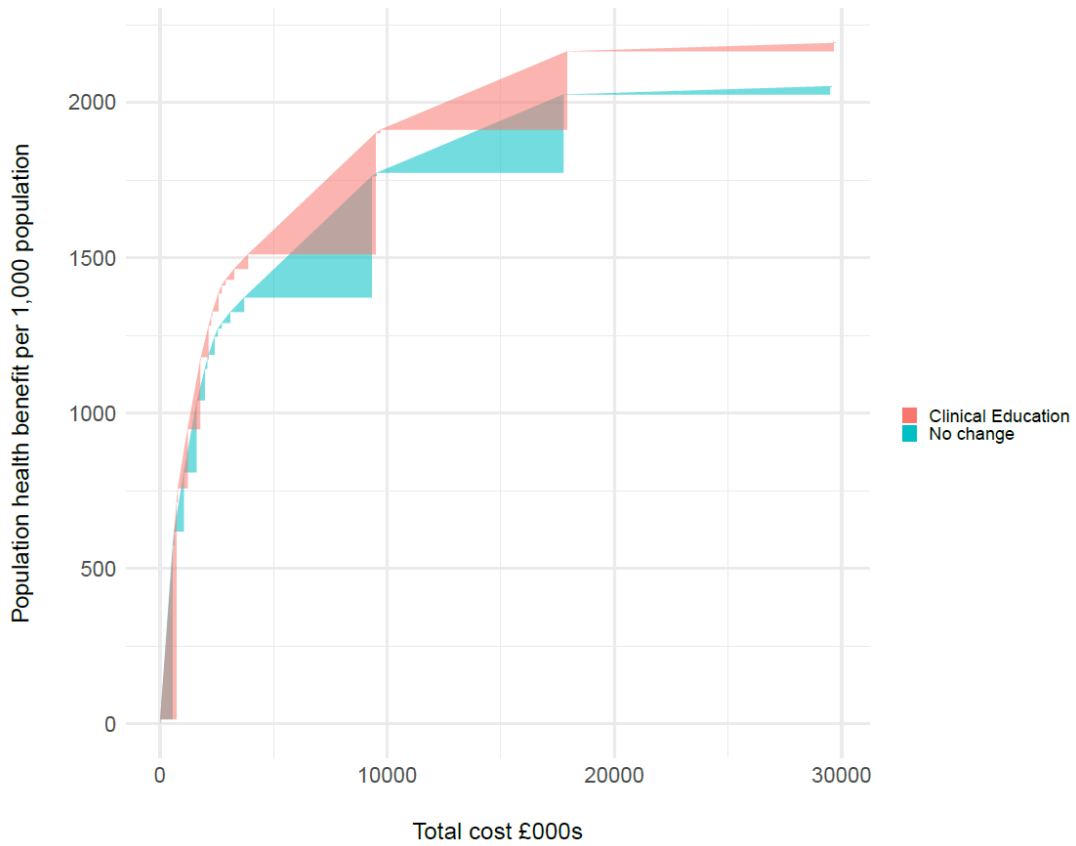


Figure 13– Expected change due to educating primary care staff in COPD care.

Metric	Total	Interpretation
Total additional pathway costs	£167,064	This pathway improvement is expected to be cost-incurring.
Additional cost / additional population health ratio	1.20	This pathway improvement is expected to cost £1.20 for every additional unit increase in population health gain.
Cost ratio	N/A	No expected cost savings.

Promoting respiratory services within localities through social prescribing – physical activity

Expected change

One prospective cohort study conducted in Copenhagen was identified in the literature review which looked 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% CI 0.53–0.97) (Garcia-Aymerich et al., 2006).

Scenarios

We have modelled what would happen if 10%, 25% or 50% of the COPD population took up a physical exercise course focusing on physiotherapy, as PR and smoking cessation are covered elsewhere in this report.

Increasing physical activity programmes through social prescribing could produce a large increase in the population health generated by the COPD pathway. Although it is not expected to be cost-saving (avoiding one hospital admission for every 70.10 people with COPD completing the course – see calculations in the [appendices](#)), it would generate more population health for the spend than a PR course (£0.26 for every additional unit of population health gain, versus £6.87 for PR).

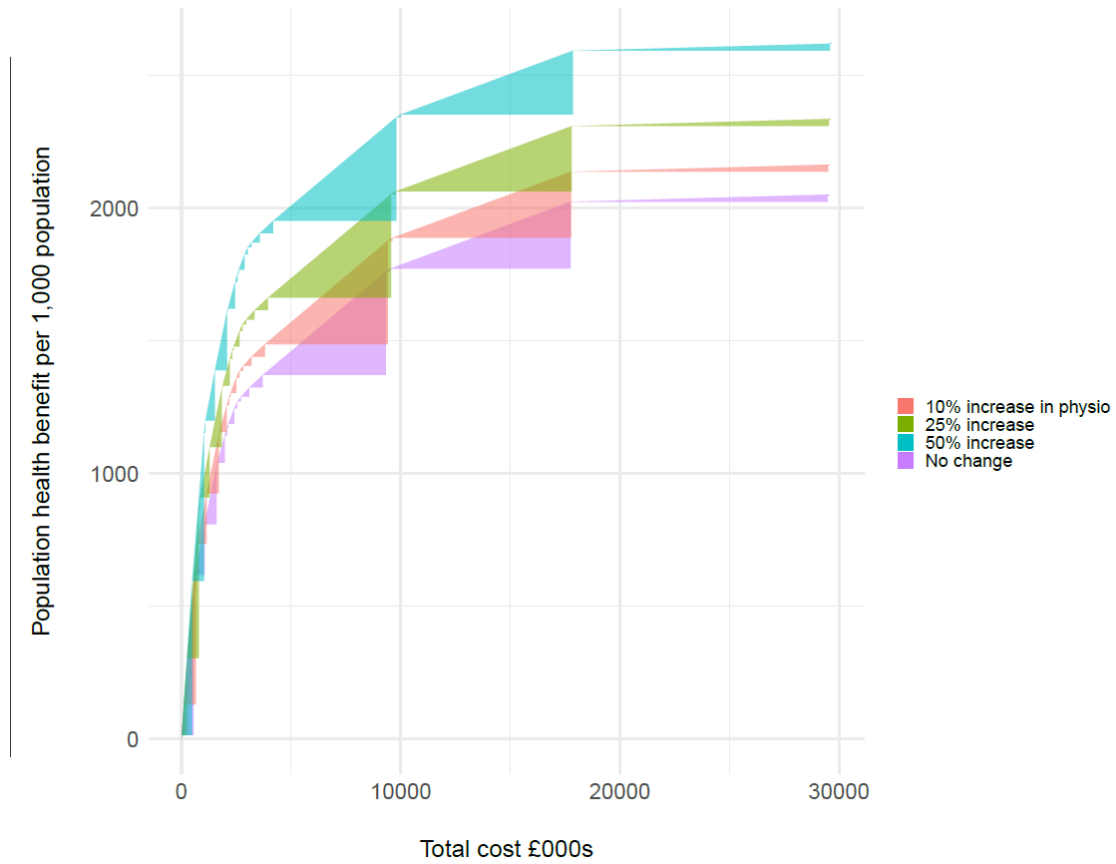


Figure 14– Expected change due to increased social prescribing of physical activity.

Metric	Total	Interpretation
Total additional pathway costs	10%: £30,016.26 25%: £77,551.44 50%: £155,143.26	This pathway improvement is expected to be cost-incurring.
Additional cost / additional population health ratio	0.26	This scenario costs £0.26 for every additional unit of population health gain it generates.
Cost ratio	0.68	£0.68 is saved elsewhere in the COPD pathway for every £1 spent.

Medicines optimisation reviews

Expected change

One cost–consequence analysis by Wright et al. (2022) used the Clinical Practice Research Datalink database to ascertain the current prescribing practices and compared them with NICE guidelines. They identified two large areas where there was a >10% difference between the number of people prescribed a medication and those recommended to receive it as part of the NICE guidelines:

- 24.58% of people with low exacerbation history and high current symptoms and 19.81% of people with low exacerbation history and low current symptoms were not prescribed Long Acting Beta Agonist / Long Acting Muscarinic Antagonist (LABA/LAMA) and should have been.
- 16.84% of people with low exacerbation history and high current symptoms and 12.76% of people with low exacerbation history and low current symptoms were prescribed LABA/LAMA/ICS and should not have been. These patients should be stepped down so that patients on LABA/LAMA/ICS triple therapy are redistributed to LABA/LAMA dual therapy.

Scenarios

While there are potential cost savings to be made by optimising medications, it is not possible to model these, for three reasons:

1. It is not possible to identify the number of people who are incorrectly prescribed medications in existing datasets. Therefore, we are unable to estimate the potential size of the prize.
2. Not all clinicians would agree on what constitutes appropriate or inappropriate prescribing; this is a matter for clinical judgement.
3. Wright et al. (2022) report a 1% increase in both moderate exacerbations and severe exacerbations due to patients on LABA/LAMA/ICS triple therapy being redistributed to LABA/LAMA dual therapy; therefore there is a risk of increasing exacerbations and hence mortality by inappropriate stepdowns.

Living well

Psychological support

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). The authors found a 13% decrease in inpatient non-elective admissions and a 14% reduction in outpatient attendances after 12 months for people with COPD compared with a matched control group (Gruber et al., 2022).

Scenarios

Here (Figure 15) we estimate what effect it would have on the COPD pathway if 10, 25 or 50% of people with COPD in Birmingham and Solihull living with anxiety or depression were referred to IAPT services. There is no data available on the proportion of people living with COPD and comorbid anxiety and/or depression in Birmingham and Solihull, so we assume the rate is 50%, in line with the prevalence of anxiety reported in the study by 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.

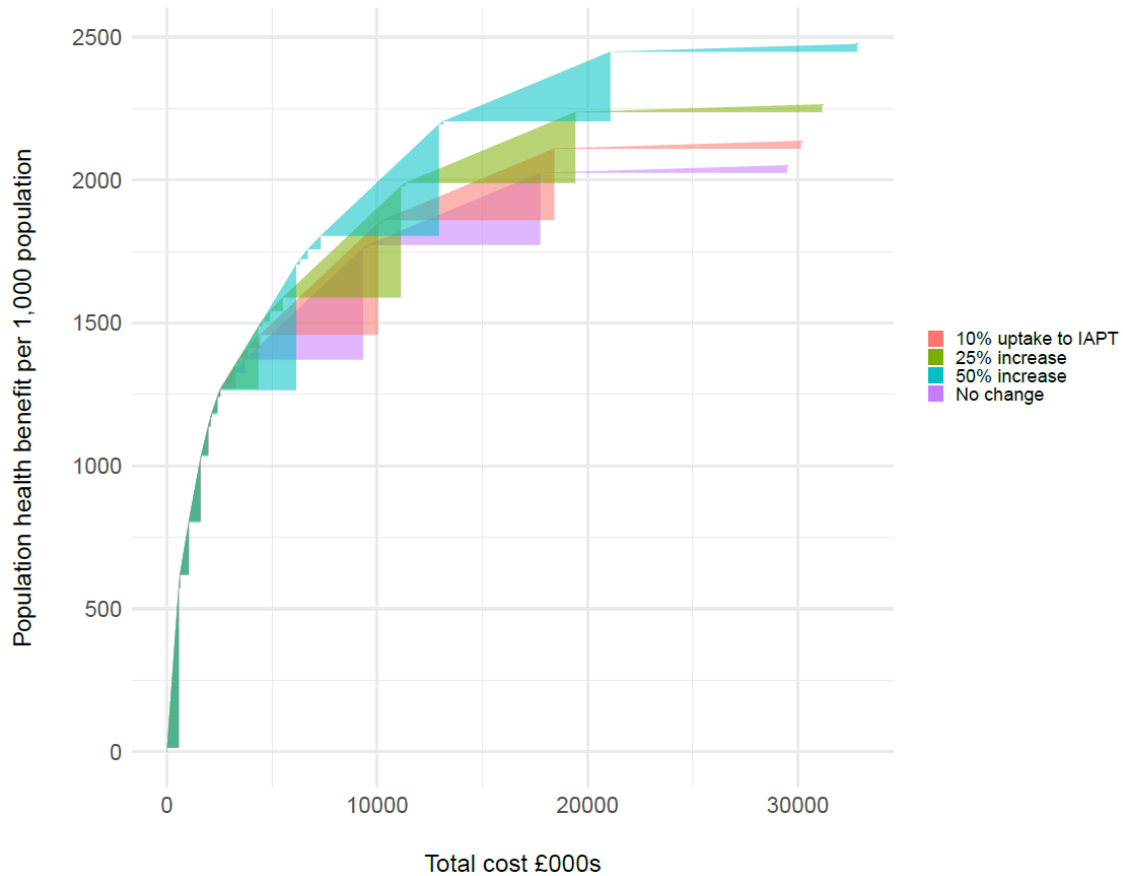


Figure 15– Expected change due to improved psychological support.

Metric	Total	Interpretation
Total additional pathway costs	10%: £766,496.91 25%: £1,919,475.44 50%: £3,836,325.89	This pathway improvement is associated with substantial costs.
Additional cost / additional population health ratio	8.71	One additional unit of population health gain is expected to be generated for every £8.71 spent.
Cost ratio	0.08	£0.08 would be saved elsewhere in the pathway for every £1 spent.

Promoting self-care through the myCOPD app

Expected change

Offering the myCOPD app will support patients to self-manage their own condition as well as receive information from their care providers.

Further evidence is required to determine the impact of the myCOPD app on cost-effectiveness and healthcare resource use (National Institute for Health and Care Excellence, 2022). Two trials cited in the NICE guidance looked at healthcare resource use (the EARLY and RESCUE trials), comparing myCOPD versus usual care, and did not show any statistically significant ($p < 0.05$) impact on hospitalisations or acute exacerbations. Therefore it is not expected that myCOPD would impact these pathway components (Crooks et al., 2020; North et al., 2020).

Scenarios

We have modelled the impact of offering the myCOPD app to everyone with COPD in Birmingham and Solihull. The myCOPD app is a relatively cheap intervention, at an estimated cost of £0.25 per person (National Institute for Health and Care Excellence, 2022). However, given that NICE recommends more research, if the myCOPD app were to be taken forward by Birmingham and Solihull ICS, an evaluation of the app should be commissioned alongside its rollout.

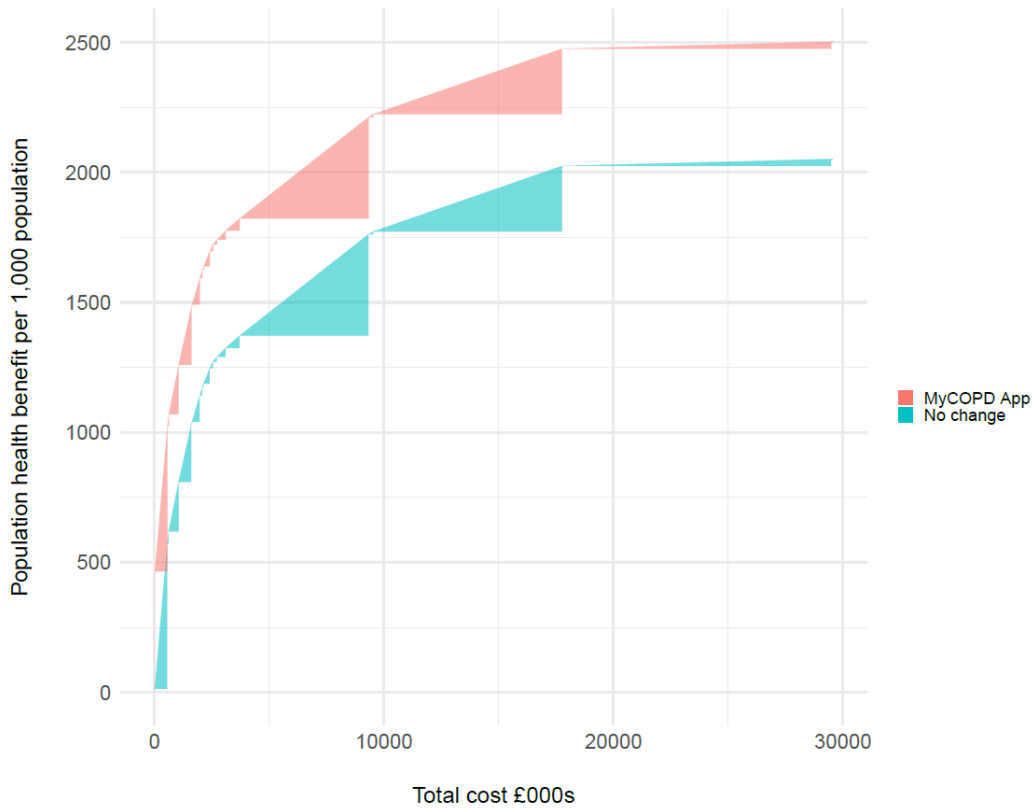


Figure 16– Expected change due to the myCOPD app.

Metric	Total	Interpretation
Total additional pathway costs	£5,868	The myCOPD app is a relatively cheap intervention compared with others.
Additional cost / additional population health ratio	0.01	This improvement would cost £0.01 for every additional unit of population health gain it generates.
Cost ratio	N/A	There are no expected cost savings from this pathway improvement.

Virtual ward: admissions avoidance

Expected change

As the use of virtual wards as an admissions avoidance intervention is a relatively new intervention, no studies looking at its impact on other pathway components were identified in the literature review.

Scenarios

The number of people at risk of a hospital admission is not known; therefore we look at offering the virtual ward as an admissions avoidance intervention to 10, 25 or 50% of people with severe or very severe COPD. As there is no published literature that suggests that people with COPD included on an admissions-avoidance virtual ward would have lower hospitalisation rates than those who were not, we are unable to say whether the intervention would be cost-saving. The virtual ward, if used for admissions avoidance, would need to avoid one hospital admission for every 1.91 people included on it to be cost-saving.

If the ward is implemented, an evaluation of the intervention should be commissioned to assess its impact. Assuming the average person spends 39.7 days in palliative care (see the [appendix](#)), GP services would cost £941.52 per person, hospice care would cost £38,469.30, and the virtual ward would cost £1,380.68 per person.

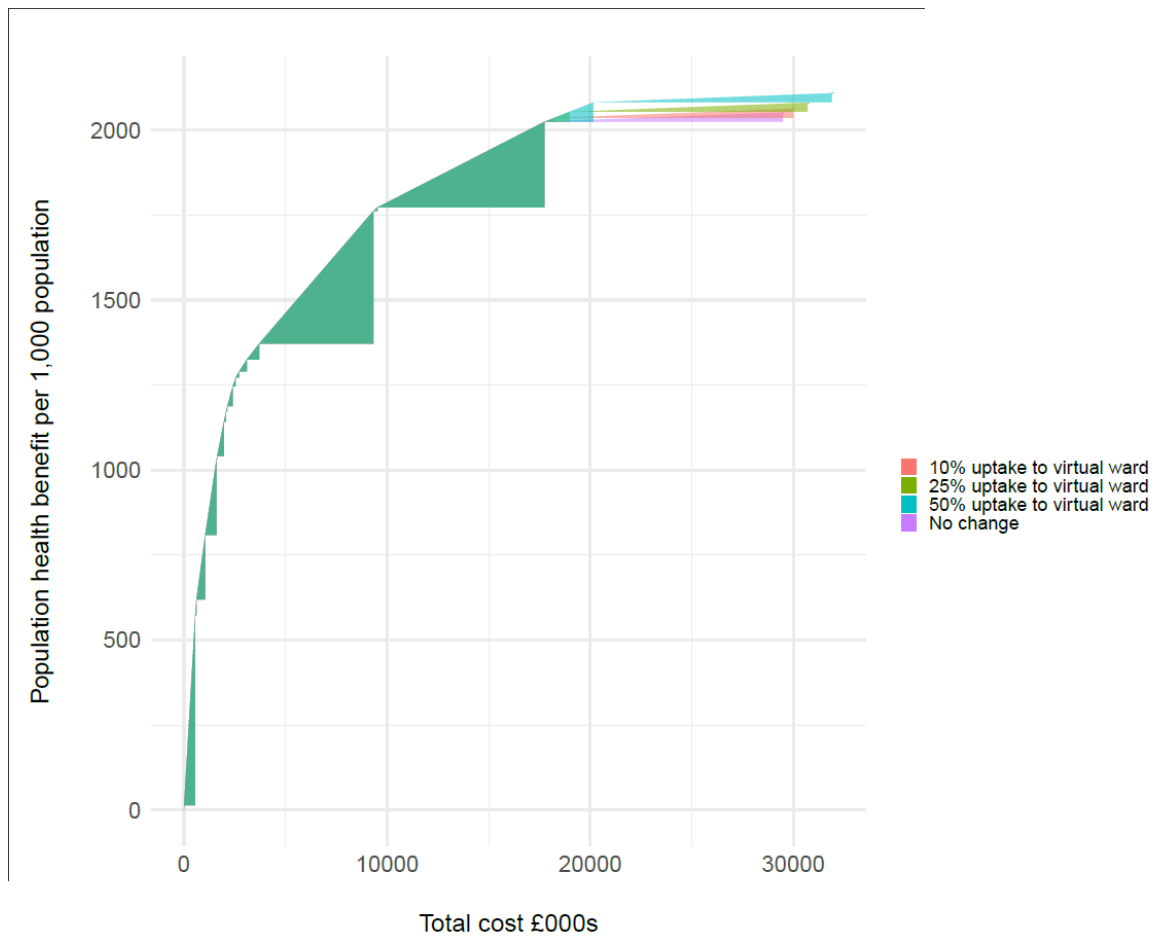


Figure 17– Expected change due to implementation of a virtual ward.

Metric	Total	Interpretation
Total additional pathway costs	10%: £504,054.15 25%: £1,217,035.88 50%: £24,405,819.90	This pathway improvement is expected to be associated with significant costs.
Additional cost / additional population health ratio	10%: 44.04 25%: 42.56 50%: 42.07	If 50% of people with severe or very severe COPD use the virtual ward, it is expected to cost £42.07 for

		every additional unit of population health gain.
Cost ratio	N/A	There are no expected cost savings from this pathway improvement as we cannot evidence a reduction in admissions due to the virtual ward.

Dying well

Expanding the palliative care offer through the hospice-at-home virtual ward

Expected change

No papers in the literature review were identified looking at the impact of end-of-life or palliative care virtual wards on the rest of the COPD pathway.

Scenarios

There is no single standard palliative care model for COPD patients, but the common models are hospice-provided palliative care, GP-provided palliative care and community-provided palliative care. Given that no data was available on community-provided palliative care, we have modelled two scenarios. In the first scenario, the expansion of the virtual ward palliative care offer is compared with the expansion of hospice-provided palliative care. In the second, it is compared with the expansion of GP-provided palliative care.

As the exact number of people with COPD requiring palliative care is unknown, in both scenarios we have assumed the number of additional people receiving palliative care through the virtual ward to be 305 (the estimated number of people with COPD given hospice care in 2021/22; see data sources in the [appendix](#)).

If the virtual ward were used instead of hospice-level care to expand palliative care, it is estimated to be vastly cost-saving (£11 million). The hospice-at-home virtual ward could be a cost-effective way of increasing the capacity in hospice provision. Replacing GP services, however, is not expected to be cost-saving. These differences are driven by the estimated cost of the three interventions: hospice-provided palliative care is expected to cost £38,469.30 per person, GP-provided palliative care is expected to cost £941.52 per person, and the virtual ward is expected to cost £1,380.68 per person.

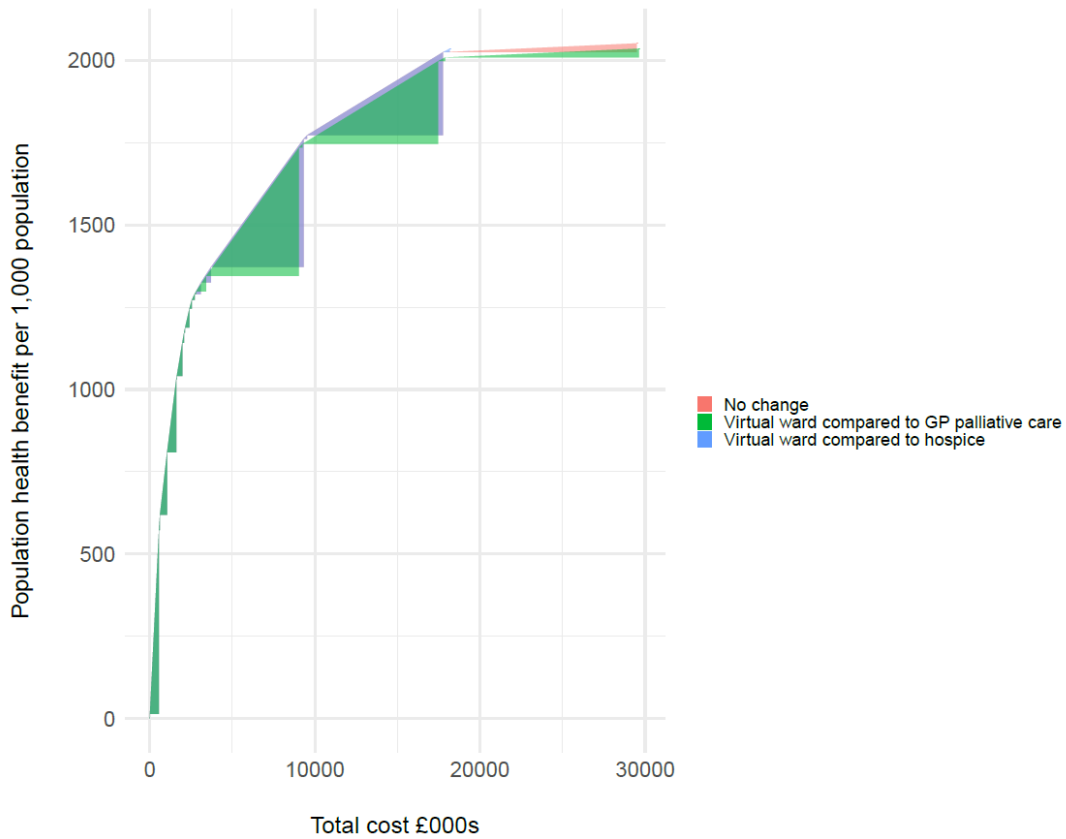


Figure 18– Expected change due to the hospice-at-home virtual ward.

Metric	Total	Interpretation
Total additional pathway costs <ul style="list-style-type: none"> - Compared with hospice care - Compared with GP palliative care 	<ul style="list-style-type: none"> -£11,312,029.10 £133,943.80 	The cost-effectiveness of the palliative care virtual ward depends on the relevant comparator.
Additional cost / additional population health ratio <ul style="list-style-type: none"> - Replacing hospice care - Replacing GP palliative care 	<ul style="list-style-type: none"> -1,059.67 12.55 	If the virtual ward palliative care replaced hospice care, it could save £1,059.67 for every additional unit of population health gain generated. If it replaced GP palliative care, it would cost 12.55 for every additional

		unit of population health gain.
Cost ratio <ul style="list-style-type: none"> - Replacing hospice care - Replacing GP palliative care 	<p>27.86</p> <p>0.68</p>	<p>If replacing hospice care, the virtual ward could save £27.86 for £1 spent.</p> <p>If replacing GP palliative care, it would save £0.68 for every £1 spent.</p>

National priorities

Expanding the virtual ward as an early supported discharge intervention

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. This estimate is supported by a more recent paper which suggested a length of stay two days less than expected, with a median length of stay of one day (Echevarria et al., 2018).

Scenarios

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).

Treating a patient on the virtual ward is expected to cost 48.15% of the cost of treating an acute exacerbation through a hospital admission alone so will save money (see data sources in the [appendices](#)).

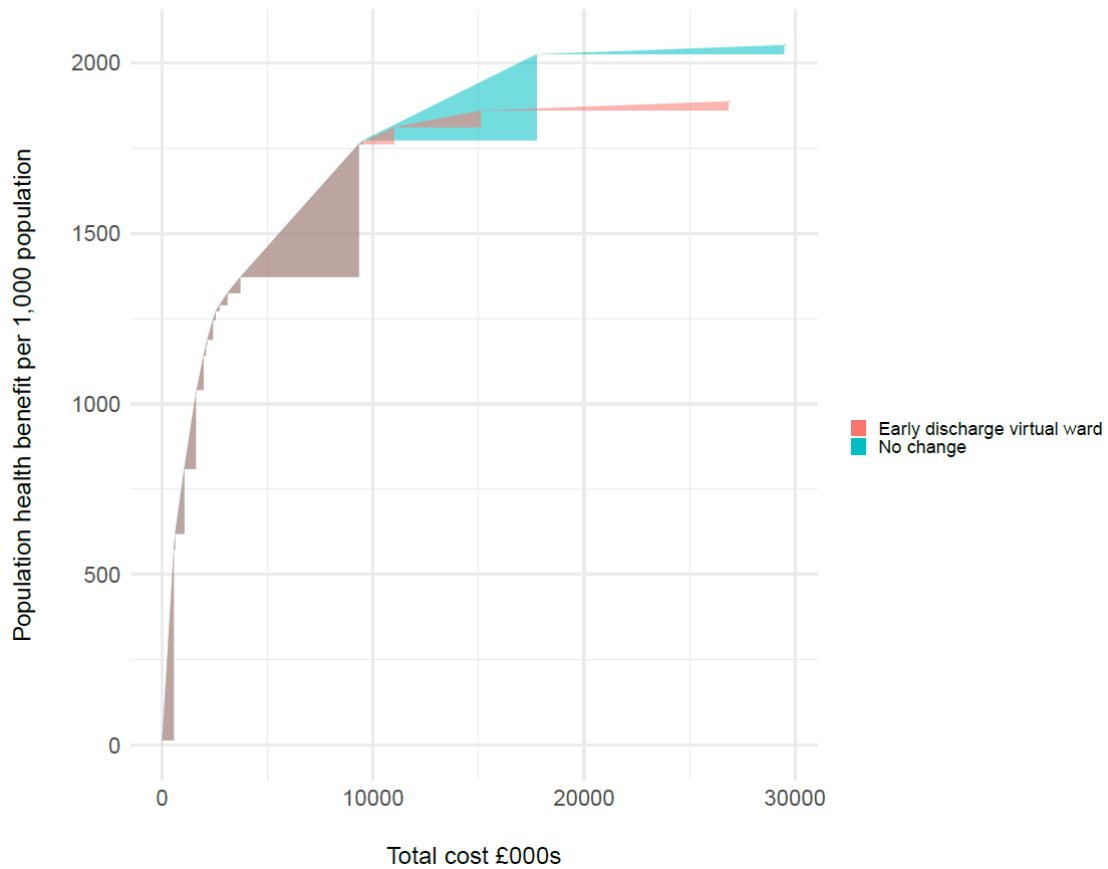


Figure 19– Expected change due to expanding the virtual ward to support early discharge.

Metric	Total	Interpretation
Total additional pathway costs	-£1,802,830	This pathway improvement is expected to be cost-saving as it is estimated that treating someone on the virtual ward costs on average 48.15% of the cost of treating someone through a normal hospital admission.
Additional cost / additional population health ratio	-36.85	This pathway improvement is expected to save £36.85 for every £1 spent.
Cost ratio	2.08	This pathway improvement is expected to save £2.08 through reduced hospital

		admission costs for every £1 spent.
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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 to 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.
- **Ranking interventions by 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.
- **Ranking interventions by 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	Hospice-at-home virtual ward (compared with hospice care)	-1,059.67
2	Virtual ward as early supported discharge	-36.85
3	Increasing uptake and quality of spirometry testing (doubling tests in primary care)	-4.38
4	Increasing uptake and quality of spirometry testing (expanding RDHs)	-3.76
5	Promoting self-care through the myCOPD app	0.01
6	Increasing uptake of smoking cessation services (tertiary prevention – Quit with Bella app)	0.23
7	Promoting respiratory services within localities through social prescribing – physical activity	0.26
8	Increasing uptake of smoking cessation services (primary prevention – Quit with Bella app)	0.54
9	Improving the quality of primary care management through clinical education	1.20
10	Driving pneumonia vaccine uptake	2.60
11	Increasing uptake of PR services (increasing completion rate to 75%)	4.36
12	Increasing uptake of PR services (doubling the number of people starting the course)	6.87
13	Psychological support	8.71
14	Hospice-at-home virtual ward (compared to GP palliative care)	12.55
15	Increasing uptake of smoking cessation services (primary prevention – smoking cessation service)	14.26

16	Increasing uptake of smoking cessation services (tertiary prevention – smoking cessation service)	15.43
17	Virtual ward admissions avoidance	42.07–44.04

Discussion

This report identifies the priority interventions to include in Birmingham and Solihull ICS's respiratory programme. It discusses 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 means that decisions on resource allocation are easy to interpret. The STAR approach provides a robust and systematic way of 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 **six priorities areas** and 13 pathway improvements which can address those opportunities.

To create a visual understanding of the current care pathway, information on health benefits was drawn out during the decision conferences. NNTs as well as numbers who benefit were 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 in terms of value for money.

Recommendations

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

- **Virtual ward as early discharge support.** This pathway improvement supports the national priority of expanding the virtual ward. As the virtual ward costs an estimated 48.15% of the cost of a hospital admission, maximising capacity in the virtual ward could save up to £1,802,830 a year.
- **Expanding spirometry testing.** This addresses the priority of accurate and timely diagnosis. Whether spirometry testing is expanded in primary care or through the RDH, it is estimated to be cost-saving. Minimising the number of tests needed for an additional diagnosis of COPD is the key to making it as cost-effective as possible.

- **Introducing the myCOPD app.** This meets the priority of living well. As a digital offering, the myCOPD app could be offered to the entire population of people living with COPD relatively easily.
- **Increasing uptake of smoking cessation services (tertiary prevention – Quit with Bella app).** This improvement meets the ‘prevention of COPD and promotion of healthier communities’ priority. It is the most cost-effective way of increasing access to smoking cessation services.
- **Promoting respiratory services within localities through social prescribing – physical activity.** This meets the priority of living well. Physical activity in any form will improve quality of life for people with COPD. A physical activity programme could be a cheaper alternative to PR.

This output should be used by the ICS’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. In total, the five pathway improvements are expected to save £1,798,053.49 per year (excluding savings from the hospice-at-home virtual ward) if they are implemented as described, and to lead to an increase of 52.46% in population health gain. The cost savings are largely due to the estimated reduction in hospital admissions due to expanding spirometry testing (due to earlier diagnoses of COPD) and the reduction in costs of hospital admissions for acute exacerbations when patients are treated on the virtual ward.

Expanding access to palliative care using a virtual ward could be a cost-effective way of expanding the palliative care offering in Birmingham and Solihull, meeting the ‘dying well’ priority. It is estimated to cost 3.6% of the cost of hospice-provided care. It has not been explicitly recommended here as there is uncertainty over how it would be implemented and what the relevant comparator (GP, community or hospice-provided care) would be, all of which would impact the cost/population health ratio.

To see how robust the recommendations are, a scenario analysis was conducted for many of the pathway improvements to examine the impact of different methods for implementing the improvements in different ways. These are displayed in the scenarios in the **[‘impact of the pathway improvements section’](#)**.

Sensitivity analysis was also conducted on the cost savings for two specific improvements: expanding spirometry testing and primary prevention smoking cessation (both through the Quit with Bella app and through the smoking cessation service). These were chosen in particular as there was a possibility that the results could change based on how the cost savings (RC_v) are calculated.

In the ‘expanding spirometry testing’ improvement, only the costs of the intervention and the expected cost savings were included. The additional costs of treating the additional

cases of COPD identified were not considered. This was in part an ethical decision – if we included the cost of treating additional cases identified, the most cost-efficient course of action would be to not diagnose anyone with COPD – but was also because it would be a reasonable assumption that the majority of the costs (i.e., hospital admissions) would be incurred whether or not someone had been diagnosed.

If the expected cost of treating someone with COPD for one year (£1,243.93, as described in the [summarising the results](#) section) was included, this would have an additional cost of £508,767.37 in the primary care scenario and £772,723.33 in the RDH scenario. In this instance, neither scenario would be cost-saving.

The exact value of primary prevention (increasing the uptake of smoking cessation services and vaping as a harm-reduction pilot) in terms of 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 USA, 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 £21,395.60 over the patient's lifetime (the expected yearly cost of an avoided case of COPD of £1,243.93 × 17.2). Using this figure, increasing capacity in the smoking cessation service as primary prevention would still have a net cost of £4,675,157.10 a year, with a cost/population health ratio of 11.98. Increasing capacity with the Quit with Bella app would have a net saving of £42,791.19, with a cost/population health ratio of -2.36, making it the fourth most cost-effective intervention.

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 Airoidi et al. (assessing each intervention on the VAS as described in the [methods document](#)) (Airoidi et al., 2014). This method has the advantage of being easy to understand and allowed us to compare more than 20 interventions in the available time.

Elsewhere, The Health Foundation has 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 impacts 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.

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 BSol v0.2.p

2. Information pack for attendees



SSPH Decision
Conference Participar

3. Sources for the population pyramid

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

1. **Total number of people with COPD registered with a GP in Birmingham and Solihull:** <https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data/2019-20>
2. **COPD population by severity level:** There is no publicly available dataset that allows us to understand the distribution of severity scores for people with COPD. One study published in the journal *Scientific Reports* uses the mean and frequency distribution of FEV1% predicted scores to predict patients' severity. This method has been used here based on a mean FEV1% of 68.9% and the estimated prevalence of COPD in Birmingham and Solihull.
<https://www.nature.com/articles/srep31893#:~:text=In%20England%2C%20the%20prevalence%20of,by%20more%20women%20developing%20COPD>

3. **Estimated undiagnosed population:** Nacul et al. (2007) estimated that in 2007, the true prevalence of COPD in the country was 3.1%. This estimate is the difference between QOF register prevalence and this expected true prevalence.
<https://pophealthmetrics.biomedcentral.com/articles/10.1186/1478-7954-5-8>
4. **Estimated number of smokers:** Lower estimate: QOF register – estimated smoking prevalence among people over the age of 18 in Birmingham and Solihull in 2020/21
<https://fingertips.phe.org.uk/search/QOF#page/1/gid/1/pat/15/ati/66/are/nE38000258/iid/114/age/1/sex/4/cat/-1/ctp/-1/yrr/1/cid/4/tbm/1>
5. **Total population registered with a GP in Birmingham and Solihull:** QOF register – numbers of people on GP practice lists in 2020/21
<https://qof.digital.nhs.uk/>.

4. Data sources for the efficiency frontier

Smoking cessation

GP practices / pharmacies

Metric	Total	Source
Relative benefit score	100	Score given in the first decision conference.
Number treated: Number of people setting a quit date	13,649	Data provided by Birmingham City Council and Solihull Metropolitan Borough Council (SMBC).
Number who benefit: Number of people quitting after four weeks	3,901	28.5% of people setting a quit date had quit after 4 weeks.
Cost per person Cost per person setting a quit date	£411.50	Cost per person setting a quit date provided by SMBC.

Quit with Bella

Metric	Total	Source
Relative benefit score	100	Score given in the first decision conference.
Number treated: Number of people setting a quit date	715	Based on five months of activity data from Quit with Bella. 19.44% of people setting a quit date had quit after four weeks.
Number who benefit: Number of people quitting after four weeks	139	
Cost per person Cost per person setting a quit date	£13.98	

Primary care health checks

Metric	Total	Source
Relative benefit score	10	Score given in the first decision conference.
Number treated: Number of people undertaking primary care health checks	22,239	Number of people aged 40–74 who received an NHS Health Check in 2021/22, according to Fingertips. Assumed that everyone benefits.
Number who benefit	22,239	
Cost per person	£25	Estimate provided by Birmingham and Solihull ICS.

Case management

Primary care case management

Metric	Total	Source
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Relative benefit score	40	Score given in the first decision conference.
Number treated: Number of people receiving yearly reviews	13,964	Number of patients who had a review in 2021/22 in Birmingham and Solihull ICB (59.5% of patients) according to QoF. Assumed that everyone benefits.
Number who benefit: Number of people receiving yearly reviews	13,964	
Cost per person	£39.23	Average cost of a GP appointment according to the PSSRU 2021/22.

Secondary care outpatients

Metric	Total	Source
Relative benefit score	59	Score given in the first decision conference.
Number treated: Number of people with COPD attending outpatient appointments	3,223	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. Assumed everyone benefits.
Number who benefit: Number of people with COPD attending outpatient appointments	3,223	
Cost per person	£134.39	Sourced from SUS. Cost per outpatient appointment attended by people with a previous hospital admission for COPD for their first appointment or structured review. SQL code available on request.

Respiratory vaccinations

Pneumonia

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: Number of vaccinated COPD patients	1,041	Data from a GP clinical system search.
Number who benefit: Number of acute exacerbations avoided	130	According to a Cochrane review, the number of patients who need to be treated to prevent one exacerbation is eight (Walters et al., 2017).
Cost per person: Cost of vaccination	£30	£30 for PPV (Pharmacy prices) https://www.well.co.uk/vaccinations/pneumonia

Influenza

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one
Number treated: Number of COPD patients vaccinated	6,103	From the health inequalities improvement dashboard. Early flu season data to 5/12/22; 26% vaccinated. According to QOF there were 23,473 patients with COPD in Birmingham and Solihull in 2021/22.
Number who benefit: Number of avoided acute exacerbations	617	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	£9.58	Item of service cost based on costs provided by Northamptonshire ICS.
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COVID-19

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: Number of vaccinated COPD patients	13,286	Health inequalities improvement dashboard. Second-dose uptake, used here, is 56.60%. According to QOF there are 23,473 patients with COPD in Birmingham and Solihull.
Number who benefit: Number of avoided acute exacerbations	1,343	Assumed that the number of avoided acute exacerbations is the same as for the influenza jab.
Cost per person: Cost of vaccination	£25.16	£12.58 was the payment made to GP/Pharmacy per vaccine. Have doubled to represent two doses.

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	1,518	Total number of spirometry tests given in 2021/22. Extracted from GP clinical systems. No data available for West Birmingham.
Number who benefit: Number of patients with diagnosis of COPD confirmed using spirometry	409	Total number of spirometry tests in 2021/22 for patients diagnosed with COPD in year. Extracted from GP clinical systems. No data available for West Birmingham.

		This is not the same as people diagnosed with COPD following a spirometry test, but that number is not available.
Cost per person: Cost of spirometry test	£72	This figure based upon tariff cost provided by Northamptonshire.

Secondary care

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: Number of people given spirometry test	1,262	Number pulled from SUS database using procedure code E932. SQL code available on request.
Number who benefit: Number of patients with diagnosis of COPD confirmed using spirometry	340	Assumed same diagnosis rate as in primary care.
Cost per person: Cost of spirometry test	£122.61	Number pulled from SUS database using procedure code E932. SQL code available on request.

Diagnostic hubs

Metric	Total	Source
Relative benefit score	75	Score given in decision conference one.
Number treated: Number of people given spirometry test	850	Data provided by GSK.
Number who benefit: Number of patients with diagnosis of COPD confirmed using spirometry	194	
Cost per person: Cost of spirometry test	£72	This figure based upon tariff cost provided by Northamptonshire.

Lung volume reduction surgery

Metric	Total	Source
Relative benefit score	80	Score given in decision conference one.
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 benefiting from LVRS	4	80% of total; according to the BLF, 20% of people say they do not receive any benefit from LVR.
Cost per person: Cost per operation	£14,239.03	Average cost of operation pulled from SUS database. SQL code available on request.

Pulmonary rehabilitation

Metric	Total	Source
Relative benefit score	89	Score given in decision conference one.
Number treated: Number of accepted referrals	499	Number provided by UHB. All accepted adult referrals by month where primary reason is PR.
Number who benefit: Number of people receiving discharge assessment	254	According to NACAP audit for 2021, 51% of people going through the PR service at BCHC have a discharge assessment. This audit only covers patients who have been admitted to hospital so does not capture all patients. Assumed that the percentage of people completing the discharge assessment overall is the same for everyone who goes through the service.
Cost per person	£346	Provided by Nottinghamshire ICS: Tariff price for 2022/23 for rehabilitation post discharge for PR services. Assumption that the cost is the same in all services.

Virtual ward

Metric	Total	Source
Relative benefit score	35	Score given in decision conference one.
Number treated: Number of people with COPD on the virtual ward	308	Patients with respiratory conditions from Feb 2022 to Feb 2023. The number with COPD is not known.
Number who benefit: Number of people attending on the virtual ward	308	Assumed everyone benefits.
Cost per person attending courses	£1,199.24	This cost assumes that:

		<ul style="list-style-type: none"> - the cost of the virtual ward software itself is negligible - each person would spend one day in hospital (at an average cost of £1,109.99 based on hospital admission data in SUS) - each patient would have a 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). <p>$0 + 1,109.99 + 89.25 = 1,199.24$</p>
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Emergency attendances

Metric	Total	Source
Relative benefit score	15	Score given in decision conference one.
Number treated: Number of people attending ED	3,153	Data for 2021/22. Extracted from SUS emergency care database using COPD SNOMED codes. This is likely to be an underestimate, as either people will attend for breathlessness without realising they have COPD or the SNOMED codes will not be recorded. SQL available on request.
Number who benefit: Number of people attending ED	3,153	
Cost per person	£194.13	

Hospital admissions

Metric	Total	Source
Relative benefit score	90	Score given in decision conference one.
Number treated: Number of people admitted to hospital	2,795	Data pulled from SUS. Average cost of a hospital admission using the same methodology as Fingertips.

Number who benefit:	2,795	SQL code available on request.
Number of people admitted to hospital		
Cost per person attending courses	£2,940.60	

Primary care-managed acute exacerbations

Metric	Total	Source
Relative benefit score	10	Score given in decision conference one
Number treated: Number of people with an acute exacerbation	5,850	The exact number of primary care-managed acute exacerbations of COPD (AECOPDs) is unknown, but the number of patients prescribed 12 or 13+ prednisolone tablets in 2021/22 was extracted from e-pact. This proxy metric was confirmed with Maisun Elftise, a GP in Coventry.
Number who benefit: Number of people with an acute exacerbation	5,850	Assumed everyone benefits.
Cost per person	£45.19	<p>According to Maisun Elftise, GP in Coventry, a patient whose AECOPD is managed in primary care will be seen by the GP and given a rescue pack (prednisolone 5mg tablets, nebuliser vial and a nebuliser). According to BNF, the NHS tariff for prednisolone per pack of 28 tablets is £0.79, a nebuliser vial (500mg/2ml) costs £2.87, and a single-use nebuliser pack costs £2.30.</p> <p>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.</p>

End-of-life care

GP-provided palliative care

Metric	TOTAL	Source
Relative benefit score	87	Score given in the decision conferences.
Number of people treated: Number of people undergoing GP-provided palliative care	399	According to Birmingham and Solihull ICS, there are 924 adults identified as being in their last year of life who have COPD; of these, 43.2% have had a palliative care support plan conversation.
Number who benefit: Number of people undergoing palliative care	399	Assumed everyone benefits.
Cost per person	£941.52	Assumed cost is the same as that of one GP appointment; the average cost of a GP appointment according to the PSSRU 2021/22 is £39.23 (Burns & Jones, 2021b). It is assumed that each person has a weekly appointment with their GP for six months (people should start engaging with palliative care services in their last six months of life) (Bonvissuto, 2022). $39.23 \times 4 \times 6 = £941.52$

Hospice-provided palliative care

Metric	TOTAL	Source
Relative benefit score	87	Score given in the decision conferences.
Number of people treated: Number of people undergoing palliative care	305	There were 305 patients undergoing palliative care in Birmingham Hospice (St Mary's & John Taylor) in February 2023.
Number who benefit: Number of people undergoing palliative care	305	Assumed everyone benefits.
Cost per person	£38,469.30	<p>According to the ICS finance team, the cost per bed day in a hospice is £969, based on data submitted by one hospice in 2019/20.</p> <p>It is difficult to predict when someone with COPD is in their last years of life. This makes it difficult to determine how long someone will need to spend in hospice (Curtis, 2008).</p> <p>One retrospective cohort study of Medicare patients in the USA followed up beneficiaries who died in 2013/14. The study suggested that patients spent an average of 39.7 days in hospice (Iyer et al., 2020).</p> <p>Therefore, we assume each person spends 39.7 days in hospice.</p> <p>$(969 \times 39.7) = £38,469.30$</p>

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

Increasing uptake of smoking cessation services

100% of people with COPD who smoke – smoking cessation service

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£411.50	Cost per person setting a quit date for smoking cessation programmes used in the original efficiency frontier .
Benefit score (B)	90	Benefit score attributed to tertiary prevention smoking cessation in the decision conference.
Number treated: Number of people setting a quit date (Nt)	8,192	There were 23,473 people with COPD in Birmingham and Solihull in the baseline year. Assume that 34.9% of them smoke. $23,473 \times 0.349 = 8,192.077$
Number who benefit: Number who quit (N)	2,341	Assuming the same quit rate for primary prevention as the original efficiency frontier of 28.58%.
Additional population health gain	210,690	$90 \times 2,341$
Additional costs of pathway improvement	£3,371,008	$8,192 \times 411.50$
Pathway effects		

Reduction in hospitalisations	46	<p>$NNT = (1 - (PEER \times (1 - HR))) / ((1 - PEER) \times (PEER) \times (1 - HR))$</p> <p>Godtfredsen et al. (2002) reported a HR of 0.57.</p> <p>In 2021/22 there were 725 hospital admissions for COPD among 15,328 people. Therefore, the patient expected event rate is 4.7 per 100 people (725/15,328).</p> <p>$NNT = (1 - (0.047 \times (1 - 0.57))) / ((1 - 0.047) \times (0.047) \times (1 - 0.57)) = 50.87$.</p> <p>Reduction in hospitalisations = 2341/50.87 = 46.02.</p> <p>The unit cost for a hospital admission is £2,940.60.</p>
Reduction in primary care-managed AECOPDs	125	<p>In 2021/22 there were an estimated 5,234 primary care-managed AECOPDs among 15,328 people with COPD. Therefore, the expected event rate is 34.15 per 100 people (5,234/15,328 × 100).</p> <p>Au et al. (2009) reported a HR of 0.78.</p> <p>$NNT = (1 - (0.3415 \times (1 - 0.78))) / ((1 - 0.3415) \times (0.3415) \times (1 - 0.78)) = 18.69$.</p> <p>Reduction in primary care-managed AECOPDs = 2341/18.69 = 125.25.</p> <p>Unit cost of primary care-managed AECOPDs = £45.19.</p>
Cost savings	£120,216.35	<p>Number of hospital admissions avoided × cost of a hospital admission + cost of a primary care-managed AECOPD × number of AECOPDs avoided.</p> <p>$(125 \times 45.19) + (46 \times 2,490.60)$</p>

100% of people with COPD who smoke – Quit with Bella

Metric	Value	Description
Pathway improvement		

Cost of improvement (C)	£13.98	Cost per person of the Quit with Bella app used in the original efficiency frontier .
Benefit score (B)	90	Benefit score attributed to tertiary prevention smoking cessation in the decision conference.
Number treated: Additional number of people setting a quit date (Nt)	8,192	There were 23,473 people with COPD in Birmingham and Solihull in the baseline year. Assume that 34.9% of them smoke. $23,473 \times 0.349 = 8,192.077$
Number who benefit: Number who quit (N)	1,593	Assuming the same quit rate for primary prevention as the original efficiency frontier of 19.44%. $8,192 \times 0.1944 = 1,592.52$
Additional population health gain	143,370	$1,593 \times 90$
Additional costs of pathway improvement	£114,524.16	$8,192 \times 13.98$
Pathway effects		
Reduction in hospitalisations	31	$NNT = (1 - (PEER \times (1 - HR))) / ((1 - PEER) \times (1 - HR))$ Godtfredsen et al. (2002) reported a HR of 0.57. In 2021/22 there were 725 hospital admissions for COPD among 15,328 people. Therefore, the patient expected event rate is 4.7 per 100 people (725/15,328).

		$NNT = (1 - (0.047 \times (1 - 0.57))) / ((1 - 0.047) \times (0.047) \times (1 - 0.57)) = 50.87.$ <p>Reduction in hospitalisations = $1593/50.87 = 31.32.$</p> <p>The unit cost for a hospital admission is £2,490.60.</p>
Reduction in primary care-managed AECOPDs	85	<p>In 2021/22 there were an estimated 5,234 primary care-managed AECOPDs among 15,328 people with COPD. Therefore, the expected event rate is 34.15 per 100 people ($5,234/15,328 \times 100$).</p> <p>Au et al. (2009) reported a HR of 0.78.</p> $NNT = (1 - (0.3415 \times (1 - 0.78))) / ((1 - 0.3415) \times (0.3415) \times (1 - 0.78)) = 18.69.$ <p>Reduction in primary care-managed AECOPDs = $1593/18.69 = 85.23.$</p> <p>Unit cost of primary care-managed AECOPDs = £45.19.</p>
Cost savings	£81,049.75	<p>Number of hospital admissions avoided × cost of a hospital admission + cost of a primary care-managed AECOPD × number of AECOPDs avoided.</p> $(2,490.6 \times 31) + (45.19 \times 85)$

Double the number of people without COPD referred to the smoking cessation service

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£411.50	Cost per person setting a quit date for 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	13,649	Number of people setting a quit date used in the original efficiency frontier.

people setting a quit date (Nt)		
Number who benefit: Number who quit (N)	3,901	Number of people quitting used in the original efficiency frontier.
Additional population health gain	390,100	3901×100
Additional costs of pathway improvement	£5,616,563.50	$411.5 \times 13,649$
Pathway effects		
Reduction in number of people developing COPD	44	<p>NNT = $1/\text{absolute risk reduction (ARR)}$</p> <p>ARR = control event rate – experiment event rate</p> <p>Terzikhan et al. (2016) reported incidences of COPD of 19.7/1000 PY in current smokers and 8.3/1000 PY in former smokers.</p> <p>ARR = $0.0197 - 0.0083 = 0.0114$</p> <p>NNT = $1/0.114 = 87.72$</p> <p>Reduction in number of people developing COPD = $3,901/87.72 = 44.47$</p> <p>This is expected to save £1,243.93 per case avoided per year.</p>
Cost savings	£54,732.92	<p>Number of cases of COPD avoided \times expected cost of treating someone with COPD for a year.</p> <p>$44 \times 1,243.93$</p>

Double the number of people without COPD referred for the Quit with Bella app

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£13.98	Cost per person of the Quit with Bella app 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)	715	Number of people setting quit dates on the Quit with Bella app in the baseline year.
Number who benefit: Number who quit (N)	139	Number of people who quit after four weeks used in the original efficiency frontier.
Additional population health gain	13,900	139×100
Additional costs of pathway improvement	£9,995.70	13.98×715
Pathway effects		
Reduction in number of people developing COPD	2	NNT = $1/\text{absolute risk reduction (ARR)}$ ARR = control event rate – experiment event rate

		<p>Terzikhan et al. (2016) reported incidences of COPD of 19.7/1000 PY in current smokers and 8.3/1000 PY in former smokers.</p> <p>ARR = 0.0197 – 0.0083 = 0.0114</p> <p>NNT = 1/0.114 = 87.72</p> <p>Reduction in number of people developing COPD = 139/87.72 = 1.58</p> <p>This is expected to save £1,243.93 per case avoided per year.</p>
Cost savings	£2,487.86	<p>Number of cases of COPD avoided × expected cost of treating someone with COPD for a year.</p> <p>2 × 1,243.93</p>

Increasing uptake of pulmonary rehabilitation services

Doubling the number of people with an MRC score of 3+ who start PR courses

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£346	Cost used in the creation of the original efficiency frontier .
Benefit score (B)	89	Benefit score assigned to PR in the decision conference.
Number treated: Number of accepted referrals (Nt)	499	There were 499 people with an MRC score of 3+ referred to PR courses in the baseline year.
Number who benefit: Number of people completing the course	254	An estimated 254 people completed PR in the baseline year.

(N)		
Additional population health gain	22,606	Number who benefit x benefit score. 254 x 89
Additional costs of pathway improvement	£172,654	Number treated x cost of improvement. 499 x 346
Pathway effects		
Reduction in hospitalisations	7	<p>$NNT = (1 - (PEER \times (1 - OR))) / ((1 - PEER) \times (PEER) \times (1 - OR))$</p> <p>Puhan et al. gave an odds ratio of 0.44 for a reduction in hospital admissions.</p> <p>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).</p> <p>$NNT = (1 - (0.053 \times (1 - 0.44))) / ((1 - 0.053) \times (0.053) \times (1 - 0.44)) = 34.52$.</p> <p>Number of hospital admissions avoided = 254/34.52 = 7.36.</p> <p>A hospital admission has a unit cost of £2,490.88.</p>
Cost savings	£17,436.16	7 x 2,490.88

Improving the quit rate for PR services to 75%

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£346	Cost used in the creation of the original efficiency frontier .
Benefit score (B)	89	Benefit score assigned to PR in the decision conference.
Number treated: Number of accepted referrals (Nt)	499	There were 499 people with an MRC score of 3+ referred to PR courses in the baseline year.
Number who benefit: Number of people completing the course (N)	374	75%
Additional population health gain	33,286	Number who benefit × benefit score. 374×89
Additional costs of pathway improvement	£172,654	Number treated × cost of improvement. 499×346
Pathway effects		

Reduction in hospitalisations	11	<p>$NNT = (1 - (PEER \times (1 - OR))) / ((1 - PEER) \times (PEER) \times (1 - OR))$</p> <p>Puhan et al. gave an odds ratio of 0.44 for a reduction in hospital admissions.</p> <p>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).</p> <p>$NNT = (1 - (0.053 \times (1 - 0.44))) / ((1 - 0.053) \times (0.053) \times (1 - 0.44)) = 34.52$.</p> <p>Number of hospital admissions avoided = $374/34.52 = 10.83$</p> <p>A hospital admission has a unit cost of £2,490.88.</p>
Cost savings	£27,399.68	$2,490.88 \times 11$

Driving pneumonia vaccination uptake (90% coverage)

Metric	Value	Description
Cost per person of vaccination (C)	£30	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)	20,085	In the baseline year 1,041 people (4.4%) in Birmingham and Solihull with COPD had a pneumonia vaccination. An additional 20,085 would need to be vaccinated to reach the 90% target.

Number who benefit: Number of people who avoid exacerbation because of vaccination (N)	2,511	Assumed that the benefit for people with COPD is avoided acute exacerbations. According to a Cochrane review, eight patients need to be treated to prevent one exacerbation (Walters et al., 2017). $20,085 / 8 = 2,510.63$
Additional costs of pathway improvement	£602,550	$20,085 \times 30$
Additional population health gain	188,325	$2,511 \times 75$
Pathway effects		
Number of primary care-managed AECOPDs avoided.	2,511	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) $20,085 / 8 = 2,510.63$ The unit cost for a primary care-managed AECOPD is £45.19.
Cost savings	£113,472.09	$2,511 \times 45.19$

Increasing uptake and quality of spirometry testing

Doubling the number of tests done in primary care

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£72	Cost of spirometry test used in the original efficiency frontier .
Benefit score (B)	75	Benefit score attributed to spirometry testing in the decision conferences.
Number treated: Number of people tested (Nt)	1,518	Number of tests conducted in the baseline year.
Number who benefit: Number of people diagnosed with COPD (N)	409	Number of people estimated to have a confirmed diagnosis following spirometry tests in the baseline year.
Additional population health benefit	30,675	409×75
Additional costs of pathway improvement	£109,296	1518×72
Pathway effects		
Predicted reduction in COPD hospital admissions	94	<p>$NNT = 1/\text{absolute risk reduction (ARR)}$</p> <p>$ARR = \text{control event rate} - \text{experiment event rate}$</p> <p>After three years, Kostikas et al. (2020) report a hospitalisation rate of 73.52 per 100 PY in late-diagnosed COPD patients and</p>

		<p>50.46 per 100 PY in early-diagnosed COPD patients.</p> <p>$ARR = 0.7352 - 0.5046 = 0.2306$</p> <p>$NNT = 1/0.2306 = 4.34$</p> <p>Predicted reduction in COPD hospital admissions: $409/4.34 = 94.24$ per year.</p> <p>A hospital admission has a unit cost of £2,940.60.</p>
Predicted reduction in AECOPDs managed in primary care	212	<p>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.</p> <p>$ARR = 1.0894 - 0.5723 = 0.5171$</p> <p>$NNT = 1/0.5171 = 1.93$</p> <p>Predicted reduction in AECOPDs managed in primary care = $409/1.93 = 211.92$.</p> <p>The unit cost for a primary care-managed AECOPD is £45.19.</p>
Cost savings	£243,696.68	<p>Number of avoided hospital admissions × cost of a hospital admission + number of avoided primary care-managed AECOPDs × cost of a primary care-managed AECOPD</p> <p>$(94 \times 2,490.60) + (212 \times 45.19)$</p>

Expanding the respiratory diagnostic hubs to cover all six localities

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£72	Cost of a spirometry test used in the original efficiency frontier .
Benefit score (B)	75	Benefit score agreed in the decision conferences.
Number treated: Number of people tested (Nt)	2,550	850 tests done in the baseline year in two hubs. In six hubs we assume that the number of tests per hub would remain the same. $850/2 \times 6$
Number who benefit: Number of people diagnosed with COPD (N)	581	An estimated diagnosis rate of 22.8% in the RDHs in the baseline year.
Additional population health benefit	43,575	75×581
Additional costs of pathway improvement	£183,600	72×2550
Pathway effects		
Predicted reduction in COPD hospital admissions	134	<p>NNT = $1/\text{absolute risk reduction (ARR)}$</p> <p>ARR = control event rate – experiment event rate</p> <p>After three years, Kostikas et al. (2020) report a hospitalisation rate of 73.52 per 100 PY in late-diagnosed COPD patients and 50.46 per 100 PY in early-diagnosed COPD patients.</p>

		<p>ARR = 0.7352 – 0.5046 = 0.2306</p> <p>NNT = 1/0.2306 = 4.34</p> <p>Predicted reduction in COPD hospital admissions: 581/4.34 = 133.87 per year.</p> <p>A hospital admission has a unit cost of £2,940.60.</p>
Predicted reduction in AECOPDs managed in primary care	301	<p>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.</p> <p>ARR = 1.0894 – 0.5723 = 0.5171</p> <p>NNT = 1/0.5171 = 1.93</p> <p>Predicted reduction in AECOPDs managed in primary care = 581/1.93 = 301.04.</p> <p>The unit cost for a primary care-managed AECOPD is £45.19.</p>
Cost savings	£347,342.59	<p>Number of avoided hospital admissions × cost of a hospital admission + number of avoided primary care-managed AECOPDs × cost of primary care-managed AECOPD</p> <p>(134 × 2,490.60) + (301 × 45.19)</p>

Improving the quality of primary care management through clinical education

Metric	Value	Definition and source
Pathway improvement		

<p>Additional benefit (B)</p>	<p>10</p>	<p>The score given to primary care management in the decision conference was 40. It is assumed the training would lead to a 10-point increase, due to the specialist advice that staff can give. This makes the total benefit of primary care case management 50.</p>
<p>Additional cost per person of the improvement due to annual reviews (C)</p>	<p>£11.96</p>	<p>According to the Birmingham and Solihull respiratory redesign plan, the clinical education programme will consist of:</p> <ul style="list-style-type: none"> - Continued ongoing education through train the trainer programme and competency-based learning and sign off. - Quarterly MDT to support all clinical teams. <p>Continued ongoing education</p> <p>Assume training is covered by a band 6 respiratory nurse specialist for each PCN for four hours for 10 months a year in each of the 32 PCNs in Birmingham and Solihull (Office for Health Improvement & Disparities, 2022).</p> <p>The cost of a band 6 nurse specialist is £51 per hour, according to PSSRU (Burns & Jones, 2021b).</p> <p>$51 \times 4 \times 10 \times 32 = £65,280.$</p> <p>Quarterly MDT</p> <p>It is assumed there will be one MDT per locality and it will consist of: Respiratory consultant for three hours per month at a cost of £123 per hour; respiratory nurse specialist (band 6) for four hours per week at a cost of £51 per hour; high-intensity therapist (band 7) for four hours per week at a cost of £65 per hour; practice nurse</p>

		<p>for 12 hours per week at a cost of £42 per hour.</p> <p>This is based on a conference abstract from Ali et al. and agreed with a respiratory consultant in Gloucestershire. Costs are sourced from the PSSRU (Burns & Jones, 2021).</p> <p>Based on this, each MDT would cost £4,241 per quarter or £16,964 per year.</p> <p>Cost per session would be: $(3 \times 123) + (4 \times 4 \times 51) + (4 \times 4 \times 65) + (12 \times 4 \times 42) = £4,241$.</p> <p>This would mean a total yearly cost of £101,784.</p> <p>Total cost</p> <p>Therefore, the additional total cost would be $£101,784 + £65,280 = £167,064$, or £11.96 per person ($167,064/13,964$).</p>
Number treated (N_i)	13,964	The number of yearly reviews in the baseline year. Assumed this rate will stay the same.
Number who benefit (N)	13,964	Assumed everyone benefits.
Additional population health gain	139,640	$10 \times 13,964$
Additional costs of pathway improvement	£167,064	$£101,784 + £65,280 = £167,064$

Promoting respiratory services within localities through social prescribing – physical activity

Metric	Value	Description
Pathway improvement		

Cost of improvement (C)	£40.38	No data on cost of the physiotherapy programme provided by BCHC is available, so we have used the cost of an activity on referral course in Northamptonshire.
Benefit score (B)	65	The score assigned to physiotherapy in the decision conference.
Number treated: Number starting the course. (Nt)	10%: 2,347 25%: 5,868 50%: 11,737	There were 23,473 people with COPD in Birmingham and Solihull in the baseline year.
Number who benefit: Number completing the course. (N)	10%: 1,788 25%: 4,471 50%: 8,944	Completion rate of the activity course in Northamptonshire was 76.2% in 2021/22.
Additional population health gain	10%: 116,220 25%: 290,615 50%: 581,360	65 × 1,788 65 × 4,471 65 × 8,944
Additional costs of pathway improvement	10%: £94,771.86 25%: £236,949.84 50%: £473,940.06	2347 × 40.38 5,868 × 40.38 11737 × 40.38
Pathway effects		
Reduction in hospitalisations	10%: 26 25%: 64 50%: 128	$NNT = (1 - (PEER \times (1 - IRR))) / ((1 - PEER) \times (PEER) \times (1 - IRR))$ <p>Garcia-Aymerich et al. (2006) give an incidence rate ratio of 0.72.</p> <p>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).</p>

		$NNT = (1 - (0.053 \times (1 - 0.72))) / ((1-0.053) \times (0.053) \times (1 - 0.72)) = 70.10$ <p>10%: $1,788 / 70.10 = 25.51$ 25%: $4,471/70.10 = 63.78$ 50%: $8,944/70.10 = 127.59$</p> <p>A hospital admission has a unit cost of £2,490.60.</p>
Cost savings	10%: £64,755.60 25%: £159,398.40 50%: £318,796.80	10%: $26 \times 2,490.60$ 25%: $64 \times 2,490.60$ 50%: $128 \times 2,490.60$

Psychological support

Metric	Value	Description
Cost per person of programme (C)	£704.32	<p>Cost of IAPT services is broken down into three parts:</p> <ul style="list-style-type: none"> - Cost of the assessment - Cost of low-intensity treatment - Cost of high-intensity treatment <p>Cost of assessment</p> <p>Assumed each patient referred will receive an initial 30-minute assessment by a band 5 psychological wellbeing practitioner (£41 per hour – £20.5 per session) (Burns & Jones, 2021a; The National Collaborating Centre for Mental Health, 2023).</p> <p>Cost of low-intensity treatment</p> <p>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).</p> <p>Low-intensity treatment can be delivered in one of three ways:</p>

		<ul style="list-style-type: none"> - Six weeks of 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, lasting a maximum of 30 minutes (£123) - Six weekly psychoeducational group sessions lasting two hours for 12 people (£41). <p>The proportion of people who undertake each kind of low-intensity treatment is unknown; therefore, we assume people are allocated equally between them.</p> <p>Expected cost = probability of treatment × cost = £61.50</p> <p>Cost of high-intensity treatment</p> <p>High intensity treatment is conducted by a high-intensity therapist (band 7) at a cost of £65 per hour.</p> <p>It consists of 12–15 weekly sessions lasting one hour each; here we have used 13.5 as a mid-point.</p> <p>£65 × 13.5 = £877.50</p> <p>Expected cost per patient</p> <p>37% of patients receive low-intensity treatment, 29% receive high-intensity treatment, and 34% receive both (The National Collaborating Centre for Mental Health, 2023).</p> <p>Expected cost per patient = 20.5 + (0.37 × 184.5) + (0.29 × 877.50) + (0.34 × 877.50) + (0.34 × 184.5) = £704.32</p>
Benefit (B)	75	Score given to psychological support in the decision conferences.
Number treated: Number of	10%: 1,174 25%: 2,934	There are 23,473 people with diagnosed COPD in Birmingham and Solihull (Office for Health Improvement & Disparities, 2022).

additional people attending IAPT sessions (Nt)	50%: 5,868	It is assumed that 50% of them have anxiety and/or depression. 10% of eligible people referred = $23,473 \times 0.5 \times 0.1 = 1,173.65$ 25% of eligible people referred = $23,473 \times 0.5 \times 0.25 = 2,934.13$ 50% of eligible people referred = $23,473 \times 0.5 \times 0.5 = 5,868.25$
Number who benefit (N)	10%: 1,174 25%: 2,934 50%: 5,868	Assumed everyone benefits.
Additional costs of pathway improvement	10%: £826,871.68 25%: £2,066,474.88 50%: £4,132,949.76	$1,174 \times 704.32 = 826,871.68$ $2,934 \times 704.32 = 2,066,474.88$ $5,868 \times 704.32 = 4,132,949.76$
Additional population health gain	10%: 88,050 25%: 220,050 50%: 440,100	$75 \times 1,174 = 88,050$ $75 \times 2,934 = 220,050$ $75 \times 5,868 = 440,100$
Pathway effects		
Number of hospital admissions avoided	10%: 18 25%: 45 50%: 91	An estimated 11.91% of people with COPD in Birmingham and Solihull had a hospital admission in 2021/22 (see data sources for the original efficiency frontier). According to Gruber et al. (2022), there was a 13% decrease in inpatient non-elective admissions compared with a matched cohort for people receiving IAPT services. This means an expected 1.55% of people (0.13×0.1191) referred to IAPT services not having a hospital admission who would have had one otherwise. $10\%: 1,174 \times 0.0155 = 18.20$ $25\%: 2,934 \times 0.0155 = 45.48$

		<p>50%: $5,868 \times 0.0155 = 90.954$</p> <p>The average cost of a hospital admission in Birmingham and Solihull is £2,490.60.</p>
Number of outpatient attendances avoided	<p>10%: 23</p> <p>25%: 56</p> <p>50%: 113</p>	<p>An estimated 13.73% of people with COPD in Birmingham and Solihull had an outpatient appointment in 2021/22 (see data sources for the original efficiency frontier).</p> <p>According to Gruber et al. (2022), psychological support leads to a reduction in outpatient appointments of 14% after 12 months.</p> <p>This would mean 1.92% of people (0.1373×0.14) referred to IAPT services would not have an outpatient appointment who would have had one otherwise.</p> <p>10%: $1,174 \times 0.0192 = 22.54$</p> <p>25%: $2,934 \times 0.0192 = 56.33$</p> <p>50%: $5,868 \times 0.0192 = 112.67$</p> <p>The average cost of an outpatient appointment in Birmingham and Solihull is estimated at £134.39.</p>
Cost savings	<p>10%: £60,374.77</p> <p>25%: £146,999.44</p> <p>50%: £296,623.87</p>	<p>$(23 \times 2,490.60) + (23 \times 134.39)$</p> <p>$(56 \times 2,490.60) + (56 \times 134.39)$</p> <p>$(113 \times 2,490.60) + (113 \times 134.39)$</p>

Promoting self-care through the myCOPD app

Metric	Total	Description
Pathway improvement		
Cost of improvement	£0.25	According to the NICE guidance, the unlimited licence plan has an annual cost of £0.25 per

(C)		person registered with a GP in the region (National Institute for Health and Care Excellence, 2022).
Benefit score	40	Assumed the relative health benefit is the same as for primary care management.
Number treated: Registered GP population	23,473	Number of people with COPD in Birmingham and Solihull in 2021/22 (Office for Health Improvement & Disparities, 2022).
Number who benefit: Number of people who use the myCOPD app	11,267	According to the NICE guidance, the myCOPD app has a national activation rate of 48%, as reported elsewhere (National Institute for Health and Care Excellence, 2022).
Additional population health gain	450,680	$40 \times 11,267$
Additional costs of pathway improvement	£5,868.25	$0.25 \times 23,473$

Virtual ward: admissions avoidance

Metric	Value	Description
Pathway improvement		
Cost of virtual ward per person (C)	10%: £1,541.45 25%: £1,489.64 50%: £1,472.35	<p>Costs have been calculated based upon the work of Jones and Carroll (2014).</p> <p>The costs are split into four categories: identification, assessment, intervention, and a virtual ward MDT (Jones & Carroll, 2014).</p> <p>Identifying patients:</p> <p>Patients will be identified by a band 3 admin assistant: this involves a yearly cost of £21,730 in salary and £6,519 a year in on-costs (30% as a standard estimate) (NHS, 2022), a total cost of £28,249. The cost per patient depends on how many patients are identified in each scenario, assuming that the admin assistant can deal with all the patients they identify:</p> <p>10%: $28,249/327 = £86.39$ 25%: $28,249/817 = £34.58$ 50%: $28,249/1,634 = £17.29$</p> <p>Assessment:</p> <p>The matron visits the patient at home to identify health and social care needs. Assumed the matron is a band 8a with an hourly cost of £70 and that each visit takes two hours (including travel) (Burns & Jones, 2021b).</p> <p>Total cost £140 per patient.</p> <p>Intervention:</p> <p>Care plan is devised in collaboration with the patient, their GP and the community matron. Estimated that this takes 30 minutes of GP time (£79) and 30 minutes</p>

		<p>of community matron time (£35) (Burns & Jones, 2021b).</p> <p>Care could involve visits five days a week from a band 4 healthcare assistant of 30 minutes each (£17.50). Patients are initially planned to be discharged after three months so this would cost £1,050 ($17.5 \times 5 \times 4 \times 3$) per patient (Burns & Jones, 2021b).</p> <p>Virtual ward team:</p> <p>Although the matron is responsible for coordinating care, they have access to an MDT team to discuss patients.</p> <p>It is assumed there will be one MDT across Birmingham and Solihull that will consist of: respiratory consultant for three hours per month at a cost of £123 per hour; respiratory nurse specialist (band 6) for four hours per week at a cost of £51 per hour; high-intensity therapist (band 7) for four hours per week at a cost of £65 per hour; practice nurse for 12 hours per week at a cost of £42 per hour.</p> <p>This is based on a conference abstract from Ali et al. and agreed with a respiratory consultant in Gloucestershire. Costs are sourced from the PSSRU (Burns & Jones, 2021).</p> <p>Cost per session would be: $(3 \times 123) + (4 \times 4 \times 51) + (4 \times 4 \times 65) + (12 \times 4 \times 42) = £4,241$.</p> <p>In each four-hour session it is assumed that they can discuss 16 patients (15 minutes each) and that each patient is discussed once. Therefore, the cost per patient is £265.06.</p> <p>Total cost per patient</p>
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		<p>10%: $86.39 + 265.06 + 140 + 1,050 = 1,541.45$</p> <p>25%: $34.58 + 265.06 + 140 + 1,050 = 1,489.64$</p> <p>50%: $17.29 + 265.06 + 140 + 1,050 = 1,472.35$</p>
Benefit score (B)	35	Score assigned to admissions avoidance in the decision conference.
Number treated: Number of patients admitted (N_t)	<p>10%: 327</p> <p>25%: 817</p> <p>50%: 1,634</p>	There are an estimated 3,268 patients with severe or very severe COPD in Birmingham and Solihull. See the population section above.
Number who benefit (N)	<p>10%: 327</p> <p>25%: 817</p> <p>50%: 1,634</p>	Assumed everyone benefits.
Additional costs of pathway improvement	<p>10%: £504,054.15</p> <p>25%: £1,217,035.88</p> <p>50%: £2,405,819.90</p>	<p>$327 \times 1,541.45$</p> <p>$1,489.64 \times 817$</p> <p>$1,472.35 \times 1,634$</p>
Additional population health gain	<p>11,445</p> <p>28,595</p> <p>57,190</p>	<p>35×327</p> <p>35×817</p> <p>$35 \times 1,634$</p>

Hospice-at-home virtual ward

Metric	Value	Description
Pathway improvement		
Cost of virtual ward per person (C)	£1,380.68	<p>There is uncertainty over the pathway for an end-of-life virtual ward for COPD. Therefore, the costs have been calculated based upon the work of Jones and Carroll (2014), based on an admissions avoidance virtual ward.</p> <p>The costs are split into four categories: identification, assessment, intervention, and a virtual ward MDT (Jones & Carroll, 2014).</p> <p>Identifying patients:</p> <p>Patients will be identified by a band 3 admin assistant; this involves a yearly cost of £21,730 in salary and £6,519 a year in on-costs (30% as a standard estimate) (NHS, 2022), a total cost of £28,249. The cost per patient depends on how many patients are identified in each scenario:</p> <p>£28249/305: £92.62</p> <p>Assessment:</p> <p>The matron visits the patient at home to identify health and social care needs. Assumed the matron is a band 8a with an hourly cost of £70 and that each visit takes two hours (including travel) (Burns & Jones, 2021b).</p> <p>Total cost £140 per patient</p> <p>Intervention:</p> <p>A palliative care plan is devised in collaboration with the patient, their GP and the community matron. Estimated that this takes 30 minutes of GP time (£79) and 30 minutes of community matron time (£35), or £114 in total (Burns & Jones, 2021b)</p>

		<p>Care could involve visits daily from a band 4 healthcare assistant of 30 minutes each (£17.50) (Burns & Jones, 2021b). It is difficult to determine the number of days someone could spend on the end-of-life virtual ward. One retrospective cohort study in the USA of Medicare beneficiaries who died in 2013/14 suggested that patients spent an average of 39.7 days in hospice (Iyer et al., 2020).</p> $114 + (17.5 \times 39.70) = \text{£}808.75$ <p>Virtual ward team:</p> <p>Although the matron is responsible for coordinating care, they have access to an MDT team to discuss patients.</p> <p>It is assumed there will be one MDT across Birmingham and Solihull, which will consist of: respiratory/palliative care consultant for three hours per month at a cost of £123 per hour; nurse specialist (band 6) for four hours per week at a cost of £51 per hour; high-intensity therapist (band 7) for four hours per week at a cost of £65 per hour; practice nurse for 12 hours per week at a cost of £42 per hour.</p> <p>This is based on a conference abstract from Ali et al. and agreed with a respiratory consultant in Gloucestershire. Costs are sourced from the PSSRU (Burns & Jones, 2021).</p> <p>Cost per session would be: $(3 \times 123) + (4 \times 4 \times 51) + (4 \times 4 \times 65) + (12 \times 4 \times 42) = \text{£}4,241$.</p> <p>In each four-hour session it is assumed that they can discuss 16 patients (15 minutes each) and that each patient is discussed once. Therefore, the cost per patient is £265.06.</p> <p>Total cost per patient</p> $265.06 + 808.75 + 140 + 92.62 = \text{£}1,380.68$
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Benefit score (B)	35	Score assigned to admissions avoidance in the decision conference.
Number treated: Number of patients admitted (N_t)	305	There are an estimated 305 patients with severe or very severe COPD in Birmingham and Solihull. See the population section above.
Number who benefit (N)	305	Assumed everyone benefits.
Additional costs of pathway improvement	£421,107.40	305 × 1,380.68
Additional population health gain	10,675	305 × 35
Pathway effects		
Potential reduction in patients cared for in hospice-provided palliative care	305	The number of people treated in hospice-provided care. It is estimated that this costs £38,469.30 per person.
Potential reduction in patients cared for in GP palliative care	305	The number of people expected to be included on the end-of-life virtual ward. GP-provided palliative care is estimated to cost £941.52.
Cost savings	Replacing hospice care: £11,733,136.50 0 Replacing GP-provided care: £287,163.60	305 × 38,469.30 305 × 941.52

Expanding the virtual ward as an early discharge support intervention

Metric	Value	Description
Pathway improvement		
Cost of virtual ward per person (C)	£1,199.24	This is the cost of the virtual ward used in the original efficiency frontier .
Benefit score (B)	35	Score used in the decision conference.
Number treated: Number of patients eligible for the virtual ward (N_t)	1,398	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 2,795 hospital admissions in 2021/22 not included on the virtual ward.
Number who benefit (N)	1,398	Assumed everyone benefits.
Additional costs of pathway improvement	£1,676,537.52	Number of people treated on virtual ward × cost of virtual ward. $1,398 \times 1,199.24$
Additional population health gain	48,930	Benefit score × number of people treated on virtual ward. $35 \times 1,398$
Pathway effects		
Number of hospital admissions replaced by virtual ward	1,397	There would be 1,397 normal hospital admissions for the people who would be ineligible for the virtual ward. A hospital admission has a unit cost of £2,490.60.

Cost savings	£3,479,368.20	Number of hospital admissions replaced by virtual ward × the cost of a hospital admission. $1397 \times 2,490.60$
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