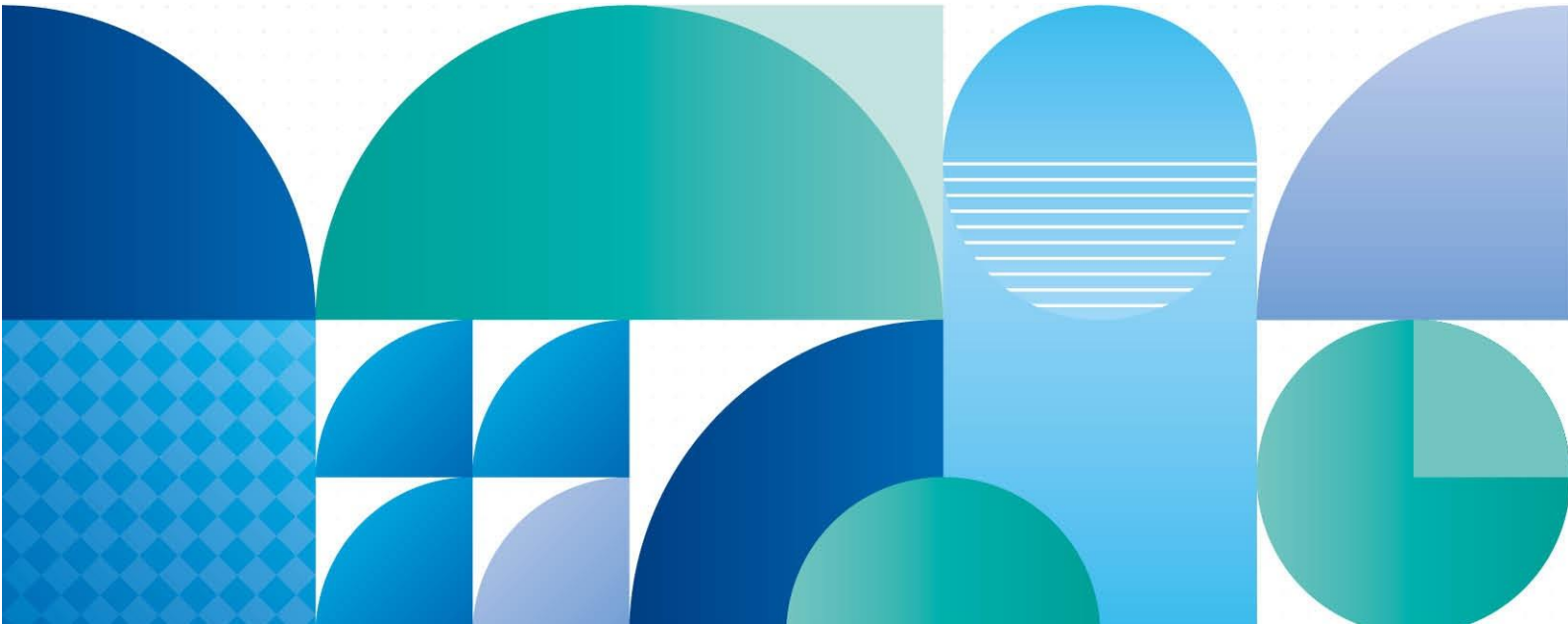
Health Economics Unit

NHS
Midlands and Lancashire
Commissioning Support Unit

Smarter Spending in Population Health

Using economic principles to set priorities for COPD resource allocation in Northamptonshire ICS



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Introduction

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

The specific aims of this project were to:

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

This project supports the ICS respiratory programme's aim to build on what already works well, while challenging traditional models that may not be providing the best solutions for people living with respiratory conditions, including COPD (Ali & Riddaway, 2021).

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

Recommendations

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

- **Post-exacerbation support** for people following a hospital admission for an acute exacerbation.
- Offering **group consultations** as an option for people's yearly reviews in general practice
- **Launching the myCOPD app** to support people to self-manage their own condition.
- Getting staff in general practice to offer **very brief advice for smoking cessation** to people with COPD.

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

Socio-technical allocation of resources

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

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

By applying STAR, commissioners can:

- Engage all relevant stakeholders in the decision-making process for prioritising resources in a transparent and systematic way
- Identify the current pathways for preventing, diagnosing and treating 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)** who have 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 Northamptonshire

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 for Northamptonshire focused on building a common understanding of the population for whom the group was making decisions (i.e., those at risk of developing COPD or already living with COPD) and understanding the relative value of all the COPD pathway components (i.e., all the interventions that are targeted at people with COPD) that are currently offered in Northamptonshire. This is summarised in the **population** and **pathway** sections, respectively.

The second focused on highlighting the **main challenges** in the pathway and proposing ways it can be improved. This process was informed by a visual model of the value for money of each intervention called the 'efficiency frontier'. The efficiency frontier can be found in the **value of the COPD pathway in Northamptonshire** section.

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

After 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 benefit 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 who 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 listed below.

Northamptonshire ICS:

- Azhar Ali, Clinical Lead of the Respiratory Programme
- Komal Gorania, Senior Programme Manager of the Respiratory Programme
- Giles Owen, Head of Prescribing & Medicine Management
- Paul Foley, Public Health Management Accountant
- Anne Holland, Business Intelligence Analyst
- Paul Birch, Associate Director of Population Health Intelligence

Northampton General Hospital:

- Fiona McCann, Respiratory Consultant
- Phillip Pearson, Respiratory Consultant
- Helen Van Uem, Specialist Physiotherapist
- Yvonne Thettan, Service Manager for Respiratory Service

Northamptonshire County Council:

- Rhosyn Harris, Public Health Consultant
- NHS England (Midlands):
- Matthew Spilsbury, Regional Head of Delivery (System Improvement) and System Improvement Partner for Northamptonshire ICS

Northamptonshire Carers:

- Gwyn Roberts, Chief Operating Officer

Northamptonshire Sport:

- Jackie Browne, Strategic Director

The COPD population, pathway and main challenges

Population

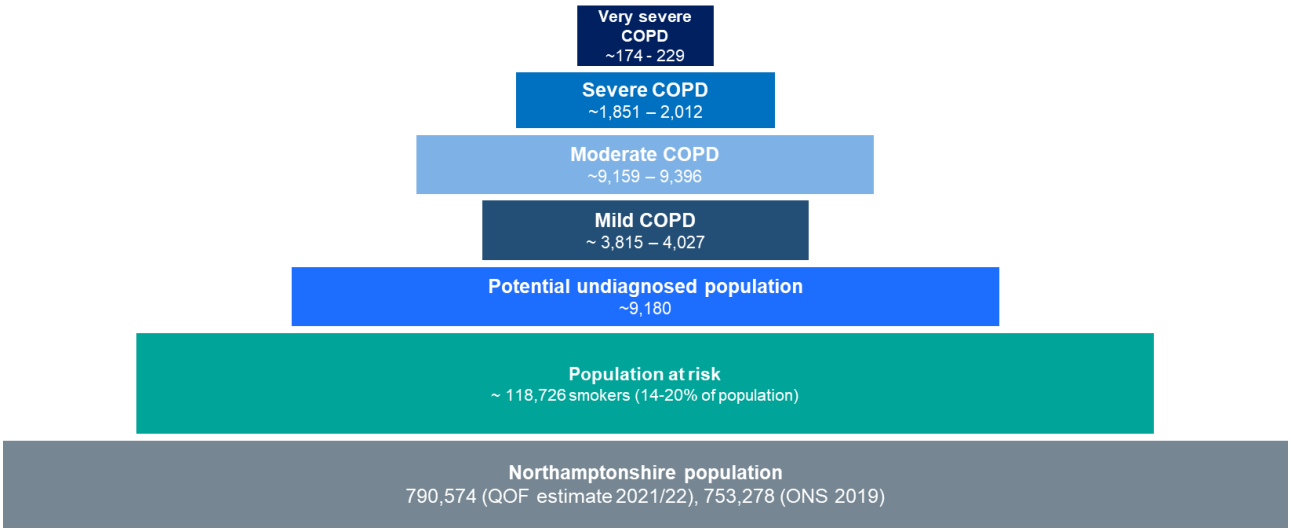


Figure 1 – Population pyramid for Northamptonshire ICS (sources are described in the appendices)

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.

As shown in Figure 1, the total population of Northamptonshire, according to the QOF register, is 790,574 people (Office for Health Improvement & Disparities, 2022).

In terms of those at risk of COPD, the percentage of smokers is between 14 and 20% according to QOF estimates, equating to around 118,760 smokers (Office for Health Improvement & Disparities, 2022). There are potentially 9,180 people living with undiagnosed COPD in the county and 15,328 people with diagnosed COPD in the county (Nacul et al., 2007; Office for Health Improvement & Disparities, 2022).

The COPD pathway

Next, participants were asked to assess the relative value of all the interventions and programmes in the COPD pathway. The pathway is described in Figure 2. This was presented to participants to ensure there was a common understanding of all the interventions offered.

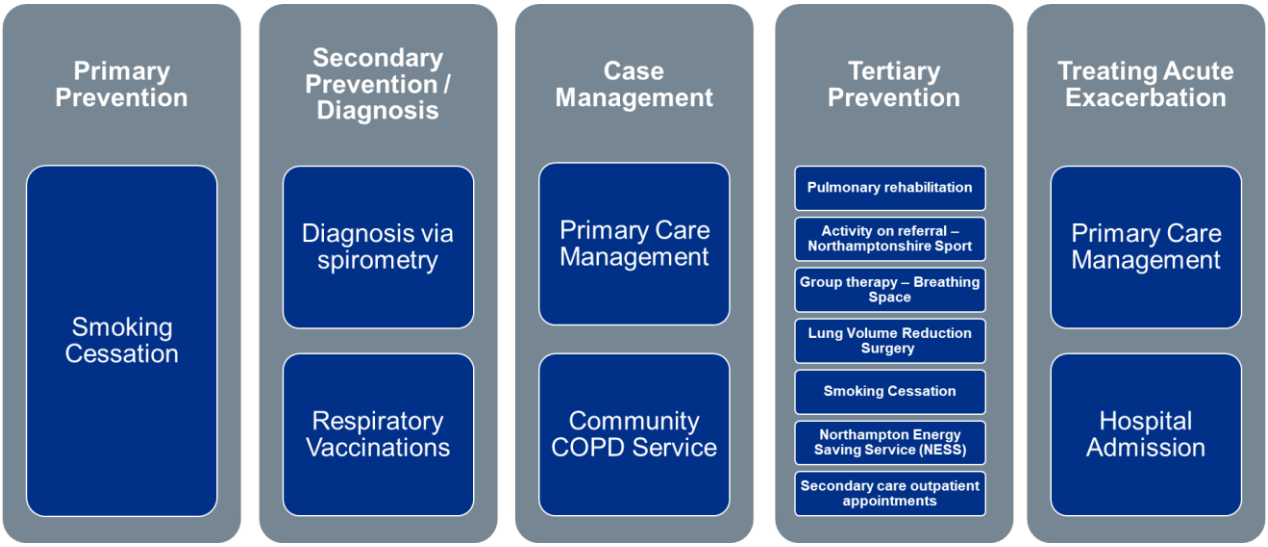


Figure 2 – The current care pathway for those living with and at risk of developing COPD

Valuing the current care pathway

Attendees were then asked to assess the relative benefit, in terms of length and quality of life, for all interventions and programmes in the pathway using a visual analogue scale. The process for doing so can be found in the **methods document** in the appendices. This formed the 'benefit score', which is a key piece of evidence used to populate the efficiency frontier (see the **interpreting the efficiency frontier** section below). This part of the decision conference also helped attendees to think about comparing different interventions with each other and the trade-offs between them; for example, some interventions may give people more health in the long term compared with others that have more immediate impacts. The discussions generated by the process of valuing can be very beneficial in determining the key challenges and potential pathway improvements as well as in helping to build the visual models.

Attendees did this by plotting Post-it notes representing the interventions and programmes in the current care pathway on a visual analogue scale, a tool widely used in health economics (Parkin & Devlin, 2006). The scale and the scores assigned to each intervention are displayed in Figure 3 below. Attendees were given an information pack (see Appendix 2) which included information from published academic studies looking at

the quality-of-life gain (in terms of quality-adjusted life years[1]) to inform the scoring process.

Smoking cessation as primary prevention (i.e., to stop people developing COPD in the first place) was given a score of 100 as the intervention deemed to give the most benefit in terms of health gain. A score of 0 indicates an intervention that gives no additional health gain compared with current care. Due to time constraints, oxygen therapy was not valued; it was decided, as it was not likely to affect decision-making, that oxygen therapy should not be included in the efficiency frontier.

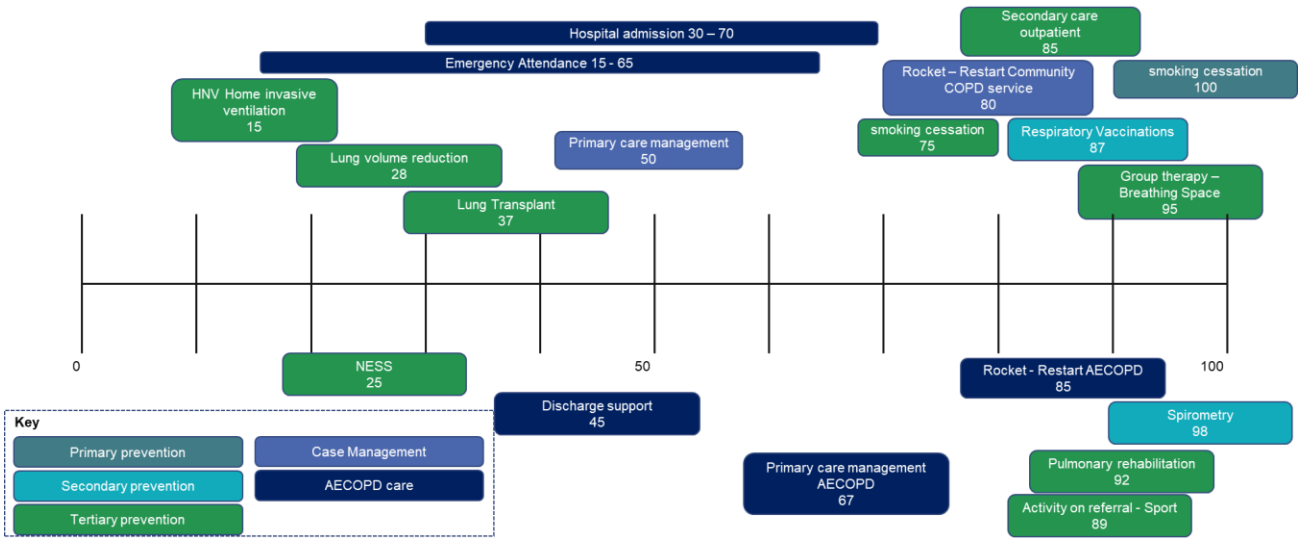


Figure 3 – Benefit scores of each of the interventions in the COPD pathway

The value of the COPD pathway in Northamptonshire

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

The methods for doing this, as well as the data points used, can be found in the **methodology document** in the appendices.

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

Interpreting the efficiency frontier

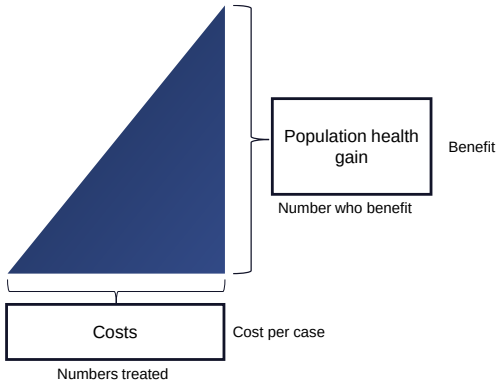


Figure 4 – Populating the efficiency frontier

The efficiency frontier produces a triangle for each intervention, which allows us to visualise the effects of, and compare, different interventions and programmes across the whole pathway (e.g., spirometry and pulmonary rehabilitation). The y-axis shows the expected population health benefit for an intervention (the product of the number who benefit and the benefit score) compared with current care. The x-axis displays the estimated annual cost for an intervention.

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

STAR's visual models are what makes it easy to interpret. In the triangles in Figure 5, we can see at a glance that the triangle on the left is for an intervention that is much more cost-effective than the intervention represented by the triangle on the right: as we increase spending, the benefits increase quickly for the triangle on the left but only slowly for the triangle on the right.

The triangles are then ordered in a sequence according to their cost-effectiveness to display the 'efficiency frontier'. This shows either where there are opportunities to spend the existing money in a different way to provide more value for money, or where additional investment will be best targeted. This shows, for each component, its relative scale in how it accounts for the total costs and contributes to the total benefits of the care pathway. 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, thus reducing costs and improving the population health benefit of the pathway.

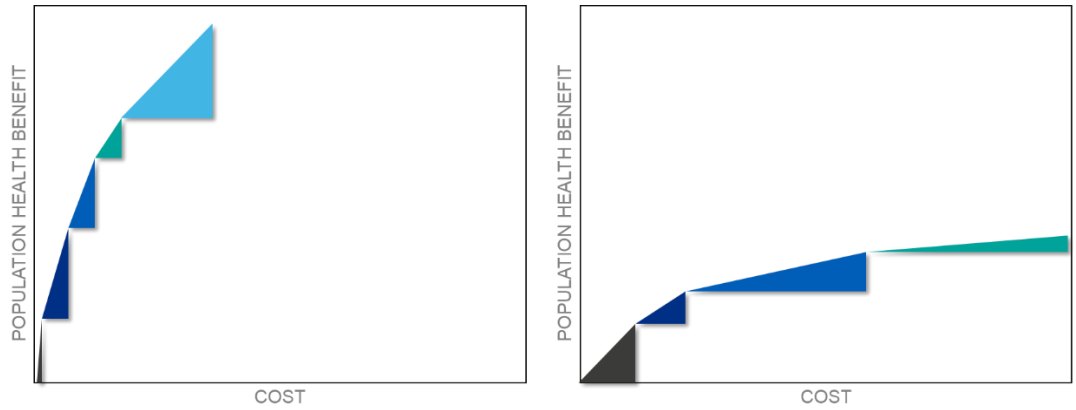
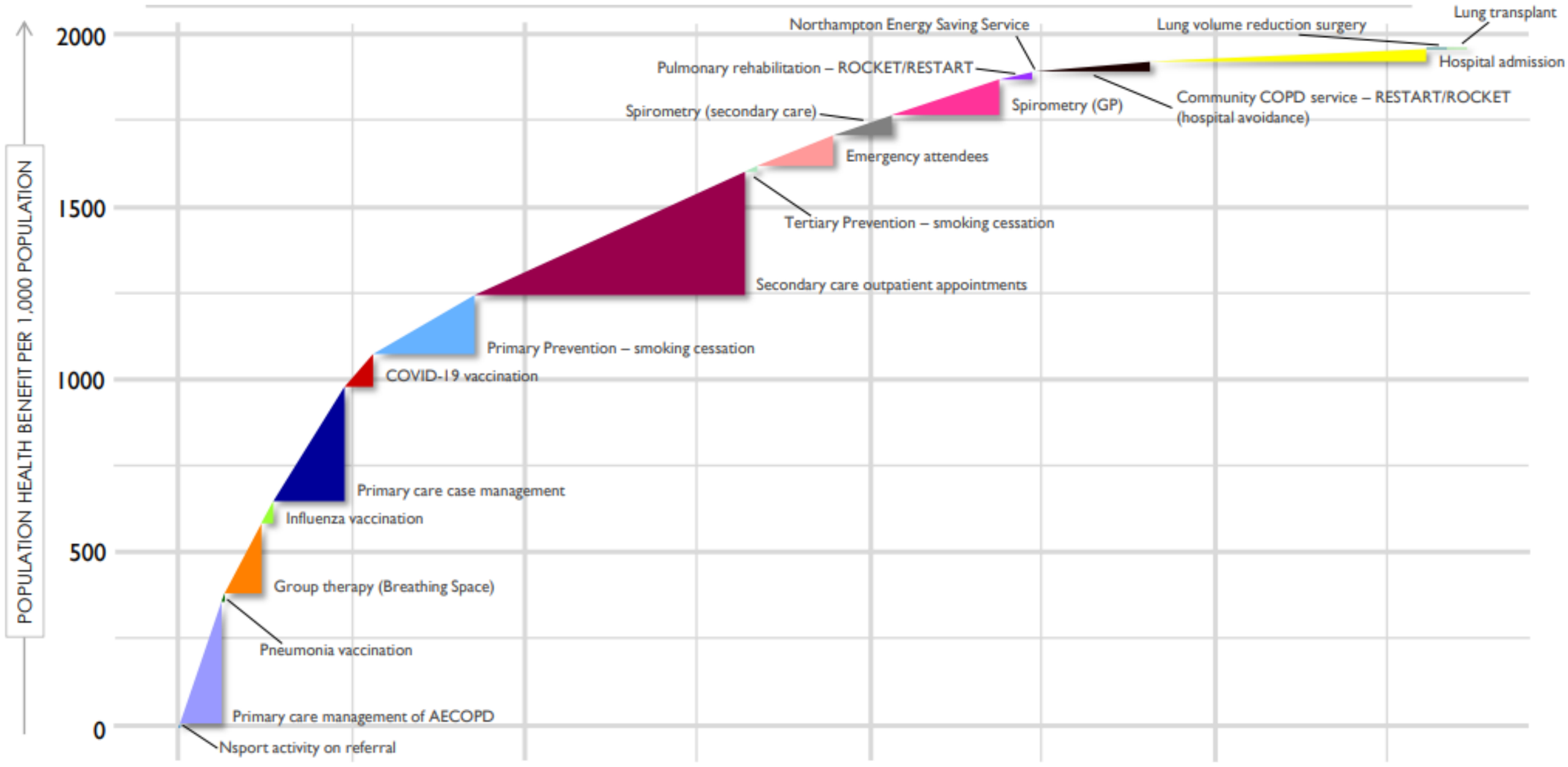


Figure 6 – Different efficiency frontiers with good (left) and bad (right) value for money.

The efficiency frontier in Northamptonshire



	PRIMARY PREVENTION	SECONDARY PREVENTION	CASE MANAGEMENT	TERTIARY PREVENTION	MANAGEMENT OF AECOPD
% of total spend	7.9%	16%	14.4%	31%	30.7%
% of pop health gain	8.7%	17.2%	18.5%	31.1%	24.6%

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

Main challenges

After being presented with the efficiency frontier and drawing upon the attendees' own experience, the following challenges were highlighted as the main areas of focus:

- Improving capacity for spirometry testing
- Reducing variability of initial patient management
- Improving uptake of pulmonary rehabilitation and similar services
- Doing more to stop people smoking
- Reducing hospital admissions

Spirometry testing capacity has not recovered to pre-pandemic levels

Spirometry testing is the gold-standard test for COPD; it measures how much air you can breathe out in one breath. Previously, spirometry was delivered through a locally enhanced service, but this ceased in March 2022. This means that practices are building up waiting lists. Although there have been other time-limited offers, such as mobile units, not all practices have taken these up. This is demonstrated by the relatively small triangles representing spirometry delivered in secondary care and GP practices.

There is variability in the quality of spirometry testing in Northamptonshire, and 16 primary care networks in Northamptonshire do not carry out spirometry due to a lack of trained staff. An estimated 12.12% of spirometry tests lead to a diagnosis of COPD.[2] This means 8.25 spirometry tests need to be done to diagnose one additional case of COPD.[3] This is why spirometry testing appears to provide relatively low value for money in the **efficiency frontier**.

There is variability in primary care case management

For most patients with COPD, their general practice will be responsible for coordinating their care (referred to as 'case management'). Compared with patients in practices where specialist nurses are not present, patients attending some general practices may receive a more comprehensive plan because they are seen by a practice nurse who specialises in respiratory illness. For example, a specialist nurse may give a patient advice on how to use their inhaler properly, improving the efficacy of the inhaler and reducing side effects. A patient not given this advice may not derive the same health benefits from their inhaler as their counterpart.

[2] According to data provided by analysts working in Northamptonshire ICS
[3] Some spirometry tests will be done to monitor people with an existing diagnosis. This means 8.25 is likely an overestimate of the number of spirometry tests necessary to diagnose one extra person with COPD.

Similarly, there is a patchwork of services available to people living with COPD. Not all clinicians are aware of all the local offers for people with COPD, which will affect the services they refer people on to.

Uptake of pulmonary rehabilitation and similar services could be improved

Pulmonary rehabilitation (PR) is widely regarded as one of the best non-pharmacological interventions for people living with COPD (Bolton et al., 2013). It involves exercise classes alongside some education on a patient's condition.

Uptake of PR services remains low, either because people are not referred or because they are not seen in a timely manner. Similarly, only a small proportion of people who start a PR course complete it. This is why PR appears as a small triangle with low value for money in the **efficiency frontier** despite the individual health benefits it can give to those who complete the course.

More could be done to stop people smoking

Stopping people smoking is one of the best interventions to prevent COPD in the first place or to improve the quality of life of someone already living with COPD. Northamptonshire currently sets approximately 3,000 quit dates a year; however, to reach the NICE target of 5% of the smoking population setting a quit date, around 4,500 quit dates need to be set.[4]

Northamptonshire has a high rate of hospital admissions for COPD compared with other areas

In 2020/21, according to QOF data, Northamptonshire had a standardised rate of 192.5 hospital admissions for COPD per 100,000 people, versus a national average of 133.5 per 100,000 (Office for Health Improvement & Disparities, 2022). As shown in the **efficiency frontier**, 30.7% of money spent on the COPD pathway is spent on managing acute exacerbations of COPD, the vast majority of which is spent on hospital admissions. Reducing the number of hospital admissions for COPD could free up resource to be used elsewhere.

Reducing the number of hospital admissions for COPD could free up resource to be used elsewhere.

[4] Numbers provided by North Northamptonshire Council's stop smoking service.

Improving the pathway

Addressing the main challenges

After discussion of the main challenges, attendees were asked to generate pathway improvements that could address them.

The pathway improvements that the attendees decided should be taken forward for consideration were:

- Increasing capacity in spirometry testing
- Launching the myCOPD app
- Conducting patients' yearly reviews through group consultations
- Post-exacerbation support for patients following a hospital admission
- Improving signposting to key services
- Expansion of pulmonary rehabilitation services
- Increasing uptake of smoking cessation services
- Very brief advice on smoking cessation training in primary care
- Introducing high-efficiency particulate air filters in schools

Pathway improvement: a definition

Here we have used the phrase ‘pathway improvements’ 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 could be a single intervention (e.g., a pathway improvement looking to expand pulmonary rehabilitation would consist of only pulmonary rehabilitation) or multiple interventions (e.g., the pathway improvement ‘improving signposting to services’ would consist of the signposting intervention itself as well as the expected increase in uptake of the services being signposted).

Increasing capacity in spirometry testing

At the time of writing, respiratory hubs are being set up to provide rapid access to a range of diagnostic tests. There are plans to develop four respiratory hubs. Clinics will operate four times a week during the year, seeing between six and ten patients per clinic.

Launching the myCOPD app

Currently in Northamptonshire, there is no offer of an online tool to help people self-manage their COPD. The myCOPD app is a smartphone application to support with self-management of 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.

Conducting patients’ yearly reviews through group consultations

Group consultations (often referred to as shared medical appointments) involve seeing multiple patients in one session. Some studies suggest that sessions tend to last around 90 minutes for up to 12 patients (Edelman et al., 2012; Hayhoe et al., 2017). This contrasts with the current reviews, which normally take around 15 minutes. Such appointments could improve the quality of primary care case management by allowing clinicians more time to give advice and allowing peer learning in the sessions.

Post-exacerbation support for patients following a hospital admission

Including some element of post-exacerbation support in the respiratory hubs was suggested as a good way of improving the information and support people have after a readmission. This would be in addition to the discharge support offered by ROCKET and RESTART (the community COPD services based at Northampton and Kettering General Hospitals) and would allow discharge support to be offered to more people.

Improving signposting to key services

The creation of an information centre as part of the respiratory hubs was suggested as a way of ensuring people with newly diagnosed COPD are aware of all the services available to them. When people get their diagnosis, they would have an initial session with a respiratory nurse specialist, where they would receive some education on how to manage their condition and would then be signposted to relevant services. Some services that could be expected to be signposted are:

- Breathing Space, a peer support group run by Northamptonshire Carers
- Activity on Referral, a 12-week 'introduction to exercise' programme currently accessible through GP referrals
- Northampton Energy Saving Service (NESS), a service that helps people struggling to heat their homes through advice and guidance and, where appropriate, through housing improvement grants

Expansion of PR services

In Northamptonshire, PR is currently offered by the ROCKET and RESTART teams based at Kettering and Northampton General Hospitals. Northamptonshire Sport is in the process of setting up a community-based PR programme which includes peer support. This will be part of a county-wide pathway for COPD, with PR considered as part of a wider social prescription programme, and will be aimed at people deemed to be low- to medium-risk when triaged by the ROCKET and RESTART teams.

Increasing uptake of smoking cessation services

Stopping people smoking is widely regarded as one of the most effective ways to prevent COPD or improve symptoms once someone already has COPD. Currently, smoking cessation services in Northamptonshire are run by the Northamptonshire Stop Smoking Service. Northamptonshire has one of the highest reported quit rates in the country. According to data provided by Public Health Northamptonshire, in 2021/22, 61% of people setting a quit date had stopped smoking after four weeks. Getting more people to attend this service will likely lead to more people quitting smoking.

Very brief advice on smoking cessation in primary care

One way of improving the number of people who quit smoking would be for general practitioners to offer very brief advice (VBA) on the benefits of stopping smoking to people as part of their yearly reviews. The National Centre for Smoking Cessation and Training (NCSCT) offers a free VBA training module that is available to clinicians working in primary care.

Introducing HEPA filters in schools

Respiratory viruses drive acute exacerbations of COPD, and it is widely accepted that the spread of respiratory viruses such as influenza and COVID-19 is driven by school-age children (Read et al., 2021). Introducing high-efficiency particulate air (HEPA) filters in school classrooms could reduce the transmission of viral particulates in the air and the incidence of respiratory conditions in schools (Lewis, 2021). Theoretically, this could in turn reduce the number of people with COPD catching respiratory viruses and therefore reduce the number of people experiencing acute exacerbations.

Assessing the impact of the proposed pathway improvements

During this phase of the programme, the HEU outlined expected changes that could occur because of the pathway improvements and produced, where possible, a visualisation of the impact each one could have on the efficiency frontier, alongside summary statistics. Different scenarios have been included where there are multiple possibilities for implementing the 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 pathway improvement and to help the respiratory programme team determine which ones they should focus on.

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

Understanding the impact of pathway improvements: literature review

As part of the Smarter Spending in Population Health programme, an umbrella literature review was conducted. The objective of this work was to better understand the impact of clinical (including pharmacological, surgical and respiratory), behavioural, environmental and socio-economic pathway improvements on COPD symptoms and/or progression.

Information from meta-analyses, randomised controlled trials, observational studies and economic evaluations identified by this review has been used to assess the potential impact on healthcare resource use that the prioritised initiatives may have.

The results of the review will be published in due course.

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 **data sources and calculations** section in the appendices.

Metric	Methods
Additional population health benefit due to pathway improvement **(PHB)**	This can be represented as: $$PHB_{j+k+i} = N_j \times B_j + N_i \times B_i + N_k \times B_k \ ...$$ Where j, I and k represent each intervention in the pathway improvement. Where Nj is the number of individuals who would benefit from the intervention j each year and Bj is the potential benefit in quality (and length) of life, assuming successful implementation, to the typical beneficiary (i.e., QALY gains), compared with current care. The benefit from improvement j consists of direct health benefit in terms of length and quality of life from the intervention itself as defined by participants in the decision conferences.

Additional costs of pathway improvement **(N_tC)**	Where j, I and k represent each intervention in the pathway improvement. This can be represented as: $$N_tC = N_{t_j} \times C_j + N_{t_i} \times C_i + N_{t_k} \times C_k \ldots.$$ Where N_{tj} is the number of individuals expected to be treated by intervention j within a given year, and C_j is the expected average cost of the intervention per individual. It is assumed that costs apply to each person treated and that there is a linear relationship between costs and numbers treated.
Expected impact on healthcare resource use **(R)**	The expected impacts on healthcare resource use elsewhere in the COPD pathway (defined as 'pathway components' and including hospital admissions, GP appointments or acute exacerbations) for each pathway improvement have been calculated using numbers needed to treat (NNT) sourced from the literature review. When information was not available in the literature, it was assumed that the improvement would not have an impact on other pathway components. NNT is an epidemiological measure representing the number of patients it is necessary to treat to avoid one additional bad outcome. For example, an NNT of five for a hospital admission would mean that five people need to be treated to avoid one hospital admission. NNTs can be estimated from odds ratios, rate ratios and mean differences (Centre for Evidence-Based Medicine, n.d.; da Costa et al., 2012). Expected changes to the pathway have only been included if the literature review identified a paper outlining a statistically significant effect ($p < 0.05$) that can be used to estimate an NNT. We have modelled the latest timeframe in which the improvements are expected to have statistically significant effects on the rest of the pathway. Number who benefit ($N_{j,I,k...}$) from each intervention in the pathway improvement has then been divided by the relevant NNT: $$R_y = \frac{N_j}{NNT_y}$$ Where y is equal to the pathway component affected by the improvement (usually hospital admissions). Due to the different timescales for the effects that primary prevention will have on the COPD pathway (through reducing the number of people developing COPD) compared with other

	pathway improvements, its effects on the rest of the pathway have not been included in the visualisations below but have been included in the **summary statistics**.
Cost savings (RC_v)	The cost savings expected for each pathway improvement have been calculated by multiplying the expected impact on healthcare resource use by the estimated costs of each improvement, as defined in the **data sources for the efficiency frontier** section in the appendices. $$RC_{y+x+z} = R_y \times C_{vy} + R_x \times C_{vx} + R_z \times C_{vz....}$$ Where y, x and z represent the components impacted by the improvement, and C_v represents the cost of the pathway component in question. For example, the expected cost of a hospital admission is £2,222.25. If a pathway improvement was expected to lead to 10 fewer hospital admissions, the cost saving would be £22,222.50.

Summarising the results

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

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

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

	methodology outlined above. This has then been multiplied by the expected cost per person per year. This has been calculated as the probability that a person with COPD would receive each intervention in the current COPD pathway multiplied by the estimated cost per person of each intervention. This is equal to £485.95. This figure has been subject to a sensitivity (scenario) analysis, which is explained in the **discussion** section below.
Additional cost/ additional population health ratio	This can be written as: $$\frac{N_t C - RC_v}{PHB}$$ This metric will help us understand the costs for each additional unit of population health gain. The lower the ratio, the better, with a negative ratio representing interventions that are both cost-saving and health-generating. A ratio of 1 would mean it costs £1 to generate one additional unit of population health gain.
Cost ratio	This metric is calculated by dividing the cost saving by the additional cost of the improvement. It can be written as: $$\frac{RC_v}{N_t C}$$ A ratio of 1 means the improvement is cost-neutral (i.e., £1 saved for every £1 spent elsewhere in the pathway). A ratio of 1.1 means £1.10 is saved elsewhere in the pathway for every £1 spent on the improvement. Numbers below 1 represent interventions that are cost incurring. This metric will help us understand the potential returns each improvement will likely give back to the system.
Timeframe	The timeframe in which the expected changes are due to be realised will differ depending on the particular pathway improvement under consideration. It is important to understand when these benefits are realised for financial and operational planning. Estimates of when the benefits are likely to be realised come from the literature. For example, a study reports a reduction in hospital admissions after 3 years; we would expect the benefits to be realised 'after 3 years'.

Impact of the pathway improvements

1. Increasing capacity in spirometry testing

Expected change to pathway

Diagnosing more people earlier in their disease pathway will allow them to access treatment in a timely fashion. In terms of healthcare resource use, it is assumed that the expansion of spirometry testing will lead to an increase in patients being diagnosed early. One paper identified in the literature review looked at healthcare resource use in people with early-diagnosed COPD compared to late-diagnosed COPD in the UK. It revealed statistically significant differences after three years ($p < 0.05$) for hospitalisation rates (rate ratio [RR] 1.18; 95% CI 1.08–1.28), emergency attendances (RR 1.19; 95% CI 1.00–1.42) and rates of exacerbations (RR 1.68; 95% CI 1.59–1.79) after three years (Kostikas et al., 2020).

Scenario

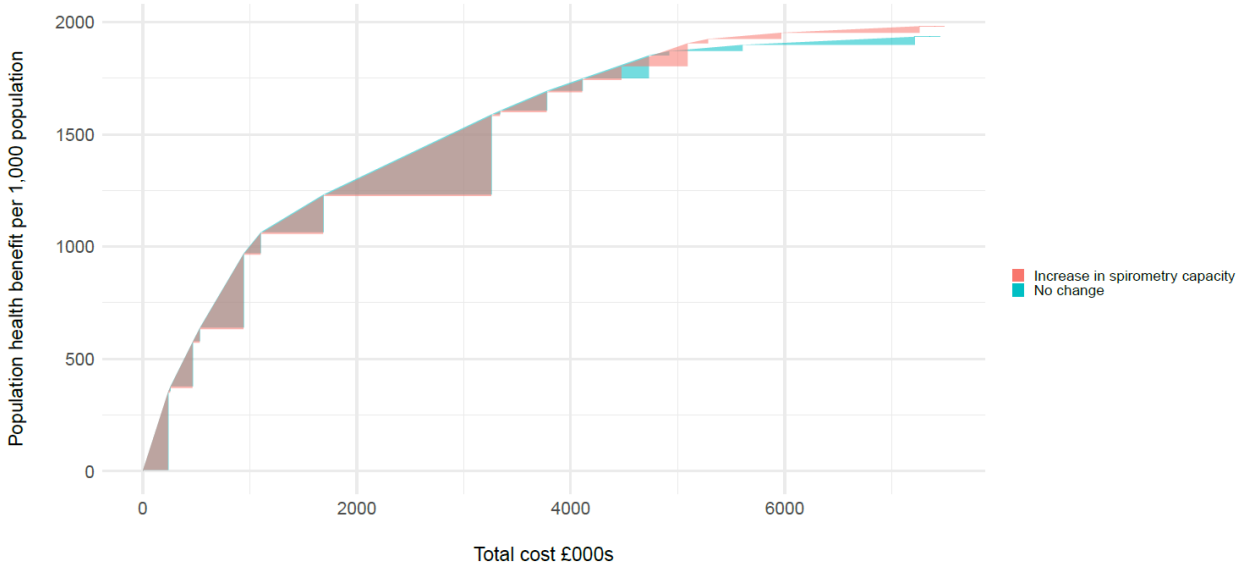


Figure 8 – expected change to the pathway following an increase in spirometry testing capacity.

According to the Respiratory Hubs June 2022 document, clinics can operate four times a week over a year, seeing 6–10 patients per clinic. Here we model what doing that number of tests over a 40-week year (accounting for 12 weeks of downtime) would look like.

A diagnosis gives people reassurance and allows them to be put on the correct treatment pathway, which leads to an increase in population health benefit. In terms of cost, although earlier diagnoses should lead to a reduction in acute exacerbations and hospitalisations, the associated cost savings are not expected to make up for the costs of the pathway

improvement. Across the whole pathway, it is expected that spirometry testing will incur an additional cost of £33,972.66 per year.

Metric	Total	Interpretation
Total additional pathway costs	£33,972.66	After accounting for cost savings due to a reduction in hospital admissions, emergency attendances and acute exacerbations, there is an estimated additional cost of £33,972.66 per year for the COPD pathway.
Additional cost/ additional population health ratio	0.56	It is estimated that increasing capacity in spirometry testing would cost £0.56 for every additional unit of population health gain generated.
Cost ratio	0.91	The intervention is not cost-saving. £0.91 is saved elsewhere in the pathway for every £1 spent.

2. Launch of myCOPD app

Expected change

Offering the myCOPD app will support patients to self-manage their own condition as well as to 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). The two trials cited in the NICE guidance that looked at healthcare resource use (the EARLY and RESCUE trials) comparing myCOPD versus usual care did not show any statistically significant ($p < 0.05$) impact on hospitalisations or acute exacerbations, and therefore it is not expected that myCOPD would impact these pathway components (Crooks et al., 2020; North et al., 2020).

Scenario

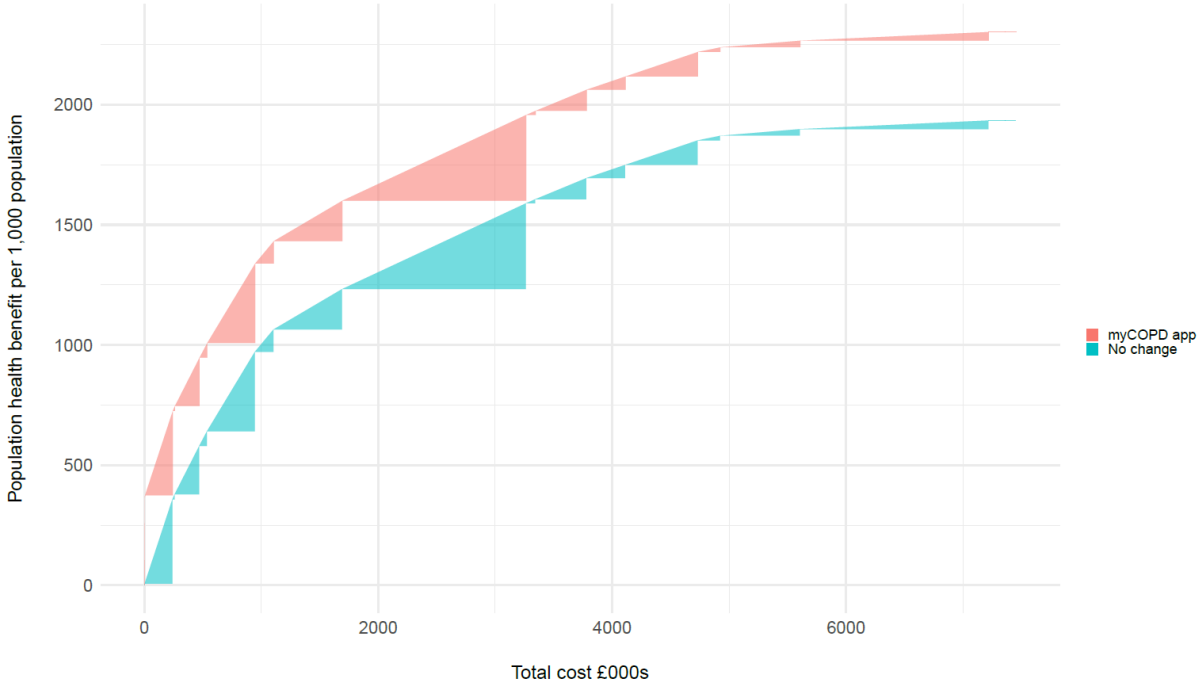


Figure 9 – Expected change to the pathway following the launch of the myCOPD app

Here we model what it would look like to offer everyone with COPD living in Northamptonshire. As there are no intended impacts elsewhere in the pathway, it can be expected the benefit will be realised once people start engaging with the app.

The myCOPD app is a relatively cheap intervention, with an estimated cost of £3,832 to offer it to everyone with COPD in Northamptonshire for a year. However, given that NICE recommends more research, if the myCOPD app were to be taken forward by Northamptonshire ICS an evaluation of the app should be commissioned alongside its rollout.

Metric	Total	Interpretation
Total additional pathway costs	£3,832	This is the estimated cost of rolling out the pathway improvement, as there are no expected cost savings elsewhere in the pathway.
Additional cost/ additional population health ratio	0.01	It is estimated that the myCOPD app would cost £0.01 for every additional unit of population health gain generated.
Cost ratio	Infinite	As there are no expected cost savings elsewhere in the pathway, the cost ratio appears infinite.

3. Conducting patients' yearly reviews through group consultations

Expected change

Group consultations could improve the quality of yearly reviews due to opportunities for shared learning and could potentially increase the number of people who can be seen in the same amount of time.

No studies were identified in the literature review which suggested that improving the quality or quantity of yearly reviews, or primary care case management more generally, would impact on other pathway components.

Scenarios

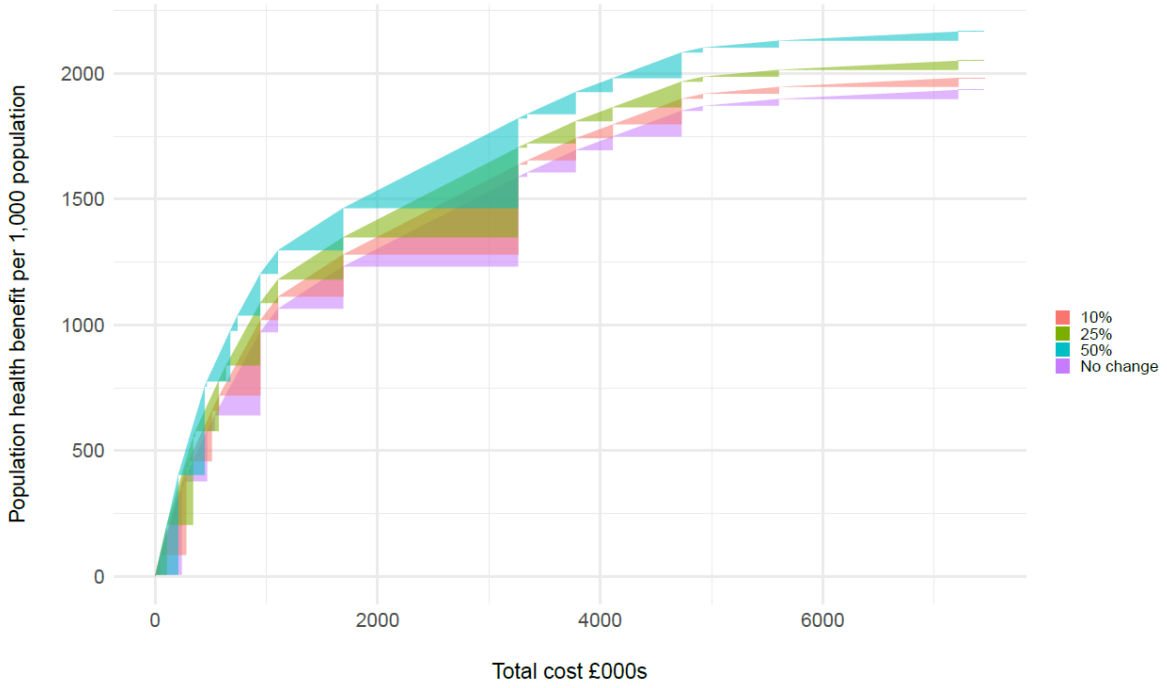


Figure 10 – Expected changes to the pathway following the implementation of group consultations accounting for 10%, 25% and 50% of the time spent on yearly reviews

Introducing group consultations would improve the value of the pathway, mainly by increasing the number of people reviewed. Allocating 10%, 25% or 50% of the time spent on yearly reviews to group consultations could lead to 11%, 28% or 56% more people being reviewed, respectively (see calculations in the **appendices**). Introducing group consultations is estimated to be almost cost-neutral and health-generating, no matter what percentage of the time spent on yearly reviews is devoted to them.

Metric	Total	Interpretation
Total additional pathway costs	10%: £178.95 25%: £14.36 50%: £28.73	In all cases, the introduction of group consultations is almost cost-neutral with minor cost savings expected.
Additional cost/ additional population health ratio	10%: 0.00 25%: 0.00 50%: 0.00	The pathway improvement is essentially cost-neutral and health-generating.
Cost ratio	10%: 1.00 25%: 1.00 50%: 1.00	The pathway improvement is essentially cost-neutral.

4. Post-exacerbation support

Expected change

Offering further post-exacerbation support could help to avoid readmissions for acute exacerbations. A recent systematic literature review examining post-exacerbation support schemes suggests they do reduce the number of readmissions (Pedersen et al., 2017). Another study explored post-exacerbation support schemes by integrated care teams in Barcelona (Spain) and Leuven (Belgium) (Casas, 2006). The schemes reduced the rehospitalisation rate after 12 months compared with usual care (1.5 vs 2.1; p = 0.033).

Scenario

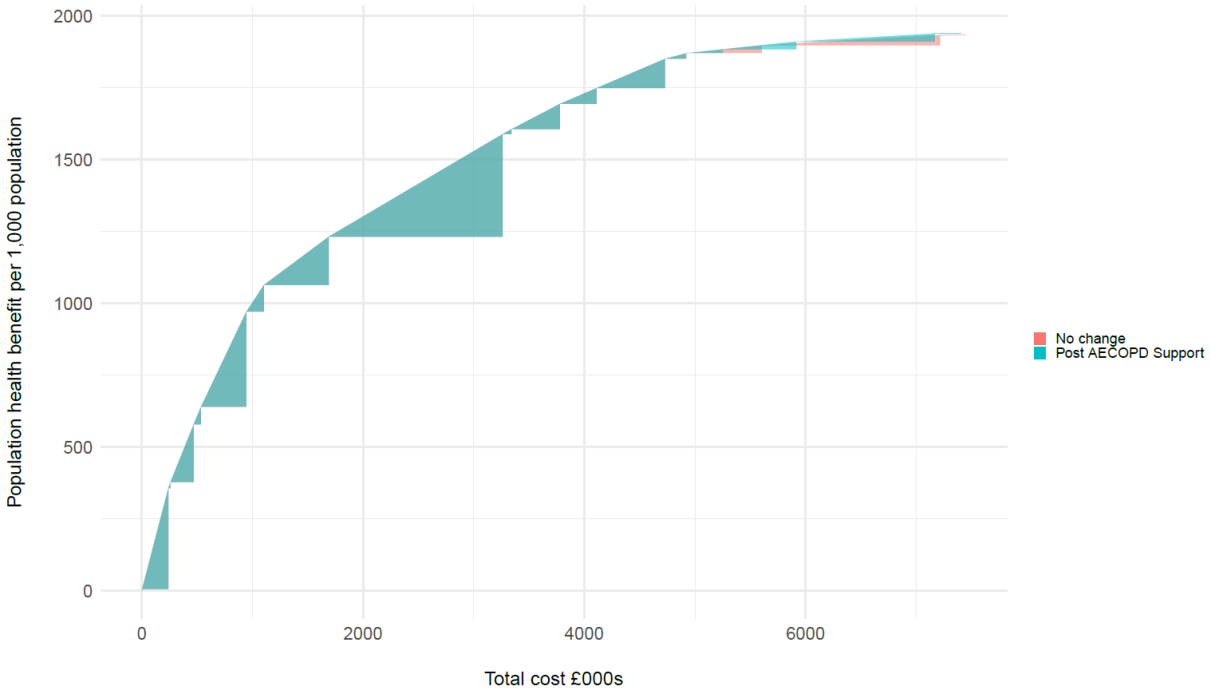


Figure 11 – Expected change to the pathway following the implementation of offering post-exacerbation support to everyone following a hospital admission

In this improvement, we model offering post-exacerbation support to everyone following a hospital admission. This improvement could have the largest effect on the reduction of hospital admissions of any of the pathway improvements reported here, with an estimated reduction of 161 hospital admissions (see calculations in the **appendices**). The cost of the pathway improvement is expected to be offset by a reduction in hospital admissions, meaning it is likely to be cost-saving.

The benefits, in terms of a reduction in hospital admissions, could be expected a year after the improvement is implemented.

Metric	Total	Interpretation
Total additional pathway costs	-£46,757.25	Post-exacerbation support is expected to be cost-saving. Although post-exacerbation support is a relatively expensive intervention, this cost is more than offset by the number of hospital admissions it is expected to avoid.
Additional cost/ additional	-0.28	Post-exacerbation support schemes are both cost-saving and health-generating. For every unit of

population health ratio		population health gain generated, this pathway improvement would save £0.28.
Cost ratio	1.15	Post-exacerbation support is cost-saving: for every pound spent on post-exacerbation support, £1.15 is saved due to a reduction in hospital admissions.

5. Improved signposting to services through the information centres

Expected change

It is expected this pathway improvement will lead to an increase in people being referred to Breathing Space, Activity on Referral and Northampton Energy Saving Service (NESS), which currently have low uptake relative to the number of people who are eligible. Furthermore, the signposting service could mean that patients are directed to the service that works best for them, and could guard against one single service becoming overwhelmed.

The sections below summarise the expected impact of increased uptake of each of these schemes on the COPD pathway.

More people with COPD attending Breathing Space

One paper identified in the literature looked at the effect of complex interventions on the use of urgent care (unscheduled GP visits, emergency department visits and hospital admissions) in COPD. Assuming that the main benefit of Breathing Space is general education, the meta-analysis in the literature review gave an odds ratio (OR) of 0.66 (95% CI: 0.55–0.81) for the reduction in urgent care use compared with treatment as usual (Dickens et al., 2014).

More people with COPD undertaking Activity on Referral

The same paper identified in the literature review suggested that interventions categorised as ‘exercise interventions’ led to the highest reduction in urgent care use. The meta-analysis in the literature review gave an OR of 0.60 (95% CI: 0.48–0.76) for the reduction in urgent care use compared with treatment as usual (Dickens et al., 2014).

More people with COPD referred to NESS

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

Scenario

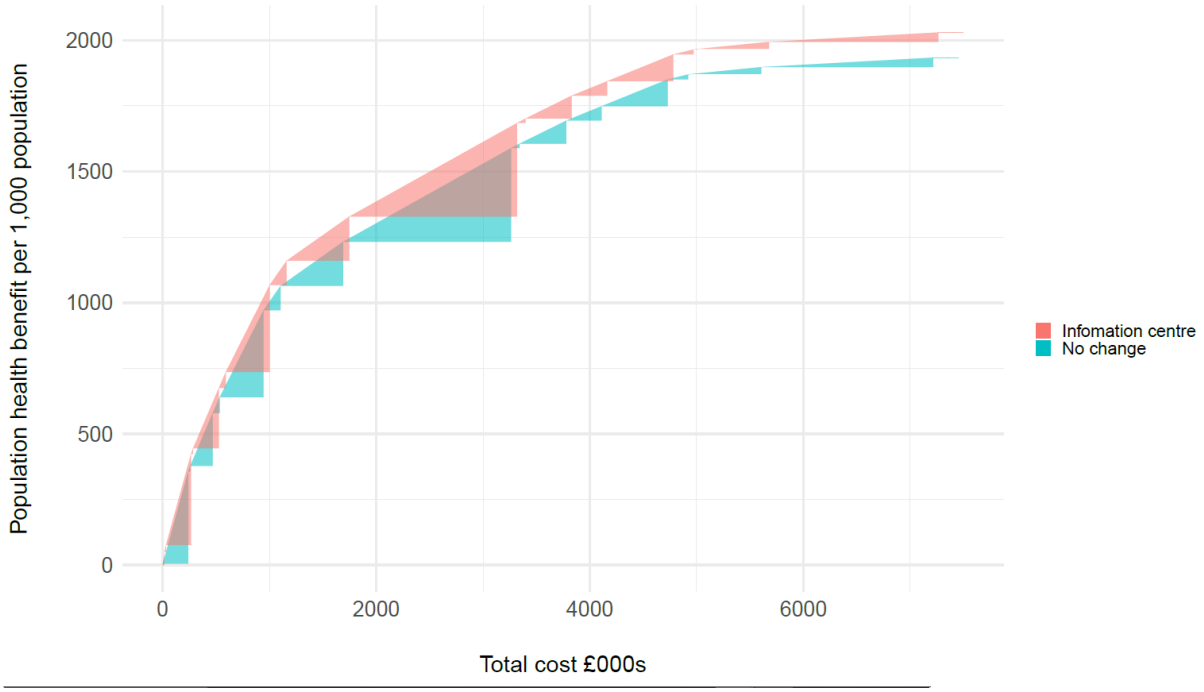


Figure 12 – Expected change to the pathway following the implementation of information centres

Here we assumed that all newly diagnosed people are sent to the information centres and that each person receives a 30-minute appointment with a respiratory nurse specialist and is then referred on to either Breathing Space or Activity on Referral (50% each). People who are in fuel poverty are referred to NESS. The extra activity in these services is considered as part of the pathway improvement.

The increases in activity for Breathing Space, NESS and Activity on Referral, as well as the benefit of the information centres themselves, improve the population health gain generated by the pathway. The reduction in urgent care services (hospital admissions, primary care-managed acute exacerbations, and emergency attendances) is not expected to offset the additional cost of the information centres pathway and the increase in activity to the three services.

Metric	Total	Interpretation
Total additional pathway costs	£47,432.86	Information centres would not be cost-saving.
Additional cost/ additional population health ratio	0.47	It is estimated that the information centres would cost £0.47 for every additional unit of population health gain generated.
Cost ratio	0.41	The intervention is cost-incurring. Only £0.41 is estimated to be saved elsewhere in the pathway per £1 spent.

6. Expansion of PR services

Expected change

The Northamptonshire Sport community-based PR offer will lead to increased capacity in PR across the ICS and therefore more people undertaking PR.

A Cochrane review suggested that PR had a positive effect on hospital readmission rates compared with usual post-exacerbation care after nine months (OR 0.44, 95% CI 0.21–0.91) (Puhan et al., 2016). No relevant papers were identified that looked at changes in healthcare resource use, such as PR in a community setting vs 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.

Scenario

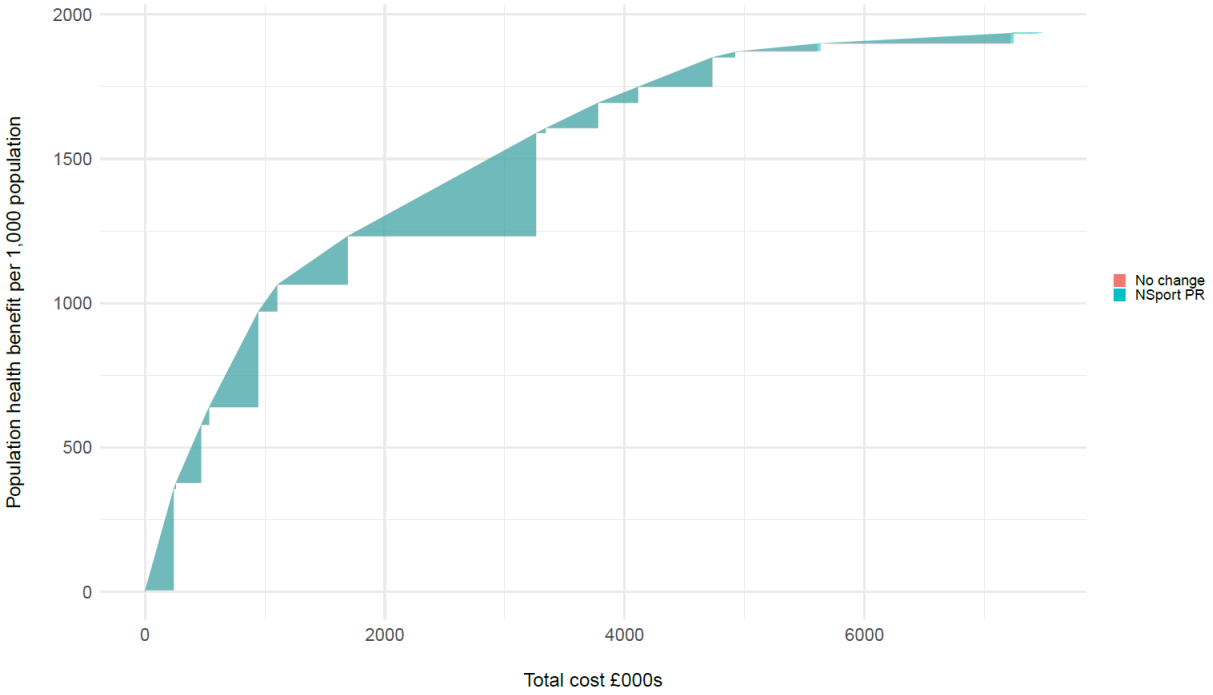


Figure 13 – Expected change to the pathway following the expansion of PR services

We expect the impact of the Northamptonshire Sport PR to be limited due to the small number of people likely to access the programme (estimated at 120–150, according to the plans at the time of writing).

The number of people expected to complete the course (15.7% based on estimates from other PR services in the county) mean the number who would benefit is also limited.

As Figure 13 shows, the existing pathway (no-change scenario) is virtually indistinguishable from the proposed pathway (NSport PR). The key to making PR a more cost-efficient treatment is to increase the number of people completing the course.

Metric	Total	Interpretation
Total additional pathway costs	£25,836.15	Expansion of PR services is not expected to be cost-saving.
Additional cost/ additional population health ratio	13.37	It is estimated that expansion in PR services would cost £13.37 for every additional unit of population health gain generated.
Cost ratio	0.08	The intervention is not cost-saving. It is estimated that only £0.08 would be saved elsewhere in the pathway due to a reduction in hospital admissions for every £1 spent.

7. 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 10 years or more (HR 0.65, 95% CI 0.58–0.74). Godtfredsen et al. found a statistically significant reduction in hospitalisations among ex-smokers compared with quitters in a Danish population, with an average follow-up time of 14 years (HR 0.57, 95% CI 0.33–0.99).

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

Scenarios

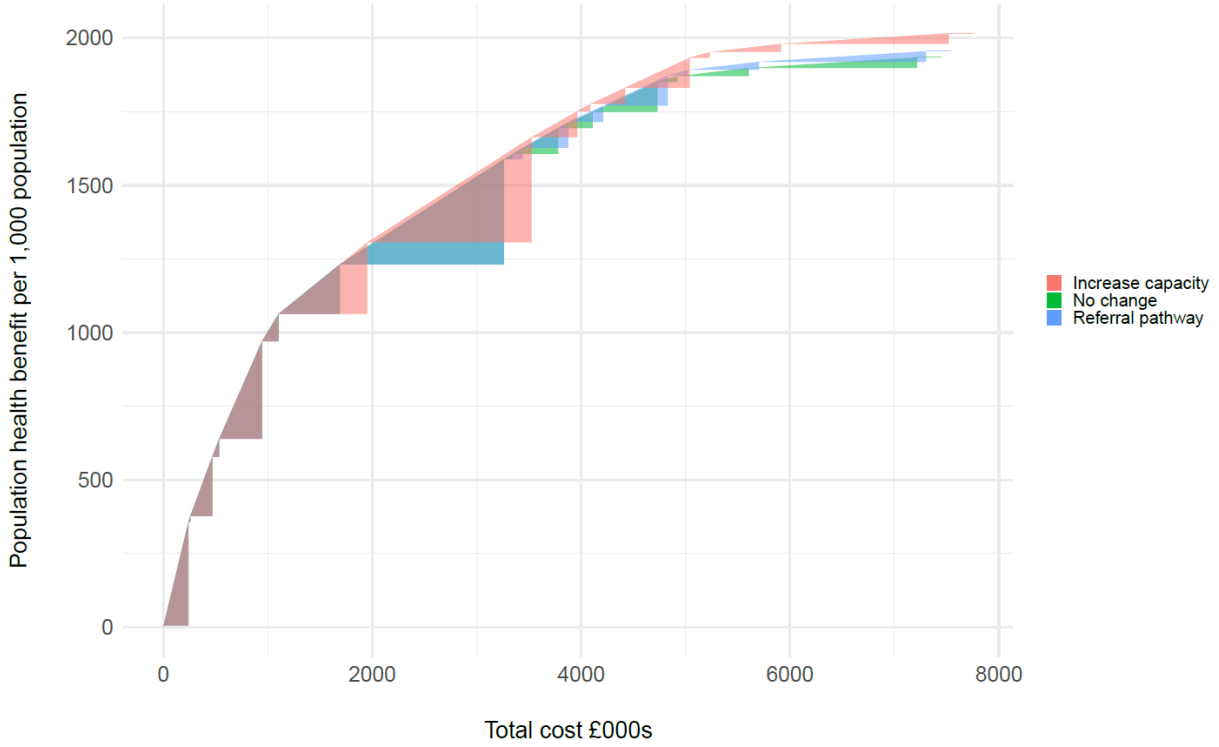


Figure 14 – Expected change to the pathway following an increase in uptake of smoking cessation services

Here we model the impact of two scenarios introducing standardised referral pathways for people newly diagnosed with COPD, and increasing the capacity of smoking cessation services to meet the NICE target of 5%. Of the two scenarios, improving the capacity of all smoking cessation services would have the greater impact on the population health gain. This is because it would lead to the highest number of people (both with and without COPD) taking up smoking cessation services.

That said, the standardised referral pathways would lead to an estimated additional 183 people with COPD quitting smoking every year compared with just increasing the capacity of the services to meet the NICE target of 5% of smokers setting a quit date (286 vs 103, as shown in the **appendices**). This means it would have a more immediate impact on the COPD pathway.

Standardised referral pathways

Metric	Total	Interpretation
Total additional pathway costs	£85,963.65	The expected reduction in acute exacerbations and hospital admissions is not expected to offset the costs of introducing standardised referral pathways for people with COPD to smoking cessation.

Additional cost/ additional population health ratio	4.01	It is estimated that the standardised referral pathways would cost £4.01 for every additional unit of population health gain generated.
Cost ratio	0.14	Standardised referral pathways are not expected to be cost-saving for the COPD pathway. Only £0.14 is saved elsewhere in the pathway for every £1 spent.

Increasing capacity

Metric	Total	Interpretation
Total additional pathway costs	£254,492.66	The yearly cost savings due to a reduction in cases of COPD, acute exacerbations and hospital admissions is not expected to offset the cost of the increase in capacity in smoking cessation services.
Additional cost/ additional population health ratio	3.05	It is estimated that it would cost £3.05 for every additional unit of population health gain generated.
Cost ratio	0.15	Increasing capacity in smoking cessation services is not expected to be cost-saving. Only £0.15 is estimated to be saved elsewhere in the pathway for every £1 spent on smoking cessation.

8. VBA in primary care

Expected change

When a GP provides VBA, they increase the likelihood that the patient will go on to successfully quit smoking.

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

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

Scenario

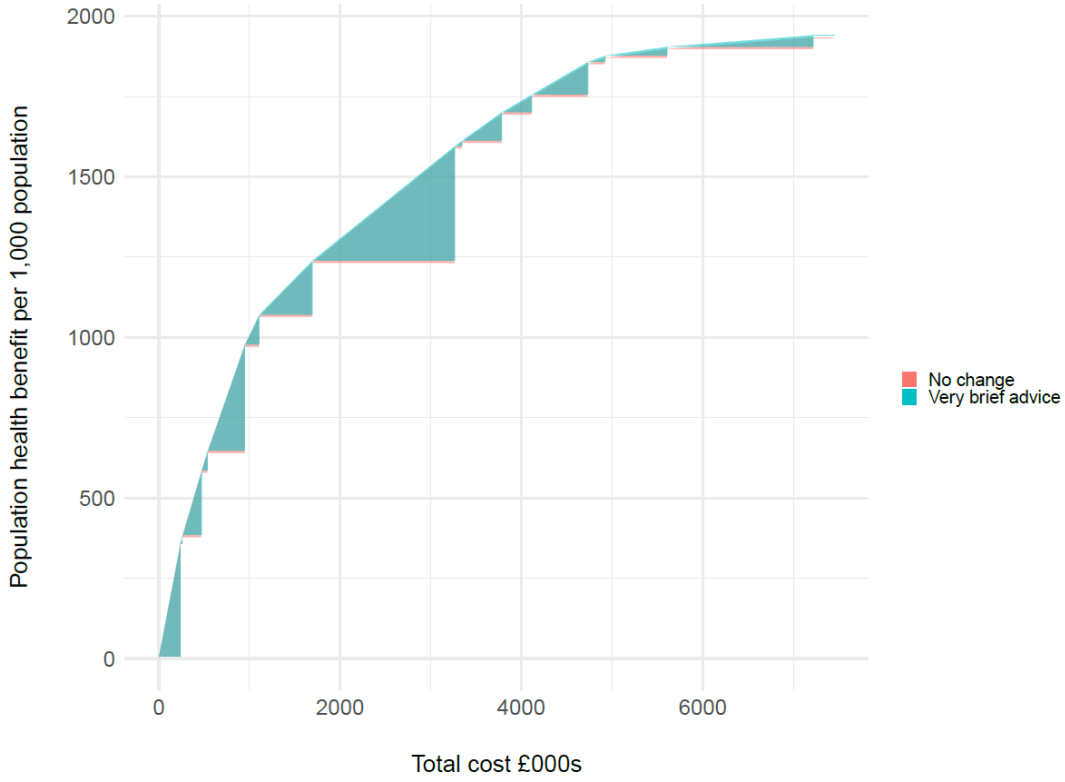


Figure 15 – Expected change to the pathway following the introduction of GP-provided VBA to support people to quit smoking

Here we model what it would look like if all general practice staff in Northamptonshire started giving VBA to patients with COPD to encourage them to stop smoking as part of their yearly review.

As the course is freely available, this pathway improvement will have little cost implication and could lead to an extra 87 people with COPD quitting smoking per year (see calculations in the **appendices**).

Metric	Total	Interpretation
Total additional pathway costs	£1,955.55	As the VBA training is free, there is very little cost associated with this pathway improvement. However, the numbers of acute exacerbations and hospital admissions it is expected to prevent are also small.
Additional cost/ additional population health ratio	0.29	It is estimated that VBA on smoking cessation would cost an additional £0.29 for every additional unit of population health gain it generates.
Cost ratio	0.70	VBA would save £0.70 elsewhere in the pathway for every £1 spent on it.

9. Introducing HEPA filters in schools

(Note that due to the uncertainties surrounding the impact that introducing HEPA filters in schools would have on the COPD pathway, this improvement has not been included in the ***determining the next steps: setting priorities*** section below.

Expected change

Introducing HEPA filters in school classrooms could reduce the transmission of viral particulates in the air and the incidence of respiratory conditions in schools (Lewis, 2021). There is limited evidence looking at whether HEPA filters are effective in reducing viral transmission; those that do exist are mainly focused on COVID-19, but some of them certainly suggest this is the case for COVID-19. One study using an aerosol transmission model does suggest that HEPA filters do reduce the cumulative dose of viruses absorbed by children in schools (Villiers et al., 2021). However, this paper was based on data from one classroom. Similarly, the same paper says that natural ventilation and mask-wearing are also effective ways of reducing transmission.

Scenario

Due to an absence of epidemiological studies and economic evaluations looking at the effect that HEPA filters in schools would have on people with COPD, it is not possible to visualise the impact of this intervention on the COPD pathway. In this section we look at what effect HEPA filters would need to have on the pathway in order to be considered for investment.

Assuming the HEPA filters were only installed in primary schools, we can estimate the number of hospital admissions that would need to be avoided to make the programme cost-neutral in terms of the COPD pathway. There are an estimated 66,213 primary school pupils in Northamptonshire (Snobe, n.d.), and the average classroom size is 26.7 children nationally (Office for National Statistics, 2022). This means there are an estimated 2,480 classrooms in the county.

Costs of HEPA filters vary but, according to one article in *The Guardian*, one supplier prices them at £1,170 and another at £424.82 (Elgot, 2021). This gives us an upper estimate of £2,901,600 and a lower estimate of £1,053,603 for the cost of installing HEPA filters in all primary schools in the county. The average cost of a hospital admission for COPD in Northamptonshire in 2021/22 was £2,222.25 (see **appendices** for source). This means the installation of HEPA filters in primary schools would have to offset between 474 and 1,306 hospital admissions for COPD before it became cost-saving. In 2021/22 there were an estimated 725 admissions for COPD (see **appendices** for source).

It should be noted that the introduction of HEPA filters could have wider benefits for the health system and society that would affect the cost–benefit calculation. However, these are out of scope of this project.

Determining the next steps: setting priorities

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

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.
- **Cost ratio.** Prioritising in this way can determine the pathway improvement that will offset the most costs elsewhere in the system. The bigger the ratio, the better.

- **Total additional pathway cost.** Like looking at the cost ratio, this method can determine whether the pathway improvement is likely to save money overall or incur additional costs. Negative numbers represent a cost saving.

We recommend that priority-setting of the pathway improvements is done based on the cost/population health ratio. Using this method will ensure the most efficient allocation of resources based on cost per unit of population health gain, therefore 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	Post-exacerbation support	-0.28
2	Reducing unwarranted variation in primary care yearly reviews through group consultations (all scenarios)	0.00
3	Launch of myCOPD app	0.01
4	VBA in primary care	0.29
5	Improved signposting to services through information centres	0.47
6	Increasing capacity in spirometry testing	0.56
7	Increasing uptake of smoking cessation services (increasing capacity)	3.05
8	Increasing uptake of smoking cessation services (standardised referral pathways)	4.01
9	Expansion of PR services	13.37

Recommendations

Based on the results presented in the above table, it is recommended that Northamptonshire ICS invest in initiatives that have the best cost/population health ratio, as this will ensure the investment leads to the most health generated per pound spent. It is recommended that the ICS focus on the following four interventions:

- **Post-exacerbation support.** This improvement is the only one to be both cost-saving and health-generating. It would be expected to offset £1.15 elsewhere in the pathway for every £1 spent due to the reduction in readmissions, and would save £46,757.25 per year. It would, however, likely require significant upfront investment to hire the staff required to conduct the sessions.
- **Group consultations.** Offering group consultations for yearly reviews is effectively cost-neutral in all three scenarios modelled (whether 10%, 25% or 50% of time spent on yearly reviews is devoted to group consultations). At the same time, a large amount of net population health gain is generated by this improvement due to the extra people who will receive a yearly review.
- **Launch of the myCOPD app.** Launching the myCOPD app is associated with only a small (£3,832) cost increase and has a large potential population health gain, as it can be offered to everyone with COPD in the county.
- **VBA for smoking cessation.** Although VBA may not generate the most population health benefit compared with some other initiatives (6,525 units), as the cost is minimal it has a favourable cost/population health ratio.

Investing in all these pathway improvements would have a yearly budget impact (sum of the additional costs of the improvements) of £362,310.60, £423,954.09 or £526,363.32 dependent on whether 10%, 25% or 50% of time spent on yearly reviews is allocated to group consultations. The vast majority of this cost (£311,025) is associated with the post-exacerbation support, but this pathway improvement is the only one that is expected to be cost-saving.

Discussion

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

One thing to bear in mind is that the exact value of primary prevention in the reduction of COPD cases is not known. Here we have used the expected cost within a calendar year, because one year was the period given as the relevant timeframe for budget planning. However, stopping someone from developing COPD will have benefits beyond the year timeframe. According to one study in the US, the average life expectancy for someone once they have developed COPD is 17.2 years (Shavelle et al., 2009). This would make the expected cost saved due to an avoided case of COPD £8,358.33 (£485.95 × 17.2) and therefore the overall cost savings due to increasing capacity in smoking cessation £723,532.02, resulting in a cost/population health ratio of -5.05. This would make it the

most cost-effective intervention and therefore it would be the first recommended pathway improvement.

Similarly, it is to be noted that different examples of the STAR approach use different methods for valuing the individual health gain generated by the interventions. Here we have used the method used by Airoldi et al. (assessing each intervention on the visual analogue scale as described in the **methods document**).(Airoldi et al., 2014) Elsewhere, the Health Foundation have weighted the quality of life of different severities of eating-disorders and calculate the proportion of patients that would deteriorate, stay the same or, to varying degrees, recover, and the resulting average quality of life. (The Health Foundation, 2012) The Airoldi et al. method was chosen here, in part because it encourages participants to think about the principle of 'relatively' of the intervention and improvements i.e. directly comparing the health gain of each intervention together. But also, the large number of interventions required to value 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.

Limitations

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

There is a lack of available data in the literature 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.

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

The pathway improvements modelled above, numbered 1 to 9, have been developed to support decisions on where best to allocate resources. When it comes to implementation, the exact nature and effect of the scenarios may vary. It is important that an evaluation of the pathway improvements that are taken forward is commissioned so their effects can be monitored. The scenarios are not meant to represent an accurate reflection of the costs and benefits of the COPD pathway pre- and post-improvement, nor do they represent a full economic evaluation. Further work would be required to build these scenarios into business cases or to conduct a full economic evaluation.

Appendix

1. Methodology document

HEU STAR framework - Northa

1. Information pack for attendees

SSPH Decision Conference Particip

2. Data sources for the efficiency frontier

Primary prevention

Smoking cessation

Metric	Total	Source
Relative benefit score	100	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people setting a quit date**	2,728	Provided by Rasa Rimaviciute, Senior Performance & Information Officer from Northamptonshire Council, for 2021/22 based on the NHS Digital Stop Smoking Services submission. Adjusted with an assumption from Coventry Place that 12% of the individuals have a diagnosis of COPD and shown in tertiary prevention smoking cessation.
Number who benefit:	1,676	

Number who quit after 4 weeks		For costs, NHS Digital provided a number for the cost per quitter. This has been combined with the four-week quit rate to derive the cost per person.
Cost per case: **Cost per person setting a quit date**	£215	

Secondary prevention and diagnosis

Spirometry testing

Spirometry in GP practices

Metric	Total	Source
Relative benefit score	98	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given a spirometry test**	8,591	Northamptonshire Spirometry Business Case 2021.
Number who benefit: **Number of people diagnosed with COPD following a spirometry test**	1,042	Northamptonshire Spirometry Business Case 2021. ~12.1% of tests confirmed as COPD.
Cost per person	£72	Costs used in Northamptonshire Spirometry Business Case 2021.

Spirometry in secondary care

Metric	Total	Source
Relative benefit score:	98	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given a spirometry test**	4,608	SUS data for procedures 2021/22.
Number who benefit: **Number of people diagnosed with COPD following a spirometry test**	559	Calculated based on the same rate of diagnosis as in primary care (~12.1%).
Cost per case: **Cost per spirometry test**	£72	Costs used in Northamptonshire Spirometry Business Case 2021.

Respiratory vaccinations

COVID-19 vaccinations

Metric	Total	Source
Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of vaccinated COPD patients**	10,630	GP events data (Primary Care Database) covering 75% of population = 7,973 uplifted to 100% for 2021–22 winter booster campaign.
Number who benefit: **Number of avoided acute exacerbations**	1,074	No data or published literature is available on the number of acute exacerbations avoided through COVID-19 vaccinations. Therefore, we have assumed the rate is the same as the influenza jab as per below.
Cost per case: **Cost of vaccination**	£15	Item of Service cost (excluding housebound) from NHSE.

Pneumonia vaccinations

Metric	Total	Source

Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of vaccinated COPD patients**	1,947	GP events data (Primary Care Database) 1,460 individuals over the past three years (this is not an annual vaccination), uplifted to 1,947 for 100% population.
Number who benefit: **Number of acute exacerbations avoided**	243.38	According to a Cochrane review, the number of patients needed to treat to prevent a patient from experiencing an exacerbation is eight (Walters et al., 2017).
Cost per case: **Cost of vaccination**	£10	£10 for PPV (pharmacy prices). Annualised value used for the analysis.

Influenza vaccinations

Metric	Total	Source
Relative benefit score:	87	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people given an influenza vaccination**	6,926	QOF register for 2020/21.
Number who benefit: **Number of acute exacerbations avoided**	700	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). Thus 2.70 people would need to be treated to avoid one additional exacerbation. This number assumes there is only one avoided exacerbation per person (12,287 / 2.70).
Cost per case: **Cost of vaccination**	£9.58	2021/22 Item of service cost.

Case management

Primary care management

Metric	Total	Source
Relative benefit score:	50	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients with COPD who have had a review**	6,626	QOF register for 2020/21.
Number who benefit: **Number of patients with COPD who have had a review**	6,626	QOF register for 2020/21.
Cost per case: **Cost of GP review**	£61.85	2020/21 QOF COPD payments £409,805.04, source John Obeng, Planning Accountant, Northamptonshire ICB.

Community COPD service case management

RESTART and ROCKET

Metric	Total	Source
Relative benefit score:	80	Score given in the decision conferences.
Number treated: **Numbers of referrals received**	1,546	There are two providers of community services in Northants: ROCKET and RESTART. Assumed the number of referrals in are the same as numbers on case load. Neither service discharges people from their service. No referral data available for ROCKET.
Number who benefit: **Number of hospital admissions avoided**	344	Main benefit of scheme, as decided in decision conference, is a reduction in hospital admissions. According to Casas et al. (2006), a similar scheme gave a number needed to treat of 4.5 to avoid one hospital admission. 1,546 / 4.5
Cost per case:	£429	Contract value divided by the number on the case load

Total cost of service		

Tertiary prevention

Pulmonary rehabilitation

Metric	Total	Source
Relative benefit score:	92	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people referred**	1,287	2021/22 contract compliance reports for NGH and KGH.
Number who benefit: **Number who complete the course**	202	2021/22 contract compliance reports for NGH and KGH Estimate of ~45.8% complete the course.
Cost per case: **Cost per person referred in of PR course**	£148.50	2021/22 NHSE National Tariff. £322 Block contract value is £191,115 overall; £148.50 per person referred in; £433.37 per person who started the course.

Activity on Referral: Northamptonshire Sport

Metric	Total	Source
Relative benefit score:	89	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people with COPD given support**	84	Northamptonshire Sport data returns for Q1 2022/23. Assumes 6.5% of referrals for people living with COPD.
Number who benefit: **Number of people with COPD who**	64	

complete the course		
Cost per case: **Cost per person**	£40.38	Estimated average costs (2021/22 rates) based on £15 for an induction or consultation; assumes all inducted will complete one month and the remaining will complete three months. Data from Northamptonshire Sport suggests in 2021/22 there was ~60% drop-off between induction and completing a course.

Group therapy: Breathing Space

Metric	Total	Source
Relative benefit score:	95	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients with COPD seen by Breathing Space**	2,112	Breathing Space Contract Monitoring Report for 2021/22.
Number who benefit: **Number of patients with COPD seen by Breathing Space**	2,112	
Cost per case: **Cost of providing Breathing Space for one year**	£99.43	2021/22 contract value of £210k split across the number of people treated.

Lung volume reduction

Metric	Total	Source
Relative benefit score:	28	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients undergoing LVR**	10	Extracted from the 2020/21 secondary user services (SUS) database. The number of people registered with a GP in Northampton or Northamptonshire who had an admitted patient episode with the OPCS code for LVR surgery (E54.6), rounded to nearest 5 for low number suppression.
Number who benefit:	8	Based on assumption that 20% of people say they receive no benefit.

80% of total treated. According to the BLF, 20% of people say they do not receive any benefit from LVRS		
Cost per case: **Cost of GP review**	£14,285.22	Extracted from SUS as above.

Smoking cessation

Metric	Total	Source
Relative benefit score:	75	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people setting a quit date**	372	Provided by Rasa Rimaviciute, Senior Performance & Information Officer from Northamptonshire Council, for 2021/22 based on the NHS Digital Stop Smoking Services submission. Adjusted with an estimate from Coventry that 12% of the individuals have a diagnosis of COPD and the remainder are in primary prevention smoking cessation.
Number who benefit: **Number who quit**	229	
Cost per case: **Cost per patient setting a quit date**	£215	Contract value divided by the number setting a quit date.

Northampton Energy Saving Service (NESS)

Metric	Total	Source
Relative benefit score:	25	Agreed upon by stakeholders in the first decision conference.
Number treated:	32	

Number of people with a respiratory condition given support		Provided by Sarah Hayle, NESS Lead. The total funding of the service is £287,641, and 465 households are seen in a year, which includes support for all conditions (not just respiratory). Specifically, 22 people were supported with respiratory conditions, but the service also saw 222 people with multiple and long-term physical illnesses, some of whom may have had COPD as a comorbidity.
Number who benefit: **Number of people with a respiratory condition given support**	32	
Cost per case: **Cost per person**	£618.58	

Secondary care outpatient appointment

Metric	Total	Source
Relative benefit score:	85	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of outpatient appointments (OPAs) offered**	4,690	Number of respiratory OPAs offered for people registered with a GP in Northamptonshire who have had a hospital admission with a primary diagnosis of COPD (DNA and attended) (TFC:340). Data from SUS database, rounded to nearest 5. SQL available on request.
Number who benefit: **Number of OPAs that were attended**	4,200	Number of attended respiratory OPAs (all respiratory, not just COPD) for people registered with a GP in Northamptonshire who have had a hospital admission with a primary diagnosis of COPD. Data from SUS database, rounded to the nearest 5. SQL available on request.
Cost per case: **Mean cost per appointment**	£335.25	2020/21 SUS database, average cost for respiratory OPA (TFC:340) for people with a hospital admission with the primary diagnosis of COPD for people registered with a GP practice in Northamptonshire. SQL code available on request.

Lung transplant

Metric	Total	Source
Relative benefit score:	37	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients receiving a lung transplant**	1	Number of people with a diagnosis of COPD or other related lung disease (e.g., bronchiectasis). SQL code available on request. Note: according to NHS Inform, 9/10 people survive lung transplant. Assumed that the one person survived.
Number who benefit: **Number of patients receiving a lung transplant**	1	
Cost per case: **Cost per person**	£89,477	Average cost of lung transplant (HRG Code DZ01Z) according to National Cost Collection 2020/21 https://www.england.nhs.uk/costing-in-the-nhs/national-cost-collection/

Management of acute exacerbations

Primary care management

Metric	Total	Source
Relative benefit score:	67	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of patients receiving prednisolone**	5,234	There is no readily available data on acute exacerbations managed in primary care. Therefore, prednisolone prescriptions of 12 or more 5-mg tablets have been sourced from e-pact as a proxy. This will capture prescriptions for people with other respiratory conditions as well as COPD. The use of a nebuliser may also be required. The assumption has been confirmed by a GP specialising in respiratory medicine.
Number who benefit:	5,234	Estimate of ~45.8% complete the course (2021/22 contract compliance reports NGH and KGH).

Number of patients receiving prednisolone		
Cost per case: **Cost of GP-managed acute exacerbation**	£45.19	Cost based on a weighted split of three potential decision points for a GP on managing an acute exacerbation following a GP-led telephone triage: prescribe rescue pack; face-to-face appointment and rescue pack; and appointment including nebuliser support. The advice from a Coventry GP split this on a 65/25/10% basis. GP and Nurse time costs from the Personal Social Services Research Unit. Prednisolone per pack of 5mg 28 tablets is £0.79 (BNF). If a nebuliser is required, the estimated cost is £5.17 based on a 500mg/2ml ipratropium bromide unit dose vial (BNF) and an estimated cost of a single-use nebuliser pack.

Hospital admission

Metric	Total	Source
Relative benefit score:	50	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people admitted for acute exacerbation of COPD**	725	Pulled from the 2020/21 admitted patient care dataset in SUS using the same strategy as PHE Fingertips. Upper estimate of 5,005 at an average cost of £2,418.52 (J44 code in any position) and lower estimate of 4,685 at an average cost of £2,089.39 based on J449 in first position). SQL code available on request. Rounded to nearest 5.
Number who benefit: **Number of people admitted for acute exacerbation of COPD**	725	
Cost per case: **Median cost of hospital admission for acute exacerbation**	£2,304.66	

Emergency attendance

Metric	Total	Source
Relative benefit score:	40	Agreed upon by stakeholders in the first decision conference.
Number treated: **Number of people with an emergency attendance for COPD**	2,205	SUS data, looking at number of emergency attendances for people living in Northampton where a SNOMED CT code for COPD is included in the record. SQL code available on request.
Number who benefit: **Number of people with an emergency attendance for COPD**	2,205	
Cost per case: **Mean cost of emergency attendance**	£198.30	

3. Sources for population health statistics

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

1. **Total number of people with COPD registered with a GP in Northampton:** 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 Northamptonshire. https://www.nature.com/articles/srep31893#:~:text=In%20England%2C%20the%20prevalence%20of,by%20more%20women%20developing%20COPD
3. **Estimated undiagnosed population:** Nacul et al. estimated that in 2007, the true prevalence of COPD in the country was 3.1%. This estimate is the difference

between QOF register prevalence and this expected true prevalence. https://pophealthmetrics.biomedcentral.com/articles/10.1186/1478-7954-5-8

4. **Estimated number of smokers:** Lower estimate: QOF register – estimated smoking prevalence among people over the age of 18 in Northamptonshire CCG in 2020/21 https://fingertips.phe.org.uk/search/QOF#page/3/gid/1/pat/167/par/E38000251/ati/7/are/M86039/iid/91280/age/188/sex/4/cat/-1/ctp/-1/yrr/1/cid/4/tbm/1.
5. **Total population registered with a GP in Northamptonshire:** QOF register – numbers of people on GP practice lists in 2020/21 https://qof.digital.nhs.uk/.

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

Increasing capacity in spirometry testing

Metric	Value	Description
Pathway improvement		
Cost of improvement (C)	£72	Provided by Northamptonshire Analysts from Northamptonshire Spirometry Business Case 2021. Assumed the cost per test is the same as current delivery.
Benefit score (B)	98	Score given in the first decision conference.
Number treated – people tested (N_t)	5,120	According to the Respiratory Hubs June 2022 document, clinics can operate four times a week over a year, seeing 6–10 patients per clinic. Assuming a 40-week year and an average of eight people per clinic, that would mean an additional 5,120 tests (4 × 8 × 4 × 40).
Number who benefit – people diagnosed with COPD	620	Assumed the same diagnosis rate as current provision.

(N)		~12.1% of tests confirmed as COPD (Northamptonshire Spirometry Business Case 2021).
Additional population health benefit	60,760	620 × 98
Additional costs of pathway improvement	£368,640	72 × 5,120
Pathway effects		
Predicted reduction in COPD hospital admissions (R)	143	NNT = 1/absolute risk reduction (ARR) ARR = control event rate – experiment event rate After three years, Kostikas et al. (2020) report a hospitalisation rate of 73.52 per 100 person years (PY) in late-diagnosed COPD patients and 50.46 per 100 PY in early-diagnosed COPD patients. ARR = 0.7352 – 0.5046 = 0.2306 NNT = 1/0.2306= 4.34 Predicted reduction in COPD hospital admissions: 620/4.34 = 142.86 per year. A hospital admission has a unit cost of £2,222.25.
Predicted reduction in emergency attendances (R)	12	After three years, Kostikas et al. report an A&E visit rate of 6.93 per 1,000 PY in late-diagnosed COPD patients and 4.92 per 1,000 PY in early-diagnosed COPD patients. ARR = 0.0693 – 0.0492 = 0.0201 NTT = 1/0.0201 = 49.75 Predicted reduction in emergency attendances = 620/49.75 = 12.46 per year. The unit cost for an emergency attendance is £198.30.
Predicted reduction in AECOPD managed in primary care	321	After three years, Kostikas et al. report an exacerbation rate of 57.23 per 100 PY in early-diagnosed COPD patients and

(R)		108.94 per 100 PY in late-diagnosed COPD patients. ARR = 1.0894 – 0.5723 = 0.5171 NNT = 1/0.5171= 1.93 Predicted reduction in AECOPD managed in primary care = 620/1.93 = 321.24. The unit cost for a primary care-managed AECOPD is £45.19.
Cost savings	£334,667.34	334,667.34 = (143 × 2,222.25) + (12 × 198.30) + (321 × 45.19)

Launch of myCOPD app

Metric	Total	Description
Pathway improvement		
Cost of improvement (C)	£0.25	According to the NICE guidance, the unlimited licence plan has an annual cost of £0.25 per person registered with a GP in the region (NICE, 2022).
Benefit score	50	Assumed the relative health benefit is the same as primary care management. Confirmed in meeting with respiratory programme leads.
Number treated: registered GP population	15,328	Number of people with COPD in Northamptonshire 2021/22 (Office for Health Improvement & Disparities, 2022).
Number who benefit: people who use the myCOPD app	7,357	According to the NICE guidance, the myCOPD app has a national activation rate of 48%, as reported elsewhere (NICE, 2022).
Additional population health gain	367,850	50 × 7,357
Additional costs of pathway improvement	£3,832	0.25 × 15,328

Conducting patients' yearly reviews through group consultations

Metric	Total	Description
Pathway improvement		
Cost of improvement (C)	£30.93	The estimate for the cost of a GP appointment used in the efficiency frontier above is £61.85 and, according to a GP working in Northamptonshire, the average time for a yearly review would be 15 minutes. Assuming a group consultation lasts 90 minutes, the cost would be £371.10; if 12 patients were seen in the appointment, the cost would be £30.93 per patient (61.85 × 6)/12.
Benefit score (B)	60	The score given in the decision conferences to primary care yearly reviews was 50. It is assumed that group consultations will improve the relative health gain by 10 points.
Number treated (N_t)	10%: 1,320 25%: 3,313 50%: 6,624	In 2021/22 there were 6,626 yearly reviews for patients. If each one takes 15 minutes, that is a total of 99,390 minutes spent on yearly reviews. If 10% of all this time were spent on group consultations, that would be 9,939 minutes allocated to group consultations. At 90 minutes per consultation, that would be 110 consultations. With 12 people in each one, that would be 1,320 people per year reviewed in group consultations. ((6,626 × 15 × 0.1) / 90) × 12
Number who benefit (N)	10%: 1,320 25%: 3,313 50%: 6,624	Assumed everyone benefits.
Additional population health gain	10%: 79,200 25%: 198,780	1,320 × 60 3,313 × 60 6,624 × 60

	50%: 397,440	
Additional costs of pathway improvement	10%: £40,827.6 25%: £102,471.09 50%: £204,880.32	1,320 × 30.93 3,313 × 30.93 6,624 × 30.93
Pathway improvement effects		
Reduction in one-to-one GP yearly reviews due to group consultations (R)	10%: 663 25%: 1,657 50%: 3,313	Assuming the time taken for both individual and group consultations remains the same, the group consultations would mean less time available for individual appointments. There were 6,626 yearly reviews in 2021/22. 10% of time spent on group consultations would mean 663 fewer individual appointments. The unit cost of a GP review is £61.85.
Cost savings	10%: £41,006.55 25%: £102,485.45 50%: £204,909.05	61.85 × 663 61.85 × 1,657 61.85 × 3,313

Post-exacerbation support

Metric	Total	Description
Pathway improvement		
Cost of intervention (C)	£429	The cost used in the original efficiency frontier for hospital avoidance scheme at ROCKET and RESTART.
Benefit score (B)	80	Score given in the decision conference.
Number treated (N_t)	725	The number of hospital admissions for COPD in 2021/22 (number used in the original efficiency frontier).

Number who benefit: Number of hospital admissions avoided	161	The people who benefit from post-exacerbation support are those who do not then go on to have a hospital admission. Casas et al. paper gave a number needed to treat of 4.5. 725/4.5 = 161.11
Additional population health gain	12,880	80 × 161
Additional costs of pathway improvement	£311,025	429 × 725
Pathway effects		
Predicted reduction in COPD hospital admissions **(R)**	161	Casas et al. paper gave a number needed to treat of 4.5 for post-exacerbation support schemes avoiding hospital admissions. 725/4.5 = 161.11 The unit cost of a hospital admission is £2,222.25.
Cost savings	£357,782.25	2,222.25 × 161

Improved signposting to services through information centres

Metric	Total	Description
Pathway improvement		
Information centres		
Cost of improvement **(C)**	£26	According to PSSRU estimates, the cost of a band 6 nurse specialist is £51 per hour. Therefore, the cost of a 30-minute appointment is £26.
Benefit score **(B)**	80	Assumed the benefit is the same as the community COPD service because it involves an appointment with a respiratory nurse specialist.
Number treated **(N_t)**	620	Number of estimated extra diagnoses per year.

Number who benefit (N)	620	Assumed everyone benefits.
Breathing Space		
Cost of improvement (C)	£99.43	Same total as used in the original efficiency frontier. Total contract value of £210,000 for the year, divided by the total number of patients seen by Breathing Space in 2021.
Benefit score (B)	95	Assumed the benefit is the same as the community COPD service because it involves an appointment with a respiratory nurse specialist.
Number of additional people treated (N_t)	310	50% of additional diagnosed people due to respiratory hubs.
Number of additional people who benefit (N)	310	Assumed everyone benefits. This assumption was used in the creation of the original efficiency frontier.
Activity on Referral		
Cost of improvement (C)	£40.38	Provided by Northamptonshire Sport (provider of AoR).
Benefit score (B)	89	Score assigned in the workshops.
Number additional treated (N_t)	310	50% of additional people diagnosed due to respiratory hubs.
Number additional who benefit (N)	236	In 2021/22, 76.2% of people with COPD who started the course completed it. It is assumed this percentage will stay the same.
NESS		

Cost of improvement (C)	618.58	Average cost per person, provided by NESS.
Benefit (B)	25	Provided in the decision conference.
Number additional treated (N_t)	34	In 2020 (latest available figures), 13.2% of households were in fuel poverty (Dept for Business, 2022). Assuming that rate is the same as among people diagnosed with COPD in the respiratory hubs, that would mean 82 people would be eligible for support through NESS. In the randomised controlled trial conducted by Osman et al. (2010), 42% of participants took up energy efficiency upgrades like those offered by NESS. Assuming this is the same in Northamptonshire, that would mean 34 people take up the scheme.
Number additional who benefit (N)	34	Assumed everyone benefits.
Additional population health gain	100,904	80 × 620 + 95 × 310 + 89 × 236 + 25 × 34
Additional costs of pathway improvement	£80,492.82	26 × 620 + 99.43 × 310 + 40.38 × 310 + 618.58 × 34
Pathway effects		
Breathing Space		
Reduction in primary care-managed AECOPD	27	NNT = (1 – (PEER × (1 – OR))) / ((1 – PEER) × (PEER) × (1 – OR)) In 2021/22, an estimated 5,234 AECOPDs were managed in primary care, in 15,328 people. Therefore the patient expected event rate is 34.15 per 100 PY Therefore NNT = (1 – (0.3415 × (1 – 0.66)))/ ((1 – 0.3415) × (0.3415) × (1 – 0.66)) = 11.56.

		Predicted reduction in primary care managed AECOPD = 310/11.56 = 26.82. The unit cost for a primary care managed AECOPD is £45.19.
Reduction in emergency attendances	14	In 2021/22 there were 2,205 emergency attendances for people with COPD. Therefore, the expected event rate is 14.39 per 100 PY (2,205/15,328). Therefore NNT = (1 – (0.1439 × (1 – 0.66)))/ ((1 – 0.1439) × (0.1439) × (1 – 0.66)) = 22.71 Predicted reduction in emergency attendances = 310/22.71 = 13.65 The unit cost for an emergency attendance is: £198.30
Reduction in hospital admissions	5	In 2021/22 there were 725 hospital admissions for COPD for of 15,328 people. Therefore, the patient expected event rate is 4.7 per 100 PY (725/15,328) NNT = (1 – (0.047 × (1 – 0.66)))/ ((1 – 0.047) × (0.047) ×(1 – 0.66)) = 64.61 Predicted reduction in hospital admissions = 310/64.61 = 4.80 The unit cost for a hospital admission is £2,222.25
Activity on referral		
Reduction in primary care-managed AECOPD	32	NNT = (1 – (PEER × (1 – OR))) / ((1 – PEER) × (PEER) ×(1 – OR)) In 2021/22 there were an estimated 5,234 AECOPDs managed in primary care, in 15,328 people. Therefore, the patient expected event rate is 34.15 per 100 people. Therefore NNT = (1 – (0.3415 × (1 – 0.60)))/ ((1 – 0.3415) × (0.3415) × (1 – 0.60)) = 9.60. Predicted reduction in primary care-managed AECOPD = 310/9.60 = 32.29. The unit cost for a primary care-managed AECOPD is £45.19.
Reduction in emergency attendances	16	In 2021/22 there were 2,205 emergency attendances for people with COPD. Therefore, the expected event rate is 14.39 per 100 people (2,205/15,328).

		Therefore NNT = (1 – (0.1439 × (1 – 0.60)))/ ((1 – 0.1439) × (0.1439) × (1 – 0.60)) = 19.13. Predicted reduction in emergency attendances = 310/19.13 = 16.20. The unit cost for an emergency attendance is: £198.30.
Reduction in hospital admissions	6	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 × (1 – 0.60)))/ ((1 – 0.047) × (0.047) × (1 – 0.60)) = 54.77. Predicted reduction in hospital admissions = 310/54.77 = 5.66. The unit cost for a hospital admission is £2,222.25.
Cost savings	£33,059.96	27 × 45.19 + 14 × 198.30 + 5 × 2,222.25 + 32 × 45.19 + 16 × 198.30 + 6 × 2,222.25

Expansion of PR services

Metric	Total	Description
Pathway improvement		
Cost of improvement	£207.84	According to Northamptonshire Sport, the total cost of the PR programme in 2022/23 would be £28,058. With an estimated 135 people on the course, that would be £207.84 per person.
Benefit score	92	The benefit score given to PR in the decision conference.
Number treated: **Number of people undertaking the course**	135	According to Northamptonshire Sport, the new PR programme would be able to see 120–150 people a year. Therefore, we have used the mid estimate of 135 people.
Number who benefit: **Number of people completing the course**	21	Assumed the percentage of people who complete the course is the same as for the programmes offered by ROCKET and RESTART (15.7%, according to data provided by Northamptonshire ICS)

Additional population health gain	1,932	92 × 21
Additional costs of pathway improvement	£28,058.40	207.84 × 135
Pathway effects		
Reduction in hospitalisations	1	NNT = (1 – (PEER × (1 – OR))) / ((1 –PEER) × (PEER) × (1 – OR)) 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 × (1 – 0.44)))/ ((1 – 0.047) × (0.047) × (1 – 0.44)) = 38.82. Number of hospital admissions avoided = 21/38.82 = 0.54. The unit cost for a hospital admission is £2,222.25.
Cost savings	£2,222.25	2,222.25 × 1

Increasing uptake of smoking cessation services

Standardised referral pathways

Metric	Total	Description
Pathway improvement		
Cost of improvement (C)	£215	Cost based on the contract value of the current service.
Tertiary prevention		
Benefit score (B)	75	Benefit score attributed to tertiary prevention smoking cessation in the decision conference.
Number treated: Number of people setting a quit date (N_t)	465	44.6% of people referred to smoking cessation services in 2021/22 set a quit date, according to Public Health Northamptonshire. In the same year there were 1,042 people diagnosed with COPD through spirometry, according to Northamptonshire ICB. Assuming this rate stays the same and all 1,042 people were referred, there would be an extra 465 people setting a quit date.
Number who benefit: Number who quit (N)	286	According to Public Health Northamptonshire, 61.5% of people who set a quit date quit after four weeks. If 465 people set a quit date, assuming 61.5% quit, an extra 286 people will quit.
Additional population health gain	21,450	75 × 286
Additional costs of pathway improvement	£99,975	215 × 465
Pathway effects		
Reduction in hospitalisations	6	NNT = (1 – (PEER × (1 – HR))) / ((1 – PEER) × (PEER) × (1 – HR))

		Godtfredsen et al. (2002) reported a HR of 0.57. In 2021/22 there were 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 × (1 – 0.57))) / ((1 – 0.047) × (0.047) × (1 – 0.57)) = 50.87. Reduction in hospitalisations = 286/50.87 = 5.6. The unit cost for a hospital admission is £2,222.25.
Reduction in primary care-managed AECOPD	15	In 2021/22 there were an estimated 5,234 primary care-managed AECOPD among 15,328 people with COPD. Therefore, the expected event rate is 34.15 per 100 people (5,234/15,328 × 100). Au et al. (2009) reported a HR of 0.78. NNT = (1 – (0.3415 × (1 – 0.78))) / ((1 – 0.3415) × (0.3415) × (1 – 0.78)) = 18.69. Reduction in primary care-managed AECOPD = 286/18.69 = 15.30. The unit cost of a primary care-managed AECOPD is £45.19.
Cost savings	£14,011.35	45.19 × 15 + 6 × 2222.25

Increasing capacity

Metric	Total	Description
Pathway improvement		
Cost of improvement (C)	£215	Cost based on the contract value of the current service.
Primary prevention		
Benefit score (B)	100	Benefit score attributed to primary prevention smoking cessation in the decision conference.
Number treated: Number of people setting a quit date	1,232	3,100 people set a quit date in 2021/22. An extra 1,400 would need to set a quit date to meet the target of 4,500.

(N_t)		Assuming 12% have COPD already (assumption used in the original efficiency frontier), 1,232 would be for primary prevention.
Number who benefit: **Number who quit** **(N)**	758	According to Public Health Northamptonshire, 61.5% of people who set a quit date had quit after four weeks. 1,232 × 0.615 = 757.68
Tertiary prevention		
Benefit score	75	Benefit score attributed to tertiary prevention smoking cessation in the decision conference.
Number treated: **Additional number of people setting a quit date**	168	12% of 1,400 = 168
Number who benefit: **Number who quit**	103	According to Public Health Northamptonshire, 61.5% of people who set a quit date had quit after four weeks.
Additional population health gain	83,525	100 × 758 + 75 × 103
Additional costs of pathway improvement	£301,000	1232 × 215 + 168 × 215
Pathway effects		
Reduction in number of people developing COPD	86	NNT = 1/absolute risk reduction (ARR) ARR = control event rate – experiment event rate Terzikhan et al. (2016) reported incidences of COPD of 19.7/1000 PY in current smokers and 8.3/1000 PY in former smokers. ARR = 0.197 – 0.083 = 0.114 NNT = 1/0.114 = 8.77 Reduction in number of people developing COPD = 757.68/8.77 = 86.39. Expected yearly cost per person with COPD is £485.95.

Reduction in hospitalisations	2	NNT = (1 – (PEER × (1 – HR))) / ((1 –PEER) × (PEER) × (1 – HR)) Godtfredsen et al. (2002) reported a HR of 0.57. In 2021/22 there were 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 × (1 – 0.57))) / ((1 – 0.047) × (0.047) × (1 – 0.57)) = 50.87. Reduction in hospitalisations = 103/50.87 = 2.03. The unit cost for a hospital admission is £2,222.25.
Reduction in primary care-managed AECOPD	6	In 2021/22 there were an estimated 5,234 primary care-managed AECOPD among 15,328 people with COPD. Therefore, the expected event rate is 34.15 per 100 people (5,234/15,328 × 100). Au et al. (2009) reported a HR of 0.78. NNT = (1 – (0.3415 × (1 – 0.78))) / ((1 – 0.3415) × (0.3415) × (1 – 0.78)) = 18.69. Reduction in primary care-managed AECOPD = 103.32/18.69 = 5.53. Unit cost of primary care-managed AECOPD = £45.19.
Cost savings	£46,507.34	86 × 485.95 + 2 × 2222.25 + 6 × 45.19

Very brief advice in primary care

Metric	Total	Description
Pathway improvement		
Cost of improvement	£1	The cost of VBA is free, and it could be given as part of a yearly review.
Benefit score	75	Benefit score attributed to tertiary prevention smoking cessation in the decision conference.

Number treated: **Number who have yearly reviews**	6,626	The number of people who had a yearly review in 2021/22, according to the QOF register.
Number who benefit: **Number additional who quit**	87	According to Stead et al. (2008), a 2% unassisted quit rate should be assumed after 12 months. Therefore, 133 of the 6,626 would be expected to quit unassisted. An increase of 66% of people quitting would mean a quit rate of 3.32%, or an additional 87 people quitting.
Additional population health gain	6,525	75 × 87
Additional costs of pathway improvement	£6,626	1 × 6626
Pathway effects		
Reduction in hospitalisations	2	NNT = (1 – (PEER × (1 – HR))) / ((1 – PEER) × (PEER) × (1 – HR)) Godtfredsen et al. (2002) reported a HR of 0.57. In 2021/22 there were 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 × (1 – 0.57))) / ((1 – 0.047) × (0.047) × (1 – 0.57)) = 50.87. Reduction in hospitalisations = 87/50.87 = 1.71. The unit cost for a hospital admission is £2,222.25.

Reduction in primary care-managed AECOPD	5	In 2021/22 there were an estimated 5,234 primary care-managed AECOPD among 15,328 people with COPD. Therefore, the expected event rate is 34.15 per 100 people (5,234/15,328 × 100). Au et al. (2009) reported a HR of 0.78. NNT = (1 – (0.3415 × (1 – 0.78))) / ((1 – 0.3415) × (0.3415) × (1 – 0.78)) = 18.69. Reduction in primary care-managed AECOPD = 87/18.69 = 4.65. The unit cost for a primary care-managed AECOPD is £45.19.
Cost savings	£4,670.45	2,222.25 × 2 + 5 × 45.19

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