EXPLORING THE IMPACT OF INTEGRATED COPD CARE IN GENERAL PRACTICE

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ABSTRACT

Integrated care is an umbrella term used to describe collaboration across differing healthcare sectors. Integrated care interventions directed towards patients with Chronic Obstructive Pulmonary Disease (COPD) in primary care have been shown to improve patient outcomes, such as quality of life. However, the utilisation of integrated care interventions to improve guideline adherence and reduce the prevalence of COPD misdiagnosis in primary care has not been explored previously.

The mixed methods systematic review demonstrated that misdiagnosis of COPD does occur in primary care and is predominantly due to difficulties utilising spirometry and differentiating COPD from asthma. Integrated care interventions utilising specialist led spirometry were shown to be able to identify misdiagnosed patients and were perceived to be able to reduce the prevalence of COPD misdiagnosis in primary care.

The impact of integrating COPD specialists into GP practices was evaluated through a pragmatic cluster randomised controlled trial (INTEGR COPD). The integration of COPD specialists led to significant improvements in the delivery of guideline adherent care, which was shown to correlate with improvements in quality of life. Integrating COPD specialists into GP practice also led to misdiagnosed patients being identified and having their diagnosis and treatment corrected.

The integration of COPD specialists into GP practices was found to be acceptable to patients and healthcare professionals. The reluctance to challenge historic diagnoses was thought to be the underlying cause of patients remaining misdiagnosed in primary, within this cohort. Specialist involvement was deemed to have a positive impact in reducing the extent of COPD misdiagnosis in primary care.

The findings from this thesis suggest that integrated COPD care has a positive impact on the delivery of optimal patient care as well as the prevalence of COPD misdiagnosis in GP practices.

DEDICATION

This thesis is dedicated to my parents.

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LIST OF ABBREVIATIONS

A&E	Accident and Emergency
ACOS	Asthma COPD Overlap Syndrome
ARTP	Association for Respiratory Technology and Physiology
BMI	Body Mass Index
BTS	British Thoracic Society
CAT	COPD Assessment Test
CCG	Clinical Commissioning Group
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CRF	Case Report File
DEFRA	Department for Environment, Food and Rural Affairs
EPR	Electronic Patient Record
ERS	European Respiratory Society
FEV_1	Forced Expiratory Volume in 1 Second
FVC	Forced Vital Capacity
GLI	Global Lung Initiative
GOLD	Global Initiative for Chronic Obstructive Lung Disease
GP	General Practitioner
HCP	Healthcare Professional
ICC	Intraclass Correlation Coefficient
ICS	Inhaled Corticosteroid
IL	Interleukin
IMD	Index of Multiple Deprivation
IRR	Incidence Rate Ratio
ITT	Intention To Treat
JBI	Joanna Briggs Institute
LABA	Long-Acting Beta Agonist
LAMA	Long-Acting Muscarinic Antagonist
LLN	Lower Limit of Normal
LTOT	Long Term Oxygen Therapy
LVRS	Lung Volume Reduction Surgery
MCID	Minimal Clinically Important Difference
MDT	Multi-Disciplinary Team
MeSH	Medical Subject Headings
MMAT	Mixed Methods Appraisal Tool
MMP	Matrix Metalloproteinases
mMRC	Modified Medical Research Council
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NIV	Non-Invasive Ventilation
NO_2	Nitric Dioxide
ONS	Office of National Statistics
PM	Particulate Matter

PP	Per Protocol
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analyses
QOF	Quality Outcomes Framework
QOL	Quality of Life
RCP	Royal College of Physicians
RCT	Randomised Controlled trial
ROS	Reactive Oxygen Species
SABA	Short Acting Beta Agonists
SD	Standard deviation
TGF	Transforming Growth Factor
TNF	Tumour Necrosis Factor
UHB	University Hospitals Birmingham NHS Foundation Trust
UK	United Kingdom
ZIP	Zero Inflated Poisson

CONFERENCE CONTRIBUTION

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Chapter 4 – Quantitative data collection and analysis was completed by KP. Interview topic guide was developed by KP under the supervision of NG. Qualitative interviews were completed by KP and Daniel Smith (DS). KP, CH and DS participated in the coding workshops to develop a coding framework under the supervision of Sunita Channa (SC). Thematic framework analysis was completed by KP under the supervision of SC and NG.

Chapter 5 – Interview topic guide was developed by KP under the supervision of NG. Qualitative interviews were completed by KP and DS. KP, CH and DS participated in the coding workshops to develop a coding framework under the supervision of SC. Thematic framework analysis was completed by KP under the supervision of SC and NG.

Chapter 6 – Produced in its entirety by KP under the supervision of AT, AD and NG.

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AUTHOR'S DECLARATION

All material within this thesis previously published has been indicated where appropriate. The contents of this thesis are all my own original work and any contributions by others have been clearly indicated. I can confirm that this thesis has not been submitted for a higher degree at any other university.

CHAPTER 1 : INTRODUCTION

1.1 Chronic Obstructive Pulmonary Disease

Chronic Obstructive Pulmonary Disease (COPD) is an incurable progressive airways disease. There are approximately 1.1 million people on primary care COPD registers in England accounting for 1.9% of the population in 2020.[1] Patients are predominantly diagnosed with COPD and managed in primary care by general practitioners (GP).[2] A minority of patients with severe or uncontrollable symptoms are referred to secondary care specialists who oversee their treatment.[2] The management of COPD requires a combination of pharmacological and non-pharmacological treatments. The goal of COPD management is to preserve quality of life (QOL) through controlling debilitating symptoms, reducing the frequency of exacerbations, and preventing multiple hospitalisations.[3] However, despite significant advancements in COPD treatment, it remains the second commonest cause for emergency admission to hospitals in England.[4]

1.2 Pathogenesis of COPD

The pathogenesis behind COPD is complex and involves a combination of inflammation, protease imbalance and oxidative stress that disrupt repair mechanisms and damage tissue.[5] An overview of COPD pathogenesis is represented in Figure 1.1.

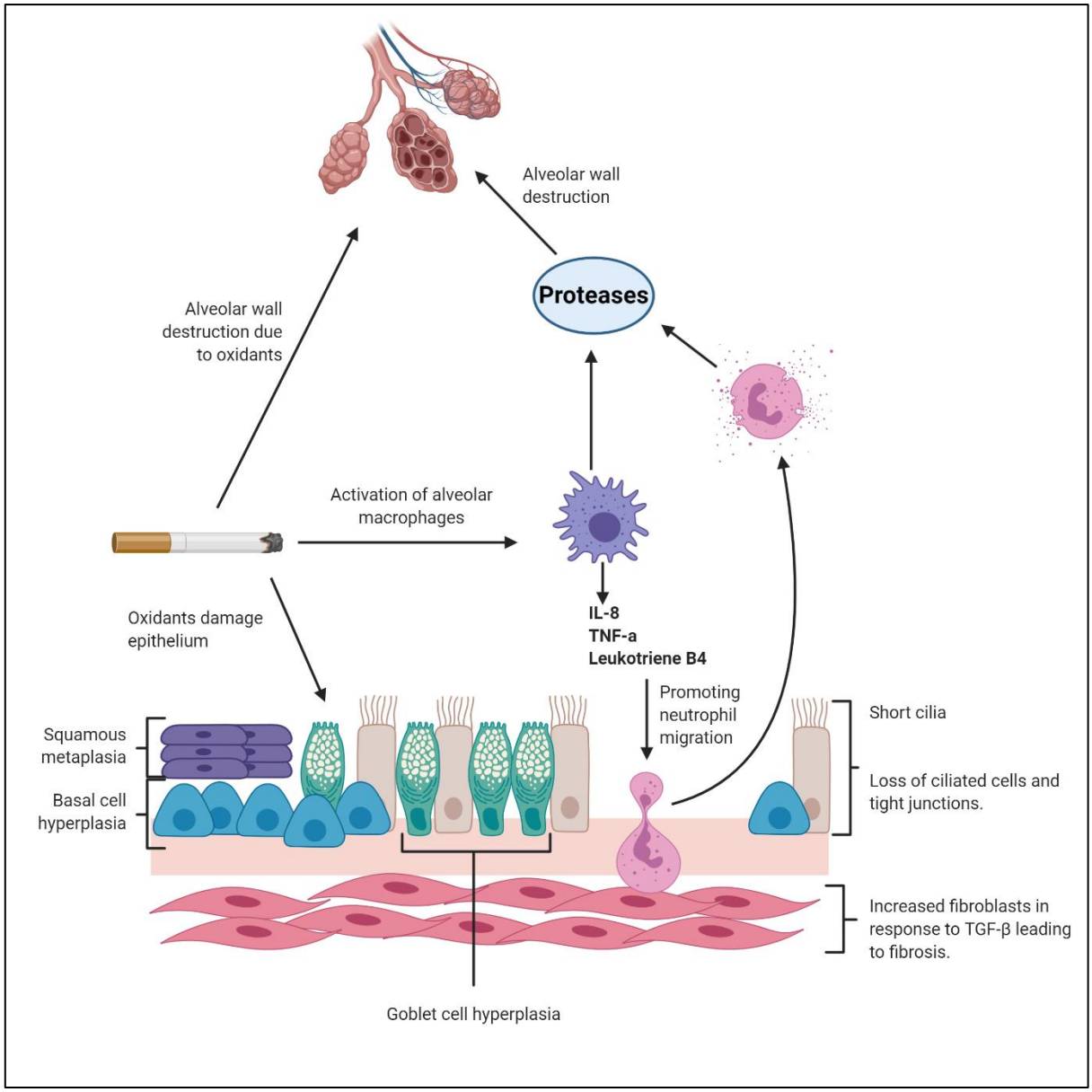

Figure 1.1 Overview of COPD pathogenesis. Tobacco smoke damages the epithelium leading the promotion of goblet cell and basal cell hyperplasia and squamous cell metaplasia. Epithelial damage leads to upregulation of transforming growth factor beta (TGF-B) resulting in increased fibroblast activity causing fibrosis. The combination of increased mucus production by goblet cells with reduced clearance due to shortened cilia and fibrotic remodelling leads to small airways disease. Activated alveolar macrophages promote neutrophil migration via interleukin 8 (IL-8), tumour necrosis factor alpha (TNF-a) and leukotriene B4. Both macrophages and neutrophils secrete proteases that lead to alveolar wall destruction. *(Created with BioRender.com)*

1.2.1 Inflammation

COPD is characterised by its augmented inflammatory response to noxious gases and particles, commonly tobacco smoke.[5] Inflammatory cells commonly associated with COPD are macrophages, neutrophils and CD8 T-Cells, studies have proven that there is a greater number of these inflammatory cells in patients with COPD compared to healthy controls.[6, 7] There is also evidence suggesting that the severity of COPD positively correlates with the intensity of inflammatory cell infiltration.[6, 8]

Tobacco smoke is thought to promote inflammatory cell infiltration to the respiratory tract through activation of alveolar macrophages.[9] There are up to 10 times more macrophages in the respiratory tract of patients with COPD compared with healthy controls,[8] with evidence that macrophages from patients with COPD have greater elastolysis activity and secrete more inflammatory proteins than smokers without COPD.[10, 11]

When activated, alveolar macrophages release pro-inflammatory mediators such as tumour necrosis factor-alpha (TNF-a), interleukin-8(IL-8) and leukotriene B4.[5] Neutrophils navigate to the respiratory tract under the control of chemokines released by macrophages including IL-8 and chemotactic agents including leukotriene B4.[5] TNF-a induces endothelial cells to express adhesion molecules to facilitate the migration of neutrophils into the respiratory tract.[12]

Neutrophils promote mucus production from goblet cells and secrete proteolytic enzymes including neutrophil elastase, matrix metalloproteinases (MMP) and cathepsins.[9] MMPs and cathepsins are also secreted by macrophages.[9] The accumulation of proteolytic enzymes leads to a protease imbalance resulting in alveolar damage.

In addition to neutrophil driven inflammation, there is evidence suggesting a sub-set of COPD patients with eosinophil driven inflammation exists.[13] Airway eosinophilia has previously been thought to be characteristic of asthma, however, examination of induced sputum in patients with COPD has shown elevated eosinophil concentrations, which positively correlates with serum eosinophil levels.[14, 15] The exact role eosinophils play in the pathogenesis of COPD is not fully understood.[16] It is thought that eosinophils contribute to fibrotic tissue remodelling through its role in type2 inflammation,[17] and contribute to alveolar wall destruction through promoting macrophages to secrete MMP-12.[18] However, current clinical evidence suggests that elevated

concentrations of respiratory eosinophils are linked to frequent exacerbations, which can be reduced through the use of corticosteroids.[14, 19]

1.2.2 Protease imbalance

Elastin is a key protein within the pulmonary extracellular matrix and is integral to maintain alveolar elasticity. However, elastin is targeted and broken down by neutrophil elastase, which is secreted by inflammatory cells associated with COPD. The proteolytic action of neutrophil elastase is inhibited by alpha-1 antitrypsin to prevent tissue damage. However, in alpha-1 antitrypsin deficiency neutrophil elastase activity is uninhibited and patients with this condition develop early onset emphysema, leading to the theory of protease imbalance contributing to the pathogenesis of COPD.[20] The protease imbalance theory suggests that in COPD, protease activity is increased due to the inhibition of anti-proteases and excess protease secretion in the respiratory tract.

Proteases such as MMP-1 and MMP-9 secreted by inflammatory cells in the respiratory tract target gelatin and collagen proteins found in the pulmonary extracellular matrix leading to alveolar damage. Human studies have shown that patients with emphysematous changes have increased concentrations of MMP-1 and MMP-9 in their bronchial alveolar lavage fluid[21, 22] and increased MMP-9 activity in lung parenchyma.[23, 24] Suggesting that increased MMP activity is associated with alveolar wall destruction.

1.2.3 Oxidative stress

Oxidative stress refers to a situation in which oxidants such as reactive oxygen species (ROS) and free radicals overwhelm natural antioxidant defences. This occurs in the lungs of patients who smoke cigarettes as tobacco smoke contains a high concentration of oxidants and this is thought to contribute to the pathogenesis of COPD.[25] Oxidants in tobacco smoke directly damage the elastin and collagen in the pulmonary extracellular matrix as well as disrupting elastin synthesis and repair, resulting in alveolar wall damage and subsequent emphysematous structural change.[26, 27]

1.3 Clinical aspects of COPD

Obstructive airways disease can be split into three sub-types: chronic bronchitis, emphysema and asthma.[28] Chronic bronchitis and emphysema are components of COPD, but their presence in a patient does not constitute a diagnosis of COPD, unless there is evidence of irreversible airways obstruction as illustrated in Figure 1.2.[29] Chronic bronchitis is a clinical diagnosis characterised by mucous hypersecretion for a period of 3 months or more per year for at least 2 years.[28] In chronic bronchitis, airflow obstruction is caused by airway remodelling due to chronic inflammation resulting in narrowing of the small airways and the filling of the airway lumen with mucus.[30] Emphysema is a pathological diagnosis characterised by permanent enlargement of airspaces distal to the terminal bronchiole either from dilatation or from destruction of their walls without obvious fibrosis.[28, 31, 32] Emphysema can be sub-divided into three sub-types based on distribution of damage within the secondary pulmonary lobule as shown in Figure 1.3. Airflow obstruction in emphysema is due to the loss of alveolar wall elasticity reducing driving pressure leading to collapse of the peripheral airways causing a reduction in forced expiratory volume in 1 second (FEV_1).[31] Asthma is a clinical and physiological diagnosis that is characterized by variability in respiratory symptoms associated with triggers and confirmed with evidence of reversible airways obstruction.[33] However, with increasing severity, asthma can progress to develop into a condition with fixed airways obstruction, making it difficult to distinguish from COPD.[34] Equally there exists a cohort of patients that have an overlap of features consistent with asthma and COPD referred to as Asthma COPD Overlap Syndrome (ACOS).[33] Diagnostic criteria have been suggested for ACOS, however, advice from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommends the use of a step wise approach balancing features of COPD and asthma, which has added to diagnostic difficulties.[33] However, recent guidance now suggests that ACOS should no longer be used as a diagnostic term and patients should be diagnosed as having both COPD and asthma.[35]

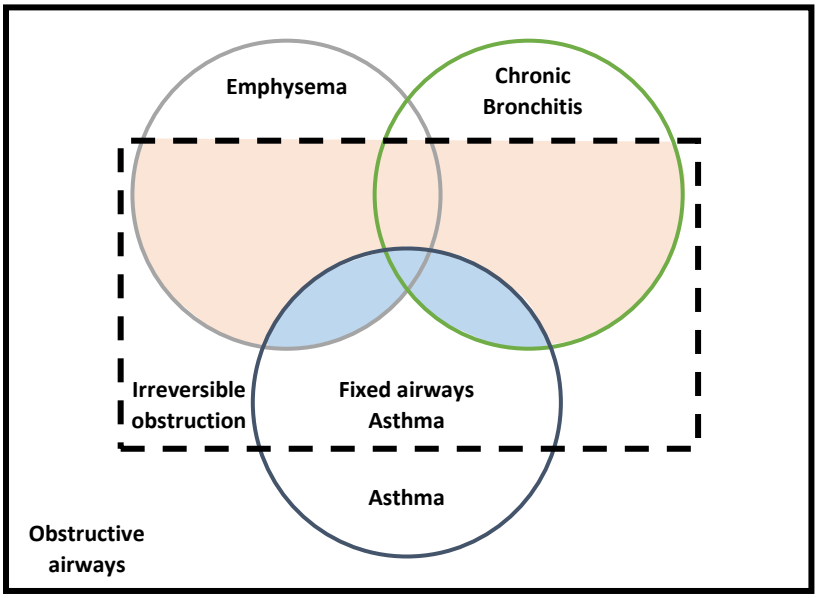

Figure 1.2 Non proportional Venn diagram of COPD phenotypes. The COPD subset is shaded in orange and includes the emphysema and chronic bronchitis phenotypes with irreversible obstruction. The ACOS subset is shaded in blue and includes the asthma, chronic bronchitis and emphysema phenotypes that have irreversible obstruction. Areas that remain unshaded are not considered to have either COPD or ACOS. (*Adapted from American Thoracic Society 1995*.)

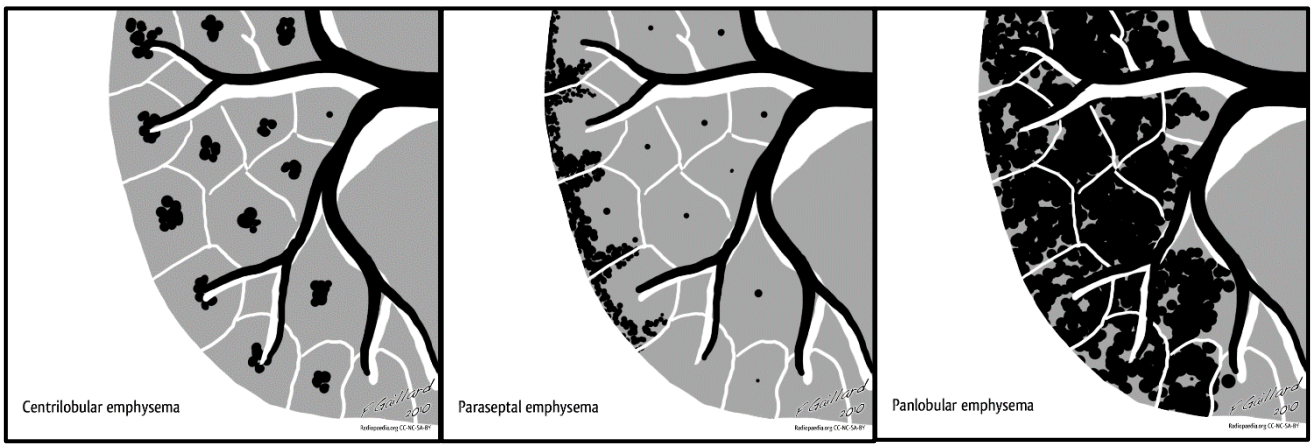

Figure 1.3 Sub-types of emphysema. Centrilobular emphysema- Most prevalent subtype and emphysematous damage affects the proximal bronchioles. **Paraseptal emphysema**- Emphysematous damage affects the peripheral parts of the secondary pulmonary lobule adjacent to the pleural surface. **Panlobular emphysema**- Emphysematous damage affects the entre secondary pulmonary lobule and is most associated with alpha-1 antritrypsin deficiency. *(Images courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 9225)*

1.3.1 Diagnosing COPD

The diagnosis of COPD is based on a patient meeting three criteria.[3] The first criterion is the presence of symptoms in keeping with COPD, primarily shortness of breath or chronic cough. The second criterion is a compatible clinical history, which is usually exposure to noxious gases or particles and being over the age of 35. The third criterion is an objective measure of irreversible airflow obstruction, the definition of which is debated amongst respiratory specialists.

The most widely accepted definition of airflow obstruction is a post-bronchodilator forced expiratory volume in one second (FEV_1) to forced vital capacity (FVC) ratio of less than 0.7, which is based on current GOLD advice.[29] However, the use of a fixed ratio can potentially lead to the overdiagnosis of COPD in the elderly, this is due to FEV_1 declining naturally with age at a faster rate than the decline of FVC. Therefore, a healthy older patient can potentially have a FEV_1/FVC ratio less than 0.7.[36, 37] Hence, some European national guidelines recommend using the FEV_1/FVC ratio lower limit of normal (LLN), which is measured as the 5^{th} percentile adjusted for age, sex and height, as the cut off for measuring airflow obstruction.[38]

In the United Kingdom (UK) the National Institute for Health and Clinical Excellence (NICE) recommend using FEV1/FVC < 0.7 to confirm a diagnosis of COPD, however, do advise to consider alternative diagnoses in elderly patients who do not have typical symptoms of COPD.[39]

The typical diagnostic process for COPD in the UK is based on opportunistic diagnosis by GPs in primary care, whereby a clinical and spirometry assessment is considered following patient reported symptoms of dyspnoea or chronic cough.[40, 41] Some local services provide proactive diagnosis through COPD case finding services, whereby GP records are searched for patients with risk factors for COPD and assessed. Proactive COPD case finding has been evaluated through the TargetCOPD study, which found it to be more effective at identifying patients with COPD than opportunistic diagnosis.[42] However, due to the lack of long term cost effectiveness data, case finding has yet to be widely implemented.[43]

The diagnosis of COPD primarily takes place either within individual GP practices or within community hubs where spirometry is available.[3, 44] Spirometry is usually performed by practice nurses with experience in COPD and spirometry, and in whom Association for Respiratory Technology and Physiology (ARTP) qualification is recommended in many areas.[44] The spirometry report is then assessed by GPs who formalise the diagnosis of

COPD using a combination of clinical and spirometry assessment.[44] The Quality Outcomes Framework scheme (QOF) encourages diagnostic accuracy via monetary incentives to GP practices that record spirometry results confirming the diagnosis of COPD.[2] However, it should be noted that the incentive is only for recording the spirometry result and is not dependent on the accuracy of the spirometry assessment.[2]

Once patients are formally diagnosed with COPD, they are classified according to severity of airflow obstruction using GOLD grading and according to symptomology using the GOLD "ABCD" assessment tool.[29] The purpose of classifying a patient's COPD is to aid in determining initial management.[29]

There are four GOLD grades of severity, as shown in Table 1.1, which are based on percentage of predicted FEV_1. The predicted FEV_1 value is adjusted according to height, weight, age, gender and ethnicity using the global lung function initiative (GLI) equation.[45] Use of the GLI reference equation to interpret spirometry results ensures greater accuracy of lung function reference ranges for the elderly and for patients of different ethnicity, reducing the risk of inaccurately diagnosing patients with COPD.[46]

The ABCD assessment tool uses a combination of exacerbation severity, COPD Assessment Test (CAT) score and modified Medical Research Council (mMRC) dyspnoea score to classify patients according to severity of symptom control as shown in Table 1.2. The ABCD classification can then be used to determine initial pharmacological management.

GOLD stage	Severity of obstruction	FEV_1 range
1	Mild	$FEV_1 \geq 80\%$ of predicted
2	Moderate	FEV_1 50% - 79% of predicted
3	Severe	FEV_1 30% - 49% of predicted
4	Very Severe	$FEV_1 \leq 30\%$ of predicted

Table 1.1 Severity of airflow obstruction.

≥ 2 moderate exacerbations or ≥ 1 leading to hospitalisation	**Group C** LAMA	**Group D** LAMA or LAMA + LABA* or ICS + LABA** *Consider if highly symptomatic **Consider if eosinophil count ≥ $0.3x10^9$ cells/L
0 or 1 moderate exacerbations (not leading to hospital admission)	**Group A** A Bronchodilator	**Group B** LABA or LAMA
	mMRC 0-1, CAT <10	**mMRC ≥ 2, CAT ≥ 10**

Table 1.2 GOLD ABCD classification and recommended initial pharmacological treatment. LABA: Long-acting beta agonist; LAMA: Long acting muscarinic antagonist; ICS: Inhaled corticosteroid *(Adapted from GOLD 2019).*

1.3.2 Management of COPD

The management of stable COPD requires a delicate combination of pharmacological and non-pharmacological interventions to maintain a good quality of life and symptom control.[3] Most interventions can be initiated by GPs, however, a minority of patients with severe symptoms and poor control require specialist led care and interventions.[3]

Initial pharmacological treatment is decided based on a patient's GOLD ABCD classification as shown in Table 1.2. Patients in group A are initially treated with either a long acting or short acting bronchodilator, the impact of the bronchodilator is then evaluated and patients either continue with the same bronchodilator or try an alternative class of bronchodilator.[29] Patients in group B are treated with a long-acting beta agonist (LABA) or long-acting muscarinic antagonist (LAMA), if their symptoms persist then they are escalated to a combination inhaler (LAMA+LABA).[29] Patients in group C are treated with a LAMA initially, however, if their symptoms of breathlessness persist, they are also escalated to a LAMA+LABA inhaler.[29] If patients in group C have persistent exacerbations and their serum eosinophil counts are ≥$0.3x10^9$ cells/L then they can be considered for treatment with a LABA and inhaled corticosteroid (ICS) combination inhaler.[29] Patients in group D can initially be started on a LAMA, however, if highly symptomatic they can be initially treated with a LAMA+LABA combination inhaler or a LABA+ICS combination inhaler if their serum eosinophil counts are ≥$0.3x10^9$ cells/L.[29] Evidence supporting the use of ICS indicates that frequency of infective exacerbations increase by 50% at the $0.3x10^9$ cells/L eosinophil count threshold.[47] However, the same evidence also shows that frequency of exacerbations begins

to increase at the $0.1x10^9$ cells/L eosinophil count threshold.[47] Therefore, GOLD also recommends considering ICS use if patients have frequent exacerbations with a serum eosinophil count of $\geq 0.1x10^9$ cells/L.[29]

As COPD is a progressive disease, we know that with time the patient's FEV_1 value will deteriorate leading to worsening severity of obstruction and symptoms.[48] Therefore, patients with COPD need regular reviews to ensure their treatment remains optimal.[39] The algorithm for escalation and de-escalation of pharmacological treatment as recommended by GOLD[29] is summarised in Figure 1.4. The overall message from GOLD is to optimise patients with dual bronchodilators first then escalate to adding inhaled corticosteroids, unless there is evidence of elevated serum eosinophils, in which case inhaled corticosteroids can be added to the treatment regime at an earlier stage.[29] In patients who are already using inhaled corticosteroids the advice is to consider de-escalating treatment and removing inhaled corticosteroids from the treatment regime if there is no evidence of improvement or if there is evidence of severe infective exacerbations or pneumonia.[29]

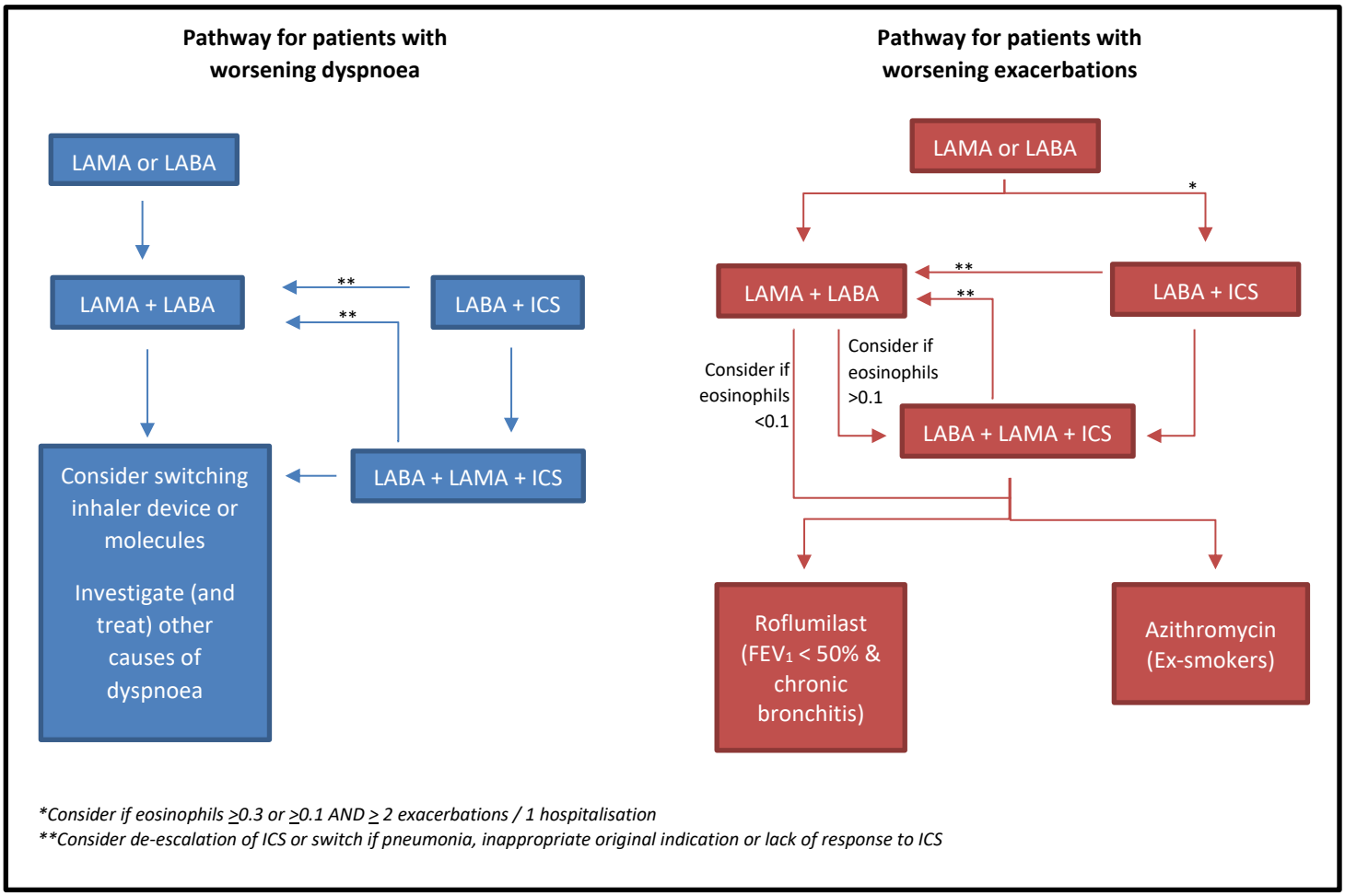

Figure 1.4 Pharmacological treatment escalation and de-escalation algorithm. LABA: Long acting beta agonist; LAMA: Long acting muscarinic antagonist; ICS: Inhaled corticosteroid; FEV_1 Forced Expiratory Volume in 1 Second *(Adapted from GOLD 2019).*

In conjunction with pharmacological treatment, pulmonary rehabilitation plays a crucial role in COPD management. Pulmonary rehabilitation has been shown to improve quality of life through promoting patient independence and reducing breathlessness in a cost-effective manner.[49, 50] GPs are encouraged with monetary incentives via QOF to refer patients with an MRC dyspnoea score of >2 for pulmonary rehabilitation due to its proven effectiveness.[2, 29] Pulmonary rehabilitation sessions are usually coordinated by community physiotherapists and often run in conjunction with patient education and self-management classes.[50]

Smoking cessation constitutes a combination of pharmacotherapy and counselling and is an important aspect of COPD treatment as abstinence from tobacco smoke is known to slow disease progression.[51] Current evidence suggests that specialist led smoking cessation services have a better success rate than services run in primary care.[52]

Vaccination to prevent influenza and pneumococcal pneumonia are vital to reduce serious illness requiring hospitalisation in patients with COPD.[53-55] The importance of preventing COPD-related hospitalisation is based on evidence that suggests following hospitalisation there is a decline in quality of life and increased risk of mortality.[56] The evidence also suggests that there is a greater burden on healthcare utilisation following hospitalisation, thus making vaccination the most cost effective intervention for COPD.[56, 57]

Specialist led care is often reserved for patients with uncontrollable COPD symptoms or frequent exacerbations despite following the algorithm in Figure 1.4.[29] Specialists are able to offer pharmacological treatments such as long-term macrolide or roflumilast in order to reduce exacerbation frequency.[3] Long-term macrolide therapy has been shown to be most effective in elderly patients with milder COPD, however, has also been shown to be ineffective in active smokers.[58] Initiation of long-term macrolide therapy requires complex assessment to rule out the presence of non-tuberculosis mycobacterium and cardiac arrhythmia, thus is done under specialist supervision.[59] Roflumilast has been shown to be effective at reducing moderate to severe exacerbations, however, is often discontinued due to intolerable side effects.[60, 61] Patients initiated on roflumilast need close monitoring for liver toxicity, weight loss and suicidal ideation, therefore, is done under specialist supervision.[3] Specialist assessment is required when patients continue to suffer with dyspnoea despite pulmonary rehabilitation and optimal inhaled therapy in order to determine if they are suitable candidates for Lung Volume Reduction Surgery (LVRS).[3] The assessment for LVRS includes a combination of

lung function testing, echocardiography and invasive cardiac investigation.[62] Surgical resection and endobronchial valve placement are the approved forms of LVRS in the UK and studies have shown both are effective at improving quality of life in those with very severe COPD with upper lobe predominant emphysema.[63] Specialists are also involved in assessing patients for Long Term Oxygen Therapy (LTOT) and domiciliary Non-Invasive Ventilation (NIV).[3] LTOT is reserved for use in patients with COPD when there is evidence of chronic hypoxia defined as a partial pressure of oxygen in arterial blood (PaO_2) of less than 7.3 kPa or 8.0 kPa if there is evidence of right heart strain.[64] The purpose of LTOT is to reduce the sequalae of cardiac failure associated with chronic hypoxia and subsequently improve QOL and reduce hospitalisations.[65] However, due to the risks of hypercapnia associated with LTOT in patients with COPD, initiation of LTOT is limited to respiratory specialists.[64] Domiciliary NIV is utilised in patients with COPD who develop hypercapnia and is thought to reduce hospitalisation frequency, however, there is minimal evidence supporting its use to improve mortality and quality of life.[66, 67] Finally, as patients enter the terminal stages of the disease, specialist guided therapy with opiates and LTOT can assisted in alleviating breathlessness.[68] However, it is important to note that specialist led care is not provided in isolation, it often requires collaboration with GPs and other generalist Healthcare Professionals (HCP) within primary care.[3]

Overall, there are four aspects of guideline based stable COPD management that are primarily initiated by GPs; inhaled pharmacotherapy, pulmonary rehabilitation, smoking cessation and vaccination.[3] In order to ensure patients receive guideline based care in the UK, GPs are incentivised via QOF with monetary reward to offer the most cost effective interventions (pulmonary rehabilitation, smoking cessation and vaccinations) to suitable patients with COPD.[2] Later therapies that are guideline recommended but initiated in secondary care include long-term macrolide or roflumilast pharmacological treatment, LVRS, LTOT and NIV.[3]

1.3.3 COPD exacerbations

An exacerbation of COPD is defined as an acute deterioration of respiratory symptoms from baseline, beyond day-to-day variation, requiring additional therapy.[69] Common symptoms experienced during an exacerbation include worsening dyspnoea and cough associated with increased sputum production and purulence.[3, 29] Exacerbations only requiring an increased use of short acting bronchodilators (SABA) such as salbutamol are classified as mild.[29] Moderate exacerbations are defined by the use of systemic corticosteroids and/or

antibiotics in addition to increased SABA use.[29] Patients requiring hospitalisation due to respiratory symptoms or acute respiratory failure are defined as having a severe exacerbation.[29]

Respiratory viral infections, bacterial infections and ambient air pollution can trigger COPD exacerbations, the symptoms of which typically last between 7 to 10 days, but full recovery may take significantly longer (6-8 weeks).[70-73] The presence of infective pathogens and pollutants in the respiratory tract causes an increased inflammatory response leading to increased sputum production.[74] Sputum analysis during exacerbations has shown a proportion of patients have elevated eosinophils and neutrophils during exacerbations, with sputum eosinophilia being more associated with viral infections and purulent sputum being associated with bacterial infections.[75, 76]

Most exacerbations are managed in the community with oral antibiotics and corticosteroids.[3] Within primary care there is an emphasis on providing patients with education and self-management packs that allow patients to manage their exacerbations independently and without delay.[77] The use of self-management has been found to lead to a reduction in hospitalisations and improvements in QOL.[78] Exacerbations requiring hospitalisation are usually due to patients developing acute respiratory failure or deterioration in physical health preventing self-management at home.[79] Care required by patients can range from level 1 (ward based no organ support) to level 3 (mechanical ventilation) and is dependent on the severity of their exacerbation.[79] The UK national COPD audit in 2014 indicated that 4.3% of patients admitted with COPD exacerbations died in hospital, and mortality was 2.8% and 8% within 30 days and 90 days of discharge respectively.[80] The necessity of acute NIV was associated with an inpatient mortality rate four times higher than average and those surviving to discharge had a mortality rate of 20.2% and 27.7% at 30 days and 90 days post discharge respectively.[80] Patients discharged from hospital often have a prolonged period of recovery associated with worsening physical and function impairment, which subsequently has a negative impact of their quality of life.[73, 81]

Overall, the impact of COPD exacerbations has been described as a downward spiral leading to death.[82] Each exacerbation leads to a reduction in lung function, which contributes to reduced activity and worsening quality of life.[73, 83] Poor quality of life and reduced activity increase the risk of severe exacerbations and/or recurrent exacerbations, which is associated with increased mortality.[84, 85] Therefore, the focus of COPD management

is often towards the prevention of exacerbations and symptom control in order to prevent patients falling down this spiral, which results in increased mortality and economic costs through hospital admissions.

1.4 Burden of COPD

COPD is currently the 5th leading cause of death in the UK.[86] In England, COPD accounted for 80,253 deaths between 2015 and 2017.[87, 88] Overall, data from Public Health England indicates that the COPD mortality rate has not decreased significantly since 2001.[87, 88] Within England there were 1.1 million people registered as having COPD in 2020 based on Public Health England data,[1] however we know there are estimates of up to 2 million more people with undiagnosed COPD (see also section 1.7 Misdiagnosis of COPD) [89]. Overall the prevalence of COPD is increasing in the UK and is projected to continue increasing as far as 2030.[90]

The management of patients with COPD varies depending on the severity of their illness.[3] Patients with mild disease often require very little intervention from their healthcare providers.[3] Whereas those with very severe disease often require repeated hospitalisation, as well as specialist community services for oxygen at home and in some cases domiciliary NIV.[3] As a result, it costs the National Health Service (NHS) ten times more to treat a patient with severe COPD than mild.[91] The overall cost to the NHS to manage patients with COPD is approximately £810 million per annum of which 47% is due to COPD related emergency hospital admissions.[92] The national COPD audit completed by the Royal College of Physicians (RCP) in 2014 found that the number of admissions to hospital due to COPD had increased by 13% between 2008 and 2014.[80] Currently COPD is the 2nd commonest cause of an emergency hospital admission in the UK; as a result COPD has become an increasing burden on the NHS.[4]

National bodies including the RCP, British Thoracic Society (BTS) and Kings Fund have advocated for a more integrated approach to the management of COPD.[93-95] Overall the recommendation is to have local collaboration between primary care teams and respiratory specialists based in secondary care (see also section 1.6 Integrated care). It is thought that with specialist support, primary care teams will be able to improve patient care leading to a reduction in hospitalisation and ultimately reduce the burden on the NHS.[96]

1.5 COPD in Birmingham

Birmingham is the second largest city in England with a population of 1.08 million people. The population is made up of people from different ethnic backgrounds and religions, similar to other major cities within England.[97]

In 2015 Birmingham was ranked the 6th most deprived area in England.[98] Within Birmingham there are large areas within the most deprived decile focused mainly around East and Central Birmingham, equally there are large areas of affluence predominantly in South and North Birmingham as represented in Figure 1.5.

Deprivation is associated with poorer health outcomes as well as behaviours, with higher smoking prevalence rates reported amongst people in deprived areas.[99] Data from the Office of National Statistics (ONS) reveals the prevalence of smoking goes from 8% in the least deprived populations to 27% in the most deprived populations (Figure 1.6).[100] The pathologies associated with tobacco smoking, including COPD and coronary artery disease, are known to reduce life expectancy.[101] As a result, within Birmingham there is evidence of health inequality with the average life expectancy differing by up to 10 years between the most affluent and most deprived regions of Birmingham.[97] However, it is important to note that the overall prevalence of smoking in Birmingham has reduced over the past 5 years in line with the national trend.[102]

Pollution in parts of Birmingham as measured by nitric dioxide (NO_2) levels and particulate matter <10 microns in diameter (PM10) are within the top 10% of levels in the UK.[97] The highest concentration of NO_2 and PM10 are in the city centre, however, levels are elevated throughout the whole city as shown in Figure 1.7 and Figure 1.8.[103] Elevated ambient air pollution has been shown to increase respiratory inflammation in COPD.[104] Data from the APHEA2 project [105] suggests elevated ambient PM10 levels in European cities including Birmingham lead to an increase in hospitalisation of patients with COPD. Subsequent meta-analyses confirmed that both PM10 and NO_2 were associated with increased hospitalisation and mortality amongst patients with COPD.[70, 106]

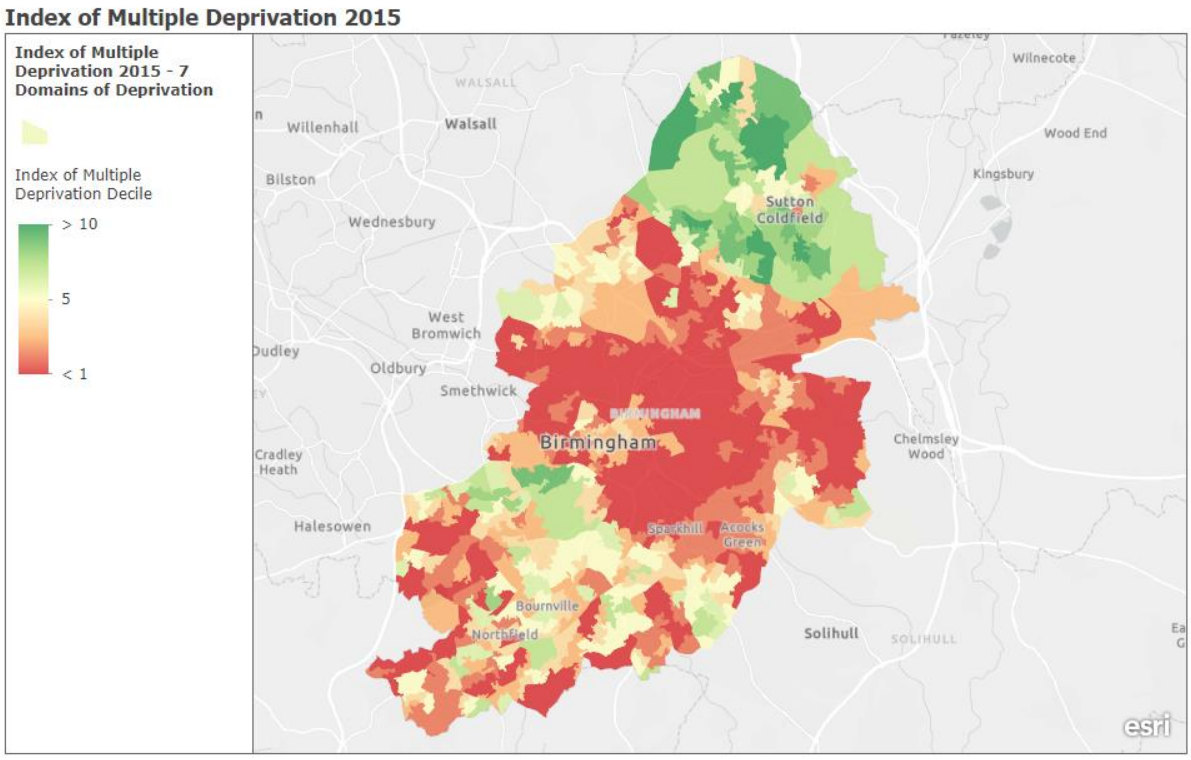

Figure 1.5 Deprivation index map of Birmingham. Index 1 indicates most deprived and index 10 indicates least deprived. *Created using ArcGIS Online (https://www.arcgis.com/home/item.html?id=14b9617e617c4ae09c0a5b0cab06044b#overview)*

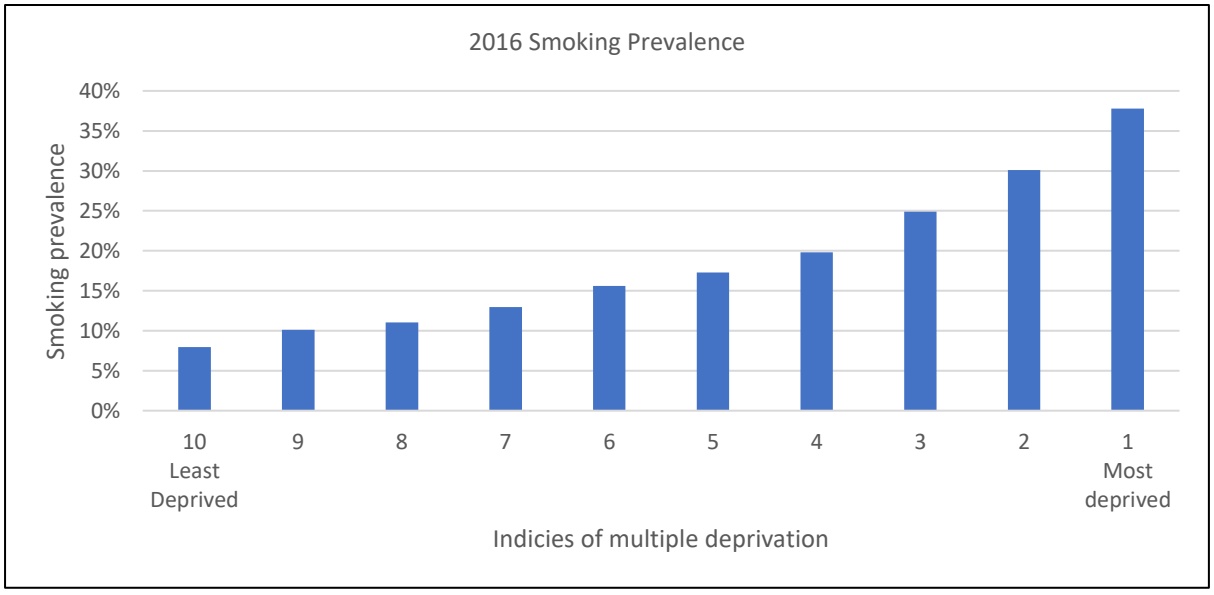

Figure 1.6 Smoking prevalence compared against deprivation index based on ONS data.

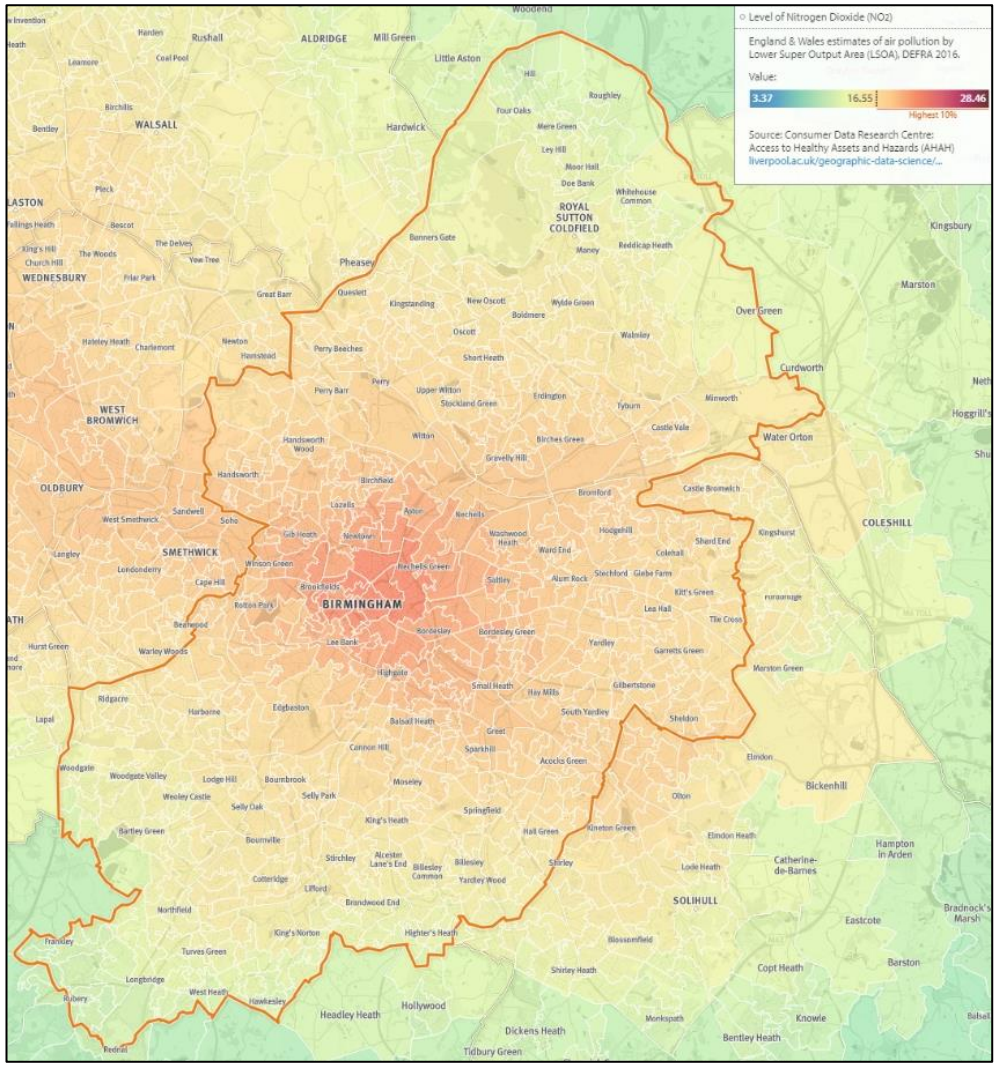

Figure 1.7 Distribution and concentration of NO_2 in Birmingham based on Department for Environment, Food and Rural Affairs (DEFRA) 2016 data. *(Created using shapeatlas.net)*

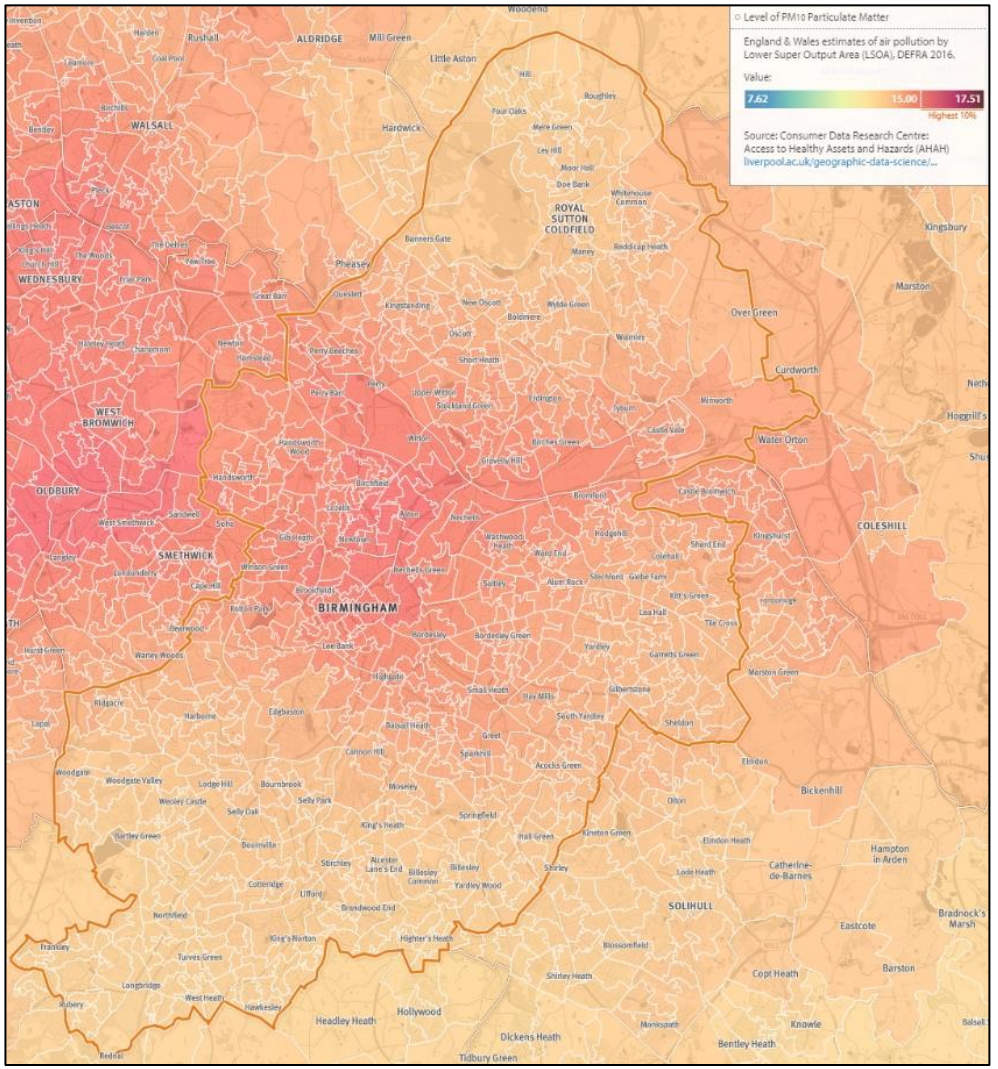

Figure 1.8 Distribution and concentration of PM10 in Birmingham based on Department for Environment, Food and Rural Affairs (DEFRA) 2016 data. *(Created using shapeatlas.net)*

Within Birmingham and Solihull there are 21,742 people registered as having COPD based on Clinical Commissioning Group (CCG) and QOF data.[107] However, as we know there are a large number of people with undiagnosed COPD, therefore the official figure is likely to be a significant under-estimate.[89] The prevalence of COPD is 1.5% in Birmingham and is increasing; however, it is below the national average 1.9% in England.[97] Despite the prevalence of COPD in Birmingham being below the national average, the rate of COPD related emergency admissions is above the national average as illustrated in Figure 1.9. Suggesting that COPD management in Birmingham may not match the national standards resulting in more hospitalisations. In 2017/18 there were 2812 emergency COPD related admissions, which averaged to 603 per 100,000 admissions.[108] Compared to the national average of 415 per 100,000 admissions,[109] Birmingham has a higher rate of COPD related admissions despite having a population with a lower prevalence of COPD. Interestingly Wolverhampton, which is a neighbouring district with similar deprivation levels as Birmingham, noticed a reduction in their emergency COPD related admissions[110] following the introduction of an integrated respiratory service in 2014[111] as shown in Figure 1.9.

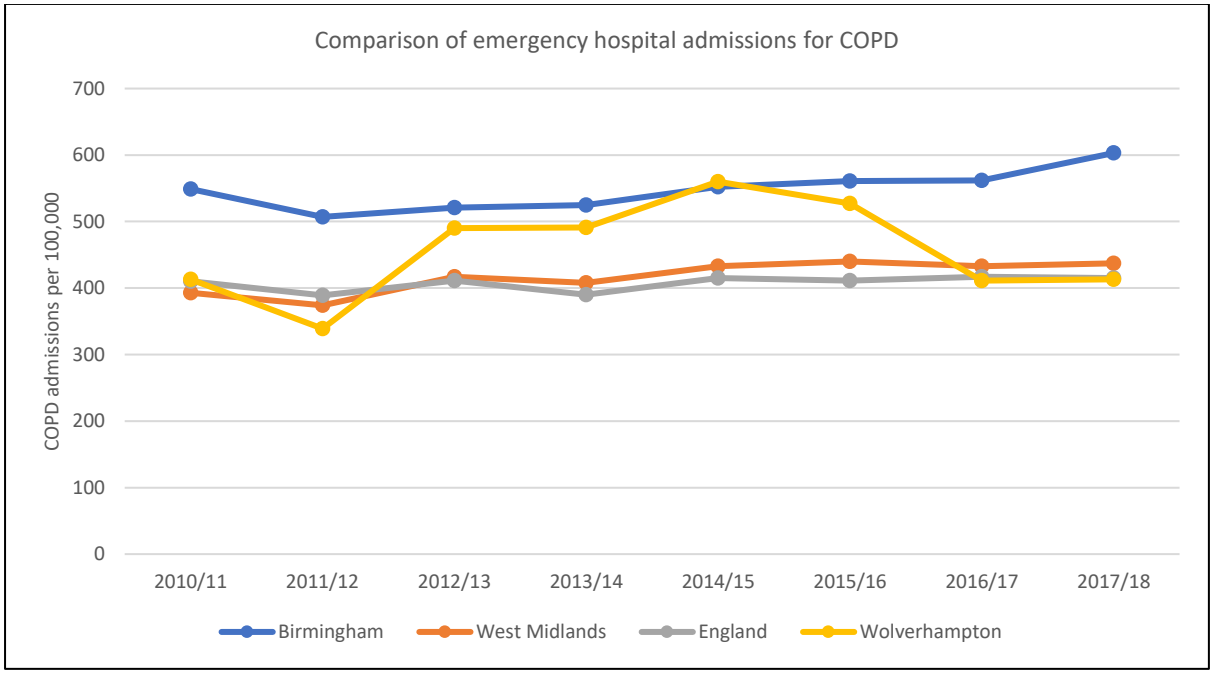

Figure 1.9 Comparison of COPD related emergency admissions between Birmingham, West Midlands, England and Wolverhampton. *Based on data from Public Health England. [110]*

Services for patients with COPD in East Birmingham are split between community and secondary care. Within secondary care there are two pathways to respiratory services, emergency and elective. Patients who are admitted via Accident and Emergency (A&E) with COPD exacerbations are reviewed via the emergency pathway. They are reviewed by a respiratory specialists physician and COPD specialist nurses on admission and discharge from inpatient wards.[112] Patients who are referred by GPs to the respiratory outpatient department are reviewed by respiratory specialists via the elective pathway.[113] The difference between the two pathways are that the emergency pathway relates to reviewing acute deterioration whereas the elective pathway is designed to review chronic deterioration. Within the community there are specialist respiratory hubs that provide pulmonary rehabilitation and community support for patients following discharge from hospital.[113] Chronic disease management and annual reviews for patients with COPD are completed in primary care by GPs and practice nurses.[3] Integration between primary and secondary care takes place in the form of virtual clinics that are led by respiratory physicians. The virtual clinics take place in GP sites across East Birmingham and are used as an opportunity to discuss difficult respiratory cases and to promote respiratory education for GPs and primary care staff.

1.6 Integrated care

Integrated care is an umbrella term that has multiple definitions, which are often stakeholder dependent; a systematic review found 175 different definitions for the term integrated care.[114] The overarching themes across all definitions were; continuity of care, cost-effectiveness, and a focus on patient/population needs.[114] Therefore, a generic definition for integrated care could be "a service that combines multiple care providers to deliver individualised care to a patient/population in the most cost-effective manner". However, despite this simplified definition of integrated care, describing the structure of an integrated care service is more complex. The description of an integrated care service needs to address *type, process, level, and intensity of integration*.[95, 115-118]

The '*type'* of integration can be described using Fulop et al's typology of integration where it is split into four dimensions: organisational, service, clinical and functional, each of which can be further defined by mechanism of integration as summarised in Table 1.3.[115] Integrated care services can incorporate some or all of these dimensions depending on the function of the service.

Mechanism of integration	
Systemic	Integration through coherence of rules and policies across the integrating parties.
Normative	Integration through shared values of co-ordinating and collaborating to deliver healthcare.
Dimension of integration	
Organisational	The formal organisational structure of the integrating parties. Such as "real" integration where both parties share physical assets or "virtual" integration where both parties form a network of collaboration but maintain separate physical assets.
Service	Integration of clinical services offered by both parties to create multi-disciplinary teams (MDT).
Clinical	Integration at the clinical team level to provide care through a single process, for example shared pathways or guidelines.
Functional	Integration of back office non-clinical processes, such as shared IT services.

Table 1.3 Description of types of integration based Fulop et al's typology.[115]

The '*process*' of integration refers to the direction and method used to integrate multiple healthcare providers.[95] Integration between services operating at different levels of care provision, such as secondary care acute hospitals and primary care GP practices is known as "vertical integration".[119] Integration between providers within the same level for example a merger between GP practices is known as "horizontal integration".[119]

'*Level*' of integration refers to the three levels of integrated decision making: macro, meso and micro.[118, 120] Integration at the macro level involves the integration of systems such as policy and finances at an organisational level and would impact an entire population.[118, 120] Integration at the meso level focuses on professional collaboration and sharing of clinical roles and responsibilities, which would impact on a sub-set of a population.[118, 120] Integration at the micro level focuses on coordinated care between relevant teams for specific individuals.[118, 120]

'Intensity' of integration can be broadly split into three levels of ascending intensity [117]: minimal integration, co-ordinated integration, and full integration as shown in Figure 1.10. However, integrated care services will not always neatly fit into one level and will often sit on the border of two levels of intensity. Therefore, the concept of intensity of integration is best conceptualised as a spectrum that ranges from minimal integration to full integration.

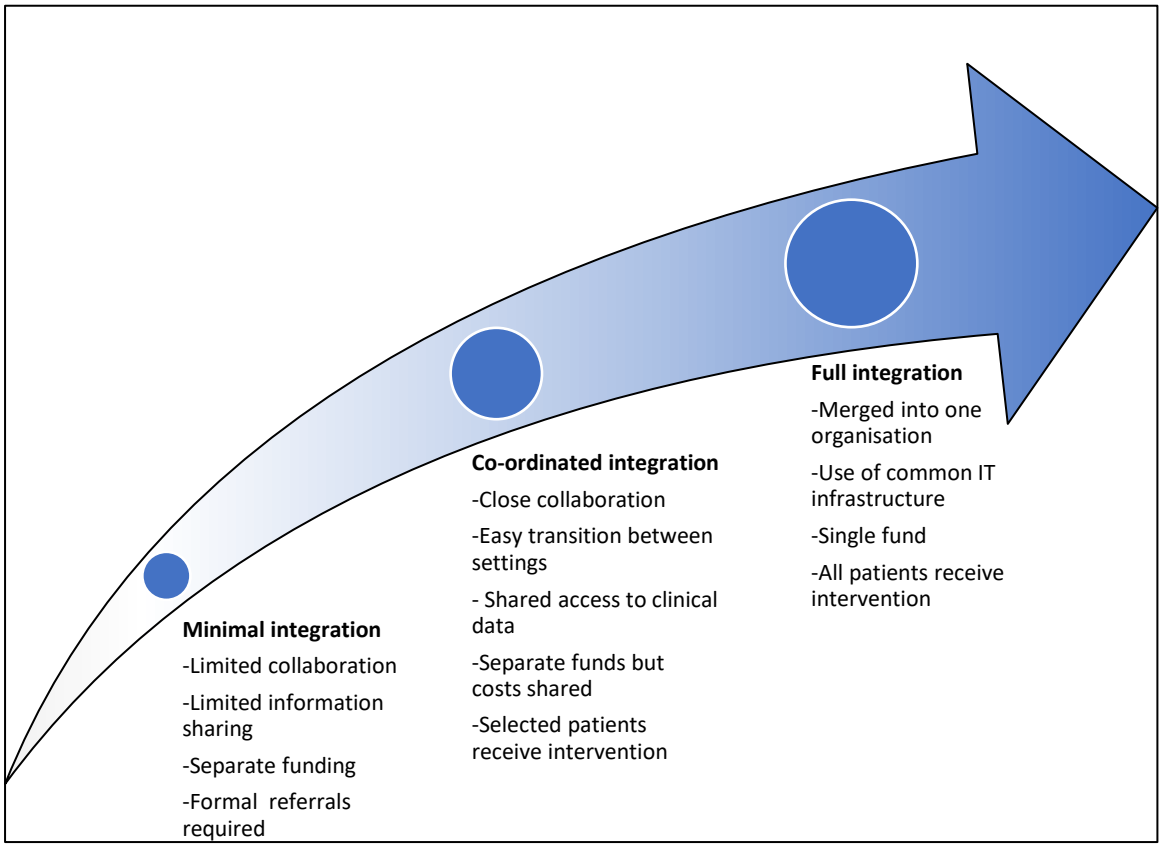

Figure 1.10 Spectrum of integration intensity. (*Adapted from Leutz et al [117]*).

1.6.1 Integrated COPD care

COPD is primarily managed by GPs in primary care with specialist support from secondary care, as a result, most integrated COPD care services use vertical integration, which is predominantly at the micro and meso levels due to the service being disease specific.[121] However, the type and intensity of integration is variable and based on stakeholder aims.

COPD specific integrated care services have been proven through systematic review to be effective at improving quality of life, exercise tolerance and reducing the number of COPD-related hospitalisations,[121] all of which are factors known to influence COPD mortality rate.[82]

Integrated care cannot work as a one size fits all service and needs to be tailored to the population and stakeholders it aims to serve. Therefore, it is understandable that multiple components have been identified when reviewing integrated COPD services.[121, 122] These components have been categorised based on their

common themes into five categories as shown in Table 1.4. These categories can potentially be used to group multiple components to allow for easier assessment of integrated COPD care interventions.

Category	Components included
Diagnostic support	Spirometry and case finding
Education	Staff education and self-management education
Pulmonary rehabilitation	Exercise and physiotherapy
Patient support	Home visits, telephone follow up and admission avoidance
Case management	Virtual clinic, medication optimisation, MDT clinic and MDT input

Table 1.4 Summary of integrated care components.

The diagnosis of COPD predominantly takes place in primary care using spirometry and clinical assessment.[2] However, due to difficulty in differentiating between COPD and conditions that mimic COPD symptoms such as asthma, GPs may require specialist support to confirm a diagnosis of COPD.[123] Diagnostic support as a component of integrated care involves a specialist led spirometry service based either in the community or GP practice to assist with confirming the diagnosis of COPD and to assist with case finding.[124]

Specialist led education as part of an integrated COPD care service can be directed at both staff and patients. Education for primary care staff typically concerns updates in management of COPD and spirometry training.[96] Patient education focuses on improving their knowledge of COPD and self-management during exacerbations.[121] Patient education is often provided in conjunction with pulmonary rehabilitation classes, however, can also be provided as a stand-alone service.[125]

A common barrier to pulmonary rehabilitation attendance is distance, due to its location within acute hospitals.[126] Pulmonary rehabilitation as a component of an integrated COPD care service involves bringing physiotherapy led rehabilitation classes to community gyms and centres as well as into patients' homes to increase uptake.[127, 128]

The patient support components focus on post COPD-related hospitalisation follow up as well as admission avoidance interventions.[129, 130] These typically involve collaboration between secondary care respiratory nurse specialists and community nurses to manage patients at home.[129, 130] The format of follow up can vary between home visits, telephone follow up and tele-health monitoring.[129, 130]

The management of patients with COPD requires a multi-disciplinary team (MDT) approach. Case management as part of an integrated COPD care service often involves the use of virtual clinics, allowing respiratory

physicians, GPs, pharmacists, physiotherapists, nurse specialists and counsellors to discuss patients and implement an MDT approach to patient care.[121, 131] Within case management interventions, specialists can physically review patients in MDT clinics alongside GPs and other HCPs where appropriate.[131]

The components of an integrated COPD care service should be determined by the needs of the population it intends to serve, and therefore may only focus on one component such as pulmonary rehabilitation, or a mixture of the components.[121] As a result, integrated COPD care models can vary significantly in content, which is likely to have an impact on their cost effectiveness.

1.7 Misdiagnosis of COPD

Spirometry is the cornerstone to diagnosing COPD and therefore its use is encouraged and incentivised in primary care when diagnosing patients with COPD. Despite this, the Welsh national COPD audit found only 19% of their 48105 patient cohort had a recorded spirometry result in their primary care record.[132] The authors did stress this does not infer that only 19% had spirometry completed, as it is possible that spirometry may not always be documented within GP records. However, of the 19% with recorded spirometry, a quarter did not have spirometry results compatible with a diagnosis of COPD, therefore representing misdiagnoses.[132]

The lack of familiarity, knowledge and access to spirometry have been identified as barriers to accurate diagnosis of COPD in primary care.[133, 134] These difficulties have been identified as factors leading to patients being misdiagnosed with COPD.[135-137] In order to improve spirometry skills within primary care there are plans within England and Wales for healthcare professionals to have standardised training and certification to perform and interpret spirometry.[138]

Misdiagnosis leads to inappropriate treatment, which comes at a financial cost. The mainstay of treatment for COPD remains inhaled therapies, which can be costly.[92] COPD currently costs the NHS £800 million per year.[91, 92] The proportion of COPD expenditure in the UK attributable to pharmacological therapies is uncertain, however, we do know that the European Respiratory Society (ERS) estimates that 30% of the direct costs of COPD in Europe are due to pharmacological management.[139]

Within the Welsh COPD audit 2255 patients were identified as being incorrectly diagnosed with COPD based on spirometry. The estimated cost of inappropriate inhaler prescribing was £1 million per year, however, this is

likely to be an underestimate as it is based only on the 19% of the cohort that had spirometry results recorded.[132]

A Greek study exploring the cost of COPD misdiagnosis in primary care found only 9.6% of their COPD cohort consisting of 3200 patients had been misdiagnosed.[140] However, 33% of the spending on inhaled therapies was for misdiagnosed patients.[140] Although the prevalence of misdiagnosis is smaller in this population compared to the Welsh population, the impact on inhaler spending remained significant. This could represent use of triple therapy in misdiagnosed cases due to lack of improvement in symptoms with bronchodilator therapy alone.

Inappropriate treatment can also lead to patient harm. As discussed earlier, the mainstay of treatment for COPD is inhaled therapy. The action of treating misdiagnosed patients with inhaled therapies can potentially lead to harm such as increased risk of pneumonia directly due to the inhaled steroids.[141] As well as harm through failure to treat the true underlying illness.[142] Historically patients with COPD not improving with long acting bronchodilators were treated with inhaled corticosteroids (ICS),[143] contrary to current recommendations.[29] As a result a large number of patients were given ICS inhalers, in particular those who had been misdiagnosed as it is unlikely they would have improved with a bronchodilator alone.[144, 145] We now know that ICS use is associated with an increased risk of pneumonia, which when given to a misdiagnosed patient comes with risk and no benefit – unless the patient has an underlying diagnosis of asthma.[146] There have been no studies exploring the outcomes for misdiagnosed patients, however, we know ICS use amongst misdiagnosed patients is prevalent.[123, 132, 140] Cardiac conditions such as heart failure can mimic the symptoms of COPD. Rutten et al[147] investigated the prevalence of undiagnosed heart failure amongst elderly patients with COPD in primary care. The study found that of the 405 patients enrolled, 83 (20%) had heart failure. Of the 83 found to have heart failure, 33 (40%) were found to have been misdiagnosed as COPD based on GOLD guidelines,[147] this number could potentially have been higher had the authors used LLN as the diagnostic criteria for COPD[148, 149]. Through misdiagnosing patients with COPD, the underlying illness goes untreated.[142] The impact of delayed treatment of the true illness causing symptoms can be devastating for patients as it can impact their quality of life and socio-economic wellbeing.[142]

Overall, the implications of misdiagnosing a patient with COPD are: (1) wasted resources through inappropriate treatment, and (2) potential harm to patients through incorrect treatment and delayed treatment. Therefore, reducing the number of patients misdiagnosed with COPD in primary care should be a priority, and methods to identify misdiagnosed patients should be explored.

1.8 Thesis aims

1. To determine through mixed methods systematic review the perceived causes of misdiagnosis and whether integrated care is a suitable and acceptable modality to identify patients misdiagnosed with COPD. (Chapter 2)

2. To explore the impact of integrating COPD specialists into GP practices on patient care. (Chapter 3)

3. To explore and understand the causes of COPD misdiagnosis in primary care. (Chapter 4)

4. To explore perceptions towards integrated COPD care amongst patients and HCPs. (Chapter 5)

1.9 Thesis summary

Chapter 2 of this thesis explores through a mixed methods systematic review whether integrated care is a suitable modality to identify patients misdiagnosed with COPD in primary care. The review utilises qualitative data pertaining to perceived causes of misdiagnosis with COPD and acceptability of integrated care intervention, as well as quantitative data representing the number of patients identified as misdiagnosed with COPD through integrated care interventions. Through the integration of both qualitative and quantitative data, comprehensive findings have been synthesised. These findings can aid in the development of integrated care interventions to identify and manage misdiagnosis of COPD in primary care as well as identify gaps in current literature to guide future research.

Chapter 3 presents the findings of the INTEGR COPD trial, which explores the impact integrating COPD specialists into GP practices has on the management of patients with COPD. The study utilises a pragmatic approach and compares the outcomes for patients managed by specialists and generalists. The study reports the impact specialists have on the delivery of guideline adherent care as well as patient health outcomes. The reported

findings from this chapter provide evidence regarding the effectiveness of an integrated care intervention, which can be used to guide development of future integrated care services.

Chapter 4 explores the causes of COPD misdiagnosis in primary care through a mixed methods approach. It firstly presents the prevalence of COPD misdiagnosis within the INTEGR COPD study cohort and the identified causes of misdiagnosis. The qualitative component explores the causes of misdiagnosis through semi-structured interviews of patients and healthcare professionals participating in the INTEGR COPD study. Through integration of the quantitative and qualitative findings, a practical interpretation and understanding of why patients are misdiagnosed with COPD in primary care is presented. The findings from this chapter provide additional information regarding the growing issue of COPD misdiagnosis in primary care and the role integrated care can play in identifying misdiagnosis.

Chapter 5 reports the views held by healthcare professionals and patients, participating in the INTEGR COPD study, regarding the integration of COPD specialists into GP practices. Data collected through semi-structured interviews and analysed using the thematic framework approach is presented to provide insight into the acceptability of integrated care services. The findings from this chapter identify potential facilitators and barriers to implementing integrated care services in the future.

Chapter 6 provides a summary of the findings from each chapter and concludes with the implications this thesis has, as a whole, on future research, practice, policy and education in the field of integrated COPD care.

CHAPTER 2 : IDENTIFYING COPD MISDIAGNOSIS THROUGH INTEGRATED CARE: MIXED METHOD SYSTEMATIC REVIEW

2.1 Introduction

The concept of the "missing millions" refers to the estimated 2 million people in the UK with undiagnosed COPD and has been a popular topic around which case finding studies have been based.[89] However, there is now growing evidence that there are many patients misdiagnosed with COPD within primary care in the UK.[132, 136, 150] Patients that are misdiagnosed with COPD often go on to receive treatment for obstructive airways disease[132, 136], which can be both detrimental for the patient as they are not receiving the correct treatment and for the economy as resources are being utilised inappropriately.

Integrated care programmes targeted at patients with COPD in primary care have been shown to improve quality of life and reduce hospital admissions.[121] Integrated care programmes are variable in design, however, operate on the basis of hospital specialist involvement in primary care.[121]

Most patients with COPD in the UK are diagnosed and managed by their GP, rather than respiratory specialists.[3, 44] Spirometry testing is essential for diagnosing COPD. The diagnosis of COPD is based on the presence of symptoms, risk factors and obstructive airways.[29] GOLD define obstructive airways as a post bronchodilator FEV_1/FVC ratio of <0.7.[29] The fixed ratio criteria was chosen in order to simplify COPD diagnosis for non-specialists.[151] However, there is still division within the respiratory community regarding the criteria to define the 'O' in COPD. Division still exists due to evidence suggesting the use of fixed ratio criteria leads to overdiagnosis of COPD in the elderly.[152, 153] The FEV_1/FVC ratio naturally declines with age, with patients older than 65 having a LLN ratio of less than 0.7.[48] As a result, healthy elderly patients would be defined as having obstructive airways using the GOLD criterion, leading to an overdiagnosis of COPD.[153] Therefore, an alternative criterion used to define obstructive airways is the FEV_1/FVC ratio being less than LLN.[154, 155] Within Europe there is no consensus regarding criteria to define obstruction resulting in variation of guidelines between regions.[38] Overall, the lack of agreement within the respiratory community of how to define obstructive airways has led to confusion within primary care and has been found to be a significant cause of patients being misdiagnosed with COPD.[135, 156] Additionally, as mentioned in section 1.7 Misdiagnosis of

COPD, difficulties associated with utilising spirometry in primary care have been identified as factors leading to patients being misdiagnosed with COPD. [132, 135-137] Lack of familiarity and access to spirometry have been identified as factors leading to under-utilisation of spirometry to diagnose COPD. [133] [134] In order to improve spirometry skills within primary care there are plans within England and Wales for healthcare professionals to have standardised training and certification to perform and interpret spirometry.[138]

Confusion regarding the thresholds defining COPD and difficulties with spirometry in primary care are the two main factors thought to lead to misdiagnosis. Other factors identified include difficulty differentiating COPD from similar conditions and lack of familiarity with COPD.[135]

2.1.1 Rationale for this review

Misdiagnosis with COPD is an issue within primary care, with economic and clinical consequences as discussed in section 1.7 Misdiagnosis of COPD. Integrated COPD care, where respiratory specialists are closely involved in the management of patients with COPD, has been shown to be successful at improving outcomes for patients with COPD.[121]

Improvement of health outcomes is the primary objective in most integrated COPD care programmes. This is achieved through a combination of multiple components as described in the Cochrane review by Kruis et al.[121] Integrated care programmes often have elements of each component, with one or two components being the focus of the integrated care intervention.[121] As a result, integrated care interventions can appear in multiple formats as discussed in section 1.6 Integrated care. Confirming a patient's diagnosis of COPD is often an aspect of integrated care.[121] Therefore, despite identification of misdiagnosis not being a specific focus for integrated care programmes, it is a feasible function.

Previous reviews have explored the rate of COPD misdiagnosis globally [156] as well as the causes of misdiagnosis [135], however, have not explored the use of integrated care to identify misdiagnosed patients in primary care. Equally reviews of integrated COPD care have focused on health and economic outcomes [121], however, have not explored its use in identifying COPD misdiagnosis nor its acceptability. Utilising both qualitative and quantitative data this systematic review addresses whether misdiagnosis in primary care can be identified through integrated care interventions and if integrated care is perceived as an acceptable intervention.

2.2 Methods

This review is utilising both qualitative and quantitative data, therefore, a convergent segregated mixed methods approach as described by the Joanna Briggs Institute (JBI) [157] was adopted. A convergent approach prevents the need for data transformation as it allows for both qualitative and quantitative data to be analysed separately, reducing the risk of data losing meaning through transformation. The qualitative and quantitative data outputs can then be integrated to give a conclusion and answer the review question.

2.2.1 Review question

The primary review question "Can integrated care be used to identify COPD misdiagnosis in primary care?" was broken down into three sub-questions:

What do clinicians perceive as the cause of misdiagnosis with COPD?

What is the rate of COPD misdiagnosis in primary care identified through integrated care interventions?

How are integrated care interventions perceived by clinicians and patients?

2.2.2 Inclusion criteria

Participants-

This review considered all quantitative studies that involved human subjects of any age who have a current or previous diagnosis of COPD. Qualitative studies were considered if participants were stakeholders in an integrated care intervention or healthcare professionals involved in the care of patients with COPD.

Interventions-

The quantitative component of the review considered studies that reported the findings from COPD specific integrated care interventions. Integrated care for the purposes of this review was defined as a collaboration of two or more people from different healthcare backgrounds, with at least one working within the primary care sector. Integration needed to involve the clinical dimension and the intervention needed to target patients with COPD.

Phenomena of interest-

The qualitative component of the review considered studies that investigated perceived causes of misdiagnosis with COPD and studies that investigated clinician and patient perceptions of integrated care, as per the definition of integrated care mentioned above.

Outcomes-

The quantitative component of this review explored the rate of misdiagnosis identified through integrated care. Studies that reported exclusion due to misdiagnosis of COPD or reported number of patients identified as misdiagnosed with COPD within their results were included in this review.

Context-

The qualitative component of this review considered studies that explored the phenomena of COPD misdiagnosis and integrated care within a primary care and community setting using qualitative methodology.

Types of studies-

The quantitative component of this review considered randomised controlled trials (RCT), cluster RCTs and observational studies. The qualitative component of this review considered qualitative research with no limitation based on qualitative research methodology. Mixed method studies were considered if data from the qualitative or quantitative aspects could be extracted.

Studies published in any language were included in this review, however, were limited to studies published from 1990 onwards, as spirometry use for the diagnosis of COPD in primary care did not become widespread until the 1990s [158, 159].

2.2.3 Search strategy

A literature search strategy was developed using Medical Subject Headings (MeSH) and free text search terms related to- 1) COPD and integrated care, and 2) COPD and misdiagnosis. MEDLINE, MEDLINE In process, EMBASE, CINAHL, Web of Science and PsycINFO bibliographic databases were searched using the identified relevant terms. Citation lists of included studies were also checked for relevant articles. The search terms used for each database is provided in Appendix 1.

Searches were performed in December 2019, with a view to completing the title/abstract stage and moving to full papers by March 2020. However, due to the corona virus pandemic I was redeployed clinically for 4 months, which delayed analysis of extracted data till December 2020. Therefore, a further search was conducted in November 2020 to ensure the latest data had been included in the analysis.

2.2.4 Study selection

Following the search, all identified citations were loaded into EndNote X9 (Clarivate Analytics, PA, USA) and duplicate search results were removed. All titles and abstracts were then screened and assessed against the inclusion criteria by me as the primary reviewer with JH, AG, PS and CH sharing the role of second reviewer. Potentially relevant studies were retrieved in full to undergo full text review. Full text review involved detailed assessment of the text against the inclusion criteria and was completed by me as the primary reviewer with AG and FM sharing the role of second reviewer. Reasons for exclusion of full text studies that did not meet the inclusion criteria was recorded and reported in the systematic review. Any disagreements between the reviewers at each stage of the study selection process was resolved through discussion, or with a third reviewer.

2.2.5 Data extraction

Generic and quantitative data as per the data extraction form in Appendix 2 was extracted by a single reviewer and verified by a second reviewer (PC). However, qualitative data was extracted by two independent reviewers (KP and PC) to ensure both reviewers were familiar with the content in detail prior to qualitative data synthesis. Qualitative data was split into findings and illustrations. Original author generated themes and narrative interpretations were extracted and defined as findings; where authors had used quoted examples to support findings these were extracted as well and defined as illustrations. To prevent reliance on reviewer interpretation, where a theme on its own provided limited description, the original author generated narrative description was extracted along with the theme. Disagreements between reviewers were resolved through discussion or through a third reviewer.

2.2.6 Assessment of methodological quality

Methodological quality of the included studies was assessed independently by two reviewers (KP and PC) using the mixed methods appraisal tool (MMAT),[160] shown in Appendix 3. The MMAT was selected to assess

methodological quality due to the tool being specifically designed and validated for use on mixed methods systematic reviews. Disagreements between the two reviewers were settled through discussion or a third reviewer.

2.2.7 Data analysis

Data analysis was completed using the convergent segregated approach whereby quantitative and qualitative data were analysed separately. Evidence produced by separate analyses were then integrated to produce the final integrated data synthesis as illustrated in Figure 2.1.[157]

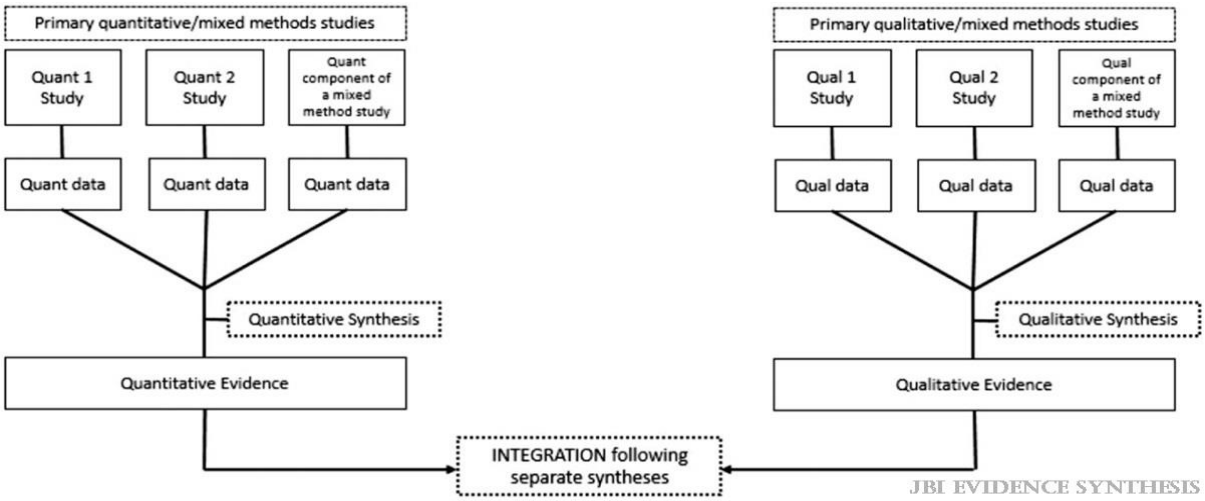

Figure 2.1 Conceptual representation of convergent segregated data analysis process. *(Image taken from JBI Evidence synthesis [157]).*

Quantitative synthesis

Data extracted from quantitative studies focused on the rate of misdiagnosis and the authors' perceived causes of misdiagnosis. Data reporting the number of patients identified as misdiagnosed with COPD as well as their corrected diagnoses were available was extracted from the quantitative components of the included studies. Alongside this quantitative data, where the authors expressed their perceived causes of misdiagnosis with COPD the relevant text was extracted to provide clarification of the quantitative data where able.

Studies were sub-grouped according to geographical region and the quantitative data for each region was tabulated and analysed using descriptive statistics. The data was then reviewed using a narrative approach to

produce a report regarding the rate of misdiagnosis and perceived causes for each geographical region. A meta-analysis was not possible due to the high level of heterogeneity amongst the included studies.

After reviewing the corroborative and contradictory findings from the reports for each geographical region, the findings were summarised into a final synthesis for the quantitative component of this systematic review.

Qualitative analysis

Qualitative data was synthesised using the meta-aggregation method. Themes and their narrative explanations were identified as 'findings' within the qualitative data components of the included studies. Participant quotes reported by authors to clarify their themes were identified as 'illustrations'. Extracted findings and their accompanying illustrations were included in the qualitative synthesis for this review. Findings initially underwent descriptive coding by two reviewers (KP and PC) independently and were subsequently categorised following reviewer discussion. Once findings were allocated to categories, the categories were summarised with supporting evidence from the extracted findings and illustrations. The category summaries were developed through discussion between two reviewers (KP and PC). The category summaries were then further reviewed by two reviewers (KP and PC) to identify corroborative and conflicting outcomes. Then through discussion between the two reviewers (KP and PC), overarching themes between categories were identified and formed the final synthesis of the qualitative data.

Integrated analysis

The synthesised outputs of the quantitative and qualitative data were then juxtaposed to identify how the two sets of outputs compliment and conflict with each other. Links were identified where the qualitative data was able to clarify or refute quantitative findings and vice-versa. These links were then discussed with a second reviewer (PC) in order to minimise interpretation bias, disagreements regarding the integration of the qualitative and quantitative data were resolved through discussion. These linkages formed the basis of the integrated analysis and were used to formulate the final output of the data analysis process illustrated in Figure 2.1. The integrated analysis was completed in accordance with JBI recommendations using a structured approach to develop a configured analysis [157].

2.3 Results

2.3.1 Study inclusion

Studies were identified using the search strategy detailed in section 2.2 Methods. The results of the search are reported in full and presented using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram in Figure 2.2. Following removal of duplicates, 8914 abstracts were screened against the inclusion and exclusion criteria. Following screening, 396 full texts were reviewed of which 38 were included in this systematic review. Of the 38 included studies; 27 were quantitative, six were qualitative and five were mixed methods studies. Two of the mixed methods studies were used in both the qualitative and quantitative syntheses, one study solely had relevant quantitative data and was used only in the quantitative synthesis, two studies solely had relevant qualitative data and were used only in the qualitative synthesis.

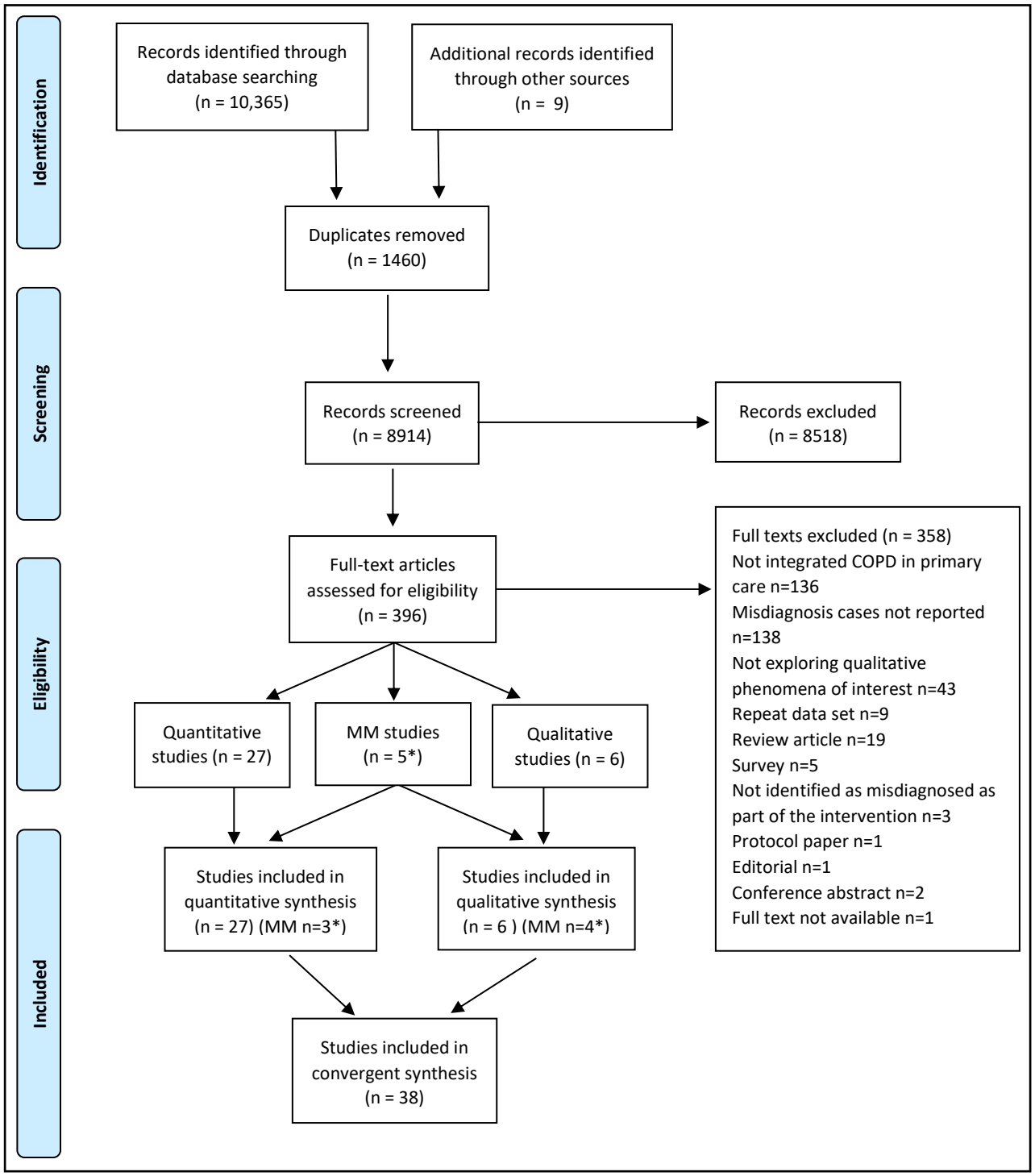

Figure 2.2 PRISMA flow diagram. MM: Mixed Methods; *2 studies used for both qualitative and quantitative synthesis, 2 studies used only for qualitative synthesis and 1 study used only for quantitative synthesis.

2.3.2 Study characteristics

Studies were initially categorised in accordance with the MMAT algorithm shown in Appendix 3[160] to aid with methodological quality assessment. 30 studies were included in the quantitative synthesis, tables detailing the characteristics of the studies included can be found in Appendix 4, a summary is shown in Table 2.1.

10 studies were included in the qualitative synthesis of which four were mixed methods studies and six solely utilised qualitative methodology. Qualitative data was collected using either semi-structured interviews or focus groups, with only one study using unstructured written feedback. Tables detailing the characteristics of studies included in the qualitative synthesis can be found in Appendix 4.

Characteristic		**Range/no. of studies**
Study design	Non-comparative – Cross sectional	17
	Observational – Before and after study	7
	Randomised controlled trial (RCT)	1
	Cluster RCT	1
	Non-randomised trial	1
	Mixed methods - RCT	1
	Mixed methods – Cross sectional	1
	Mixed methods – Observational	1
Mean age		52.9 – 72.5
Male %		37.5% - 82.7%
Participants		11 - 14572
Setting	GP	20
	Community	6
	Secondary care	4
COPD diagnostic criteria	$FEV_1/FVC < 0.7$	27
	$FEV_1/FVC < 0.7$ and <LLN	2
	Not stated	1

Table 2.1.Summary of characteristics of studies included in quantitative synthesis.

2.3.2 Methodological quality

The methodology of the included studies was assessed against MMAT criteria to identify areas of weakness within the methodology of the studies. The developers of MMAT discourage the use of scoring based on the MMAT assessment therefore studies have not been scored for methodological quality. An overview of the MMAT assessment report can be found in Appendix 4. Solely qualitative studies did not raise any concerns during quality assessment. Two quantitative studies[161, 162] did not adequately represent the target group. Two mixed methods studies[163, 164] did not report sufficient qualitative evidence to corroborate their findings, one[164] of which also did not adequately integrate their qualitative and quantitative findings. Lanning et al [164] was not included in the qualitative synthesis based on lack of qualitative evidence, Gillett et al [163] was included in the qualitative synthesis as the authors' narrative was used to clarify their qualitative findings.

2.3.3 Qualitative data synthesis

Qualitative analysis was completed using meta-aggregation methodology.[157] 144 findings were extracted from the ten studies included for qualitative synthesis. Six categories were derived from the extracted findings,

which were then reviewed for similarities and overarching descriptions, resulting in three synthesised findings being produced. An overview of the meta-aggregation process of synthesising findings from categories is illustrated in Figure 2.3.

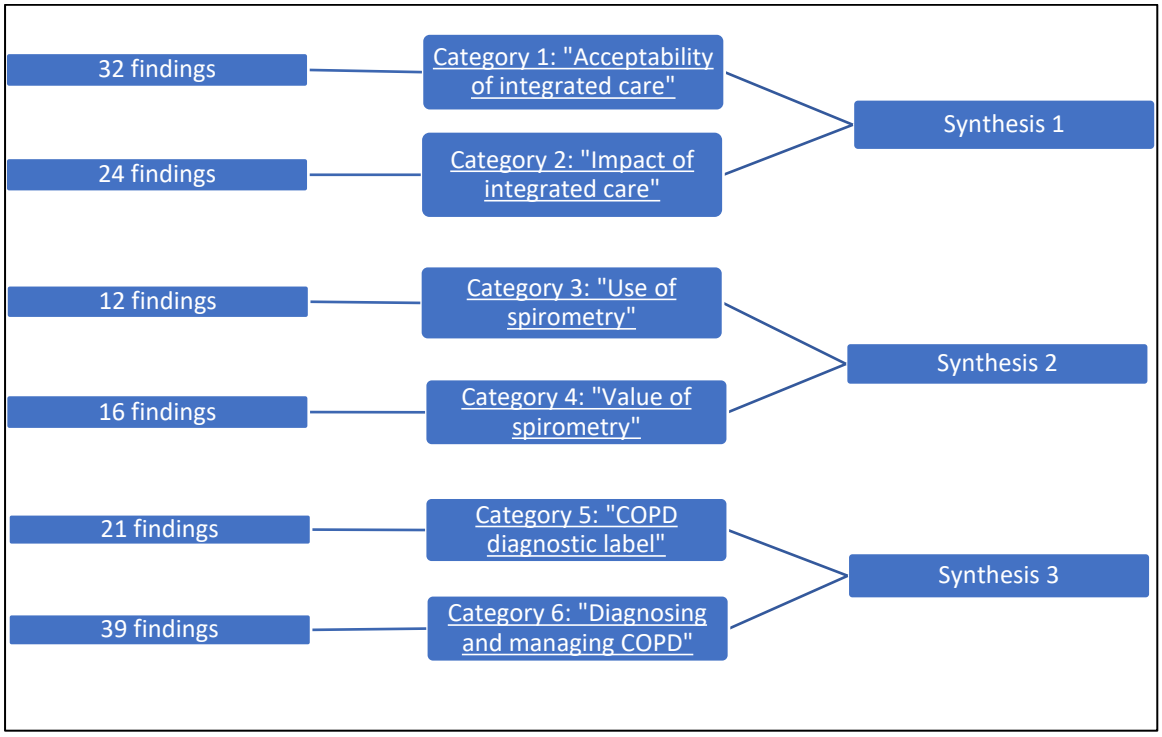

Figure 2.3 Meta-aggregation of qualitative findings. Findings were reviewed and summarised into 6 categories, that were cross referenced for similarities to produce the final syntheses.

2.3.3.1 Categories

Category 1 "Acceptability of integrated care"

This category reports on the perceived benefits and disadvantages of integrated COPD care and is supported by 32 extracted findings which were separated into primary care HCPs perceptions and patients' perceptions. Overall, the findings report a positive perception of integrated care, however, primary care HCPs had reservations regarding implications on finances and resources.

Primary care HCPs perceptions-

Primary care HCPs were positive about the use of integrated care for case finding and understood that it would benefit patients and improve the care delivered.

> *"That's how I would like to work, where you're targeting the people, the actual patients that may well have COPD but haven't yet presented for anything to do with COPD. I think it would*

be so much better to be able to do that rather than the opportunistic. [Practice Nurse 29213, Female]" (illustration from [165])

However, a recurring drawback was the perceived negative impact case finding would have on primary care resources and finances.

"The cost [of targeted case-finding]. […] Someone to search the people, someone to call the people, the nurse then to see them, the healthcare support worker to do the spirometry, etcetera, etcetera, and as I said, it's difficult. We're finding it very difficult in our practice at the minute anyway for appointments' (Nurse Practitioner29216, Female)" (illustration from [165])

If resources and funding could be provided, then primary care HCPs felt there would be benefit to an integrated care intervention focused on case finding.

"Provided the time and resource, […] and if you can wrap it up with some education then it's a win for the practice in terms of education. […] make sure that the practice sees that both them and their patients are getting something positive out of it and it isn't going to be too time consuming." [GP 23109, Male]" (illustration from [165])

Patient perceptions-

Patients perceived integrated care as a positive intervention to solve many of the issues with existing services. Improved communication between hospital and primary care was perceived to lead to improved follow up care.

"When the health centre (the community nurses headquarter) is told that I have come home, then I would like them to contact me, because I do need them to come. [Individual interview, female patient recently discharged from hospital]" (illustration from [166])

Patients perceived specialists were better equipped to manage COPD when compared with their GP and would prefer more direct access to specialists. Patients also perceived specialist care in the community would prevent hospitalisation.

"Most participants preferred contact with specialists over contact with GPs because of the specialists' expert knowledge and because many patients had experiences of GPs neither caring nor having sufficient knowledge about COPD" (finding from [166])

"Participants reported that they had no access to the pulmonary outpatient clinic outside of scheduled appointments, but they expressed a wish for easier access, e.g., over the telephone or by computer." (finding from [166])

"Participants suggested bringing specialist care into patients' homes by educating and equipping GPs, community nurses and home helpers to care for patients at home with stable

symptoms and, during periods of symptom instability, to prevent or delay hospitalization" (finding from [166])

Category 2 "Impact of integrated care"

"Impact of integrated care" is based on reports from stakeholders (HCPs, patients, and relatives) regarding their lived experience of being involved in an integrated COPD care intervention and the impact of that experience. The category is supported by 24 extracted findings, which were separated into experiences for each stakeholder group. Overall, the findings indicate involvement in an integrated care intervention was a positive experience. Extracted findings comprised feedback from HCPs, patients and relatives involved in integrated care telemonitoring, specialist led clinics in primary care and community based pulmonary rehabilitation.

HCP experience-

Primary care HCPs experienced a greater confidence with using and interpreting spirometry and felt this led to improved teamwork and patient care.

"Some PNs used the spirometry in discussions with the GP to facilitate teamwork and as a joint learning opportunity." (finding from [167])

"All PNs valued the training and felt that they had improved their technical and interpretative spirometry skills." (finding from [167])

Primary care HCPs had positive responses to specialist led education as part of integrated care provision and felt this led to a change in practice to improve patient care.

"Taking part in the study provided a catalyst for some practices to rethink the way that they organized care, moving from reactive to more proactive care." (finding from [167])

However, there was concern that telemonitoring led to increased antibiotic usage, and it was uncertain if this was appropriate or not.

"But quite what effect all these antibiotics are going to have at the end of the line is a different story. It may be good if it keeps them out of hospital or if it makes them feel better generally, but I think … these drugs are not without side effects.[GP 1]" (illustration from [168])

Patient experience-

Patients appreciated primary care staff being able to utilise specialist knowledge to improve the care they received.

> *"And she explained to me […], what the printout meant, and what my results were in relation to what it should be.[Male 71 y, Practice 1]" (illustration from [167])*

Patients felt specialist integration using telemonitoring provided an automated service of care, reducing time wasted before treatment for exacerbation.

> *"Patients consistently expressed anxieties about managing exacerbations, describing the difficulty of recognising the onset of an exacerbation, delays as they considered whether to seek professional advice, and the practical barriers to accessing professional care. Tele-monitoring was almost universally considered by both patients and their carers as helping to address these problems. The technology was perceived as being able to detect the early signs of an exacerbation (even before the patient realised he/she was ill) and, by providing a tangible symptom score, both validated the decision to seek help and ensured a prompt appointment." (finding from [168])*

Patients using telemonitoring valued the relief and sense of security it provided, however, this was noted to be potentially harmful as it led to a relaxing of their vigilance regarding health.

> *"You would have thought that they could have picked it up. With people of my age you would have thought that was one of the things they would have been looking for, you know, if someone has a low pulse rate.[Male patient, 78 yrs, post-installation]" (illustration from [168])*

Patient relatives' experience-

Relatives of patients with COPD had provided positive feedback from an integrated intervention focused on patient education and rehabilitation.

> *"A sense of deepened understanding - Noticing changes in patient's health" (finding from [169])*

It was noted that relatives felt the education helped change how they viewed the patient and the disease.

> *"I must say that I really learnt a great deal. I did that when I was allowed to attend that day, and learnt that sometimes it is impossible to make demands. Previously, I would come home from work and say 'but were you not out today, you must go out every day' and things like that. But I learnt here that one does not always have the strength to go out every single day. Yes, it was excellent, really excellent. [S711]" (illustration from [169])*

Relatives appreciated being involved in the care process and receiving support from the integrated care intervention.

> *"A sense of relief of burden - Support of others in the same situation" (finding from [169])*

Category 3: "Use of spirometry"

This category is based on the 12 extracted findings that reported factors influencing spirometry use in primary care. The findings indicate there are both enabling factors and barriers to spirometry use in primary care. Specialist led support and education are perceived as an enabling factors as primary care staff felt greater confidence to perform and interpret spirometry. Having spirometry within primary care is also seen as an enabler due to ease of access to the service. However, time required by nurses to perform spirometry and difficulty in retaining skilled nurses are perceived as healthcare related barriers to spirometry use. Cost of spirometry is a patient related factor perceived to reduce compliance, however, is only applicable to regions where patients are required to pay for healthcare.

Enabling factors-

Education and support from specialists provided practice nurses with the confidence to perform and interpret spirometry. Additionally easy access to spirometry when available in practices promoted its use.

> *"The PNs valued the feedback from the pulmonary physiologist on their spirometry technique and they were able to use this to improve their skills. They were also positive about their experience working with patients to address health issues such as smoking.." (finding from [167])*

> *"While time was an issue, having the spirometry in-house was a facilitator." (finding from [167])*

Barriers-

Time required to perform spirometry acted as a barrier to its use.

> *"It takes at least about half an hour because you've got to do the pre [spirometry]. First of all they want to know what the study is about. […] then you have to explain what COPD is, then you have to go through how you want them to do the spirometry and you go through the spirometry, then you get them to have a 10 minute wait by the time you work it out […] and by the time you get to the end of it you [are] ticking on for 45 minutes.[PN5, Practice 5, Intervention]" (illustration from [167])*

Loss of skilled staff acted as a barrier due to the time required to train new staff to perform spirometry in addition to the cost of providing the service.

> *"There was a high turnover of PNs in the study (~25%), which meant that practices lost the increased skills of the trained PN." (finding from [167])*

> *"Cost a disincentive without appropriate funding" (finding from [170])*

The perceived negative impact on the patients financial situation was also seen as a barrier to provide an adequate spirometry service.

> *"Although most PCPs agreed that provider preference was the most common reason spirometry was not obtained in a work-up of a patient for COPD, patient related factors were mentioned. Some providers felt that patient's would not follow up with the test even if it was ordered because it required taking time off from work, finding transportation, re-ordering patient priorities, and co-payments for services. Finally, health insurance was perceived as a barrier in that some insurances may not always cover spirometry and some require a referral to another physician. However, most PCPs did not believe these patient related and health systems related barriers were unique to spirometry testing." (finding from [171])*

Category 4 "Value of spirometry"

Findings that reported perceived importance/lack of importance of spirometry to diagnose COPD in primary care are categorised as "value of spirometry". Based on the reports from 16 extracted findings we found that spirometry is seen as a useful tool when managing patients with COPD by some, however, GPs questioned its necessity when diagnosing COPD and place greater importance on clinical assessment.

Spirometry perceived to be important-

Spirometry was seen as a useful tool help confirm a diagnosis of COPD and classify the severity. Additionally, spirometry was also perceived to provide objective measures that can be compared over a period of time to determine if patients are deteriorating.

> *"Objective measurement useful in future" (finding from [170])*

> *"Use in differential diagnosis" (finding from [170])*

> *"Classifying the severity of COPD" (finding from [170])*

Spirometry results were also perceived as a useful aid to promote smoking cessation, through visualising the severity of the patient's disease using the flow graph.

> *"Personalise quit advice" (finding from [170])*

Spirometry perceived not to be important-

Primary care staff felt that spirometry was not needed for diagnosing COPD, when confident of the diagnosis based on clinical assessment. GPs were reassured of the correct diagnosis if they witnessed a positive response to treatment.

> *"Emphasis on clinical basis for diagnosis of respiratory disease" (finding from [170])*
> *"First, they felt very confident in their diagnosis after obtaining a history from the patient, especially if the patient responds to a trial of inhaler pharmacotherapy." (finding from [171])*

> *"Second, when PCPs felt confident in their diagnosis, they were unlikely to change their management regardless of the spirometry results." (finding from [170])*

GPs also perceived spirometry as a tool that did not lead to any change in patient outcomes, thus felt it to be unnecessary.

> *"Finally, some PCPs did not believe that spirometry actually made any difference in patient outcomes in those with COPD." (finding from [170])*

GPs cited confusion amongst specialist regarding the spirometry criteria for diagnosing COPD as a reason to not use spirometry.

> *"PCPs were also not confident of and/or confused by the pulmonologist and their definition of airways obstruction. This seemed to further their confidence in their own diagnosis of COPD in the absence of spirometry." (finding from [170])*

Category 5: "COPD diagnostic label"

This category consists of 21 extracted findings that report the thoughts of patients and HCPs regarding COPD as a diagnostic label and the perceived impact the label has on patients. Findings focus on the value of a COPD diagnosis, however, also report perceived understanding of the term COPD.

There are contrasting findings between HCPs and patients regarding the impact of being diagnosed with COPD. GPs often felt labelling patients with COPD would lead to limited benefits but cause stress and anxiety. However, patients report that being informed of a COPD diagnosis would prompt a positive change in lifestyle and would

prefer to be fully informed. Findings also report greater familiarity with the term “emphysema” over “COPD” amongst patients.

Value of diagnosis-

GPs were reluctant to inform patients or label patients as having COPD due to the perceived negative impact it would have on the patient, which may have stemmed from personal perceptions of COPD.

> *“Potential drawbacks to diagnosing COPD were noted across all interviews. It was recognised that, for patients, receiving a COPD diagnosis could entail stress, worry and stigmatisation. People also commented on the personal financial ramifications of diagnosing someone with COPD, such as increased insurance costs, adverse effects on an individual’s occupation, and unnecessary medicalisation.” (finding from [165])*

> *“Negative personal assessments of COPD were held by GPs and this could influence them against communicating the diagnosis” (finding from [172])*

There were contrasting perceptions between GPs and patients regarding the benefit of informing patients of their COPD diagnosis. In particular, surrounding the impact on lifestyle and smoking cessation. Some GPs felt a COPD diagnosis would not have an impact of likelihood of quitting smoking.

> *“A major disadvantage of withholding a diagnosis is potentially losing the opportunity for preventing deterioration by achieving smoking cessation. GPs appeared pessimistic that a diagnosis of COPD could assist patients to stop smoking” (finding from [172])*

However, patients perceived a diagnosis of COPD and physician advice as a catalyst to stop smoking.

> *"The doctor told me ‘Smoke or die’. So I gave up. That is when I first had an outbreak of emphysema.(Female, 60)” (illustration from [172])*

GPs had contrasting views regarding the benefit of informing patients of their COPD diagnosis. Some felt there was no benefit gained from informing patients of their diagnosis. Whereas some GPs and patients felt informing patients and educating regarding COPD would ultimately lead to improved care and healthcare savings.

> *“Formal diagnosis was often delayed as no apparent advantage was seen by GPs in applying the diagnosis” (finding from [172])*

> *“All the participants considered diagnosing COPD to be important. Advantages ascribed to diagnosing COPD included: giving patients the knowledge, and possibly motivation, to make positive lifestyle changes; ensuring medical management was optimal, thereby enhancing patient quality of life; and saving NHS resources through reduced admissions for exacerbations and other problems associated with COPD.” (finding from [165])*

"Patients expressed frustration when not given a diagnosis. Delay meant doctors often failed to provide information about COPD, causing patients to seek information elsewhere, or remain poorly informed" (finding from [172])

There were contrasting views regarding early diagnosis of COPD between primary care health care professionals. Some felt that early diagnosis led to improved care and prevented progression of disease, however others viewed early diagnosis as a "luxury" in the current climate of limited healthcare resources.

"A majority of GPs and nurses (23/26) argued that diagnosing COPD as early as possible was key, including those with mild COPD." (finding from [165])

"While these GPs considered diagnosing people with mild COPD to be beneficial if it resulted in smoking cessation, no other benefits to diagnosing COPD in the mild stage were perceived. Furthermore, they viewed the consequence of having to see those with mild/asymptomatic COPD for annual review as placing unnecessary strain on already stretched services. A practice manager, who described proactively diagnosing cases (of any condition) earlier as "a luxury", epitomised this view." (finding from[165])

Diagnostic terminology-

There was often confusion amongst patients regarding the correct term for their respiratory condition, with most having a familiarity with the term emphysema but not COPD. However, GPs public understanding of COPD to be poor.

"The diagnosis of COPD was rarely named directly by any patient. When asked to describe their illness, 13 interviewees used the term emphysema, one used COPD in addition to emphysema and one called it asthma. The diagnosis was rarely given as a direct, specific answer. Frequently it was qualified with a description of another perceived prior respiratory condition, usually ''asthma''" (finding from [172])

"GPs would generally use the term ''emphysema'' to a patient when they made a diagnosis of COPD as they felt patients were familiar with emphysema but did not understand the acronym." (finding from [172])

Category 6: "Diagnosing and managing COPD"

39 extracted findings that report thoughts and perceptions surrounding the diagnostic process of COPD and its management form this category.

Findings report that there is a perception of teamwork within primary care between GPs and practice nurses working towards diagnosing patients with COPD. Contrasting views emerged when reviewing findings regarding the diagnostic process. There are conflicting views regarding the necessity of spirometry to confirm a COPD

diagnosis, which overlaps with category 4. There are also contrasting views regarding approach to diagnosis, with two approaches emerging- proactive and reactive. Multiple healthcare related barriers to accurate diagnosis are reported in the findings reviewed, with lack of spirometry and lack of knowledge being perceived as the most important. Patient related barriers include a perception of poor public awareness of COPD, which is thought to lead to poor compliance with healthcare.

Teamwork-

Reported findings indicate there is a perception that practice nurses and GPs have set roles in the diagnostic process. Practice nurses felt their role was to perform spirometry and provide GPs with the results to then be interpreted, a perception that was mirrored by patients as well.

> *"neither [PNs] were particularly inclined to make their own interpretations. So what they did was to do the spirometry which they did well […] and then once the results were there the doctor was able to make comment and seen where things could have gone from there.[GP1, Practice 3, Intervention]" (illustration from [167])*
>
> *"These differences in roles were reflected in the patient comments." (finding [167])*

However, GPs felt that training helped make practice nurses capable of performing and interpreting spirometry to confirm a diagnosis of COPD.

> *The GPs felt that because of the PNs new skills the practice was better at identifying and managing patients with COPD. (finding from [167])*

Staff and patients perceived there to be an element of teamwork when deciding the diagnosis and management of COPD, however, this perception was not universal.

> *"This teamwork was reflected in the patient's description of the way the GP and PN worked." (finding from [167])*
>
> *"Once the diagnosis of COPD had been made, there was little evidence of teamwork to manage the condition and this seemed to be related to existing perceptions of professional roles and organizational culture within the practice." (finding from [167])*

Diagnostic process-

The reported findings suggest there is variation in how COPD is diagnosed, broadly grouped into GPs who do and GPs who don't use spirometry to confirm a diagnosis of COPD.

> *"When PCPs took care of a patient who had a COPD diagnosis and were using respiratory medications prior to being seen by them, they did not routinely confirm the diagnosis when past spirometry was not available, especially if the patient had other medical problems." (finding from [171])*

> *"Spirometry was described as essential for making a diagnosis of COPD[...]" (finding from [134])*

GPs not using spirometry to diagnose COPD, favoured risk factors and clinical features to guide their diagnosis. These GPs felt patients evolved into their diagnosis of COPD following multiple presentations with respiratory symptoms and sometimes following a trial of inhaled treatment.

> *"If the patient was of the appropriate age with a smoking history and/or did not have any self-reported symptoms and/or had other acute medical problems, most physicians would not reinvestigate the diagnosis of COPD." (finding from [171])*

> *"Diagnosis was often preceded by frequent presentation by patients to a GP" (finding from [172])*
> *"Treatment was usually initiated before formal diagnosis of the emerging clinical picture by the GP" (finding from [172])*

Where the diagnosis was not formalised in primary care it was often made following a hospital admission.

> *"Eventually, formal diagnosis often resulted from admission to hospital for an acute exacerbation of COPD" (finding from [172])*

> *"Extraction of data from practice records contemporary with the time of diagnosis was possible for 10 participants and this confirmed that of those, seven had the diagnosis of COPD made in hospital. More unusually, the diagnosis resulted from the process of ''gradual evolution'' in patients being seen regularly" (finding from [172])*

Timing of diagnosis was debated in the reported findings with two views emerging: reactive and proactive diagnosis.

> *"Participants mainly reported that patients were investigated for COPD on an opportunistic basis when consulting the health services, particularly when presenting with suggestive symptoms. Others discussed using a more active approach such as screening at smoking cessation clinics. A wide range of factors were considered to be important triggers for considering COPD, such as smoking status and a history of asthma. Participants also*

highlighted the potential of clinical information systems to help identify and flag high-risk patients." (finding from [134])

Reactive diagnosing was advocated on the basis that patients who present with symptoms are more likely to be compliant with treatment.

"The other GP argued that opportunistic case-finding was more likely to yield a population amenable to behaviour change, in contrast to targeted case-finding, which he considered more likely to identify those who were not ready for advice or intervention." (finding from [165])

Proactive diagnosing was felt to be difficult to achieve due to lack of standardised electronic coding of risk factors to identify patients.

"Staff use different terms/approaches to electronic documentation ('read coding') within and between practices—so reliability of electronic searches may be poor" (finding from [165])

However, use of screening spirometers and prediction tools were thought to be a viable option for proactive diagnosing.

"[…]Handheld flow meters were also described as quick and easy to use within a consultation."(finding from [134])

"Most participants felt that the use of electronic risk prediction tools would be useful for identifying patients at high risk of undiagnosed COPD[…]" (finding from [134])

Barriers to accurate diagnosis in primary care-

Limited resources and funding were perceived as the most important barriers to proactive diagnosing in primary care.

"Limitation of time, finances, and resources were seen as important barriers to implementing case finding and diagnosing COPD. Participants felt that primary care services were already stretched to capacity managing patients with established COPD and a lack of additional funding and resources would prohibit the implementation of case finding." (finding from [134])

There was a perception of limited knowledge and skill amongst primary care HCPs, which acted as a barrier to accurate diagnosis of COPD. However, it was felt that the impact of poor knowledge could be mitigated with training and access to specialist support.

> *"There was also felt to be a significant lack of knowledge and expertise on COPD in primary care. This included poor understanding of spirometry; difficulties distinguishing between COPD, asthma, and COPD–asthma overlap disease; and underrecognition of the signs of COPD." (finding from [134])*

> *"Access to community respiratory services, including specialist COPD nurses, and support from secondary care and community outreach were also seen as important, particularly since expertise on respiratory medicine in primary care was generally perceived to be low. Participants also discussed the importance of sharing diagnostic services between practices, which was especially important for smaller practices with limited service capacity." (finding from [134])*

> *"Training of health professionals was seen as one of the key facilitators for case finding and diagnosing COPD[…]" (finding from [134])*

Limited access to quality assured spirometry within primary care was identified as a barrier to accurate diagnosis in primary care. However, the emergence of specialist led spirometry services in the community can potentially minimise the impact of limited primary care spirometry.

> *"Limited access to diagnostic services was also cited as a barrier, particularly in smaller practices, which often lack provision of in-house spirometry. Challenges to providing spirometry included costs of equipment and training, quality assurance, and availability of appropriately trained staff." (finding from [134])*

> *"However, some participants did comment on the gradual improvement of diagnostic testing for COPD in the community" (finding from [134])*

In addition to healthcare related factors, patient factors were also perceived to play a role in preventing accurate diagnosis of COPD. Poor compliance with healthcare surveillance was perceived as an important factor, which was thought to stem from lack of public awareness of COPD.

> *"Several patient-related factors were also described as barriers to diagnosing COPD. These included poor attendance in primary care and late presentation with advanced disease." (finding from [134])*

> *"There was also a view that awareness of COPD among the general public was low, that patients were more likely to be aware of the more severe stages of the disease, and that smokers with undiagnosed COPD often have low expectations of their health. They also felt that communicating information about COPD was challenging." (finding from [134])*

2.3.3.2 Synthesised findings

Synthesis 1: Integrated care is perceived as a viable option to improve the care of patients with COPD, provided it is funded and resourced appropriately.

This synthesis was based on the findings reported in categories 1 and 2. Reviewers found both categories focused on integrated COPD care interventions and contained feedback from stakeholders as a whole rather than one specific component of integrated care. The summaries of both categories were interpreted by reviewers to indicate an overall acceptance of integrated COPD care as its benefits outweighed its drawbacks. However, adequate funding was interpreted as an important factor in accepting its implementation.

Synthesis 2: Spirometry is not universally utilised in primary care due to a perceived lack of value added and barriers to its use, integrated care is perceived as an enabling factor to spirometry use in primary care.

This synthesis was derived from the reported findings in categories 3 and 4. Reviewers identified that the focus of these categories was spirometry in primary care, either as a part of an integrated care intervention or usual care. Discussion of these categories led to debate between reviewers as to whether negative perceptions towards spirometry held by GPs was due to lack of COPD knowledge or due to personal factors such as GP age and training. However, with the limited data available this could not be further explored. Interpretation of the findings from categories 3 and 4 was that spirometry use in primary care was variable in the included studies due to a combination of HCP perceptions and barriers to spirometry access. However, the studies generally showed that integrated care interventions promoted spirometry use.

Synthesis 3: Limited knowledge and negative perceptions of COPD combined with limited diagnostic ability in primary care hinders the validity of COPD diagnoses made in primary care. Specialist support through integrated care interventions could improve diagnostic validity.

This synthesis was generated based on the reported findings from categories 5 and 6. Both categories focused on thoughts and perceptions of the whole process of being diagnosed with COPD from initial patient symptoms to formalised diagnosis and being informed. Reviewers indicated that HCP perceptions toward COPD and diagnostic ability was variable in the included studies. Negative perceptions and limited diagnostic ability were interpreted as important factors leading to poor diagnostic validity. However, integrated care was interpreted by reviewers as being perceived as a solution to poor COPD diagnostic validity in primary care.

2.3.4 Quantitative data synthesis

Extracted quantitative data was analysed in depth using narrative synthesis divided into 5 subgroups based on geographical regions (Europe, UK, Australia, North America, South America and Asia). Division according to geographical region was chosen so as to allow fair comparison between studies within each subgroup, as each region is expected to have similar healthcare provisions and culture. A summary of the misdiagnosis rate for each region has been illustrated using a boxplot presented in Figure 2.4.

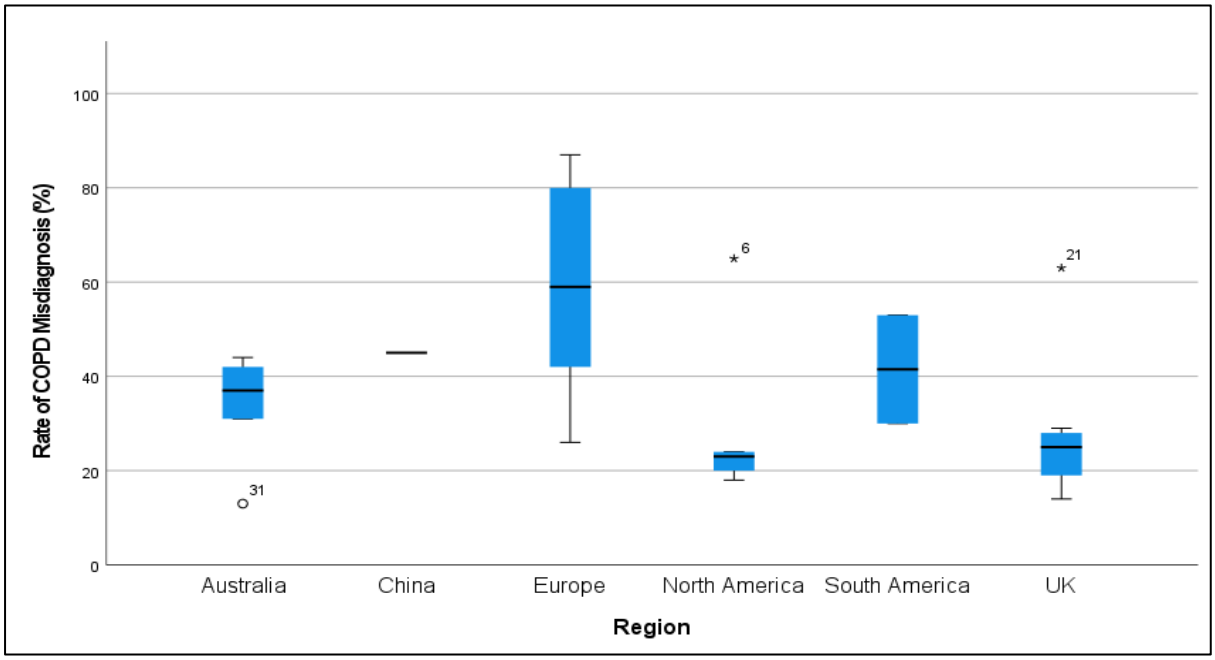

Figure 2.4 Boxplot summarising rate of COPD misdiagnosis across 5 regions. Represents the distribution of COPD misdiagnosis rate represented as a percentage within each region included within the quantitative analysis. Outliers are represented with a star or circle with study ID identified.

North America

Within North America five studies were included, two from Canada [173, 174] and three from USA [175-177]. The study methodologies were variable with two studies being observational [173, 177], two studies being non-comparative [175, 176] and one being a randomised controlled trial [174]. The characteristics of the integrated care interventions of the included studies are shown in Table 2.2.

All five studies defined COPD based on GOLD diagnostic criteria, in particular FEV_1/FVC ratio of less than 0.7. The studies utilised multiple components of integrated care, however, a common feature across all studies was the use of specialist led spirometry as part of the integrated care intervention. This is understandable as spirometry is required to confirm diagnostic accuracy.

A Canadian RCT assessing the impact of integrated care on quality of life[174], confirmed diagnostic accuracy in all patients prior to randomisation as part of its integrated care service. As a result, a larger population were subjected to diagnostic testing in comparison to the other studies within this subgroup, which were limited to smaller populations receiving the integrated care intervention. However, the study did not provide additional information regarding patients identified as misdiagnosed and reported the number within its list of excluded participants.

However, Ghattas et al[176] focused on identifying misdiagnosis within primary care and suggested difficulty differentiating between COPD and asthma was a cause for misdiagnosis in primary care. This was based on the finding that 35% of the misdiagnosed patients in this study had reversible airflow obstruction suggestive of asthma. Ghattas et al[176] was an outlier within this subgroup with a higher rate of misdiagnosis, this likely due to the study targeting poorly served communities who often did not have health insurance and due to the cost of spirometry did not complete spirometry at the time of COPD diagnosis. The cause of misdiagnosis was not discussed in all 5 studies, however, the authors of two studies[173, 176] identified difficulties with access and use of spirometry in primary care as the root cause of misdiagnosis.

Study ID	Ref#	Country	Year of intervention	Methodology	Setting	Study aim	Description of intervention	Components of integrated care	Diagnostic criteria	Confirmed pre-existing COPD Diagnosis (n)	Identified as misdiagnosed (n)	Misdiagnosis rate (%)
2	[173]	Canada	Jan 2013 - Mar 2014	3 - Observational (Before and After study)	GP	Assess impact of self management coaching on quality of life.	Respiratory therapists working alongside GPs in primary care. Patients attended 4 visits and received COPD education and spirometry & clinical assessment.	Self-management, Patient Education, Case management, Medication optimisation, Spirometry	GOLD 2016, Fixed ratio	54	13	24%
4	[175]	USA	2008 - 2010	4 - Non comparative	GP	Assess value added by pharmacist led spirometry	Pharmacist with lung function certification providing spirometry services within primary care, in addition to services normally provided by pharmacists.	Spirometry, Medication optimisation, Smoking cessation	GOLD 2009, Fixed ratio	11	2	18%
6	[176]	USA	*Feb 2011 - June 2012*	4 - Non comparative	Community	Identify patients misdiagnosed with COPD	Specialist led spirometry in community hub to confirm diagnosis within primary care.	Spirometry	GOLD 2011, Fixed ratio	80	52 (34 No obstruction, 18 reversible obstruction)	65%
22	[177]	USA	*Not stated*	3 - Observational (Before and After study)	GP	Assess adequacy of office spirometry in primary care	Specialist led spirometry training for primary care staff. Specialist over-sight of spirometry interpretation.	Spirometry, Staff Education	GOLD 2007, Fixed ratio	100	23 (18 No obstruction, 5 Restriction on spirometry)	23%
24	[174]	Canada	*Nov 2011 - Jan 2014*	2 - RCT	GP	Develop an integrated COPD intervention that includes case management, patient education and accurate diagnosis. Then assess impact of quality of life.	Specialist led spirometry, case management, education, and skills training, including self-management. Within primary care.	Follow up, Self-management, Case management, Patient Education, Spirometry	GOLD 2017, Fixed ratio	1186	240	20%

Table 2.2 North America subgroup - Summary of integrated care interventions and rate of misdiagnosis.

United Kingdom

In the UK, eight studies were identified as meeting the criteria of integrated care and reported their number of misdiagnosed patients. The studies spanned from 1997 to 2015 and included four descriptive studies [124, 178-180], three non-randomised trials [162, 181, 182] and one mixed methods study that used non-randomised trial methodology for the quantitative component [164]. A summary of the studies in this subgroup is shown in Table 2.3.

Four out of the eight studies utilised multiple components to deliver their integrated care intervention [164, 179-181]. Spirometry was the common component of integrated care utilised in all studies except one [181]. The study by Angus et al[181] provided specialist input in primary care through the medium of specialist computer software rather than human interaction as seen in the other studies.[181] However, despite this difference, the study had a similar rate of misdiagnosis when compared to other studies within the subgroup that utilised specialist led spirometry.

The diagnostic criteria applied to patients in this subgroup varied due to the time span over which the interventions had been delivered, however, a common feature in each criteria was the necessity of an FEV_1/FVC ratio <0.7 to have been defined as having obstructive airways. Patients were identified as having been misdiagnosed by authors using the criteria in use at the time of the intervention.

The rate of misdiagnosis ranges from 14% to 63% within this subgroup, study 21[162] was an outlier within this subgroup with a higher rate of misdiagnosis. This is likely to be due to the intervention targeting patients that the GP had themselves identified for diagnostic review due to uncertainty regarding the original COPD diagnosis.

Five studies in this subgroup reported the corrected diagnosis following integrated care intervention [124, 162, 178, 181, 182]. The commonest corrected diagnoses were normal lung function and asthma as shown in Table 2.4. Authors from all five studies [124, 162, 178, 181, 182] indicated difficulties with spirometry in primary care to be a key factor leading to misdiagnosis. Poor spirometry quality and interpretation was identified as a cause of misdiagnosis in three studies [178, 181, 182] where the authors suggested that their integrated care interventions were able to improve spirometry quality and subsequent diagnostic accuracy. Underutilisation of spirometry to diagnose COPD was also identified as a cause of misdiagnosis in two studies [124, 162], where authors noted primary care teams were at times diagnosing COPD solely on patient reported symptoms. Authors

of two studies [179, 180] indicated difficulty differentiating COPD from other respiratory conditions in particular asthma was a key factor leading to misdiagnosis in primary care.

Study ID	Ref#	Year of intervention	Methodology	Setting	Study aim	Description of intervention	Components of integrated care	Diagnostic criteria	Confirmed pre-existing COPD Diagnosis (n)	Identified as misdiagnosed (n)	Misdiagnosis rate (%)
1	[181]	Not stated	3 - Non-randomised trial	GP	Assess impact of specialist software on diagnosis and management of COPD	Specialist software guiding COPD review in primary care, embedded with guidelines and treatment algorithms.	Follow up, Case management	NICE 2010, Fixed ratio	236	69 (30 Normal, 15 Restrictive defect, 12 Asthma, 10 Cardiac pathology, 2 Bronchiectasis)	29%
8	[178]	*Feb 2005 - Mar 2006*	4 - Non comparative	GP	Assess quality of the COPD registers in primary care	Specialist nurse led diagnosis review within primary care	Spirometry	NICE 2004, Fixed ratio	580	158 (94 Normal, 39 Asthma, 23 Restrictive defect, 2 Cardiac pathology)	27%
13	[179]	1997-2001	4 - Non comparative	GP	Assess impact of specialist spirometry and clinical assessment on diagnosis	Specialist nurse led review clinics in primary care to review diagnosis alongside GPs	Spirometry, Follow up	BTS COPD 1997, Fixed ratio	14572	2028 (847 Mixed disease, 648 Asthma, 533 Other diagnosis)	14%
16	[180]	*May 2007 - May 2010*	4 - Cross-sectional	Community	Review COPD diagnosis in primary care	Specialist nurse led respiratory hub based in the community	Exercise, Spirometry, Medication optimisation	NICE 2004, Fixed ratio	1044	197 (86 Asthma, 12 Bronchiectasis, 13 Restrictive lung disease, 5 Non obstructive emphysema, 33 normal, 48 unknown)	19%
19	[182]	*Jan 1999 - Dec 2003*	3 - Observational (Before and After study)	Community	Assess impact of using spirometry in primary care on COPD management	Community based specialist led spirometry for diagnosis review	Spirometry	GOLD 2005, Fixed ratio	63	15	24%
21	[162]	*Not stated*	3 - Observational (Before and After study)	Secondary care	Review of primary care respiratory diagnoses using spirometry	Open access spirometry service for primary care based in secondary care.	Spirometry	GOLD 2004, Fixed ratio	101	64	63%
26	[124]	*Jan 2005 - Dec 2008*	4 - Non comparative	Secondary care	Improve diagnosis of respiratory conditions in primary care	Open access spirometry service for primary care based in secondary care.	Spirometry	Fixed ratio	180	35	19%
32	[164]	*Sept 2015 - Nov 2015*	5+1+3 - Mixed Method	GP	Assess impact of integrated care on number of exacerbations Patient feedback on integrated care.	MDT approach to COPD care based in primary care	Patient Education, Self-management, Smoking cessation, Case management, Spirometry, Follow up	NICE 2010, Fixed ratio	58	15 (8 Asthma, 6 ACOS, 1 Heart Failure)	26%

Table 2.3 UK subgroup - Summary of integrated care interventions and rate of misdiagnosis.

Study ID	Ref#	Total misdiagnosed	Asthma (%)	Normal (%)	Restrictive (%)	Cardiac pathology (%)	ACOS (%)	Other respiratory pathology (%)	Unknown (%)
1	[181]	69	12 (17%)	30 (43%)	15 (22%)	10 (4%)	0	2 (3%)	0
8	[178]	158	39 (25%)	94 (59%)	23 (15%)	2 (0.3%)	0	0	0
13	[179]	2028	648 (32%)	33 (2%)	0	0	847 (42%)	533 (26%)	0
16	[180]	197	86 (44%)	0	13 (7%)	0	0	17 (9%)	48 (24%)
19	[182]	15	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded
21	[162]	64	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded
26	[124]	35	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded
32	[164]	15	8 (53%)	0	0	1 (2%)	6 (40%)	0	0

Table 2.4 UK subgroup - Summary of identified underlying pathologies in misdiagnosed patients.

Europe

Nine studies were included in the European subgroup and reported on findings from Spain [183], Netherlands [184, 185], Italy [161, 186], Greece [140, 187], Serbia [188] and Norway [189], the findings are summarised in Table 2.5. The nine studies consisted of eight descriptive studies [140, 161, 183-188], and one non-randomised study [189]. The studies took place between 2004 and 2016, guidelines used during this period by eight studies defined obstructive airways using a fixed ratio of <0.7 between FEV1 and FVC [140, 161, 183-185, 187-189]. One study used both a fixed ratio of <0.7 and a ratio <LLN to define COPD [186].

Within this subgroup, all the studies except one [186] delivered integrated care using a single component rather than multiple components. The commonest component utilised in this subgroup was spirometry, eight studies included spirometry as a component of their integrated care intervention [140, 161, 184-189], seven of which used spirometry as their sole integrated care component [140, 161, 184, 185, 187-189]. Study 5 [183] did not utilise spirometry and focused on virtual diagnostic review. Although, not using specialist led spirometry as a component of their integrated care intervention, the authors of study 5 [183] reported a misdiagnosis rate of 64%, which is comparable to other studies within this subgroup. The misdiagnosis rate within this subgroup ranged between 26% and 87%.

Lack of spirometry use to diagnose COPD in primary care was identified as the cause of misdiagnosis by the authors of four studies [161, 183, 187, 189]. The authors of two studies [183, 187] found patients were being diagnosed with COPD and initiated on treatment without spirometry to confirm the diagnosis. Authors of the Norwegian study[189] suggested that lack of spirometry was the key cause of misdiagnosis and attributed their lower rate of misdiagnosis to initiatives that disseminated COPD guideline education amongst GPs.

Difficulty differentiating COPD from asthma was the identified as the cause of misdiagnosis by the authors of five studies [140, 184-186, 188]. However, authors of three studies noted that diagnostic accuracy did improve with the use of spirometry [184-186]. Authors of two studies [140, 188] also felt poor respiratory knowledge amongst GPs contributed to misdiagnosis. Misdiagnosis rates were felt to be higher in Greece due to the lack of respiratory training for GPs.[140]

Study ID	Ref#	Country	Year of intervention	Methodology	Setting	Study aim	Description of intervention	Components of integrated care	Diagnostic criteria	Confirmed pre-existing COPD Diagnosis (n)	Identified as misdiagnosed (n)	Misdiagnosis rate (%)
5	[183]	Spain	*Nov 2009 - Jun 2010*	4 - Non comparative	GP	Assess quality of the COPD registers in primary care	Virtual review of COPD diagnosis	Virtual review	GOLD 2010 & SEPAR 2009, Fixed ratio	382	244	64%
7	[161]	Italy	*Not stated*	4 - Non comparative	Community	Evaluate frequency of spirometry use and concordance of diagnosis and spirometry results	Specialist led spirometry for primary care	Spirometry	GOLD 2017, Fixed ratio	75	65 (42 Asthma, 23 Normal)	87%
10	[184]	Netherlands	*Jan 2006 - Jul 2008*	4 - Non comparative	Community	Compare GP diagnosis against specialist review	Community based respiratory hub to confirm diagnosis	Spirometry	GOLD 2005, Fixed ratio	57	34	60%
11	[185]	Netherlands	*Jan 2004 - Jul 2004*	4 - Non comparative	Community	Assess inter specialist diagnosis reliability	Community based respiratory hub to confirm diagnosis	Spirometry	GOLD 2005, Fixed ratio	87	39	45%
12	[186]	Italy	*Not stated*	4 - Non comparative	Secondary care	Assess accuracy of respiratory diagnosis in primary care	Hospital based diagnostic service for primary care	Case management, Spirometry	2 guidelines used: Post BD ratio <0.7 or Pre BD ratio <0.7 + <LLN	128	75 (43 chronic bronchitis, 22 Asthma)	59%
14	[140]	Greece	*Jan 2012 - Jan 2015*	4 - Cross-sectional	GP	Review diagnosis of patients with COPD in primary care	Specialist physician led spirometry	Spirometry	GOLD 2014, Fixed ratio	275	113	41%
15	[187]	Greece	*May 2016 - Nov 2016*	4 - Cross-sectional	GP	Review the diagnosis of patients with a smoking history or COPD	Specialist led spirometry surveillance in primary care	Spirometry	GOLD 2016, Fixed ratio	113	94	83%
18	[188]	Serbia	*Oct 2009 - Jun 2010*	4 - Cross-sectional	Secondary care	Compare GP diagnosis against specialist review	Specialist led diagnosis review through clinical exam and spirometry	Spirometry	ATS/ERS 2005, Fixed ratio	394	166	42%
25	[189]	Norway	*Apr 2009 - Mar 2010*	3 - Observational (Before and After study)	GP	Assess prevalence of misdiagnosis in primary care through specialist spirometry	Specialist led spirometry in primary care to clarify diagnosis	Spirometry	GOLD 2007, Fixed ratio	128	33	26%

Table 2.5 European subgroup - Summary of integrated care interventions and rate of misdiagnosis.

South America

Two descriptive studies from South America were included in this review, the extracted data is summarised in Table 2.6. One study focused only on patients based in Brazil [190] whereas another included patients from Argentina, Colombia, Venezuela and Uruguay [191]. Very few studies exploring COPD in primary care have originated from South American nations, possibly due to the structure of healthcare provision within those nations.

A total of 140 patients with a prior diagnosis of COPD were included within this subgroup of which 51 were found to have been misdiagnosed. The reported misdiagnosis rates were 30% [191] and 53% [190]. The two studies within this subgroup varied in their diagnostic methodology. One study used GOLD 2011 criteria of a FEV1/FVC fixed ratio of <0.7 to define COPD [190] whereas the other defined COPD by FEV1/FVC ratio of <0.7 and LLN [191]. The use of LLN as the cut off criteria to diagnose COPD could explain the lower rate of misdiagnosis as this was noted in a study within the European subgroup that used a similar diagnostic method. Lack of access and use of spirometry was identified as the primary causes of misdiagnosis in both studies by the authors [190, 191].

Although the number of patients and studies included in this subgroup are smaller than other subgroups the studies cover a large area of South America. The findings from this subgroup indicate that COPD misdiagnosis does occur within primary care in South America however, due to the limited data it is unclear how widespread this problem is across South America.

Study ID	Ref#	Country	Year of intervention	Methodology	Setting	Study aim	Description of intervention	Components of integrated care	Diagnostic criteria	Confirmed pre-existing COPD Diagnosis (n)	Identified as misdiagnosed (n)	Misdiagnosis rate (%)
3	[191]	Argentina, Colombia, Venezuela, Uruguay	Not stated	4 - Cross-sectional	GP	Assess underdiagnosis and misdiagnosis of COPD in primary care	Diagnosis confirmation with spirometry	Spirometry	Post BD <0.7 and LLN	102	31	30%
27	[190]	Brazil	*May 2011 - Sep 2011*	4 - Cross-sectional	GP	Estimate prevalence of underdiagnosis of COPD in primary care	Specialist led spirometry in primary care	Spirometry	GOLD 2011, Fixed ratio	38	20	53%

Table 2.6 South American subgroup - Summary of integrated care interventions and rate of misdiagnosis.

Australia

Five studies originating from Australia met the inclusion criteria and were included for quantitative analysis. Two studies utilised mixed methods methodology, the quantitative components of these studies were randomised controlled trial [170] and descriptive study [172]. The remaining three studies solely utilised quantitative methodology of which, two were non-randomised studies [192, 193] and one was a randomised controlled trial [194] as summarised in Table 2.7.

Within this subgroup only one study utilised multiple components of integrated care [194], the remaining studies solely utilised specialist led spirometry to deliver integrated care. Similar to other subgroups, spirometry was the common component utilised in all interventions within this subgroup of studies.

All five studies defined COPD using a post bronchodilator FEV1/FVC ratio of <0.7 as being the diagnostic criteria for obstructive airways [170, 172, 192-194]. The misdiagnosis rate ranges from 13% to 44% within this subgroup. Study 31 [172] stood out as an outlier with the lowest rate of misdiagnosis within this subgroup. The study identified 106 patients with a pre-existing diagnosis of COPD, of which only 32 (30%) participated in the study and were reviewed as part of the integrated care intervention. This potentially impacted the rate of misdiagnosis as it is likely that misdiagnosed patients were unlikely to participate as they had minimal respiratory symptoms. Four studies identified corrected diagnoses in patients misdiagnosed with COPD [172, 192-194]; the frequency of alternative diagnoses for each study is shown in Table 2.8. Within this subgroup the predominant finding in misdiagnosed patients was normal spirometry.

The authors of three studies [192-194] perceived the lack of spirometry use in primary care as the cause of misdiagnosis. Lack of awareness of spirometry was felt to "lead to diagnoses based on social history, symptoms, or chest x-rays alone" [194]. As a result, misdiagnosis was felt to be more likely in patients with pathologies that lead to function impairment such as obesity.[192]

Study ID	Ref#	Year of intervention	Methodology	Setting	Study aim	Description of intervention	Components of integrated care	Diagnostic criteria	Confirmed pre-existing COPD Diagnosis (n)	Identified as misdiagnosed (n)	Misdiagnosis rate (%)
9	[194]	*Feb 2015 - Apr 2017*	2 - Cluster RCT	GP	Evaluate impact of integrated care on QoL	MDT integrated care in primary care with structured follow up	Spirometry, Follow up, Smoking cessation, Case management, Patient Education, Staff Education, Exercise	Australian & NZ COPD Guidelines 2017, Fixed ratio	245	91 (1 Asthma, 76 Normal, 14 Unknown)	37%
20	[192]	*2008*	3 - Observational (Before and After study)	GP	Assess extent of misdiagnosis in primary care and impact on patients	Specialist led spirometry to provide accurate respiratory diagnosis in primary care	Spirometry	GOLD 2008, Fixed ratio	341	107 (60 Normal, 7 Borderline normal, 40 Restrictive)	31%
23	[193]	*Nov 2006 - April 2008*	3 - Observational (Before and After study)	GP	Compare GP diagnosis against specialist review	Specialist led spirometry in primary care	Spirometry	Post bronchodilator Fixed ratio <0.7	445	188 (16 Asthma, 82 Normal, 90 Other)	42%
30	[170]	*Nov 2004 - Jun 2005*	5+1+2 - Mixed Method	GP	Assess impact of specialist led spirometry on diagnosis in primary care	Specialist nurse led spirometry in primary care	Spirometry	Australia and NZ guidelines and GOLD, Fixed ratio	41	18	44%
31	[172]	*Not stated*	5+1+4 - Mixed Method	GP	Assess use of spirometry for diagnosis	Specialist led clinical assessment and spirometry	Spirometry	GOLD 2005, Fixed ratio	32	4 (2 Asthma, 2 Chronic bronchitis)	13%

Table 2.7 Australian subgroup - Summary of integrated care interventions and rate of misdiagnosis.

Study ID	Ref#	Total misdiagnosed	Asthma (%)	Normal (%)	Restrictive (%)	Other respiratory condition (%)	Unknown (%)
9	[194]	91	1 (1%)	76 (84%)	0	0	14 (15%)
20	[192]	107	0	67 (63%)	40 (37%)	0	0
23	[193]	188	16 (8%)	82 (44%)	0	90 (48%)	0
30	[170]	18	NR	NR	NR	NR	NR
31	[172]	4	2 (50%)	0	0	2 (50%)	0

Table 2.8 Australian subgroup - Summary of identified underlying pathologies in misdiagnosed patients.

Asia

Of the studies included in this review, only one originated from Asia [195]. The intervention was based in China and focused on utilising specialist led spirometry to review primary care COPD diagnoses. COPD was diagnosed using GOLD 2014 guidance, whereby the diagnostic criteria for COPD is a post bronchodilator FEV1/FVC ratio of <0.7. The misdiagnosis rate was reported as 45%, however, the authors did not report the corrected diagnoses in patients found to have been misdiagnosed.

Lack of access and use of spirometry was the perceived cause of misdiagnosis. The authors felt "primary care physicians who are not ready or without direct access to spirometry can only make the diagnosis of COPD clinically" [195].

More data is needed from this region to ascertain whether integrated care could be implemented to identify misdiagnosed patients in primary care.

Study ID	Ref#	Country	Year of intervention	Methodology	Setting	Study aim	Description of intervention	Components of integrated care	Diagnostic criteria	Confirmed pre-existing COPD Diagnosis (n)	Identified as misdiagnosed (n)	Misdiagnosis rate (%)
17	[195]	China	*Jan 2005 - Jan 2012*	4 - Cross-sectional	GP	Review COPD diagnosis in primary care	Specialist led spirometry in primary care	Spirometry	GOLD 2014, Fixed ratio	152	69	45%

Table 2.9 Asia subgroup - Summary of integrated care interventions and rate of misdiagnosis.

2.3.4.1 Synthesised quantitative findings

The quantitative data indicates that the rate of misdiagnosis across different regions is variable and is likely due to differences in healthcare provision in different regions. However, the quantitative studies demonstrate that misdiagnosis can be identified through integrated care interventions. The majority of interventions utilised specialist led spirometry as a component of their integrated care service. Understandably spirometry would be a required component for integrated care interventions that are involved in COPD diagnosis and management as spirometry is needed to confirm a diagnosis.

The findings from the subgroup narrative syntheses have been summarised into two synthesised findings:

Synthesised finding 1: "COPD misdiagnosis in primary care can be identified through integrated COPD services that utilise specialist led spirometry"

Synthesised finding 2: "Difficulties utilising spirometry and differentiating COPD from similar pathologies is perceived as the cause of COPD misdiagnosis in primary care"

2.3.5 Integration of qualitative and quantitative syntheses

Combining the narrative findings from the quantitative synthesis with the synthesised findings from the meta-aggregation of the qualitative data identified two areas where the data was complementary – "Cause of COPD misdiagnosis" and "Use of integrated COPD care".

Cause of COPD misdiagnosis

Synthesis of the quantitative data identified difficulty utilising spirometry results as a perceived cause of misdiagnosis of COPD in primary care. This is supported by the qualitative data synthesis, which identified a perceived lack of value of spirometry in primary care. Combining the synthesised findings suggests that difficulty utilising spirometry in primary care could be explained by the perceived lack of value attached to spirometry in primary care.

Difficulty differentiating COPD from similar pathologies was also identified as a perceived cause of misdiagnosis, which is further corroborated by the quantitative data indicating most misdiagnosed patients had asthma rather than COPD. This finding is supported by the qualitative data synthesis, which indicated a perception of limited

knowledge and diagnostic ability in primary care. Combined this would suggest that difficulty differentiating COPD from similar pathologies could be due to limited knowledge and diagnostic ability in primary care.

Use of integrated care

The quantitative data synthesis identified that integrated care interventions that utilised specialist led spirometry were able to identify patients who had been misdiagnosed with COPD in primary care. This finding was supported by the qualitative synthesis, which indicated that integrated care interventions were deemed acceptable by stakeholders, thereby potentially improving uptake of the intervention. The qualitative synthesis indicated a perception of improved diagnostic ability in primary care through integrated care. This is partially confirmed by the quantitative data, which confirms that diagnostic review can occur through integrated care and identify misdiagnosed patients. However, the quantitative data does not include data to suggest an improvement on validity of initial COPD diagnosis.

2.4 Discussion

This systematic review is unique in its use of a mixed methods approach to determine if integrated COPD care is a suitable intervention to identify COPD misdiagnosis in primary care. Through the analysis of data from both qualitative and quantitative studies, a comprehensive review exploring the causes of COPD misdiagnosis and the role of integrated care in identifying misdiagnosed patients in primary care has been achieved.

2.4.1 Principal findings

Difficulties surrounding spirometry and differentiating COPD from asthma were found in this review to be the key causes of COPD misdiagnosis in primary care. These findings correlate with existing literature surrounding misdiagnosis of COPD in general without a focus on primary care [135]. Considering the cause of misdiagnosis is mostly due to difficulty utilising spirometry and differentiating COPD from asthma, specialist input in primary care is understandably perceived to have a positive impact on the diagnosis of COPD. It is due to this perception that integrated care is likely to have been deemed an acceptable intervention by relevant stakeholders, which in turn is likely to have led to its high level of uptake to allow for detection of misdiagnosis in primary care. Integrated care interventions, particularly those that utilise specialist led spirometry, have in this review been

shown to be able to not only identify misdiagnosed patients in primary care but also potentially correct their diagnosis.

2.4.2 Strengths and limitations

A quantitative systematic review alone would be able to demonstrate the ability to utilise integrated care to identify misdiagnosed patients, however, it would not provide an information pertaining to acceptability nor an explanation to why patients were being misdiagnosed. Equally, a stand-alone qualitative systematic review would be able to portray the causes of misdiagnosis, but not offer any data as to the extent of misdiagnosis in primary care. Utilising a convergent segregated approach allowed qualitative and quantitative data to be analysed without the risk of data losing meaning through data transformation.[157] Integrating the qualitative and quantitative findings provided an understanding of the extent of COPD misdiagnosis in primary care and why patients were being misdiagnosed. Additionally, integrating the data provided an understanding of the role integrated care interventions can play in reducing COPD misdiagnosis and its acceptability. The use of both qualitative and quantitative data is the key strength of this systematic review as it is able to portray the extent of COPD misdiagnosis, why it is occurring and how it can potentially be managed. All of which are important details when deciding healthcare policy.

Although this review indicates misdiagnosis can be identified through integrated care interventions, it is not possible to comment on the effectiveness of integrated care interventions to detect misdiagnosis. This is due to identification of misdiagnosis rarely being an outcome measure of randomised controlled trials. Prevalence of misdiagnosis cannot be inferred from this review as the studies included required the use of an integrated care intervention, all of which had inclusion criteria, therefore, are not representative of the whole primary care COPD population. However, rates of misdiagnosis for each region identified in this review were similar to those identified in a literature review exploring prevalence of misdiagnosis [156]. Although this review did not restrict by language or country, there were very few studies available from regions with low income economies. This issue is present in other reviews focusing on integrated care [121, 196] and misdiagnosis [135, 156] where African, South American and Asia nations are poorly represented. Integrated care services are utilised in low income economies however, the aims of these interventions often differ significantly to those in high income economies [197] and so may not have been included in the scope of this review. Therefore, the results and recommendations of this review are restricted to only be applicable to health services in high income economies.

2.4.3 Implications for future research and policy

The findings from this systematic review suggests that patients are misdiagnosed with COPD within primary care, and it is often due to issues that could be evert through COPD specialist involvement in primary care. However, cost-effectiveness was not within the scope of this systematic review. Although there is evidence of long-term financial impacts from COPD misdiagnosis (see section 1.7 Misdiagnosis of COPD), this has not been fully evaluated through systematic review. An in depth understanding of the financial burden of COPD misdiagnosis is essential to determine the cost-effectiveness of integrating COPD specialists into primary care. The funding of COPD specialists integrated into primary care is complex, due to the cross-sector nature of their work funding is often required from both primary and secondary care providers. Equally, COPD specialist involvement in primary care is known to reduce hospital admissions and referrals [121], which can have a financial impact on secondary care providers as admissions and referrals are a source of income. Therefore, the findings from this systematic review recommend the use of integrated COPD care interventions to reduce COPD misdiagnosis in primary care, however, further cost-effectiveness evaluations need to be completed to determine if implementation is financially viable.

Within this systematic review, causes of COPD misdiagnosis were interpreted from the comments of authors presenting quantitative data. The interpreted causes of COPD misdiagnosis were compared with the qualitative findings regarding perceptions of integrated care and the diagnostic process. However, there were no studies found in this systematic review that directly asked the question of why patients were misdiagnosed with COPD. This gap in the literature is addressed in Chapter 4 of this thesis, where causes of misdiagnosis are explored through a sequential mixed methods approach.

2.5 Conclusion

This review demonstrates that integrated care would be an acceptable intervention to identify patients misdiagnosed with COPD in primary care. Based on the findings of this review, specialist led spirometry is a vital component for the integrated care intervention to be able to identify misdiagnosed patients. The recommendation would therefore be, for future integrated COPD care interventions to consider diagnostic review as a component of their service to identify misdiagnosed patients.

Potential future research could focus on the economic impact of COPD misdiagnosis and the effectiveness of integrated services at reducing that impact, as this will aid policy makers in determining the cost-effectiveness of integrated care services.

CHAPTER 3 : IMPACT OF INTEGRATED COPD CARE ON GUIDELINE ADHERENCE

3.1 Introduction

The management of stable COPD in primary care involves a combination of both pharmacological and non-pharmacological interventions.[3] Pharmacological management predominantly focuses on the use of different classes of bronchodilator inhalers and inhaled corticosteroids, however, can also include the use of smoking cessation therapy.[198] Non-pharmacological therapy focuses on the use of pulmonary rehabilitation delivered by respiratory physiotherapists, however, can also include sputum clearance training, smoking cessation counselling and palliative support.[199] Pneumococcal and influenza immunisation are preventative measures used in primary care to reduce the risk respiratory infections that can be life threatening in patients with COPD.[200] Patients that deteriorate despite optimal management in primary care are often referred to specialists in secondary care for consideration of further interventions.[3] Typically, the patients referred to secondary care have severe or very severe COPD and are referred due to worsening breathlessness or increasing frequency of exacerbations.[201] Pharmacological interventions available through specialist input include theophylline to reduce breathlessness, and long-term macrolides/roflumilast to reduce frequency of exacerbations.[3] Non-invasive interventions including oxygen therapy and non-invasive ventilation (NIV) are specialist therapies available from secondary care and are primarily used to improve the quality of life of patients with chronic hypoxia and hypercapnic respiratory failure respectively.[201] Invasive interventions such as lung volume reduction procedures and lung transplantation require specialist multi-disciplinary team input and is only offered to patients who meet strict physiological criteria and who have completed pulmonary rehabilitation and are non-smokers.[201] Through a combination of these interventions the aim is to reduce the burden of symptoms from COPD as well as reducing the frequency of exacerbations and hospitalisations, which in turn is thought to improve quality of life and prognosis.[202, 203] Although patients can be managed using a combination of these interventions, there is still a divide between interventions that can be provided by generalists in primary care and specialists in secondary care, which potentially can lead to fragmented and delayed care.[204] However, there is growing evidence suggesting that the delivery of COPD care through a service integrating respiratory specialists into primary care can improve patient care and outcomes.[121]

COPD management guidelines developed by local CCGs are based on local specialist advice and current national guidance.[113] The guidelines consist of a bundle of procedures that are essential in the management of COPD, such as referral to pulmonary rehabilitation and offer of influenza vaccination.[113] Through the use of COPD guidelines, the aim is to ensure optimal care is delivered to all patients in order to improve their quality of life and clinical outcomes. However, in the UK, the rate of adherence to COPD guidelines is variable and low in primary care settings.[144, 205] This is likely to be due to variability in clinician knowledge and experience between GP practices. Similarly, within the secondary care setting there is evidence of variability in the care delivered to patients with COPD,[206] to combat this variability, standardised care bundles were implemented in a UK based study.[207] The study not only found an improvement in mortality and length of admission but also found that respiratory specialist involvement led to improved rates of bundle completion.[207] Therefore, through the integration of respiratory specialists into primary care, we could potentially improve the rate of guideline adherent management being delivered in a primary care setting. However, there is limited data regarding the impact of respiratory specialist integration on COPD guideline adherence in primary care. The purpose of INTEGR COPD is to address this gap in the current literature through a cluster randomised controlled trial, which will explore the impact of respiratory specialist integration in primary care.

3.2 Methods

3.2.1 Study design

INTEGR COPD was a pragmatic cluster randomised controlled trial in which, specialists were integrated into GP practices. GP practices located in East Birmingham with equal access to secondary care services were approached to participate in the study. 18 practices were stratified according to the size of their COPD registers and practice size then randomised into either the intervention or usual care arms of the study using SealedEnvelope.com. Stratification based on practice population demographics was not deemed necessary as the practices included in the study were all located within a small region of East Birmingham and shared a similar patient population. Ten practices were randomised to the intervention arm and eight to the control arm. In order to assess the real-world impact of integrating specialist led COPD clinics in primary care a pragmatic approach was adopted. Taking a pragmatic approach meant implementing minimal changes from usual care within key domains set out by the PRECIS-2 toolkit.[208] The study was deemed to be very pragmatic overall

based on the scoring system used in the PRECIS-2 toolkit,[208] a summary of the PRECIS-2 domains and the rationale for the score in each domain is shown in Table 3.1.

PRECIS-2 Domain	Score	Rationale
Eligibility Criteria- to what extent are the participants in the trial similar to those who would receive this intervention if it was part of usual care?	5	Patients were eligible for the study if they had a diagnosis of COPD and attended routine annual COPD review with their GP or practice nurse. If the intervention was implemented as usual care the same cohort of patients would receive the intervention.
Recruitment Path- how much extra effort is made to recruit participants over and above what that would be used in the usual care setting to engage with patients?	5	Minimal additional effort was required to recruit patients for the study. Patients were recruited for the study through the usual appointment booking system used in usual care, whereby those due for their annual review were contacted by the practice receptionist and were offered to be seen by a specialist as part of a trial.
Setting- how different is the setting of the trial and the usual care setting?	5	There was no difference between the trial setting and usual care. The intervention was being delivered within GP practices and using practice resources, which would have been used as part of usual care.
Organisation- how different are the resources, provider expertise and the organisation of care delivery in the intervention arm of the trial and those available in usual care?	4	There was no difference between the resources used or available in the intervention arm and usual care arm of the study. The delivery of the intervention required respiratory specialists with expertise in respiratory medicine, which is not part of usual care. However, the mode of care delivery was identical between the intervention and usual care as both used standardized COPD templates to guide the review, which is part of usual care.
Flexibility (Delivery)- how different is the flexibility in how the intervention is delivered and the flexibility likely in usual care?	5	As the intervention was being delivered within the same setting as usual care and was bound by the same timing and room availability constraints there was no difference in flexibility of care delivery between intervention and usual care.
Flexibility (Adherence)- how different is the flexibility in how participants must adhere to the intervention and the flexibility likely in usual care?	5	Measures to ensure adherence to the intervention were identical to usual care. The measures used were messages and calls from GP receptionists to patients reminding them to book and attend for their annual COPD review, which was usual practice.
Follow up- how different is the intensity of measurement and follow-up of participants in the trial and the likely follow-up in usual care?	5	There was no difference in follow up intensity between intervention and usual care. Patients were offered annual follow up as per usual care and measurements carried out in the intervention were as per local COPD guidelines used in usual care.
Primary outcome- to what extent is the trial's primary outcome relevant to participants?	5	The primary outcome is guideline adherence. The outcome can be measured in a usual care setting without additional expertise or resources as it is based on data collected as part of usual care. It is very relevant to participants as it reflects the quality of evidence-based care they have received.
Primary analysis- to what extent are all data included in the analysis of the primary outcome?	5	Primary outcome data will be analysed using an intention to treat approach, using all available data of patients who were deemed eligible and consented to participate in the trial.

Table 3.1 Summary of PRECIS-2 domain scoring and rationale.

3.2.2 Participants

GP practices located within East Birmingham who gave consent to have their patient data extracted were eligible to participate in the study. Patients at participating GP practices were eligible to be included in the study if they had a diagnosis of COPD recorded in their electronic patient record. Patients were excluded from the study if they were found to have been misdiagnosed with COPD. Diagnosis review was completed virtually at GP practices randomised to provide usual care, as part of the virtual clinic. All patients with a recorded COPD diagnosis were invited to the specialist led annual review at GP practices randomised to the intervention arm of the study and diagnosis review was completed in person by the specialist during the annual review.

A review of the COPD diagnosis was deemed necessary based on the findings of the systematic review in Chapter 2 indicating that within the UK the rate of COPD misdiagnosis in primary care ranged from 14% to 29%. This ensured that only patients with a confirmed diagnosis of COPD were included in the final analysis.

Patients at GP practices randomised to provide usual care were recruited to the study at the practice level whereby all patients with a recorded diagnosis of COPD were included. Patients were informed of their participation through posters displayed at the GP practices, patients declining to be included in the study were able to opt out, patients that were either house bound or did not attend the GP surgery during the recruitment phase were not included.

Patients at GP practices randomised to the intervention arm were contacted as per usual care for their annual COPD review by GP practice staff, however, were given the option to attend a specialist led annual review at the GP practice as part of the research study in lieu of seeing their usual clinician. Patients were provided with information about the study and asked to provide consent prior to having their annual review completed with the specialist at intervention GP practices.

3.2.3 Usual Care

The established usual care for patients with COPD in primary care, prior to the start of the study, consisted of an annual COPD review with their GP or practice nurse at their GP practice. The annual review included a clinical and spirometric assessment as per the local guidelines [113] and was recorded in the electronic patient record using an embedded electronic COPD review template. Usual care also included access to a virtual respiratory clinic led by respiratory physicians based in secondary care. The virtual clinic was utilised by GPs and practice nurses to discuss difficult respiratory cases and diagnostic difficulties, thus patients received indirect specialist led care.

3.2.4 Intervention

Patients at practices randomised to the intervention arm of the study had their annual COPD review completed by a respiratory specialist. Respiratory specialists were defined as healthcare professionals based in secondary care with specialist respiratory training, this included, respiratory consultant physicians, respiratory trainee physicians and respiratory physiotherapists. The annual review was completed and recorded as per the

electronic template embedded in electronic patient record (EPR) software used in usual care. The review was also recorded using paper case report files (CRF) for the purpose of data checking after extracts were made from the care record; the CRFs were mapped to match the electronic COPD annual review template used in usual care and the extraction protocol refined according to the findings. The intervention was therefore, limited only to a change in the healthcare professional delivering the annual review, all other aspects of the annual review remained the same as usual care, thus allowing the intervention to reflect real-world impact. Patients were enrolled in the trial for 12 months and received two annual COPD reviews led by respiratory specialists in a primary care setting.

3.2.5 Data collection

As this study was taking a pragmatic approach there were no controlled data collection templates used, instead data recorded routinely as part of usual care using the electronic COPD template embedded in the GP practice's software was used. Data recorded using the EPR software or the embedded COPD template is coded using Read coding, these codes were then used to identify relevant patient data for extraction to be used for analysis.

All patients included in the study had a unique read code inserted into their electronic medical record to denote participation in the INTEGR COPD study, the read code was assigned by the CCG IT team to ensure only patients involved in this study had their data extracted. Using the EPR software's data extraction tool, study patients were identified using the research read code, data relevant to the study was extracted using read codes pertaining to each variable. The read codes associated with each variable are listed in Appendix 5. Due to variations in read code use and emergence of new read codes, extracted data was checked for missing data in each variable. Where data was found to be missing, the patient record was interrogated to determine if data was missing due to lack of recording or due to different read code being used to record the data. Where an alternative read code was used the extraction was repeated with the additional read code added to the extraction algorithm. This process was repeated until there was either no missing data in the extraction or it was found that the data missing from the extraction was due to lack of recording. This process was overseen by me and carried out by a data manager. Data regarding COPD-related hospitalisations and respiratory outpatient attendance were extracted from secondary care electronic records by my supervisor and I in conjunction with the Trust informatics department.

3.2.6 Primary outcome measure

Guideline adherence was a binary outcome that was represented as a proportion of the control and intervention cohorts. Rate of guideline adherence was compared between the two cohorts through logistic regression adjusting for clustering and patient demographics. Patients that received four or more items of the guideline care bundle summarised in Table 3.2 were deemed as having guideline adherent care. Guideline adherence was measured at two intervals – at baseline, using patient data recorded up to 12 months prior to the baseline visit, and at follow up 12 months post baseline visit. Guideline adherence was chosen as the primary outcome measure as the component variables required to measure guideline adherence were routinely recorded in usual care, thus allowing a pragmatic approach to the data collection.

The study took place between 2017 and 2020, during which two guidelines were in use, local guidance published in 2017[113] and GOLD guidance published in 2019[29]. The guidelines varied with regard to inhaled corticosteroid guidance. Local 2017 guidelines recommended the addition of inhaled corticosteroids to the treatment regime only if the FEV_1% predicted is less than 50%, whereas GOLD 2019 guidelines recommended the addition of inhaled corticosteroids only if serum eosinophil count is greater than 300 cells/µL. The addition of inhaled corticosteroids was seen as acceptable in both guidelines if patients had a history of asthma. Therefore, guideline adherence was measured using both local 2017 guidelines and GOLD 2019 guidelines.

Item number	Guideline item	Adherence rule
1	Influenza vaccination	Record of either receiving or declining influenza vaccine within 12months of visit will be deemed adherent. No recording will be deemed as non-adherent.
2	Pneumococcal vaccination	Record of either receiving or declining pneumococcal vaccine at any time will be deemed adherent. No recording will be deemed as non-adherent.
3	Offer of pulmonary rehabilitation	Record of either, offer, referral, declining, commencing, completing or being unsuitable for pulmonary rehabilitation in patients with a recorded MRC score of 3 or higher within the previous 12 months will be deemed adherent, no recording will be deemed non adherent. Patients with MRC score of 2 of less are deemed adherent for this item.
4	Offer of smoking cessation	Record of either smoking cessation advice, referral, or declining advice in patients with a recorded smoking status of current smoker within the previous 12 months will be deemed adherent, no recording will be deemed non adherent. Patients with a never smoker or ex-smoker status will be deemed as adherent for this item.
5a	Medication 2017 guidance	Use of LABA+ICS and LAMA with an FEV_1% predicted of <50% and/or history of Asthma is adherent. Use of LABA+ICS alone if patient has a history of asthma is adherent. Use of LABA+ICS outside of these rules is non-adherent.
5b	Medication 2019 guidance	Use of LABA+ICS and LAMA with an eosinophil count of >300 cells/µL and/or history of Asthma is adherent. Use of LABA+ICS alone if patient has a history of asthma is adherent. Use of LABA+ICS outside of these rules is non-adherent.

Table 3.2 Guideline items and rules of adherence. LABA: Long-acting beta agonist; LAMA: Long-acting muscarinic antagonist; ICS: Inhaled corticosteroid; FEV_1: Forced expiratory volume in 1 second**.**

3.2.7 Secondary outcome measures

The secondary outcomes measured changes from baseline to follow up in: 1) frequency of COPD exacerbations, 2) number of COPD-related hospitalisations, 3) number of respiratory outpatient attendances, and 4) quality of life, scored using CAT.

3.2.8 Sample size

Based on the number of patients registered with COPD at participating GP practices and assuming 15% of patients would not participate in the study, 1500 patients were envisaged to be recruited to the study. No prior data on bundle completion or guideline adherence with specialist input was available from a primary care setting. Therefore, ideal sample size was calculated using published secondary care data where COPD admission bundles were completed in 26.8% of patients when seen by a specialist, compared to 18.2% of patients when seen by a generalist.[207] Using these figures the sample size needed to detect a difference with 80% power (α=0.05) was calculated as 369 per study arm. When adjusted for clustering, with an assumed intraclass correlation coefficient (ICC) of 0.01[209] with an estimated 1500 participants across 18 clusters, the ideal sample size was 748 patients in each arm of the study.

3.2.9 Statistical analysis

Analysis was completed using an intention to treat principle. Baseline characteristics were summarised using descriptive statistics and organised based on data type and group. Primary and secondary outcomes were assessed at the participant level and all regression analyses were adjusted for clustering, age, deprivation and gender. Guideline adherence was compared between the two arms of the study at baseline and follow up using logistical regression analysis, due to the guideline adherence variable being a binary outcome. Mean change from baseline to follow up at 12 months in the secondary outcomes – CAT score, frequency of exacerbations, number of COPD-related hospitalisations, and respiratory outpatient attendances – was calculated within each arm of the study and compared between the two arms using regression analyses. Mean change in secondary outcomes were also compared between guideline adherent and non-adherent populations using regression analyses. Patients who had attended both the baseline and 12 month follow up visit were deemed as having completed as per protocol. A per-protocol analyses was completed for comparison against the results from intention to treat analyses. Analysis of variables with data deemed to be missing at random will also undergo

analysis using multiply imputed datasets. All analyses were performed using Stata version 16 (StataCorp, College Station, TX, USA) and statistical significance was set at $p \leq 0.05$.

3.2.10 Ethical approval

The study was approved by West Midlands-South Birmingham Research Ethics Committee (REC 17/WM/0342) and was registered on the clinicaltrials.gov database (NCT03482700). Changes made to the study protocol during the study period were reported as amendments to the Research Ethics Committee.

3.3 Results

3.3.1 Baseline characteristics

1458 patients were screened between December 2017 and May 2019, of which 183 were excluded at baseline and a further 33 at follow up due to not having a diagnosis of COPD. 1242 patients were included in the intention to treat analysis, of which, 656 patients were recruited from control practices and 586 patients were recruited from intervention practices. The study flow diagram is presented in Figure 3.1.

The demographic and baseline clinical, physiological and exacerbation characteristics are presented in Table 3.3 and are separated between control and intervention practices. The baseline characteristics data were collected at the baseline visit and recorded in the electronic patient records. Patients in the intervention group had this data collected by the specialist and those in usual care had this data collected by either their GP or practice nurse. At baseline, patients from the control and intervention practices had similar characteristics, however, there was missing data amongst the patients from control practices regarding CAT score, spirometry, and frequency of exacerbations.

	Control (n=656)	Intervention (n=586)
Demographic characteristics		
Male (%)	339 (52%)	307 (52%)
Mean age (SD)	69.7 (10.7)	67.8 (10.9)
Index of Multiple Deprivation (IMD) decile		
IMD 1st Decile (%)	350 (53%)	385 (66%)
IMD 2nd Decile (%)	136 (21%)	95 (16%)
IMD 3rd Decile (%)	76 (12%)	53 (9%)
IMD 4th Decile (%)	36 (6%)	21 (4%)
IMD 5th Decile (%)	25 (4%)	16 (3%)
IMD 6th Decile (%)	13 (2%)	3 (1%)
IMD 7th Decile (%)	9 (1%)	5 (1%)
IMD 8th Decile (%)	9 (1%)	6 (1%)
IMD 9th Decile (%)	1 (0.2%)	0
IMD 10th Decile (%)	1 (0.2%)	1 (0.2%)
Unknown (%)	0	1 (0.2%)
Smoking status		
Smoker (%)	281 (43%)	288 (49%)
Ex-Smoker (%)	337 (51%)	284 (48%)
Never-Smoker (%)	36 (6%)	14 (2%)
Not recorded (%)	2 (0.3%)	0
CAT score		
0-10	151 (23%)	159 (27%)
11-20	147 (22%)	207 (35%)
21-30	67 (10%)	152 (26%)
31-40	21 (3%)	67 (11%)
Not recorded (%)	270 (41%)	1 (0.2%)
MRC Dyspnoea score		
1	124 (19%)	90 (15%)
2	223 (34%)	169 (29%)
3	179 (27%)	161 (27%)
4	86 (13%)	135 (23%)
5	14 (2%)	24 (4%)
Not recorded (%)	30 (5%)	7 (1%)
Spirometry		
Mean FEV_1% predicted (SD)	61.2% (19.2)	60.5% (19.6)
GOLD 1 (%)	75 (11%)	96 (16%)
GOLD 2 (%)	254 (39%)	272 (46%)
GOLD 3 (%)	103 (16%)	140 (24%)
GOLD 4 (%)	27 (4%)	24 (4%)
Not recorded (%)	197 (30%)	54 (9%)
Exacerbations in 12 months prior to baseline visit		
Mean number of exacerbations (SD)	1 (1.4)	1 (1.9)
No exacerbations	186 (28%)	254 (43%)
1-2 exacerbations	126 (19%)	200 (34%)
>2 exacerbations	50 (8%)	121 (21%)
Exacerbation frequency not recorded	294 (45%)	11 (2%)
COPD related Hospitalisations in 12 months prior to baseline visit		
Mean number of hospitalisation (SD)	0.2 (0.6)	0.1 (0.5)
No hospitalisation (%)	556 (85%)	530 (90%)
Respiratory Outpatient attendance in 12 months prior to baseline visit		
Mean number of respiratory outpatient attendances (SD)	0.4 (0.9)	0.2 (0.7)
No attendances (%)	537 (82%)	519 (89%)

Table 3.3. Demographics and baseline characteristics table for the intervention and control groups. Data presented as frequency (%) or mean (SD). FEV_1: Forced Expiratory Volume in 1 second; SD: Standard deviation; CAT: COPD Assessment Test; GOLD: Global Initiative for Chronic Obstructive Lung Disease, airflow limitation stage based on 2018 criteria.

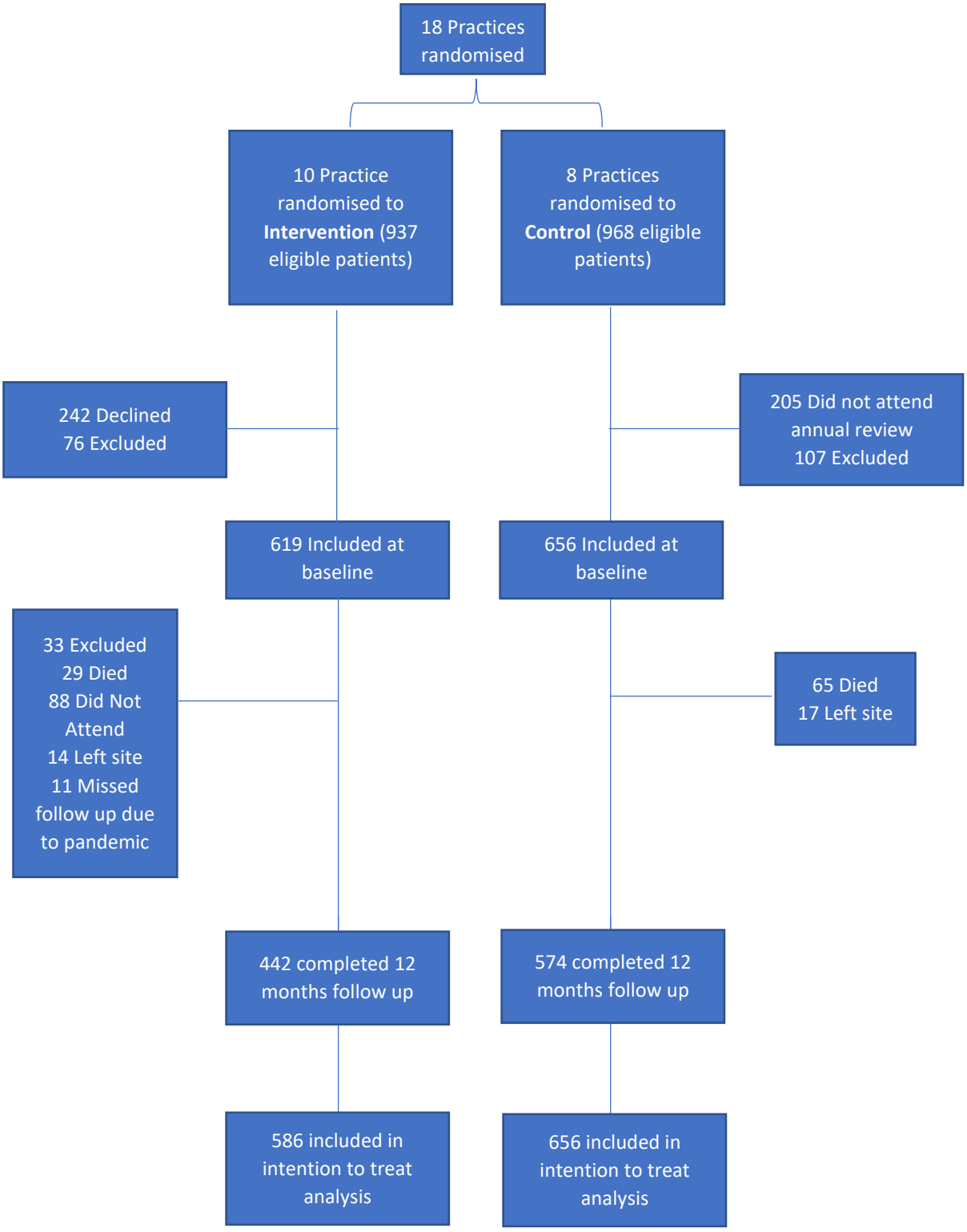

Figure 3.1 Study flow diagram.

3.3.2 Primary outcome

Guideline adherence improved in both the control and intervention group, however, as shown in Table 3.4 there was a greater improvement in the intervention group. At baseline there was no statistically significant difference in guideline adherence between control and intervention. However, at follow up the odds ratio of adherence to 2017 and 2019 guidelines was 4.06 and 5.18 respectively in favour of the intervention versus usual care, which was statistically significant (p<0.001).

	% at Baseline		Between group odds ratio at baseline* (95%CI)	% at 12 month Follow up		Between group odds ratio at 12 month follow up** (95%CI)
	Control (n)	Intervention (n)		Control (n)	Intervention (n)	
GA2017	76.1% (499)	70.1% (411)	0.74 (0.27-1.99) **p=0.55**	79.4% (521)	92.7% (543)	4.06 (2.07-7.96) **p<0.001**
GA2019	81.1% (532)	74.1% (434)	0.49 (0.16-1.50) **p=0.21**	83.8% (550)	95.1% (557)	5.18 (2.70-9.92) **p<0.001**

Table 3.4 Guideline adherence at baseline and follow up (intention-to-treat). Control n=656; Intervention n=586; GA2017: Guideline adherence with 2017 guideline; GA2019: Guideline adherence with 2019 guidelines; CI: Confidence interval. *-adjusted for clustering, age, gender, deprivation **and baseline guideline adherence.

Attainment for each guideline item is represented in Table 3.5. Both the control and intervention groups showed improvement in influenza vaccination and pneumococcal vaccination from baseline to follow up. The intervention group showed improvement in all guideline items, however, the control group worsened in attainment of guideline items regarding offer of pulmonary rehabilitation, smoking cessation, and guideline adherent medication. Comparing attainment of guideline items at follow up between the control and intervention groups, the intervention group performed better in all items except guideline adherent medication. Adherence to the 2019 medication guidance was greater than the 2017 guidance in both the control and intervention groups.

	Control (n=656)		**Intervention (n=586)**	
	Baseline	**Follow up**	**Baseline**	**Follow up**
Influenza vaccine	514 (78%)	593 (90%)	532 (91%)	561 (96%)
Pneumococcal vaccine	548 (84%)	575 (88%)	452 (77%)	524 (89%)
Offer of pulmonary rehabilitation	493 (75%)	481 (73%)	390 (67%)	579 (99%)
Offer of smoking cessation	630 (96%)	573 (87%)	541 (92%)	583 (99%)
Medication 2017 guidance	518 (79%)	493 (75%)	380 (65%)	406 (69%)
Medication 2019 guidance	601 (92%)	592 (90%)	439 (75%)	503 (86%)

Table 3.5 Adherence to each guideline item at baseline and follow up (intention-to-treat).

The recorded response from patients following the offer of pulmonary rehabilitation in both the intervention and control groups for eligible patients is represented in Table 3.6. Of the patients eligible for referral to pulmonary rehabilitation (MRC score $\geq$3) the percentage that accepted a referral to pulmonary rehabilitation

was similar for both the intervention and control groups. However, within the intervention group the percentage of patients recorded as having declined or being unsuitable was greater than the control group. Whereas in the control group there was a greater percentage of patients with no recorded response. This could be due to clinicians within the control arm not recording patients being unsuitable or declining pulmonary rehabilitation as it was deemed not clinically relevant. However, as the clinician did not record this in the electronic record, it was assumed that pulmonary rehabilitation was not considered or offered to these patients.

Patient response to offer of PR	Patient accepts referral to PR	Patient states already completed PR	Patient states already enrolled in PR	Patient deemed unsuitable for PR	Patient declines referral to PR	Patient attempted PR and did not complete course	NR
Intervention n=327	95 (29%)	30 (9%)	8 (2%)	82 (25%)	106 (32%)	3 (1%)	3 (1%)
Control n=309	70 (23%)	18 (6%)	0 (0%)	3 (1%)	55 (18%)	0 (0%)	163 (53%)

Table 3.6 Recorded frequency of patient responses following the offer of pulmonary rehabilitation, in patients with an MRC score ≥3 within the intervention and control groups. Data presented as frequency (%). NR: Not recorded; PR: Pulmonary rehabilitation.

3.3.3 Secondary outcomes

Quality of life

Quality of life was measured using the CAT questionnaire; the minimum clinically important difference (MCID) for CAT is a change in the score by 2 or more points. There were 250 paired CAT scores in the control group and 450 in the intervention group. CAT scores were seldom recorded as part of usual care, thus leading to the control group having fewer paired scores than the intervention group. A comparison between the control and intervention of the mean change in CAT score from baseline to follow up indicates that a clinically significant reduction was only observed in the intervention arm (Table 3.7). However, the adjusted difference in CAT score change at 12 months follow up between the intervention and control was a -1.81 with a 95% confidence interval of -2.85 to -0.77 (p=0.001). Therefore, the difference between intervention and control, although statistically significant, was not clinically significant as it was not greater than the MCID for CAT.

CAT score outcome	Control				Intervention				Between-group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	250	14.46 (8.51)	13.77 (7.51)	-0.35 (-1.19 – 0.48)	450	17.50 (9.76)	14.02 (9.71)	-3.19 (-3.90 – -2.49)	-1.81 (-2.85 – -0.77)	0.001

Table 3.7 CAT score outcome: comparison between and within control and intervention groups (intention-to-treat). SD: Standard deviation; CI: Confidence interval; *Adjusted difference represented by using coefficient and adjusted for clustering, age, gender, deprivation and baseline CAT score.

COPD-related hospitalisation

Frequency of COPD-related hospitalisations was compiled using secondary care data and a complete dataset was obtained. 1,086 (87.4%) and 1,071 (86.23%) patients had zero hospitalisations at baseline and follow up respectively, indicating an excess of zero counts within this variable. An analysis of the whole cohort (Table 3.8) indicates that the mean number of hospitalisations increased from baseline to follow up in both arms of the study. When adjusted for clustering, gender, age and, deprivation the number of hospitalisations from baseline to follow up did not differ significantly between the control and intervention arms of the study. After accounting for excess zero counts using zero-inflated poisson (ZIP) regression (Table 3.9) the adjusted difference in number of hospitalisations, from baseline to follow up, between the control and intervention arms is statistically significant. The results indicate that the intervention led to a significant increase in hospitalisation from baseline to follow up versus the control with an IRR of 1.96 (95%CI 1.45 – 2.64, p<0.001.

COPD-related hospitalisations outcome	**Control**				**Intervention**				**Between group difference***	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	656	0.20 (0.55)	0.25 (0.72)	0.05 (-0.01 – 0.11)	586	0.14 (0.52)	0.31 (1.20)	0.17 (0.07 – 0.26)	1.28 (0.93 – 1.78)	0.13

Table 3.8 COPD-related hospitalisations outcome: comparison between and within control and intervention groups (intention-to-treat). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline COPD-related hospitalisations.

COPD-related hospitalisations outcome – Adjusted for zero counts	**Control**				**Intervention**				**Between group difference***	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	100	1.34 (0.07)	0.69 (1.20)	-0.65 (0.40 – 0.90)	56	1.45 (0.95)	0.98 (2.11)	-0.47 (-0.08 – 1.01)	1.96 (1.45 – 2.64)	<0.001

Table 3.9 COPD-related hospitalisations outcome adjusted for excess zero count: comparison between and within control and intervention groups (intention-to-treat). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline COPD related hospitalisations.

COPD Exacerbations

Frequency of exacerbations was compiled using primary care data. There was missing data due to frequency of exacerbations being poorly recorded in the primary care clinical system, as a result there were 214 paired exacerbation frequencies in the control group and 437 paired exacerbation frequencies in the intervention group. An analysis adjusting for excess zeros was not required within this variable, due to there not being an excess of zero counts, which is possibly due to missing data within the dataset. Missing data potentially could

represent the zero counts that were not recorded in the primary care clinical record as recording zero exacerbations may have been deemed not clinically relevant.

An analysis of the whole cohort (Table 3.10) indicates that the mean number of exacerbations increased from baseline to follow up in the control arm however, decreased in the intervention arm of the study. However, when adjusted for clustering, gender, age and, deprivation the number of exacerbations from baseline to follow up did not differ significantly between the control and intervention arms of the study.

COPD Exacerbations outcome	**Control**				**Intervention**				**Between group difference***	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	214	0.87 (1.33)	0.98 (2.16)	0.11 (-0.19 – 0.41)	437	1.43 (2.02)	1.39 (1.95)	-0.04 (-0.22 – 0.14)	1.16 (0.88 – 1.52)	0.29

Table 3.10 COPD exacerbations outcome: comparison between and within control and intervention groups (intention-to-treat). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline number of exacerbations.

Respiratory outpatient attendance

The number of respiratory outpatient attendances was compiled using secondary care data, allowing for a complete dataset to be obtained. 1,056 (85%) and 1,067 (86%) patients had no respiratory outpatient attendance at baseline and follow up respectively, indicating excess zero counts within this variable.

An analysis of the whole cohort (Table 3.11) indicates that the number of respiratory outpatient attendances from baseline to follow up did not differ significantly between the control and intervention arms. Equally, after accounting for excess zero counts with a ZIP regression analysis (Table 3.12) no significant difference was found between the two arms of the study.

Respiratory outpatient attendance outcome	**Control**				**Intervention**				**Between group difference***	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	656	0.35 (0.92)	0.27 (0.75)	-0.08 (-0.14 – -0.01)	586	0.21 (0.72)	0.21 (0.75)	0 (-0.07 – 0.07)	0.85 (0.54 – 1.34)	0.49

Table 3.11. Respiratory outpatient attendance outcome: comparison between and within control and intervention groups (intention-to-treat). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline respiratory outpatient attendances.

Respiratory outpatient attendance outcome – Adjusted for zero count	Control				Intervention				Between group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	119	1.92 (1.31)	1.05 (1.16)	-0.87 (-1.11 – -0.62)	67	1.85 (1.25)	0.70 (1.23)	-1.15 (0.40 – 1.00)	0.91 (0.63 – 1.30)	0.60

Table 3.12. Respiratory outpatient attendance outcome adjusted for excess zero counts: comparison between and within control and intervention groups (intention-to-treat). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline respiratory outpatient attendances.

Impact of guideline adherence on secondary outcomes

The impact of adherence to the guidelines at baseline on the secondary outcomes is shown in Table 3.13. There were statistically significant differences in CAT score, COPD exacerbations and, COPD-related hospitalisations between adherent and non-adherent care. A reduction in CAT score was observed when either the 2017 or 2019 guidelines were adhered to, however, the reduction was not clinically significant as the confidence interval was not greater than the MCID. The incidence rate ratio of guideline adherence to non-adherence for COPD-related hospitalisations was 1.21 (2017 guidelines) and 1.20 (2019 guidelines) indicating there were more COPD-related admissions in the guideline adherent cohort at baseline. There were fewer COPD exacerbations in the guideline adherent cohort at baseline with an adherence to non-adherence IRR of 0.75 (2017 guidelines) and 0.80 (2019 guidelines). Therefore, the provision of guide adherent care at baseline was associated with a reduction in CAT score, although not clinically significant, and fewer COPD exacerbations. However, guideline adherence was also associated with more COPD-related hospital admissions. There was no significant difference found between the adherent and non-adherent cohorts when comparing change in the secondary outcomes from baseline to follow up as shown in Table 3.14.

Impact of adherence/non-adherence at baseline	2017 Guidelines			2019 Guideline		
	Coeff (95%CI)	IRR (95%CI)	*p*-Value	Coeff (95%CI)	IRR (95%CI)	*p*-Value
CAT Score	-2.06 (-3.47 - -0.65)	N/A	0.004	-1.49 (-3.01 – 0.03)	N/A	0.05
COPD-related Hospitalisations*	0.19 (0.02 – 0.36)	1.21 (1.03 – 1.43)	0.03	0.19 (0.02 – 0.35)	1.20 (1.02 – 1.42)	0.03
COPD exacerbations	-0.29 (-0.42 – -0.15)	0.75 (0.66 – 0.86)	<0.001	-0.22 (-0.36 – -0.08)	0.80 (0.70 – 0.93)	0.003
Respiratory outpatient attendances*	-0.15 (-0.34 – 0.03)	0.86 (0.71 – 1.03)	0.12	-0.01 (-0.17 – 0.15)	0.99 (0.85 – 1.17)	0.94

Table 3.13. Impact of adherence to 2017 and 2019 guidelines: comparison of secondary outcomes between guideline adherent and non-adherent patients at baseline (intention-to-treat). Coeff: Coefficient; CI: Confidence Interval; IRR: Incidence rate ratio. All outcomes have been adjusted for clustering, age, gender, deprivation, and randomisation group. *adjusted for excess zero count. Coefficients and IRRs are of guideline adherence to non-adherence.

Impact of adherence/non-adherence at follow up	2017 Guidelines			2019 Guideline		
	Coeff (95%CI)	IRR (95%CI)	*p*-Value	Coeff (95%CI)	IRR (95%CI)	*p*-Value
CAT Score	-1.76 (-4.31 – 0.79)	N/A	0.18	-2.32 (-5.83 – 1.18)	N/A	0.19
COPD-related Hospitalisations*	-0.26 (-0.69 – 0.17)	0.77 (0.50 – 1.19)	0.24	-0.05 (-0.60 – 0.51)	0.95 (0.55 – 1.66)	0.87
COPD exacerbations	-0.12 (-0.44 – 0.22)	0.90 (0.65 – 1.25)	0.52	-0.09 (-0.55 – 0.36)	0.91 (0.58 – 1.43)	0.68
Respiratory outpatient attendances*	-0.24 (-0.48 – 0.01)	0.79 (0.62 – 1.01)	0.06	-0.23 (-0.51 – 0.06)	0.80 (0.60 – 1.07)	0.13

Table 3.14. Impact of adherence to 2017 and 2019 guidelines: comparison of secondary outcomes between guideline adherent and non-adherent patients at 12 months follow up (intention-to-treat). Coeff: Coefficient; CI: Confidence Interval; IRR: Incidence rate ratio. All outcomes have been adjusted for clustering, age, gender, deprivation, and randomisation group. *adjusted for excess zero count. Coefficients and IRRs are of guideline adherence to non-adherence.

3.3.4 Per protocol analysis

As this study took a pragmatic approach, the primary analysis method used was intention-to-treat (ITT) so as to reflect the impact of the intervention in real life. An exploratory per-protocol (PP) analysis was completed to determine if outcomes to the intervention differed when patients completed the 12 month follow up review as intended, the results are presented in Appendix 6. The PP analysis produced the same statistical and clinical relevance as the ITT analysis when analysing the cohort as a whole.

3.3.5 Multiple imputation

The CAT score and number of COPD exacerbations variables both had missing data, however, data in the number of COPD exacerbations variable was not missing at random. Data missing within the number of COPD exacerbations variable was likely to be due to clinicians not recording zero exacerbations in the EPR, as it was not clinically relevant. Therefore, as the data was not randomly missing the variable could not be analysed using multiply imputed datasets. Whereas data missing from the CAT score variable was deemed as missing at random, therefore, mean calculation and regression analyses were repeated for this variable using 10 generated imputed datasets, the results are presented in Appendix 7. The multiply imputed datasets analysis produced results with the same statistical and clinical relevance as the ITT analysis when analysing CAT scores.

3.4 Discussion

3.4.1 Principal findings

The integration of COPD specialists into GP practices has been shown to significantly improve the delivery of guideline adherent care. Prior to the intervention, guideline adherence ranged from 70% - 75%, however, 12 months following the intervention, it increased to >90%. Quality of life differed significantly between the control

and the intervention, favouring a lower CAT score with the intervention. However, as the confidence interval of the adjusted difference passed below the MCID for CAT, the difference between control and intervention may not have been clinically significant. It is feasible that the changes in the secondary outcomes observed in this study are due to the impact of guideline adherence, since this was significantly associated with lower CAT scores and fewer COPD exacerbations. However, guideline adherence did not have an impact on respiratory outpatient attendance.

3.4.2 Comparison to current literature

This study is the first to measure provision of guideline adherent care as a primary outcome following implementation of an integrated care service in a primary care setting. The results reflect the findings from secondary care,[207] whereby completion of COPD guideline bundles and delivery of guideline adherent care was greater with respiratory specialist input. However, the results do not corroborate previous findings from Price et al,[144] wherein primary care data of 24,967 COPD patients was analysed and found that 17% did not received pharmacological treatment for COPD and overall there was excessive use of inhaled corticosteroids. Data from INTEGR COPD indicates that within the control group at follow up 90% of patients had received guideline adherent pharmacological treatment based on 2019 GOLD guidelines. Equally the UK COPD audit found that the rate of referral to pulmonary rehabilitation for eligible patients was 15%,[205] however, the rate is 23% in the INTEGR COPD control cohort. The difference seen between the INTEGR COPD control cohort and the average UK primary care cohort could be due to the implementation of virtual clinics as usual care, which may have improved prescribing and pulmonary rehabilitation referral practices amongst primary care clinicians within the INTEGR COPD cohort.

Although the intervention led to a lower CAT score and the mean change within the intervention cohort from baseline to follow up was clinically significant, the difference between the intervention and control was not clinically significant. Therefore, the results are inconsistent with the findings from the most comprehensive systematic review exploring the effectiveness of COPD integrated care,[121] where it was found that quality of life improved with integrated interventions. However, as discussed earlier, integrated care can cover a wide array of interventions. The subgroup analysis of primary care interventions within the systematic review by Kruis et al which concluded improvement in quality of life was based on six studies, four of which focused on the

exercise component and two focused on the self-management education component. As INTEGR COPD was a pragmatic study, the intervention needed to include all components provided within usual care, namely diagnostic support through spirometry; education through patient self-management education; and case management through clinical review and treatment optimisation. As a result, INTEGR COPD was a multi-component intervention, therefore, does not truly reflect the studies included in the meta-analysis by Kruis et al[121]. However, a recent study[174] utilising multiple components similar to INTEGR COPD, reported an improvement in quality of life measured using CAT. Ferrone et al took a non-pragmatic approach and targeted high risk COPD patients, however, their intervention included the same components found in INTEGR COPD, and they reported an improvement in quality of life. A recent Australian integrated COPD care study[210] took a pragmatic approach similar to INTEGR COPD and focused their intervention on case management, diagnostic support, staff education and exercise. They found the change in CAT score from baseline to 12 months follow up to no different between integrated care and usual care. However, it is important to note that within the Australian study usual care GPs were provided with additional guideline information and lung function testing/results, which potentially led to a change in behaviour in the usual care arm during the study. Within the INTEGR COPD cohort the control arm did have ongoing specialist support through virtual integrated care, which is not a common feature in usual care in most studies. This potentially could explain why a clinically significant difference was not observed between control and intervention.

Within the INTEGR COPD cohort COPD-related hospitalisations reduced in both the control and intervention groups, however, the reduction was greater in the control group, which contradicts the findings of the Kruis et al systematic review[121];their subgroup meta-analysis concluded integrated interventions that reduced COPD-related hospitalisations. Within that subgroup seven studies were included of which four focused on patient education and action plans, one focused on exercise, one focused on structured follow up and one focused on both structured follow up and patient action plans. The control comparator in these studies was usual primary care, which did not include virtual integration. The INTEGR COPD cohort is not a good reflection of the studies included in the systematic review, as the intervention focused on multiple components and the control utilised virtual integrated care. There are no studies comparing virtual and real integrated COPD care, however, the results of the INTEGR COPD cohort suggest that virtual integration may be more effective at reducing COPD-

related hospitalisations. Greater admissions in the intervention group compared to the control group in this study could reflect greater safety netting amongst specialists, due to inexperience of working in primary care.

No difference was found between the control and the intervention regarding change in number of COPD exacerbations from baseline to follow up within the INTEGR COPD cohort. This finding is consistent with the findings of the Kruis et al subgroup meta-analysis[121]. A study completed in the Netherlands also found no significant difference in number of exacerbations between integrated care and usual care.

There are no published studies reporting the impact of integrated COPD care on respiratory outpatient attendances. No difference was observed between the control and the intervention in this cohort, however, this could be due to outpatient appointments being booked in advance as follow ups, thus remain unamended by the patients involvement in the intervention.

3.4.3 Strengths and weaknesses

The pragmatic approach taken in this study allowed it to represent real life impact of a multi component integrated care intervention set in general practice. However, although multiple GP surgeries of varying size and resources were recruited, the practices were all based within the East Birmingham region and shared similar patient demographics regarding deprivation. The study also only recruited GP practices participating in the virtual integrated respiratory care service. These limitations were necessary to ensure practices had equal access to secondary care, however, it could reduce the ability to generalise the findings from the INTEGR COPD cohort to other areas within the UK which are less deprived or less urban in nature.

Missing CAT score and COPD exacerbation data was a key limitation. Due to the nature of the study, only routinely collected clinical information could be used. Although CAT score and number of exacerbations in the past 12 months are fields present on COPD review proformas used by GPs and practice nurses they were poorly recorded as part of usual care. Primary care data was obtained through the extraction of coded clinical entries in the EPR. Recording of clinical data in primary care is often coded to allow for clinical audit to ensure government targets known as QOF are met. QOF applies a monetary incentive for meeting targets, which are measured through the audit of clinical notes. The recording of smoking status, smoking cessation advice, influenza vaccination, MRC score, spirometry, and pulmonary rehabilitation are all part of QOF[2], and as such

these variables had minimal missing data. Whereas the recording of CAT score and number of exacerbations do not have monetary incentives, which could explain why these variables were less well completed.

The INTEGR COPD cohort is larger than the majority of other studies exploring integrated COPD care included in the Kruis et al[121] systematic review and studies[96, 174, 210] following the review. However, as this study was a cluster randomised controlled trial a greater number of patients were required to overcome the impact of cluster bias. Based on the original power calculation the study is under powered. The original sample size calculation was based on an estimated population of 1500 patients, however, this did not take into account the number of misdiagnosed patients. 14% to 29% of patients are estimated to be misdiagnosed with COPD in UK primary care, based on the findings from the systematic review in Chapter 2. Assuming a 20% misdiagnosis rate, the number of potential patients for recruitment reduced to 1200. The ICC for the INTEGR COPD cohort was calculated to be 0.11, using this and the estimate of 1200 potential patients in the geographical area of the study the ideal sample size is recalculated to be 585 per arm of the study with 80% power. Based on this calculation the study is adequately powered.

3.4.4 Implications on clinical practice

Although this study is posed as a comparison between integrated care and usual care, a more appropriate description would be a comparison between "real" integration and "virtual" integration. Adherence to prescribing and pulmonary rehabilitation guidelines the usual care cohort was above the UK average[144, 205], this is likely to be due to the utilisation of virtual integrated COPD services as usual care. Virtual integration provided patients with indirect specialist led care, however, with the addition of direct specialist led care or "real" integrated care the intervention significantly improved the provision of guideline adherent care. Within this cohort, guideline adherence was shown to have an impact on quality of life, COPD exacerbations and COPD-related hospitalisations. However, the difference in quality-of-life outcome between virtual and real integration was not clinically significant and virtual integration had fewer hospitalisations at follow up. Therefore, at least theoretically, a hybrid model involving components of both virtual and real integration should be tested against a comparator with no integrated care to determine the true effectiveness of integrated care. The fact that sites were generally practicing at a level above UK average would bring into question the ethics of removing this virtual support, however, and perhaps supports its use. The impact of integrating specialists into general practice

is described in this study through changes in numerical data, however, it does not represent the human impact. This aspect of the study does not represent whether the intervention changed clinician behaviours and perceptions, nor did it represent acceptability of the intervention amongst patients and staff in GP practices. These factors are important to determine whether integrating respiratory specialists into primary care would be successful or not. Chapter 5 will explore how integrated care was perceived by patients and clinicians to provide a further understanding of how integrating respiratory specialists into general practice impacts patients. Using a combination of both qualitative and quantitative results would provide better guidance for future integrated care interventions. However, cost effectiveness also needs to be assessed, and will be the subject of a separate student project.

3.4.5 Conclusion

The provision of guideline adherent care has a significant impact on quality of life, COPD exacerbations and COPD-related hospitalisations. Within this cohort, integrating a respiratory specialist into general practices significantly improved the provision of guideline adherent care.

CHAPTER 4 : EXPLORING CAUSES OF MISDIAGNOSIS WITHIN THE INTEGR COPD COHORT USING A MIXED METHODS APPROACH

4.1 Introduction

COPD in the UK is primarily diagnosed and managed by generalists in primary care.[2] Specialist are only involved in the care of patients when there is uncertainty with diagnosis or difficulty with management.[201] However, specialist involvement requires GPs to identify the problem first then make a referral,[211] the integration of respiratory specialists into GP practices potentially could assist in reducing the impact of COPD misdiagnosis as discussed in Chapter 2.

Diagnosing COPD requires a combination of spirometry and clinical skills.[29] The skill to perform a spirometric test is necessary to confirm the presence of obstructive airways, however, clinicians also need to have adequate skills to interpret the spirometry results.[212] Primary care clinicians also need to be able to assess the clinical history and examination to determine if patients truly have COPD or other diseases that mimic COPD symptoms.[213] These skills require specialist training as well as constant maintenance of skills to prevent deskilling.[142] However, it is difficulty with these skills that are associated with misdiagnosis of COPD in primary care.[135] Current literature exploring COPD misdiagnosis focuses on the use of quantitative data to understand the root causes of COPD misdiagnosis.[135] The mixed methods systematic review in Chapter 2 of this thesis used both qualitative data and quantitative data to understand why patients were being misdiagnosed with COPD. However, the systematic review identified a gap in the current literature. There were minimal qualitative studies directly exploring the causes of COPD misdiagnosis in primary care. Perceived causes of misdiagnosis were primarily based on interpretations of quantitative data from authors. Equally there were no studies directly exploring the perceived impact on misdiagnosis after integrating respiratory specialists into primary care.

The INTEGR COPD study described in Chapter 3 of this thesis produced a cohort of patients identified as misdiagnosed following diagnostic review as part of an integrated care intervention. Data was collected as part of the INTEGR COPD study for these patients and reviewed to determine the cause of misdiagnosis in each case. The findings from the quantitative data were used to develop a topic guide to conduct semi-structured

interviews with HCPs and patients. Using a mixed methods approach, the cause of COPD misdiagnosis within the INTEGR COPD cohort was explored and addressed the gap in current literature.

4.2 Methods

Diagnostic review formed part of the INTEGR COPD study in view of the prevalence of misdiagnosis amongst patients on COPD registers in primary care as discussed in Chapter 2 of this thesis. As a result, a cohort of misdiagnosed patients was formed and became the participants of a sub-study exploring COPD misdiagnosis in primary care. The sub-study used a mixed methods explanatory sequential approach[214], wherein quantitative data was collected from misdiagnosed patients to determine the cause of misdiagnosis, this in turn was used to develop the topic guide for qualitative data collection. Qualitative data was collected using semi-structured interviews with HCPs and misdiagnosed patients to explore and understand why misdiagnosis occurred. A conceptual view of the study design is illustrated in Figure 4.1.

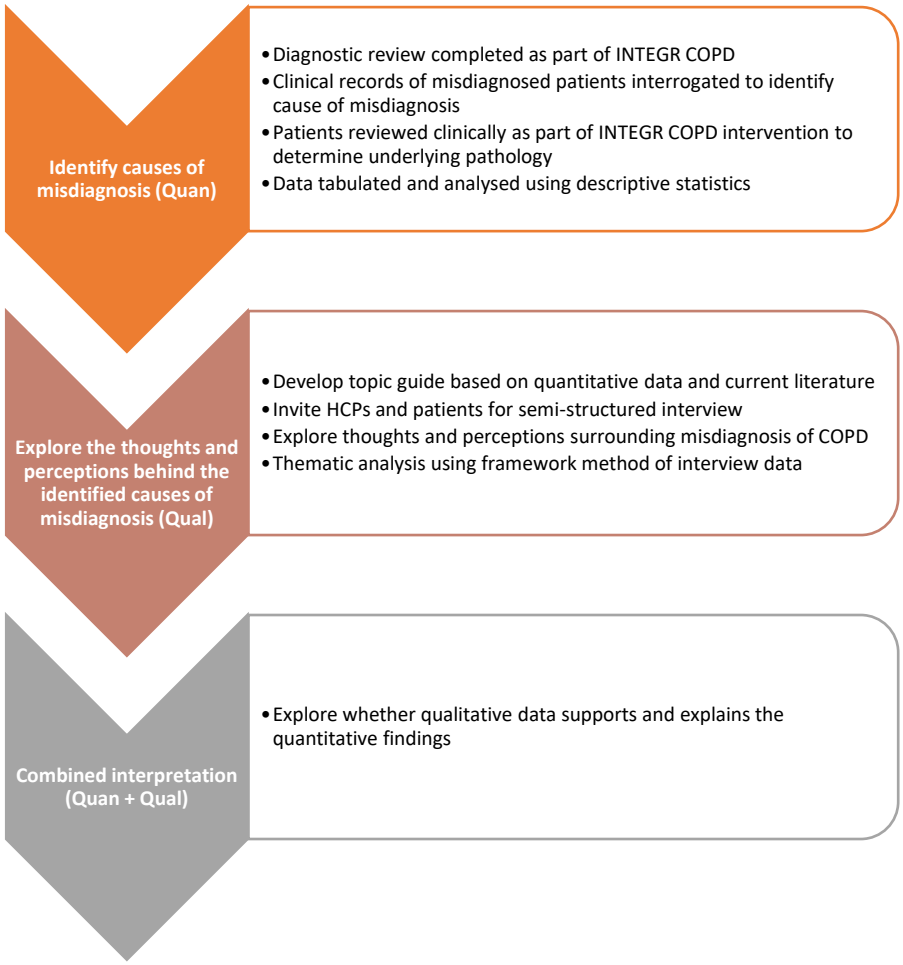

Figure 4.1 Overview of explanatory sequential mixed methods study design. Quan: Quantitative; Qual: Qualitative.

4.2.1 Quantitative component

4.2.1.1 Participants

Patients were defined as having COPD if they met criteria set out by the Global Initiative for Chronic Obstructive Lung Diseases (GOLD)[29]. GOLD criteria states that COPD is defined as a post bronchodilator forced expiratory volume in 1 second (FEV_1) to forced vital capacity (FVC) ratio of <0.7 associated with symptoms of dyspnoea and cough.[29] Patient not meeting these criteria but having a diagnosis of COPD recorded in their clinical records were deemed as having been misdiagnosed. However, patients diagnosed with emphysema with confirmed presence of emphysematous radiographic changes on CT scan but not meeting GOLD criteria for COPD were not classed as misdiagnosed as the recorded emphysema diagnosis was deemed as being accurate. Diagnostic review took place as part of the INTEGR COPD study following consent being obtained for recruitment to the trial. Within the intervention arm of the INTEGR COPD study, diagnostic review was conducted in person with the patient by the specialist. This involved a review of the patient's clinical history, a clinical examination and spirometric testing. Patients found to have been misdiagnosed with COPD were excluded from the main study and included into the COPD misdiagnosis sub-study cohort. Appropriate investigations and management were initiated by the specialist for misdiagnosed patients to identify the underlying pathology. The patient's GP was kept informed to ensure ongoing clinical management was continued as this was outside the scope of the study. Within the control arm of the INTEGR COPD study, diagnostic review was completed virtually. The electronic clinical records of patients with a diagnosis of COPD were reviewed by specialists in collaboration with GPs and practice nurses. Patients identified as having been misdiagnosed were excluded from the main study and included into the COPD misdiagnosis sub-study. As specialist were not to have direct contact with patients in practices randomised to the control arm of the study, GPs were asked to clinically review misdiagnosed patients and arrange appropriate investigations and initiate treatment.

4.2.1.2 Data collection

In addition to data collected as part of the INTEGR COPD study as described in Chapter 3, cause of misdiagnosis was recorded for each patient within the sub-study. The underlying diagnosis, where available, was also recorded in patients who were part of the intervention arm of INTEGR COPD, as this data was recorded by the specialist during clinical review. Underlying diagnosis could not be recorded in the patients who were part of the control arm as the clinical review to determine underlying pathology was not within the scope of INTEGR COPD.

Cause of misdiagnosis was described in narrative format and was based on identifying when the patient was diagnosed with COPD and interpreting why misdiagnosis occurred. As this variable was reliant on reviewer interpretation, the narrative description produced by the specialist was discussed with the patient's GP or practice nurse to ensure corroboration. Where there was disagreement, this was resolved through re-assessment of the clinical record and discussion with a third clinician. The narrative descriptions were then summarised and standardised. Underlying pathology was based on the results of further clinical investigation where appropriate. As the underlying pathologies were based on investigation findings, they did not require corroboration with the patient's GP.

4.2.1.3 Data analysis

Demographic characteristics were tabulated and descriptive statistics were used to determine the commonest identified factors leading to misdiagnosis of COPD. This information was then used to guide participant selection and develop the topic guide for the qualitative component of the sub-study. Further quantitative data analysis was not deemed necessary as its primary purpose was to inform the qualitative component of the sub-study.

4.2.2 Qualitative component

A topic guide focusing on the acceptability of integrating specialists into primary care had already been developed for the main INTEGR COPD study, which is explored further in Chapter 5. To avoid participant fatigue, the topic guide generated for the misdiagnosis sub-study (Appendix 8) was combined with the INTEGR COPD topic guide (Appendix 10) so that participants would only have one interview to attend. However, the misdiagnosis section of the combined topic guide was only used when interviewing participants eligible for the misdiagnosis sub-study.

4.2.2.1 Participants

Patients who had been enrolled in the INTEGR COPD study described in Chapter 3 were approached for participation in the qualitative component of the INTEGR COPD study which is presented in Chapter 5. Of the patients who had accepted to participate in the qualitative component of the INTEGR COPD study, patients who had been misdiagnosed, as per the definition described earlier, were interviewed using both the topic guide in Appendix 8 and 10. HCPs who had been involved in either the usual care or intervention arm of the INTEGR COPD study were also approached for participation in the qualitative component of the INTEGR COPD study. Of

the HCPs that agreed to participate in the qualitative component of the INTEGR COPD study, those who were routinely involved in the management of patients with COPD were also interviewed using both the topic guide in Appendix 8 and 10. To ensure heterogenicity in the sample, maximum variation purposive sampling was used to select patients and HCPs for interview. Patient variables that were considered during purposeful sampling included: age, gender, smoking status and deprivation index. HCP variables that were considered during purposeful sampling included job role, interest in respiratory medicine and number of years qualified. Participants who were unable to speak English were not eligible to participate in the qualitative component as the language barrier would have had an impact on obtaining a clear picture of the participants opinions and experiences. However, this is unlikely to have had an impact on representation of the cohort as the majority of patients and HCPs in the INTEGR COPD study were able to speak English. The aim was to interview 10 HCPs with 2 participants from each job role (GP, Practice Nurse, Respiratory Physician, Respiratory Nurse, Respiratory physiotherapist) and interview 10 patients who had been misdiagnosed, providing a sample size of 20. However, the end point of recruitment was determined by reaching theoretical saturation, whereby no new viewpoints or concepts were arising from the interviews.[215, 216]

4.2.2.2 Interviews

The interviews were conducted between March 2020 and March 2021 using a semi-structured design which followed a topic guide. Patients deemed eligible for the misdiagnosis sub-study were asked the additional misdiagnosis topic questions from the combined INTEGR COPD topic guide. A semi-structured approach rather than a structured approach was chosen so as to allow participants to give an in-depth story of their experience and to allow flexibility for the interviewer to probe where appropriate. The topic guide was kept flexible and was allowed to evolve based on emerging concepts from early interviews. The semi-structured approach also had an advantage over an unstructured approach. Using a semi-structured approach reduced interviewer bias as the interview was guided by a topic guide that was grounded in evidence, rather than the interviewer's own thoughts.

Participants were offered the opportunity to have their interview either face to face or via telephone. However, as the qualitative component of the INTEGR COPD study took place during the COVID-19 pandemic the majority of interviews were completed via telephone to maintain social distance. Participants were not required to return for a second or follow up interview. Interviews were recorded using an electronic Dictaphone and transcribed

using Microsoft Word. Any comments made that would lead to the identification of the interviewee were redacted from the transcripts. The interview recordings and transcripts were stored within the secure servers at University Hospitals Birmingham NHS Foundation Trust (UHB).

4.2.2.3 Topic Guide

The misdiagnosis topic guide consisting of prompts and aims for each topic can be found in Appendix 8. These topics were chosen as the quantitative component of the sub-study identified difficulty interpreting spirometry and differentiating between COPD and asthma as the common causes of misdiagnosis. These findings are similar to those of Hangaard et al[135] and Sator et al[136]. The topic guide also explores the barriers to diagnosing COPD adequately, which builds on the work completed by Haroon et al[134] and Summers et al[165].

4.2.2.4 Thematic analysis

The transcripts were analysed using the thematic framework method outlined by Gale et al[217]. Three transcripts deemed to be rich and informative were selected to be coded by myself, a medical student (DS), a clinical researcher (CH) and a non-clinical qualitative researcher (SC). The coding and transcripts were discussed, under the supervision of an experienced qualitative researcher. This process was repeated again with a further three transcripts to identify additional codes after which the initial coding framework was developed. The remaining transcripts were coded using this framework, which developed as coding continued. Once all transcripts were coded, a matrix framework as developed with quotes from the transcripts tabulated with their associated codes. Similarities between codes were identified and formed into categories which were summarised with explanatory quotes, the category summaries can be found in Appendix 9. Linkages between these categories were then reviewed to form themes.

4.2.2.5 Reflexive process

In any form of qualitative social research, the researcher's identity, background and personal views or values can directly influence the research, both through the social interaction of the data collection process, and through the approach taken to the data analysis and interpretation process.[218] In order to mitigate against personal identity or biases having undue or unacknowledged influence, a reflexive process was utilised.[218] My personal experiences and biases were reflected upon to identify areas for potential influence over the data, this was

followed by adjustments being made to mitigate against those influences where possible. This process has been explained fully in Chapter 5, which presents the qualitative component of the INTEGR COPD study.

4.2.2.6 Ethical approval

An amendment was made to the INTEGR COPD study ethics approval (REC 17/WM/0342) to allow the inclusion of misdiagnosis topics in the interview topic guide for patients and HCPs.

4.3 Results

4.3.1 Quantitative data

Between December 2017 and May 2020, 1,458 patients had undergone diagnostic review as part of the INTEGR COPD study of which 206 (14%) patients were identified as having been misdiagnosed with COPD. The demographic and clinical characteristics of the misdiagnosed cohort is shown in Table 4.1 and is split between patients identified via the intervention arm and control arm of the INTEGR COPD study. As expected within the misdiagnosed cohort the mean FEV_1/FVC ratio was greater than 0.70 with a mean FEV_1% of predicted suggesting borderline mild airflow obstruction. Within this cohort, the majority of patients were either ex-smokers or never smokers, which corroborates with the findings from Sator et al[136]. However, the majority of misdiagnosed patients were symptomatic with breathlessness (MRC score >1), which contradicts the current literature[136].

	Intervention	Control	Whole cohort
Number undergoing diagnostic review	695	763	1458
Number misdiagnosed (%)	99 (14%)	107 (14%)	206 (14%)
Demographics			
Male (%)	52 (53%)	46 (43%)	98 (48%)
Mean Age (SD)	66 (13.78)	65 (13.31)	66 (13.54)
Spirometry			
Mean FEV1% (SD)	82.88% (17.72)	78.10% (16.02)	80.87% (17.19)
Mean FEV1/FVC (SD)	0.77 (0.08)	0.76 (0.09)	0.76 (0.09)
MRC Dyspnoea Score			
MRC1 (%)	24 (24%)	14 (13%)	38 (18%)
MRC2 (%)	28 (28%)	37 (35%)	65 (32%)
MRC3 (%)	17 (17%)	29 (27%)	46 (22%)
MRC4 (%)	18 (18%)	12 (11%)	30 (15%)
MRC5 (%)	3 (3%)	1 (1%)	4 (2%)
No MRC score recorded (%)	9 (9%)	14 (13%)	23 (11%)
Smoking Status			
Smoker (%)	33 (33%)	42 (39%)	75 (36%)
Ex-Smoker (%)	50 (50%)	45 (42%)	95 (47%)
Never Smoker (%)	14 (14%)	19 (18%)	33 (16%)
No smoking status (%)	2 (2%)	1 (1%)	3 (1%)
Co-morbidities			
Asthma	11 (11%)	33 (31%)	44 (21%)

Table 4.1 Demographic and clinical characteristics for misdiagnosed patients in the intervention and control arms of INTEGR COPD. Data presented as frequency (%) or mean (SD). FEV_1: Forced Expiratory Volume in 1 second; SD: Standard deviation.

The identified causes of misdiagnosis are listed in Table 4.2. 59% of patients were misdiagnosed with COPD due to assumed difficulty interpreting the spirometry report and a further 18% were misdiagnosed due to the lack of spirometry use when making the diagnosis of COPD. Difficulties with spirometry were by far the commonest cause of misdiagnosis, however, it is important to note that 17% of patients were misdiagnosed due to misinterpretation of the clinical history. Misinterpretation of the clinical history could also explain why 16% of patients were diagnosed with COPD despite being never smokers (Table 4.1).

The underlying pathology was uncovered in misdiagnosed patients within the intervention arm of the INTEGR COPD study, the results are shown in Table 4.3. The majority of patients were found to have spirometry results within the normal range for their demographics. It is possible that these patients were misdiagnosed initially due to misinterpretation of the spirometry report or due to spirometry not being utilised for diagnosis. 40% of patients were found to have significant reversibility on spirometry and were subsequently diagnosed with asthma rather than COPD. Interestingly, of the 40 patients found to have asthma rather than COPD, 24 (60%) had a concurrent diagnosis of asthma already. Overall, 21% of misdiagnosed patients had a concurrent diagnosis

of asthma (Table 4.1) within their electronic patient records. This indicates that there is an element of difficulty deciding between a diagnosis of COPD and asthma within this cohort, which correlates with existing literature.[123]

Identified cause of misdiagnosis	Misdiagnosed cohort n=206
Misinterpreted spirometry	122 (59%)
Spirometry not used	37 (18%)
Misinterpreted clinical History	34 (17%)
Poor quality spirometry	10 (5%)
Miscommunication from secondary care	2 (1%)
Unknown	1 (<1%)

Table 4.2 Identified causes of misdiagnosis within the misdiagnosed cohort of INTEGR COPD. Data presented as frequency (%).

Underlying diagnosis	Misdiagnosed cohort – Intervention arm (n=99)
Normal Spirometry	41 (41%)
Asthma	40 (40%)
Interstitial lung disease	5 (5%)
Obesity	4 (4%)
Restrictive disease	4 (4%)
Heart failure	2 (2%)
Bronchiectasis	2 (2%)
Lung cancer	1 (1%)

Table 4.3 Identified underlying diagnoses in misdiagnosed cohort within the intervention arm of INTEGR COPD. Data presented as frequency (%).

The quantitative aspect of the misdiagnosis sub-study suggested that difficulty with spirometry in primary care is the root cause of COPD misdiagnosis, however, difficulty differentiating COPD from asthma also played a role. Based on these findings, topics surrounding “spirometry in primary care”, “diagnosing COPD” and “differentiating COPD from asthma” were included in the misdiagnosis sub-study topic guide.

4.3.2 Qualitative data

4.3.2.1 Participant characteristics

21 HCPs involved in the management of patients with COPD in primary care and were involved in the INTEGR COPD study were interviewed. In addition to the 21 HCPs, eight patients who had been found to have been

misdiagnosed with COPD through the INTEGR COPD study were also interviewed. A summary of their characteristics is presented in Table 4.4.

Participant Role	Number of participants	Number of male participants	Mean age	Mean years of clinical practice
Patient	8	4	66 (54 – 79)	N/A
GP	12	6	50 (30 – 75)	20 (6 – 46)
Practice nurse	3	0	41 (31 – 57)	8 (3 – 12)
ACP	1	0	50	3
Respiratory consultant	1	1	55	31
Respiratory SpR	2	2	31	8
Respiratory physiotherapist	1	0	41	20
Respiratory nurse	1	0	48	13

Table 4.4 Summary of participant characteristics. Data presented as frequency and mean values with range given in brackets.

4.3.2.2 Thematic analysis

Three categories were generated from the coding framework and have been summarised in Appendix 9. A review of these three category summaries led to the identification of multiple subthemes. These subthemes were then used to formulate the interpretation of three main themes emerging from the collected qualitative data. A thematic map of how the three main themes were interpreted is shown in Figure 4.2.

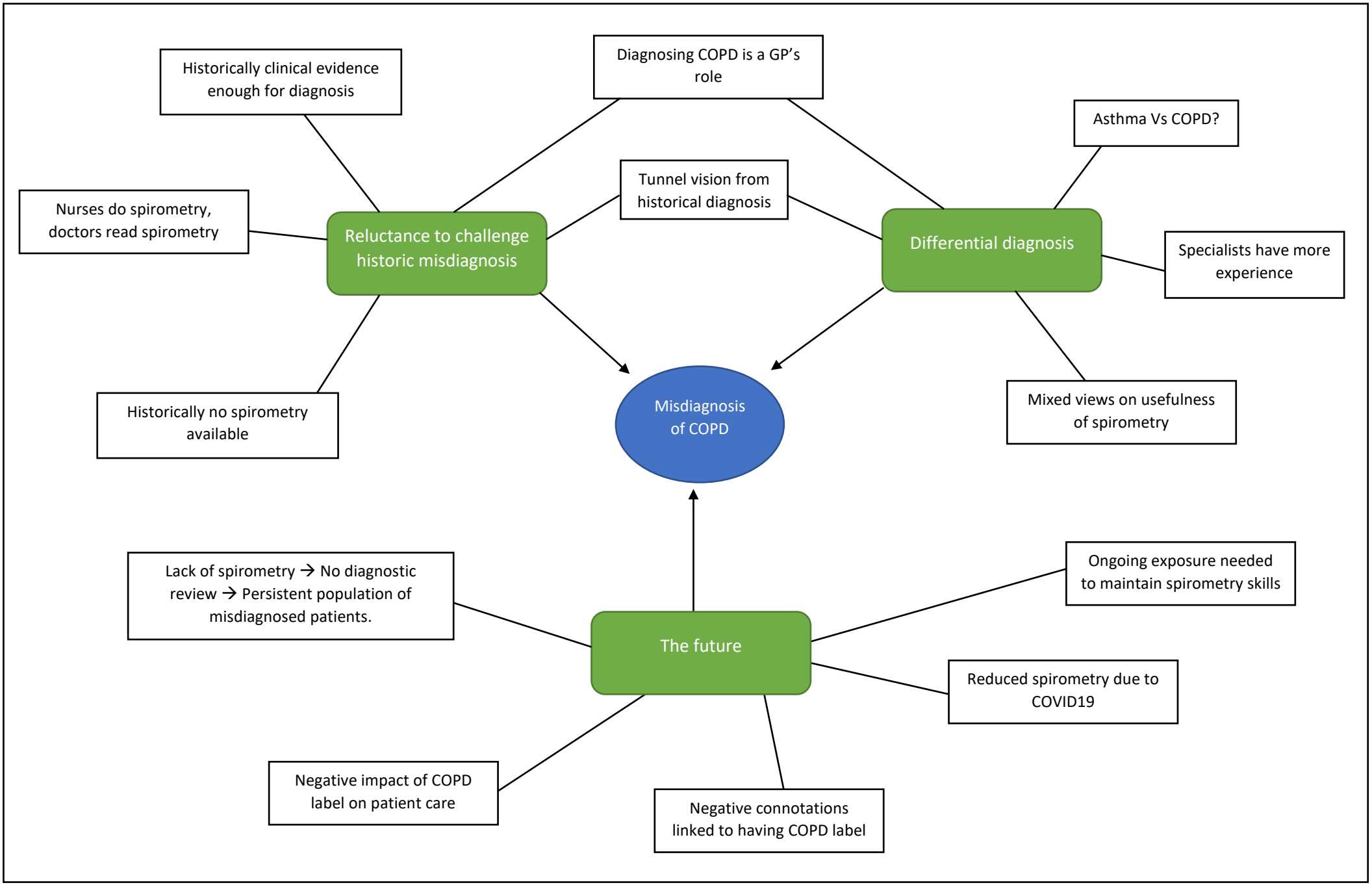

Figure 4.2 Thematic map exploring misdiagnosis of COPD. Main themes in green boxes with linked subthemes.

4.3.2.3 Reluctance to challenge historic misdiagnosis

Patients found to have been misdiagnosed were perceived to be patients that had historic misdiagnosis due to limitations in the diagnostic process at the time of diagnosis. Participants focused on the limited availability of spirometry to confirm diagnoses of COPD, and so many historic diagnoses were made based on clinical findings alone.

> *"Okay, some of them may have been historically misdiagnosed. We only started doing spirometry about five years ago, I think or something like this. I'm certain about it. Because I was diagnosing COPD on history in the past, smoker who's got recurrent infections, wheezing etc and lots of things over there. And I'm talking about more than 10 years ago, or even 15 years ago, spirometry started coming in." -SIN007 GP*

A historic diagnosis of COPD was perceived to lead clinicians down a single pathway and prevent them from considering alternative diagnoses even if the original COPD diagnosis was made without spirometry.

> *"I've come across a few people who have just been diagnosed with COPD, but have actually had that overlap with asthma. And I find once someone is diagnosed as COPD, and we sort of forget that there can be other things" -SIN018 GP*

> *"Once people are diagnosed, they've got that diagnosis for life haven't they? Whereas when he (specialist) came in, he looked at them as if they were a new presentation and started again with his history taking. And I think that's where he picked up errors" -SIN021 ACP*

Participants appreciated that spirometry played a role in the diagnostic process and was also perceived as a useful tool for annual monitoring of patients with COPD in primary care.

> *"You know, to have a spirometry done every year or two. And certainly, if there's a deterioration in symptoms, you know, doing another one at that point, just so that we can see clearly what is happening (…) So yeah, I quite like to be able to look back over several different readings and see how it's changed over a period of time" -SIN020 GP*

However, despite regular monitoring, patients found to have been misdiagnosed were not being identified for further review.

> *"I'm not confident that it always the surgeries go back to reassess that. I think they just once they mentioned COPD on their read codes.... it's hard, isn't it to pick up where the diagnosis and when the diagnosis occurred" -SIN013 Respiratory Nurse.*

> *"Well, I was a bit shocked really but even when I went for the um.. the um.. you know, for them to check, she(nurse) turned around, she said "I don't know why you're doing this because I don't think you've got it" but, that's what they do. So I said "but the doctor sent me" you know, I couldn't go beyond that (...) But she(nurse) still put me down as COPD" - IN14076 Patient.*

GPs were perceived as the HCPs to make the decision to investigate for possible COPD and then label a patient as having COPD. Nurses perceived their role as one of monitoring disease and performing spirometry, but not to challenge the COPD diagnosis. As a result, despite patients being found as have normal spirometry at annual reviews by the nurse, the diagnosis would not be challenged as it had been assigned by a doctor.

> *"But we only do that if that comes from the GP. So, it's the GP that decides whether we do spiros, on which patients and when" -SIN010 Practice nurse*

> *"the nurse because of their expertise might actually be able to help the GP or the GP trainee, because we're a training practice, might help them to interpret the results (…) but in terms of putting their firm diagnosis on the record, it will be done to a doctor" -SIN022 GP.*

Regular review of the patient's COPD diagnosis, alongside specialist support and education, was perceived as an intervention that would help reduce the prevalence of misdiagnosis within primary care.

> *"if patients are reviewed on a regular basis, what depending on what symptoms they've got, you might be reviewing them 12 months later and thinking hold on. This doesn't look like COPD. And therefore I'm going to arrange other tests so not just making a diagnosis, but making sure they have regular reviews, even those that don't seem to be having a frequent exacerbations. Perhaps having a standard whereby you review them once a year, at the very minimum. And when you review them, it could very well be that it comes to light then that the diagnosis wasn't made correctly" -SIN022 GP*

4.3.2.4 Differential diagnosis

Participants felt most COPD diagnoses were straightforward and could be made with clinical findings alone but would use spirometry to confirm their clinical assumptions and to meet QOF requirements. However, participants did appreciate the availability of spirometry in primary care to assist with the diagnostic process when there was diagnostic uncertainty.

> *"if it's, if it's easy, you almost don't need this spirometry like you look at them and clinically, you make the diagnosis and you are almost certain, and you're like, "Yeah, you've got COPD" and you do spirometry to tick a box" -SIN009 GP.*

However, due to the risk of missing diagnoses that mimic COPD symptoms, participants perceived spirometry as an essential tool within primary care to identify COPD mimics.

> *"I think, it's the history that raises it, and then the spirometry might clinch it. But it's the history that's the starting point. But in terms of onus, I think, I think if you end up with spirometry and it's inconclusive, or it's not what you expect. Then you need to start thinking about other things I guess and getting help" -SIN004 GP.*

"You want them to have spirometry. If you couldn't offer it in primary care, you'd probably have to send refer them to secondary care to have it done. And again, because with COPD, you've got people that might have a mixed mixture, and there are other things that could be going on, so I think you really need to have the spirometry to determine what's going on" - SIN022 GP.

Participants focused on their difficulty differentiating COPD from Asthma despite making use of spirometry in primary care.

"I think that occasionally COPD is difficult to diagnose (…) I'm suspecting it COPD or possibly asthma or possibly overlap, and I don't either have the knowledge for it or, or is my suspicion, I definitely think that my senior My, my, my colleagues who are specialists in it should give me feedback, they should see that person they should advise me" -SIN007 GP

"There are patients that have a mixed picture. In terms of when you look at his spirometry, it seems like they've got a bit of asthma and COPD as well. And I think it can be difficult for a GP that's not experienced to, to hedge their bets and say it's COPD, and it could very well be that they're wrong, maybe COPD and asthma. I think it's unlikely that they will diagnose them with asthma" -SIN022 GP

Participants perceived primary care as the appropriate environment for diagnosing patients with COPD, due to it being cost effective and easier for patients to access. However, participants appreciated that although primary care clinicians can diagnose the majority of patients, specialist involvement through MDT meetings would help improve confidence in the diagnoses being made in primary care.

"both can diagnose, so if specialists are, if only a diagnosis can be made from secondary care, you might increase your ability to diagnose, but you will have really long waiting lists and wait for that will be much, much longer" -SIN016 GP.

"So mentally, I think I think it's nice to have a specialist who can focus on it. And then we can have that discussion its useful to have a with our situation healthcare assistant who is very interested in COPD and chest medicine, and then GP with ongoing kind of interest and then having the specialist so we kind of bounce the ideas that description, that is what a multidisciplinary team is. And I think I think the days of having have one I'm the GP and I made a diagnoses, it doesn't hold you know.. we should discuss it in a multidisciplinary team kind of way" -SIN012 GP.

4.3.2.5 The future

HCPs perceived misdiagnosis with COPD led to a detrimental impact on the patients, health, mental and social wellbeing. However, patients had no concerns about having been misdiagnosed, but did express a sense of relief when told they did not have COPD, due to the perceived impact COPD had on their health.

"it can impact on people's life insurance, travel insurance. Have they been taking steroids that perhaps they didn't need to take? Has that put them at higher risk of getting pneumonia? You know, you know, have been given lots of courses of steroids that, that didn't need putting them at risk of osteoporosis, you know, so suppose and I don't know, maybe psychologically, the thing, they've got this sort of, not death sentence, but it's a long term condition, isn't it that's progressively gets worse over time. You don't know whether that perhaps has a psychological effect on some people and, you know, and, and people's occupation, if they if they put it down to they can't do the job because they've got COPD, whereas actually, it could be something else." -SIN021 ACP.

"Well, COPD that's where your tubes are shrinking and you know and I thought that was it .. the beginning of the end if you get what I mean. Now we know that it's not, it's taken that bit of weight off my mind" -IN16038 Patient.

HCPs in primary care expressed their concerns about future misdiagnoses due to the impact the COVID19 pandemic was having on spirometry use and training in primary care.

"I know at the moment, we're not doing it because of the COVID. The nurse is not comfortable in delivering so. So my worry at the minute is my patients have not had spirometry" -SIN006 Practice manager and nurse

It was perceived that the COVID19 pandemic could potentially lead to a cohort of patients diagnosed with COPD without spirometry to confirm and add to the existing cohort of misdiagnosed patients unless efforts are made to complete spirometry and review the diagnosis on these patients in the future.

"No, I think that's just how we felt within the practice that, you know, there, is this going to be this group of patients that haven't ever had a spirometry, and, you know, we would like that documented at some point" -SIN019 Respiratory SpR

4.3.2.6 Combined interpretation

Spirometry

The quantitative data suggested misinterpretation of spirometry as a leading cause of misdiagnosis. However, qualitative data revealed that initial diagnoses were often made without spirometry and were the cause of misdiagnosis. Subsequent spirometry monitoring was completed by nurses with experience and training to interpret spirometry, however, due to perceived healthcare roles, the COPD diagnosis was not challenged and the spirometry results were simply recorded to meet QOF targets. As a result, when diagnostic review was completed, COPD patients with normal or fully reversible spirometry recorded were assumed to have been misdiagnosed due to misinterpretation of the spirometry. Therefore, it is more likely that patients were

misdiagnosed initially due to lack of spirometry rather than misinterpretation. However, reluctance to challenge the diagnosis at subsequent reviews led to patients remaining misdiagnosed.

COPD Vs Asthma

The quantitative data indicated potential difficulties differentiating COPD from asthma within primary care, this was corroborated in the qualitative data. Asthma and COPD were perceived as having similar symptoms and were difficult to differentiate between despite the use of spirometry. Diagnostic uncertainty is likely to have led to clinicians labelling patients with both diagnoses, to ensure they receive adequate treatment to improve their quality of life. As a result, patients were mislabelled as having COPD, but received the appropriate treatment for asthma.

4.4 Discussion

4.4.1 Main findings

Despite advancements in spirometry training and experience, reluctance to review a historical COPD diagnosis is potentially the leading cause of a persistent prevalence of COPD misdiagnosis in primary care. The findings from this sub-study indicated that although difficulties interpreting spirometry were identified as the cause of misdiagnosis in the majority of cases, this was a simplistic view. Qualitative exploration revealed that primary care nurses were capable of interpreting spirometry, however, were reluctant to challenge historic COPD diagnoses. The reluctance to challenge historic diagnoses of COPD may stem from the established roles of nurses and doctors, whereby nurses find it difficult to contradict a doctor's decision. However, the chronic management of COPD in primary care is often nurse led, with GP involvement during acute exacerbations. As a result, a cohort of historically misdiagnosed patients has persisted. Patients were likely to have initially been misdiagnosed 5-10 years prior to this study and due to differences in acceptable diagnostic procedure at that time, patients were labelled with COPD based on clinical findings alone. Previous studies have focused on difficulties with spirometry as the leading cause of misdiagnosis, however, the concept of reluctance to challenge historic diagnoses as a cause of persistent misdiagnosis has not been addressed in previous literature[135].

In addition to reluctance to challenge historic diagnoses, this sub-study also identified difficulty differentiating COPD and asthma as another key cause for misdiagnosis. Primary care HCPs had difficulty differentiating between COPD and asthma due to similarities in symptoms and concerns regarding ACOS leading to uncertainty

regarding treatment. As a result, due to diagnostic uncertainty clinicians perceived treating for both asthma and COPD was the safest path, and so patients were labelled with both asthma and COPD.

4.4.2 Current literature

The prevalence of COPD misdiagnosis identified through integrated care in the UK ranges from 14% to 29%, as discussed in Chapter 2. The INTEGR COPD cohort was at the lower end of that range with a prevalence of 14% within the cohort. However, prevalence of misdiagnosis could be higher as more patients may have been identified in the control group had they received a specialist clinical review. Existing literature focuses on the inadequacies of spirometry use and interpretation in primary care as the cause for COPD misdiagnosis.[135] The Welsh COPD audit identified a significant lack of spirometry recording in primary care but also identified that 26% of those with spirometry results recorded had results incompatible with a COPD diagnosis.[132] An audit of primary care in Hampshire reported over a 3 year period, 12% of patients had spirometry recorded that was inconsistent with COPD.[219] In both cases the authors suggested improvement in spirometry training were needed to address the issue of misdiagnosis in primary care. The quantitative findings from this sub-study support the findings from the current literature, however, no qualitative studies exploring the causes of COPD misdiagnosis in primary care currently exist. This sub-study is the first to explore and understand the perceived causes of COPD misdiagnosis amongst HCPs and patients. The addition of qualitative data in this sub-study has shown that improving spirometry training alone will not be effective in reducing the prevalence of COPD misdiagnosis and that more work needs to be done to change perceived job roles and encourage diagnostic review.

Perceived difficulty differentiating between COPD and asthma amongst primary care clinicians has been demonstrated previously by Akindele et al. They explored, through qualitative interviews, challenges met when diagnosing asthma in primary care and found that clinicians had difficulty differentiating asthma from COPD.[220] The same perception of symptom similarity and difficulty differentiating asthma and COPD was found in this sub-study. Diagnostic uncertainty between asthma and COPD amongst primary care HCPs resulted in patients having concomitant asthma and COPD diagnoses, this was similar to the findings in current primary care literature.[221, 222]

4.4.3 Limitations

The quantitative data for this sub-study was limited in the intervention arm to patients that had attended for their annual COPD review and agreed to be seen by a specialist as part of a trial. This limited the number of patients having diagnostic review completed and potentially underestimated the causes and prevalence of COPD misdiagnosis in the intervention practices. Whereas at the control sites all patients with a pre-existing COPD diagnosis underwent a specialist diagnostic review, albeit virtually, which prevented assessment to determine the underlying pathology. Qualitative interviews were conducted by me, therefore, there was a risk of participants biasing their responses due to the interviewer being a specialist and involved in the INTEGR COPD study. However, HCP interviews were split between me and a medical student who the participants had not met previously. The interview transcripts produced by both interviewers were compared in a workshop with a non-clinical qualitative researcher and it was deemed that the responses did not vary between the two interviewers.

4.4.4 Implications for practice

Primary care is the optimal setting for diagnosing patients with COPD, however, specialist support is needed for complex cases that are difficult to diagnose and support GPs when there is diagnostic uncertainty. Specialist support through “virtual” or “real” clinics would assist in reducing misdiagnosis, however, its cost-effectiveness and acceptability needs to be assessed.

Historically patients had been diagnosed with COPD without spirometric confirmation of irreversible airway obstruction due to standards of that time not requiring it. Due to historic poor diagnosing standards a cohort of misdiagnosed patients has emerged and remain misdiagnosed despite annual spirometry as part of COPD monitoring. Annual COPD monitoring is completed by practice nurses, who are experienced and capable of reading spirometry results, with minimal GP input. However, due to set job roles they do not make or review COPD diagnoses. To reduce the prevalence of COPD misdiagnosis in primary care practice nurses need to be supported and encouraged to review and challenge COPD diagnoses when spirometry is not compatible with the diagnosis. Throughout the COVID19 pandemic spirometry ceased in primary care and patients have been diagnosed on the basis of clinical findings alone. As a result, there is the potential for a new cohort of misdiagnosed patients and without encouragement to review their diagnoses, at annual monitoring review, they risk remaining misdiagnosed until reviewed by a specialist in secondary care. As reported in Chapter 2, patients misdiagnosed with COPD can be identified through integrated COPD care interventions. Therefore, the integration of respiratory specialists into GP practices could potentially reverse the impact of the COVID19

pandemic on COPD misdiagnosis. In this chapter, the findings indicate that both virtual and real integrated care interventions were able to identify misdiagnosed patients. Therefore, if integrated COPD care interventions were to be reintroduced following the COVID19 pandemic the cohort of patients misdiagnosed with COPD in primary care could be reduced.

4.4.5 Conclusion

Misdiagnosis of COPD in primary care is likely to have occurred at a time when spirometry was rarely used, however, due to COPD diagnoses not being reviewed or challenged when subsequent spirometry is incompatible, a cohort of misdiagnosed patients has emerged in primary care. Newly misdiagnosed patients are likely to be misdiagnosed due to difficulty differentiating COPD from asthma, however, are also likely to be treated for both conditions. In order to reduce the prevalence of COPD misdiagnosis in primary care we need greater specialist involvement and support nurses to challenge historic COPD diagnoses.

CHAPTER 5 : EXPLORING PERCEPTIONS OF INTEGRATED COPD CARE AMONGST PATIENTS AND HEALTH CARE PROFESSIONALS

5.1 Introduction

Specialist led integrated care is a concept that has been implemented for the management of patients with COPD in the UK since 2014.[223] Integrated care has multiple definitions, however the most relevant definition relating to the management of COPD in the UK comes from the BTS.[224] The BTS definition of integrated care focuses on the provision of efficient care by the most appropriate healthcare professional in the most appropriate environment.[224] This has been interpreted by many integrated care projects to mean a push towards hospital specialists working across both hospital and community environments, at present there are 16 integrated care programmes targeting respiratory illnesses with varying formats established across the UK.[223]

In England there are 1.1 million adults who are diagnosed with COPD, the bulk of whom are managed entirely by their GP.[225] COPD is currently the second commonest cause for admission to A&E in England[4] and costs the National Health Service (NHS) approximately £810 million per annum, of which 47% is due to emergency hospital admissions.[92] In addition to direct healthcare costs, COPD has a significant impact on the economy through indirect costs caused by loss of productivity due to illness.[226] As a result, COPD is a significant burden on both the NHS and the economy, and with the prevalence of COPD projected to increase as is the burden.[90] The aim of implementing integrated COPD care is to improve outcomes for patients with COPD, which in turn is thought to reduce the burden of COPD on health services.

There have been multiple trials exploring the impact of specialist led integrated care services on outcomes for patients with COPD.[121] A systematic review concluded that integrated care improved quality of life and reduced the number of hospital admissions related to COPD exacerbations.[121] However, the systematic review focused primarily on quantitative data looking at clinical outcomes, and did not explore the qualitative data. Qualitative studies allow researchers the ability to explore opinions and thoughts of individual participants, which when collated together can produce an overall opinion in the form of themes.[217] The qualitative aspect of an intervention is essential to aid in determining future health policy as it can provide information regarding acceptability and compliance to an intervention.[227] However, there is currently a dearth of evidence regarding

the acceptability of specialist led COPD clinics within primary care in the UK akin to the intervention of the INTEGR COPD study described in Chapter 3.

Interviews were conducted with patients and HCPs participating in the INTEGR COPD study and their thoughts and perceptions of specialists being involved in primary care COPD management were explored.

5.2 Method

5.2.1 Study design

A qualitative component was added to the original INTEGR COPD study in order to explore the acceptability of specialist led COPD clinics in primary care settings. The qualitative study used a broad phenomenological approach to obtain data, which was analysed using thematic framework analysis.[217] A phenomenological approach was chosen as this design focused on obtaining data regarding experiences surrounding a particular event or phenomenon.[228] In this case the phenomenon was specialist led COPD clinics in a primary care setting as part of the INTEGR COPD study. Through semi-structured interviews, I explored the participants' experiences and perceptions of integrated COPD care. The interviews were conducted between March 2020 and March 2021, to ensure safe social distancing due to the ongoing COVID19 pandemic interviews were predominantly conducted via telephone. However, where safe to do so, face to face interviews were the preferred option.

5.2.2 Sample selection

Patients who were enrolled in the INTEGR COPD study within the intervention clusters were eligible for the qualitative study and were approached to participate in an optional interview. HCPs that were involved in the delivery of integrated COPD care as part of the INTEGR COPD study were eligible to participate and were approached to be interviewed as part of the qualitative study.

The INTEGR COPD study was a cluster randomised control trial, whereby patients and staff belong to one GP practice (cluster). Participants from one cluster were likely to have similar experiences due to similar healthcare access and provision, therefore, maximum variation purposive sampling was used to select participants for interview. This ensured that participants were selected from multiple clusters to reduce the effect of cluster bias and ensured adequate variation in the sample population.[229] Patient variables that were taken into consideration during purposeful sampling included: age, gender, smoking status and deprivation index. HCP

variables that were considered during purposeful sampling included job role, interest in respiratory medicine and number of years qualified. Participants who were unable to speak English were not eligible to participate in the qualitative study as the language barrier would have prevented an adequate representation of their experience being obtained.

Based on current literature, a target sample size was not chosen, instead interviews were conducted until theoretical saturation was reached.[215, 216] Saturation was deemed to have been reached when no new viewpoints emerged from the interviews.

Participants included in the qualitative component of the mixed methods study exploring causes of COPD misdiagnosis, which is presented in Chapter 4, were also included in the qualitative component of the INTEGR COPD study exploring acceptability of integrated care, which is presented in this chapter.

5.2.3 Interview structure

The interviews followed a semi-structured design with a topic guide to ensure relevant areas were covered during the interview, whilst still allowing flexibility for participants to tell their story or experience unrestricted. The topic guide was reviewed regularly and updated based on emerging topics from interviews. Interviews with patients were conducted either via telephone or at the patients GP practice. Interviews with HCPs took place either via telephone or at their place of work. Participants were only required to complete one interview, which was estimated to last a maximum of 30 minutes. Interviews were audio recorded using an electronic Dictaphone, participants were advised not to mention identifiable information such as names of people or locations. However, if identifiable information was mentioned during the interview, it was redacted from the interview transcript. Interviews were conducted and transcribed by me and a medical student (DS), who was assisting in the study. The recordings and transcripts were stored on a secure server within University Hospitals Birmingham NHS Foundation Trust.

5.2.4 Topic Guide

Patients were viewed as consumers of integrated COPD care, whereas, HCPs were viewed as providers of integrated COPD care, therefore, topics needed to be participant specific. Topics related to experience of receiving COPD care through the intervention were specifically for patients and topics regarding perceptions of

providing integrated COPD care were specifically for HCPs. Patient specific topics initially included: “knowledge of disease”, “specialists”, “location”, and “service”. These topics were based on current literature,[166, 230] which suggested that access and coordination of healthcare; communication; setting; and clinician competence were themes of importance to patients when discussing primary and secondary care interaction. Additionally, as the interviews took place during the COVID19 pandemic this topic emerged frequently in interviews and so it was added to the topic guide. Topics regarding the provision of integrated care were based on the six dimensions of healthcare integration.[115] The overall topic guide is shown in Appendix 10.

5.2.5 Thematic analysis

Interview transcripts were analysed using the thematic framework method.[217] Interviews for three participants were selected and coded by myself, a medical student (DS), a clinical researcher (CH) and a non-clinical qualitative researcher (SC). The coded interview transcripts were discussed in a workshop with all coders to agree on initial codes. This process was repeated with a further three interview transcripts after which an initial coding framework was agreed upon. The transcripts used to develop the initial coding framework included a mixture of both HCP and patient interviews. The initial coding framework was then used to code the remaining interview transcripts and was updated with additional codes as they emerged. Transcripts were coded using NVivo software to allow for easy extraction of quotes when tabulating the matrix framework. Once tabulated into a matrix, similar codes were aggregated to form categories. Categories were then summarised and discussed to identify linkages between categories to form themes, the category summaries can be found in Appendix 11.

5.2.6 Reflexive process

In qualitative research, the researcher is an integral part of the research process as their own prior experiences, beliefs and assumptions can influence the research outcomes.[218] To understand how my own experiences and background could influence the qualitative research process I reflected on who I am as a person, then explored how this could influence the interviews and data interpretation. I then explored means by which to mitigate against my own biases. A summary of my personal reflection is presented in Appendix 12.

My own experiences with COPD as a caregiver in both a primary care and secondary care setting and biases favouring integration of specialists into primary care had the potential of influencing the direction of my

interview questions. To mitigate against this, a topic guide was developed that was grounded in published evidence and had been reviewed by my qualitative supervisor (NG) who had no vested interest in the outcomes of the INTEGR COPD study. Additionally, a sample of 12 interview transcripts were discussed and critiqued in a workshop supervised by a qualitative researcher (SC) to look for evidence of biased questioning, of which there was none.

All patient interviews were conducted by me. Patients were made aware that I was a specialist and the lead researcher for the INTEGR COPD study prior to their interview. Some of the patients interviewed may have had previous encounters with me, during which I was their physician. I was aware that patients may have altered their responses to please me due to concerns that negative responses may negatively impact their care due to our prior doctor-patient relationship. To mitigate against this, all patients were made aware that they had completed the clinical aspect of the trial and therefore, I was no longer their doctor, so that they can talk freely and criticise the intervention.

Interviews with HCPs explored perceptions regarding misdiagnosis, which I was aware could make some people uncomfortable, as it can potentially be perceived as exposing weaknesses in personal clinical practice. As a secondary care doctor, I was aware that some HCPs in primary care may feel intimidated and uncomfortable speaking to me as I was perceived as a secondary care specialist. This was difficult to mitigate against, however, interviews with HCPs were split equally between myself and a medical student (DS). As the medical student was perceived as a non-specialist it was assumed that HCPs would feel comfortable talking to him about difficulties with diagnosing COPD in primary care. The transcripts for interviews conducted by myself and DS were compared in a qualitative workshop with a qualitative researcher (SC). Minimal differences in responses were found between transcripts of interviews conducted by me and DS. Therefore, it is unlikely my position as lead researcher or a specialist altered the responses given by HCPs.

I recognised that clinical and non-clinical researchers would have differing professional experiences that can influence how they interpret data. To ensure a single background doesn't influence the interpretation of the data towards a particular direction, the data was interpreted as a group exercise with members from a clinical and non-clinical background. The group consisted of myself, DS (medical student) and SC (non-clinical qualitative researcher). Equally to ensure transparency as to how themes were interpreted, categories were summarised

with quotes to corroborate interpretations of the data, thus providing an audit trail as to how categories and subsequent themes were interpreted.

5.2.7 Ethical approval

The INTEGR COPD study was approved by the West Midlands Research Ethics Committee (REC: 17/WM/0342). A substantial amendment to the study protocol was made to allow for a qualitative aspect to be added to the study.

5.3 Results

5.3.1 Participant characteristics

49 participants involved in the INTEGR COPD study were interviewed, of which 26 were patients and 23 were HCPs. Patients were invited for interview following the completion of their follow up visit, three interviews were conducted in-person, however, due to the COVID pandemic the remaining 23 interviews were conducted via telephone. The average length of a patient interview was 17 minutes (range: 7mins – 50mins). Most patient participants were male and had an MRC dyspnoea score of 2 or less as well GOLD stage 2 or less as shown in Table 5.1. Suggesting that the population interviewed were predominantly those with milder dyspnoea and severity, which is reflective of the overall COPD population in the primary care setting. 45 HCPs involved in either the intervention arm or control arm were invited for interview of which 23 were recruited from 8 GP practices and one acute care NHS trust. Due to the need to maintain social distancing during the COVID pandemic, only seven interviews were conducted in-person with the remaining 16 being conducted via telephone. The average length of an interview with a HCP was 31 minutes (range: 11mins – 49mins). A table summarising the characteristics of the participating HCPs is shown in Table 5.2. The 23 HCPs represented 8 different roles and had a minimum of 3 years' experience within their role at the time of their interview. Five HCPs were specialists involved in the delivery of the specialist intervention, 4 HCPs were based in practices randomised to the control arm of the INTEGR COPD study and 14 HCPs were based in practices randomised to the intervention arm of the study.

Patient demographics (n=26)	
Mean age (range)	65 (41 – 81)
Male (%)	17 (65%)
GOLD COPD Stage	
GOLD 1	8 (31%)
GOLD 2	12 (46%)
GOLD 3	6 (23%)
GOLD 4	0
MRC Dyspnoea Score	
MRC 1	4 (15%)
MRC 2	12 (46%)
MRC 3	2 (8%)
MRC 4	5 (19%)
MRC 5	2 (8%)
MRC Not recorded	1 (4%)
Smoking status	
Smoker	13 (50%)
Ex-Smoker	13 (50%)

Table 5.1 Characteristics of patients participating in the qualitative component of INTEGR COPD. Data presented as frequency (%) or mean. GOLD: Global Initiative for Chronic Obstructive Lung Disease, airflow limitation stage based on 2018 criteria.

Participant Role	Number of participants	Number of male participants	Mean age	Mean years of clinical practice
General Practitioner (GP)	12	6	50 (30 – 75)	20 (6 – 46)
Practice nurse	3*	0	41 (31 – 57)	8 (3 – 12)
Advanced Care Practitioner (ACP)	1	0	50	3
Respiratory Physician consultant	1	1	55	31
Respiratory Physician registrar	2	2	31	8
Respiratory physiotherapist	1	0	41	20
Specialist Respiratory nurse	1	0	48	13
Practice manager	2	0	53 (49 – 56)	18 (13 – 22)

Table 5.2. Summary characteristics of participating healthcare professionals. Data presented as frequency and mean values with range given in brackets. *Includes a practice nurse who fulfilled the roles of both practice nurse and practice manager.

5.3.2 Thematic analysis

Seven categories were generated from the coding framework and have been summarised in Appendix 11. A review of these seven category summaries led to the identification of multiple subthemes. These subthemes were then used to formulate the interpretation of four main themes emerging from the collected qualitative data. A thematic map of how the three main themes were interpreted is shown in Figure 5.1. The transcripts for patients and HCPs were analysed together and the resultant interpreted themes are from a combination of both

groups of participants. However, where components of themes are attributed predominantly to patient or HCP perceptions this has been stated in the theme description.

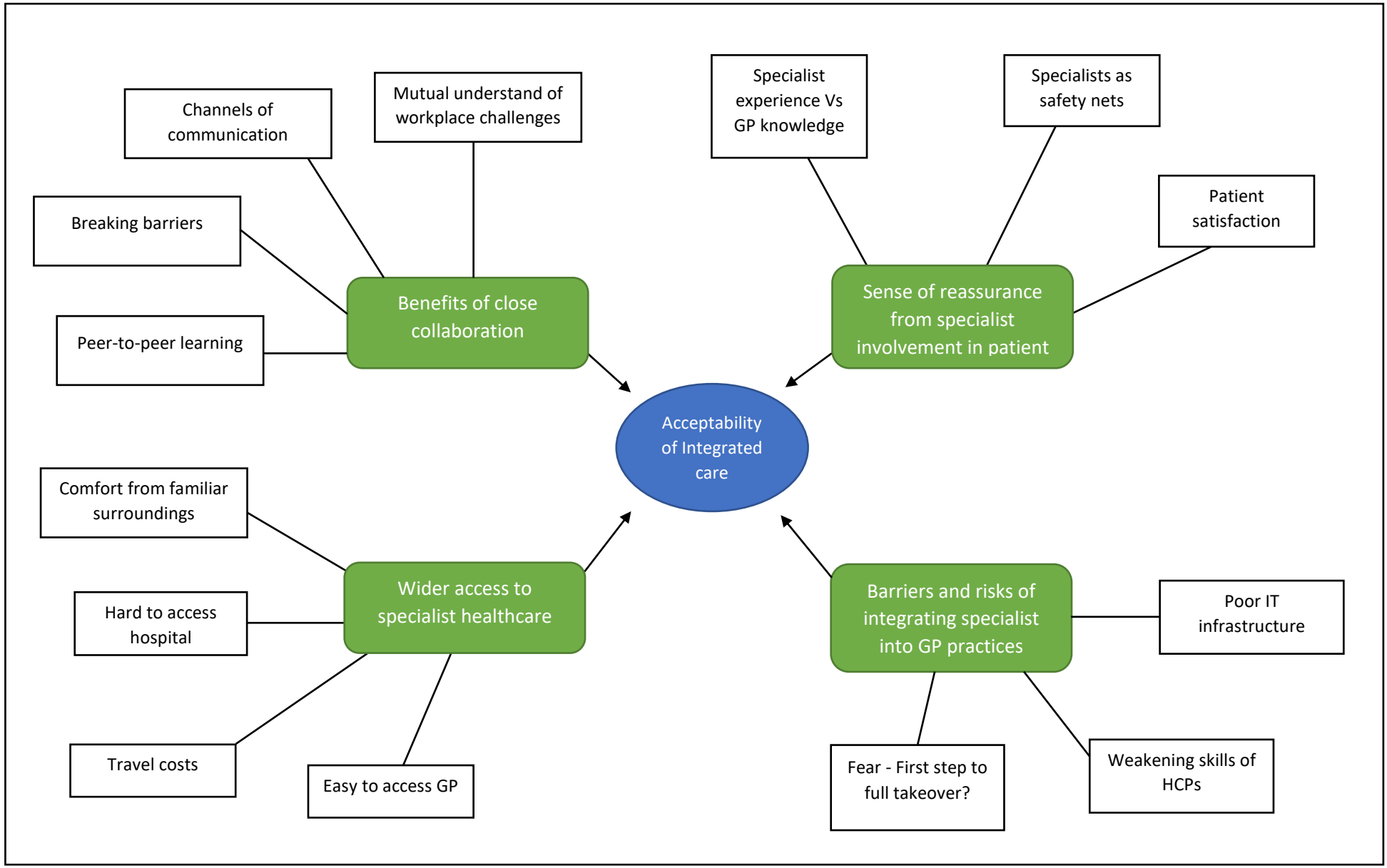

Figure 5.1 Thematic map exploring acceptability of integrated care. Main themes in green boxes with linked subthemes.

5.3.3 Theme 1 – Wider access to specialist healthcare

Participants identified that within the local area, specialist care was predominantly only delivered in hospital settings, thus excluding patients without means of travel from accessing specialist healthcare. The integration of specialists into general practices that were local and within travelling distance for most patients was perceived to widen access to specialist care to include patients with restricted travel abilities.

> *"The sort of patient population that we look after are often socio economically disadvantaged and if you see patients in a hospital setting, it may involve them having a journey to hospital. If they're lucky enough to have a car, there might be expensive car parking fees. And if they don't have a car, they're very breathless, they may need to come on one or two bus journeys to come to hospital. So, there's certainly benefits from taking care nearer to patients' homes." -SIN023 Respiratory Consultant*

> *"Because you have people walking about on trains and whatever that can't get to a hospital. So, it's easier for them to be able to talk to somebody at the doctor's surgery rather than go all the way to the hospital" -IN16038 Patient*

Participants that were able to drive to hospital often associated the experience with delays and being costly due to parking charges. Which, is a potential barrier for patients to access specialist care as they may not be able to afford the parking charges.

> *"When you go to a hospital and you have to park, your appointment could be at one o'clock, but you're sitting there and could not be seen till three o'clock and then it's too much with the parking for me I have to pay nearly £8 to park." -IN5044 Patient*

A sense of feeling at ease and comfortable within the clinical environment was also felt to be important for patients to be able to share their concerns and be encouraged to attend clinical appointments.

> *"I think it's very important for the patient to feel relaxed and comfortable, and know their surroundings, especially with somebody with breathing difficulties, they don't want to be going too far, and they want to be familiar with people that they know." -IN5012 Patient*

The hospital environment was commonly described with negative connotations, focusing on cost, delays and lack of familiarity. However, participants attributed positive connotations of comfort, informality and ease of access to GP practices.

> *"No, I can wait around. But it's just a completely different atmosphere (hospital), isn't it if you'd have to, you're at your local GP you're comfortable because you know them there. But if you go into the hospital, you're in amongst complete strangers, because you don't know them." -IN20025 Patient.*

> *"It's more personalised for the patients, because then they're seen here (GP practice), or at home, whichever one is easier, rather than going to a foreign situation, essentially, in the hospital.. And it's, you know, they're less comfortable... For patient's, obviously for them to access, it is easier to get to the practice." -SIN008 GP.*

> *"It's great, it's a lot more convenient. I think it seems like more of a personal touch at the surgeries versus the hospital." -IN5048 Patient*

5.3.4 Theme 2 – Benefits of close collaboration

Integrating specialists into GP practices was perceived to lead to closer collaboration between primary care HCPs and specialists based in secondary care. Breaking down of cultural barriers between HCPs in primary and secondary care was seen as a beneficial impact of close collaboration. Prior to the integration of specialists into primary care, specialists were perceived as unapproachable and patronising by primary care HCPs.

> *"My initial thoughts, initially, I thought, well, how is this going to work? And I think I thought that it would be a snooty consultant in a suit and a bow tie... that would sort of talk down to us and would be difficult to work with. That was my initial thoughts." -SIN003 Practice Manager*

> *"GPs are quite antagonistic towards hospital consultants and there's a bit of a 'them and us' so there's that understanding of what each discipline brings to the party and some suspicion and some hostility in some cases." -SIN023 Respiratory Consultant*

> *"I think our colleagues in secondary care, think that we always refer patients as soon as we see them, but no, we tend to see them as long as we can, and manage them as best as we can before referring." -SIN015 GP*

However, following integration, cultural barriers were felt to have dissolved due to specialists developing more insight into the challenges faced in primary care as well as close working relationships being formed between the specialists and primary care HCPs.

> *"I think it's been a big benefit for the doctors as well. Because I think the doctors, once the consultant came out and he was great. He came out worked really well with the practice, he was very amicable and fitted into the practice. And we were then fitting everything in around him. The way that we work together, organising the timetables, meeting the staff, I think the staff integration was really good." -SIN003 Practice Manager*

> *"I think both physicians or nurses, whatever is working together, makes you realise some of the difficulties and the barriers that both have. So, you know, working in the GP practice is very difficult to sort of see the volume of patients that they're seeing, and then equally a GP might sort of see the other way. And so, you know, we're seeing quite complex cases here, but in we can therefore help each other a little bit, which would be one of the main advantages, really, we're both bringing the same skills to the table or different skills to the table." -SIN011 Respiratory Registrar*

> *"And they built a really strong relationship with them. Knowing that that helps with, you know, sometimes something doesn't need to be a formal referral, it can be an informal conversation. Again, that just makes everything easy for everybody." -SIN004 GP*

Developing links between primary care HCPs and specialists was felt to promote the use of informal communication channels. Following the intervention, GPs and Practice nurses felt more comfortable simply calling or emailing specialist for advice. Whereas previously, GPs would have used formal patient referral pathways, which were perceived to be slow and delayed patients receiving optimal COPD care.

> *"Definitely. Because I wouldn't think of anything now of having to phone up. And also like pulmonary rehab and anything like that, you know, speak to them if I've got a query anything at all, whereas before I just wouldn't have done it." -SIN010 Practice Nurse*

> *"Definitely speeds up care, because obviously, with emails now, or even phone calls, you can get it straightaway and give them that changing care within a week rather than waiting eight weeks, 10 weeks for an actual appointment. The other thing is, is by that communication, sometimes the consultant can, then say, "Well, actually, we'll get the community team to see them", who again, works with the consultant, and then the patient gets better care that way." -SIN008 GP*

Collaborative working also led to specialists and primary care HCPs developing skills and learning from each other. Primary care HCPs felt more confident about their knowledge of COPD management following joint clinics with specialists, which in turn was thought to benefit patients.

> *"the relationship with the nurses in particular, because I suppose I mean, obviously they have the, they've, they've done their training, and they've got their skills, but I suppose it's like anything really, I mean, you can do training for things, but then there's always something extra that you might pick up when you work with somebody." -SIN002 Practice Manager*

> *"the consultant can give me educational tips as well... hints and tips about various things they have found in people's records or you know, diagnoses and things like that. It means you work better together and provide a better service for the patients." -SIN008 GP*

> *"raising the competency, raising the skill base in primary care is what it's about. So, working jointly, we, we understand each other, and we have a lot more information about patients in primary care than you would have in secondary care, we don't just treat COPD, or asthma, we treat the whole family" -SIN012 GP*

> *"if I were an integrated respiratory clinician, I might want to be doing joint clinics so that then there is learning that I can give to the GP or practice nurse that then they can translate to many other patients that I wouldn't necessarily see" -SIN023 Respiratory Consultant*

The impact of upskilling primary care HCPs was noted by community-based specialists nurses who felt GPs were better able to identify and manage COPD exacerbations following involvement in integrated care clinics.

> *"after the MDT side, or obviously clinics, that yourself and the consultant, were doing.. GPs seem to be better at exacerbation recognition, management was, you know, those exacerbations were dealt with in a more timely manner. I would say more targeted antibiotic prescribing. And in a fair few cases, the practices where, I think yourselves had been in the GPs weren't quite as, what's the word in terms of dishing out? They weren't? They didn't just give steroids and antibiotics out willy nilly or just because I think they were a little bit more let's be sure is a true exacerbation." -SIN013 Specialist Respiratory Nurse*

5.3.5 Theme 3 – Sense of reassurance from specialist involvement in patient care

Patients felt a sense of reassurance that a specialist was involved in their COPD management. Reassurance stemmed from a perception that specialists were more knowledgeable about COPD compared to their GP counterparts.

> *"Well, he specialises in the treatments, and I suppose he's more savvy about what's happening, and he can tell more than your GP. I mean your GP can only just refer you to a specialist which most of them do." -IN5025 Patient*

"Yeah the nurse is great, but seeing a specialist you had more in depth information, if you know what I mean. Where she (nurse) went through the motions, she knew what she did.. [REDACTED name](specialist) knew more answers if you like, that the nurse couldn't really answer. And I'm not downgrading nurses at all they are doing a great and fantastic job." -IN5048 Patient

"I like seeing the specialist, well, listening to the specialist because I'll tell him everything, he specialises in what's the matter with you. Whereas the general practitioner, he is for mostly for everything else, you know, what I mean. If you're talking to somebody who specialises in what you've got, I feel comfortable." -IN20025 Patient

"Although you are you seeing somebody at the surgery, for COPD, its like another opinion... It's like... How would I put it... like a second check in case.. because some people do miss things out. ... they do miss by accident so, you know, it's like a second opinion to me sort of thing." IN14076 Patient

Specialist advice and treatment was perceived to improve the symptoms of COPD. Most patients reported feeling better after following advice from the specialist. Patients also reported feeling more informed about COPD and how to manage their symptoms after attending their annual COPD review with a specialist, which was thought to be due to specialist having more time than GPs.

"They (specialists) put me at ease, told me what I need to do, what I've got, what was the cause of it, which I thought was really helpful because the doctors(GP) didn't mention what caused asthma and shortness of breath and so forth (…) Because when I first started, I was very shortness of breath, I found it very difficult to breath and stopped me where I was standing. Now its fine now where I said I'm slowly getting used to working... physically and its seems well." -IN14047 Patient.

"You ask them (specialists) more questions, you feel as if that's specially for you, so you're not wasting their time. Whereas with a doctor (GP), you're have to just say what the problem is there and then come away, because personally, you feel as if you should perhaps hurry up a bit." -IN5066 Patient

"Good, that's really good. Because if I've got a question, you were able to answer my question to the best of your ability. And I've just, I've just felt good." -IN5112 Patient

Reassurance that their COPD was being optimally managed was important to most patients as they experienced significant impact on their daily activities due to the breathlessness caused by COPD. Patients also felt that being fully informed of their disease empowered them to better manage their symptoms. Specialist involvement in the annual COPD review was thought to have been beneficial in addressing gaps in patients' knowledge of COPD and to help them cope with the symptoms of COPD.

“I think the only one that needs to know a lot about managing the breathing is the actual patient themselves.” -IN16038 Patient

“Well, it's better because you know, what you're looking for, you've had all the information so you can sort of monitor when things are going a bit askew or when you're in a flare up, and that so yes” -IN20025 Patient.

“Well I really never delved into that as a situation when I was first found out to be suffering from COPD naturally I followed the GPs instruction And whoever came to check my COPD on occasion but I have to admit this since I have been involved with you for the second time now I have a lot more information” -IN14051 Patient.

Being able to discuss patient management plans, and have their patients reviewed by a specialists reassured primary care clinicians that their patients were receiving optimal COPD care. HCPs associated their reassurance in specialists with their perception that specialists had greater COPD knowledge than primary care clinicians. HCPs associated specialist oversight with optimal care delivery and was perceived to lead to better outcomes for their patients. At intervention sites, where specialists led COPD clinics, primary care HCPs were reassured that this would help them attain their annual COPD QOF targets.

“Now, you're speaking to a doctor who doesn't necessarily is a specialist in COPD, I manage it when they have exacerbation. I do change their inhalers, etc, and so on and so forth. But I'm not a specialist. So for me, it was an extremely beneficial and I think from patient point of view, very safe approach to dealing with patients. COPD is very difficult to manage when they are in later stages. And, and I think that I couldn't, couldn't appreciate the service enough” -SIN007 GP

“From our perspective, I also felt that the particularly obviously the COPD patients, were actually getting decent care as well. And I was confident that what was being done, with them accurate, because although I may be the respiratory lead, I'm not sure all of the GPs have the same level of knowledge.” -SIN008 GP

“Oh definitely, definitely, because we weren't sure. So, by having yourself or a colleague there, we could come, and we could ask them and would say, "look, are we doing this right? Have we done that right? Is the correct information in where it should be?" -SIN010 Practice nurse

“Benefits for the practice? Yes, in terms of QOF registers, our COPD patients the spirometry, etc, we haven't had to worry so much about those things and getting the patients back in again. Whereas you would see them in sort of manage those things with them. So yeah, it has benefited us in that way.” -SIN006 Practice Manager and Nurse

5.3.6 Theme 4 – Barriers and risks of integrating specialist into GP practices

Although welcomed for its benefit to patient care, specialist led COPD clinics in primary care risked practice nurses and GPs becoming deskilled in COPD management and spirometry. GPs were concerned that primary care clinicians could become complacent and leave all COPD related decisions to a specialist. Although this was thought to already be the case in practices with some GPs taking the lead in respiratory. However, the concern raised by deskilling was the potential impact on patient care if specialist support was suddenly stopped due to lack of funding as GPs may no longer feel confident to manage COPD related issues.

> *"The answer would be yes, there is a risk of deskilling, but I think that's already happened in as much that people seem to rely on their respiratory lead. Fair enough. And you may have got that feedback from other people as they go on "Just ask...." Which is a shame because that's not what we want." -SIN008 GP*

> *"I think, as is often the case, you can, you can sometimes get a bit complacent or a little bit deskilled. And so, I think it was much easier to say, it's fine [REDACTED (specialist's name)] will be in we'll ask him. And I wonder if had the study continued for longer, how much more of that would have happened for increasingly simple stuff. So, I think at the beginning, it very much was just the patients that we were uncomfortable managing or really struggled with, but then after that, it became it, it might have led to a bit of, "Oh, it's fine, someone's coming in, we don't really think about this, they can sort this out."" -SIN009 GP*

> *"It's a case of, if there is integrated care, and it is rolled out, then it needs to be rolled out over a sustained period of time. So there needs to be the funding there for five years, seven years of integrated care, not one year, because you come, you offer a fantastic service, and then you disappear. And that's not it's not great for patients, not great for practices, you know, over those 12 months, they start to build relationships, they start to get a feel for where they're at. And then suddenly, all of that support and, and everything disappears and they're back to where they were, potentially in a slightly worse off position, because patients expect now to see respiratory physician and don't, everyone in the practice is then slightly more rusty" -SIN009 GP*

Primary care HCPs welcomed clinical integration, however, they were wary of how far integration would go and resisted the idea of organisational integration between primary and secondary care. Organisational integration was resisted due to the perception it would lead to loss of practice autonomy and would remove the ability to provide care tailored to local communities. However, one GP in a small practice welcomed the idea of integration at an organisational level.

> *"So what, what, my impression of vertical integration involves is basically, hospital trust taking over GP practices. And the reason why I would be concerned about that is because, because I'm thinking about small units of delivery, where there's a local person who's*

responsible for a local area, so or a local, you know, something that just needs to happen. For example, if I put broken chairs in the waiting room, I say, "fix those chairs", and it happens. Or if we need, you know, we need if something needs to happen, if something needs to change, we can do it quickly, because we feel responsible for it. Whereas, I think if you've got whole hospital system, you've got a huge bureaucracy, and a number of processes of forms that you have to fill in and procedures that you have to go through before something can change. That's, that's, that's one of my concerns. So, it's about loss of control really." -SIN004 GP

"I think the volume that GPs, particularly as partners, PCNs (primary care network), the practice managers actually just have to absorb and work through, the secondary care trust wouldn't be able to keep up with that. Because we've literally weekly changing stuff weekly, having new guidance, new targets, new things we have to do, and we just have to adapt all the time. And I think if it was overseen seen by secondary care management, they wouldn't be able to do that." -SIN008 GP

"I would question the motives and or as to why secondary care is interested in, in primary care. And usually, its profit driven is my personal feeling, and that I disagree with. Like our motto has always been if you provide good patient care, then then patients will come and your list will grow and and your growth will come from that. See, I think I think primary care should be primary care and secondary care should be secondary care, much more linked, and even perhaps a, you know, a decoupling of the budget between the two, it's fine." -SIN009 GP

A single IT system across primary and secondary care sites was deemed as being necessary for integrated care to work well. However, difficulty integrating multiple IT systems into a single IT infrastructure was seen as a barrier to integrated care. Hospitals and GP practices used different IT software to manage electronic patient records, as a result, records kept on one site could not be viewed at another, making it difficult at times to make clinical decisions.

"It depends whether again you have access to appropriate IT. So, if I sat in a GP surgery, I want to access system one or umm... my brains gone... to prison, the other GP health IT system, but I'd also want access to my inpatient systems as well. So, there may be disadvantages there in not having full access to all the different IT systems that you need." -SIN023 Respiratory Consultant

"Integration means when you're there, you sort everything out. And that to me is having the same IT system. So, when I've seen your consultation, you then you don't have to write your letter, your secretary of letters when you've done all this, right, and I can see what you've written, I can see your plan and you put it on." -SIN012 GP

"No, I think that's the mammoth part, anything that is integrated or anything where you try and combine community and acute care or different services and different systems, everyone is using different procedures, different protocols, different systems, different computer systems and to combine the two is a mammoth task." -SIN014 Respiratory Physiotherapist

5.4 Discussion

5.4.1 Main findings

The integration of COPD specialists into GP practices was supported by patients and HCPs. Their support was based on the perception that integration ultimately led to improvements in COPD care delivery and patient outcomes. Improvements in patient care and outcomes were achieved through widened access to specialist advice and the promotion of close collaboration between primary and secondary care HCPs. However, despite overwhelming support for integrated care, primary care clinicians still had concerns regarding the long-term impact of integration.

The cost and complexity of traveling to hospital for specialist advice was a significant barrier for some patients within our population. GP practices were viewed as more comfortable and accessible healthcare settings when compared with hospitals. The integration of COPD specialists into GP practices widened access to specialist care and advice for some patients. Patients felt more at ease attending a specialist review in their GP practice due to the setting being more informal than a hospital clinic room.

The presence of COPD specialists in GP practices was felt to promote close collaboration between primary care secondary care HCPs as well as reassure patients and primary care clinicians. Specialists were perceived to have greater knowledge of COPD than GPs and Practice nurses. Participants associated greater knowledge of COPD with optimal care delivery, thus were reassured that patients were receiving optimal care as it was delivered with specialist oversight. As well as receiving optimal care, participants felt that delays in patient care were reduced due to improved communication between specialists and primary care clinicians as a result of close collaboration. Close collaboration through joint clinics between specialists and primary care clinicians were also felt to be beneficial as patients received holistic care taking into account the GPs' knowledge of the patient and the specialists' knowledge of COPD.

In addition to the perceived benefits for patients, HCPs felt that the integration of specialists into GP practices provided an educational opportunity for primary care clinicians. Primary care clinicians felt left behind with the updates in COPD management and appreciated the opportunity to learn through observing specialists leading COPD clinics in their GP practices. The skills and knowledge that HCPs developed through integrated care clinics were seen to translate into improved care for patients within primary care.

Primary care clinicians becoming deskilled in COPD management was posed as a potential long-term risk of integrated care. Although in this study there was no evidence of staff becoming deskilled, concerns were raised that had the study continued for longer, staff may have become complacent about COPD management as COPD would be managed by the integrated care specialist. Deskilling of HCPs was not seen as a new issue within primary care as one GP would often take the lead with COPD, resulting in others having less experience and deskilling. However, there were concerns about the security of sustained specialist involvement in primary care, as it was dependent of sufficient funding, therefore, there was a risk that HCPs would become deskilled in COPD management and specialist services may end abruptly resulting in poor COPD care for patients.

Clinical integration was repeatedly supported by primary care HCPs, however, organisational integration was met with negative feedback amongst primary care HCPs. Organisational integration was perceived to limit the autonomy of GP practices and result in additional bureaucracy. Primary care HCPs cited examples of "vertical integration" to illustrate their concerns of GP practices being "taken over" by acute care trusts. Autonomy was viewed as an important aspect for GP practices to function well within the local community. GP practice autonomy was associated with the ability to adjust and react rapidly to changes in the local population to ensure adequate care is provided. Whereas organisational oversight from acute care trusts was thought to add unnecessary delays in changing care delivery at a local level, ultimately disadvantaging patients. As a result, some GPs were wary of integration due to concerns that initial clinical integration would eventually lead to organisational integration.

Integration of IT systems across primary and secondary care was seen as essential for clinical integration to work well. However, the current infrastructure of the NHS is such that there are multiple IT systems in use across the multiple health service providers. Participants reported concerns that integration of the IT infrastructure would be difficult and viewed lack of integration of IT infrastructure as a barrier preventing integrated care from succeeding.

5.4.2 Current literature

A scoping review exploring the clinical integration of secondary care into primary care identified findings similar to this study.[231] The scoping review reported stronger communication and the development of professional relationships following integrated care interventions, similar to this study. Patients perceived integrated care as

a positive experience, even in studies where the clinical and cost effectiveness outcomes were negative.[231] The reasoning behind positive feedback is not clarified in the scoping review, however, in this study positive feedback was due to easier specialist access in primary care and reassurance felt following a specialist review. Lack of IT infrastructure integration was reported in the scoping review to hinder integration, sentiments that were also reflected in this study as a barrier to integrated care succeeding.[231] However, as the scoping review focused on clinical integration, it was not able to address concerns regarding integration at an organisational level.

The views of GPs and Practice managers regarding integration at an organisational level reported in this study are similar to the views of primary care HCPs reported by Sidhu et al[232]. The qualitative study completed by Sidhu et al explored the perceptions of primary care HCPs following vertical integration, whereby GP practices and acute care trusts were integrated at an organisational level.[232] The study reported that GPs had a lack of trust in vertical integration and were sceptical of the ability of secondary care managers to manage primary care services effectively. However, Sidhu et al did find that vertical integration was supported in areas where funding threaten GP practices with closure.[232]

5.4.3 Strengths and limitation

A key strength to this study is that it represents the opinions of multiple stakeholders in integrated COPD care, to provide both a service user and service provider perspective. 51% of HCPs invited for interview agreed to participate in this study and included a mixture of clinical and non-clinical HCPs. Participating HCPs included those who were involved in delivering specialist care as well as primary care HCPs involved in both the control and intervention arm of INTEGR COPD, therefore providing a representative view of HCPs as stakeholders in integrated care. Patients were selected for interview using purposeful sampling, which provided a mixture of COPD severity representing the overall primary care cohort, and theoretical saturation was reached within the patient cohort.

However, findings from patient interviews are limited by the potential bias introduced. Patients had been interviewed by myself, and as I had been involved in the patient's care as a COPD specialist it is possible that patients may have biased their responses to favour specialists or the intervention. HCP interviews had been split between me and a medical student (DS), the responses we received were similar indicating that HCPs responses

were unlikely to have been influenced by the interviewer being a COPD specialist. Due to the difference in perspectives between HCPs and patients, a mixture of transcripts from both groups were used to develop a broad coding framework. The framework was developed through discussion between clinical and non-clinical researchers to reduce the influence of prior beliefs regarding integrated COPD care. However, the interpretation of the coded transcripts and the subsequent generation of themes was completed by me and my prior beliefs regarding integrated care may have influenced the findings of this study. A further limitation of the study is that the findings only portray the perspectives of patients and HCPs within a small deprived urban area (East Birmingham). Therefore, cannot be applied to a wider area with differing patient demographics and healthcare provisions.

5.4.4 Implications for future services and research

In this study, the clinical integration of COPD specialists into GP practices was welcomed by patients and HCPs. However, integration of primary and secondary care IT infrastructures would be required, prior to wider implementation of this service, for it to succeed in improving patient care. The role of the COPD specialists as educators was unintentional and was not included within the defined role as part of the INTEGR COPD study, however, was met with positive feedback from primary care clinicians. Future interventions would need to address the need for education to be included within the role of the integrated COPD specialist, which may alleviate concerns surrounding the deskilling of primary care clinicians. Views from this study and current literature suggest that GPs held negative views regarding integration of GP practices and acute care trusts at an organisational level where practices were not at risk of closure. These views need to be respected and addressed when developing future integrated care interventions and services.

The findings from this qualitative study only present the perspectives and experience of patients and HCPs within a deprived urban area and cannot be applied to areas with differing demographics. A qualitative study evaluating the perceptions of patients and HCPs sampled from multiple regions with differing demographics would provide results with wider representation. Findings developed from a wider representation of the population could then be used to better inform policymakers when designing integrated care services that include large regions with varying demographics.

5.4.5 Conclusion

Integrating COPD specialists into GP practices was perceived to widen access to specialist care and build stronger relationships between primary and secondary care clinicians, ultimately reassuring patients that they were receiving optimal COPD care from the convenience of their local GP practice. It is due to these benefits that the intervention was deemed acceptable by patients and HCPs, however, future interventions would need to address concerns regarding integration of IT infrastructure and risks of deskilling primary care clinicians. Further qualitative research needs to be completed to obtain the perspectives of a wider more varied population to better inform policy makers developing integrated care interventions.

CHAPTER 6 : THESIS DISCUSSION

6.1 Introduction

COPD is predominantly managed by GPs and Practice nurses in primary care, specialist involvement is reserved for patients referred to secondary care. The management of patients with COPD is complex and involves a combination of smoking cessation, pulmonary rehabilitation, vaccination and inhaled therapies.[3] Recent UK based audits suggest that patients are not receiving optimal guideline adherent COPD management in primary care.[144, 178, 205] The accuracy of COPD registers in UK primary care has been questioned through multiple local and national audits that have found patients diagnosed and treated for COPD without diagnostic spirometry.[132, 178, 219] The studies included in this thesis address the role of COPD specialists in maintaining the integrity of primary care COPD registers and improving the delivery of guideline adherent COPD management in primary care. In this chapter the principal findings from this thesis will be summarised and implications for future practice will be discussed.

6.2 Thesis findings

6.2.1 Chapter 2

The current evidence pertaining to the causes leading to patients being misdiagnosed with COPD and the role of integrated COPD care in identifying them was reviewed through a mixed methods systematic review. The quantitative component of the mixed methods systematic review indicated that misdiagnosed patients could be identified through integrated care interventions that utilised spirometric review. The regional rates of COPD misdiagnosis found in the systematic review were comparable to estimated rates described in the current literature[156]. The qualitative component of the systematic review suggested that integrated care services were deemed to be acceptable by stakeholders and perceived to improve the diagnostic abilities of primary care. However, effectiveness of integrated care interventions to identify misdiagnosed patients could not be commented on as there were no studies that used identification of misdiagnosis as an outcome measure. Equally cost-effectiveness could not be commented on as this was outside of the scope of the review. However, a further review evaluating the financial burden of COPD misdiagnosis would help address the cost-effectiveness of integrated COPD care as an intervention to reduce misdiagnosis. The cause of COPD misdiagnosis was interpreted to be due to diagnostic difficulties in primary care stemming from inability to differentiate COPD

from asthma and underutilisation of spirometry. However, there were no qualitative or mixed methods studies found that directly explored perceived causes of COPD misdiagnosis in primary care. The review highlighted the need for further qualitative research focusing on understanding what patients and healthcare professionals perceive to be the cause of COPD misdiagnosis in primary care. This gap in the literature led to the mixed methods study exploring causes of COPD misdiagnosis within the INTEGR COPD cohort, which is reported in Chapter 4.

6.2.2 Chapter 3

The impact of integrated COPD specialists on guideline adherence within primary care was evaluated through a pragmatic cluster randomised control study (INTEGR COPD). The study intervention involved COPD specialists working alongside GPs and practice nurses in GP practices and completing the annual COPD review for patients on the practice's COPD register. The study control was the continuation of usual care whereby annual COPD reviews were completed by the GP and practice nurse, however, GPs still had access to specialist COPD care via virtual clinics with respiratory specialists. The results from the INTEGR COPD study demonstrated that the intervention led to significantly greater guideline adherence than the study control. The study also suggested that the delivery of guideline adherent COPD care was associated with a better quality of life, fewer COPD exacerbations, but more COPD-related hospitalisations. In addition to guideline adherence, the intervention led to significantly better quality of life compared to the study control, however, the difference may not have been clinically significant. Clinically significant difference in quality of life may not have been achieved in this study due limitations in the study control group. Ongoing access to specialist integrated care through virtual clinics was included as part of usual care, therefore, patients may have received specialist led care indirectly, which may have impacted quality of life and frequency of exacerbations. Whereas normal COPD care in most regions of the UK do not include virtual COPD clinics between GPs and specialist. Therefore, the INTEGR COPD study compared integration of specialists into GP practices against virtual integrated care rather than truly unintegrated practice and the results need to be viewed with this in mind. The study demonstrated effectiveness of integrated specialists to provide guideline adherent care, however, further studies exploring cost effectiveness need to be completed. Cost effectiveness evaluation would be crucial for future policymakers in order to help aid decisions regarding the widespread implementation of specialist integration into GP practices for the management of COPD.

6.2.3 Chapter 4

Based on the evidence from the systematic review in Chapter 2, all patients participating in the INTEGR COPD study underwent a diagnostic review to ensure only correctly diagnosed patients were included in the effectiveness analysis reported in Chapter 3. Patients identified as misdiagnosed with COPD formed a new cohort within the INTEGR COPD study and were included in a sub-study exploring the causes of COPD misdiagnosis. The sub-study utilised an explanatory sequential mixed methods approach, whereby the quantitative data was used to develop the topic guide to obtain qualitative data pertaining to COPD misdiagnosis. The findings of the misdiagnosis sub-study were synthesised through an interpretation of the combined quantitative and qualitative results. The misdiagnosis sub-study indicated that historic diagnoses of COPD, based on inaccurate spirometry or clinical findings alone, persisted despite changes in diagnostic criteria. The persistence of inaccurate diagnoses of COPD was due to the reluctance of primary care clinicians to challenge established diagnoses. Furthermore, when the GP had difficulty differentiating between asthma and COPD, labelling and treating the patient for both was perceived as the safest option. This sub-study suggests that misdiagnosed patients are often those within a cohort of patients diagnosed prior to the establishment of spirometric criteria for the diagnosis of COPD. During the COVID 19 pandemic, spirometry services were suspended by most primary care providers and GPs were advised to diagnose patients with COPD based on clinical findings.[233] As a result, patients may have been incorrectly labelled as having COPD and added to the existing cohort of misdiagnosed patients. However, greater involvement of COPD specialists in primary care may reduce the impact of the pandemic on COPD misdiagnosis.

6.2.4 Chapter 5

Although integration of COPD specialists into GP practices was found to be effective at improving guideline adherence and assist in the management of misdiagnosed patients, further understanding of its acceptability as an intervention was needed. 26 patients and 23 HCPs who participated in the INTEGR COPD study were interviewed to explore their thoughts and perceptions of the intervention following participation in the study. The interviews suggested that patients viewed GP practices as a more convenient and comfortable location to receive COPD care when compared to hospitals. HCPs felt that GP practices were more accessible for patients and that delivering specialist care in GP practices led to widened access to specialist COPD care. Feedback from HCPs suggested that the integration of specialists into GP practices promoted stronger relationships between

specialists and GPs, which improved communication between primary and secondary care. Participants also reported a sense of reassurance that patients were receiving optimal COPD care due to the presence of specialist in GP practices. The combination of these perceived benefits led to participants welcoming the integration of specialists into GP practices, however, concerns were raised regarding potential risks and barriers. The deskilling of primary care clinicians was viewed as a potential negative outcome from integrating specialists. GPs were concerned that specialists would take over the role of COPD management, resulting in practice nurses and GPs having less experience and potentially deskilling in that area. However, during the study there was no reported evidence of staff deskilling, instead primary care clinicians felt more confident about their skills in managing COPD following shared learning with the specialists. Integration of primary and secondary care IT infrastructure was viewed as essential by participants. Poor integration of primary and secondary care IT infrastructure was seen as a barrier to maximising the potential benefits of integrating specialists into GP practices. Overall, the findings suggest that clinical integration of COPD specialists into GP practices would be welcomed patients and HCPs, however, further development of IT infrastructure would be needed to maximise the potential benefits.

6.2 Thesis strengths and limitations

Mixed methods research has been recognised as a useful methodology in the research of primary care interventions and has increasingly become more prominent in healthcare research overall.[234, 235] A mixed methods approach allows researchers to view research questions from multiple angles and integrate findings to provide a comprehensive conclusion.[236, 237] Throughout this thesis a combination of both quantitative and qualitative data has been used to explore the impact of integrating COPD specialists into GP practices, with the thesis conclusion drawing on an integration of both forms of data. The quantitative data in this thesis was able to confirm the extent of COPD misdiagnosis in primary care and that integrating specialists into GP practices was effective at improving the delivery of guideline adherent care. The qualitative data was able to present the perceived impacts of integrating specialists into GP practices and its acceptability, as well as provide an understanding of why misdiagnosis was occurring in primary care. Quantitative and qualitative data both have a role to play in shaping policy. Policymakers need to be reassured that an intervention is effective and acceptable. Effectiveness of an intervention to bring about a positive impact is best demonstrated through quantitative analysis. Whereas acceptability of intervention requires stakeholder perceptions to be explored and is best presented through qualitative analysis. Individually the quantitative and qualitative data outcomes are

useful, however, the strength of this thesis comes from the integration of both quantitative and qualitative data as it is the integrated conclusion that is of most use to healthcare policy makers.[238] In this thesis, the qualitative interpretations were integrated with quantitative findings, whereby the qualitative interpretations were used explain the quantitative findings. Through this form of integration, the thesis findings have triangulated why patients were being misdiagnosed with COPD in primary care and why integrating respiratory specialists into GP practices had an impact on patient outcomes. Thus, providing robust conclusions that can be used to inform future healthcare policies.

The qualitative components of this thesis were subject to researcher bias. As with all qualitative research, the researcher's own personal beliefs have the potential of influencing data collection and subsequent interpretation of the data.[239, 240] To mitigate against prior researcher beliefs influencing the integrity of the qualitative findings a reflexive process was implemented, as this has been shown to add validity to qualitative research.[241] Through a reflexive process, factors in my background as the lead researcher that may influence the data were identified and documented in a reflective statement to ensure transparency. After identifying factors that could influence the validity of the data, I implemented processes within the methodology to mitigate against these factors where possible. Interpretation of the qualitative data is also open to being influenced by researcher beliefs.[240] Providing transparency as to how themes were interpreted has been suggested to add rigour to the research findings.[242] To ensure transparency in the interpretation process of the collected data, category summaries were produced where quotes were used to corroborate interpretations of the qualitative data. Therefore, an audit trail existed whereby the themes interpreted could be tracked back to quoted data. Therefore, although researcher bias is a limitation in the qualitative components of this thesis, through utilising a reflexive process and providing an audit trail in the analysis process the validity and rigour of the qualitative components have been maintained.

The results presented in this thesis are based on the findings from the INTEGR COPD cohort. The cohort was made up of patients on the COPD registers at 18 GP practices and the HCPs who had agreed to participate in the INTEGR COPD pragmatic RCT. Eligibility for GP practices to participate in the study was limited to those that were already participating in the existing virtual respiratory clinic service led by the local hospital. This limitation was necessary to ensure minimal variability in access to specialist advice amongst the included GP practices in the study. However, this inadvertently limited the scope of the study to only include patients living and HCPs working

within the East Birmingham region. The East Birmingham region is an urban area with a mostly deprived population, as described in Chapter 1. As a result of this limitation, the qualitative data analysis only presents the perspective of HCPs who have mostly worked in deprived communities and patients living with deprivation. Deprivation is inversely linked to access to healthcare,[243, 244] therefore, it is possible that specialist involvement was viewed positively by patients in this study due to pre-existing limited healthcare provisions. Whereas patients in more affluent areas may not hold similar views. The findings from the quantitative data analysis may also have been influenced by a predominantly deprived cohort. GPs working in deprived areas are more likely to have heavier workloads due to a lower ratio of GPs to patients.[243, 245] Within the INTEGR COPD it is possible that a significant difference was seen between the intervention and control due to GPs in this cohort being overworked and thus unable to provide guideline adherent care. Whereas in affluent areas it is possible that GPs have more time to ensure COPD management is guideline adherent thus a significant difference may not be seen. It is difficult to quantify the extent to which the findings have been influenced by the limitation in the cohort, however, this needs to be considered when reviewing the results in this thesis.

6.3 Future implications

6.3.1 Research

Although the delivery of guideline adherent COPD management in primary care is known to be poor, the control group in the INTEGR COPD study were performing better than the national average.[205] Better than average performance in the control group was thought to be due to the utilisation of virtual integrated care. However, when compared to the intervention group, guideline adherence was significantly better when COPD care was delivered by a COPD specialist. Current literature exploring the effectiveness of integrated COPD care has focused on comparing integrated care against usual care which involves no integration.[121] However, the INTEGR COPD study differs from current literature as effectiveness has been compared between two formats of integrated care, namely “direct” where the specialist is directly involved in patient care and “indirect” where the specialist is involved from afar through virtual clinics. In the INTEGR COPD study, direct specialist involvement was shown to be statistically superior to indirect involvement in delivering guideline adherent care and improving quality of life. Overall, specialist integration into primary care is needed to improve patient care through greater adherence to guidelines-based management. However, further studies comparing direct,

indirect and no integration need to be completed to determine the extent to which the two forms of integration differ from no integration.

Cost-effectiveness has not been addressed in this thesis, and there is a dearth of evidence regarding the cost-effectiveness of integrated COPD care interventions.[196] The lack of evidence relating to cost-effectiveness in the current literature has been blamed on cost-effectiveness often being an after-thought in research studies exploring integrated COPD care.[196] Therefore, future research will also need to ensure cost-effectiveness analyses are included in the planning stages in order to address this gap in the current literature. Addressing the gap in data relating to cost-effectiveness of integrated COPD care is important as cost-effectiveness is a significant factor when considering future healthcare policies.[246]

6.3.2 Practice

In this thesis, the integration of specialists into GP practices has been shown to improve the delivery of care to patients with COPD, this statement is supported by the findings presented in Chapters 3 and 5. Chapter 3 demonstrates that integration of specialists resulted in an improvement in the delivery of guideline adherent COPD care, which was assumed to improve patients outcomes as shown in previous studies.[112, 247] Chapter 5 presents the qualitative findings and demonstrates that integration was perceived to improve patient care through widening patient access to specialists led care and improving collaboration between specialists and GPs.

The findings of the mixed methods systematic review reported in Chapter 2 suggested that patients were misdiagnosed with COPD in primary care due to under-utilisation of spirometry and difficulty differentiating COPD from asthma. These findings corroborate the current literature[132, 135, 156] and are supported by findings from the mixed methods sub-study reported in Chapter 4 of this thesis. In Chapter 4 under-utilisation of spirometry was found to be the initial cause of misdiagnosis, however, reluctance to challenge historic misdiagnoses led to patients remaining misdiagnosed. The combined findings from the systematic review (Chapter 2) and mixed methods sub-study (Chapter 4) suggest that primary care clinicians require specialist support when dealing with difficult cases and challenging historic diagnoses. This may be relevant in the near future due to the potential impact of reduced spirometry use in primary care during the COVID 19 pandemic. Interventions maybe needed to identify and manage patients misdiagnosed with COPD in primary care during

the pandemic, and the evidence from this thesis suggests integrating specialists into GP practices is a potential option.

The implications on future practice made by this thesis, favours a move towards the integration of respiratory specialists into GP practices to improve the care delivered to patients with COPD, and improve the integrity of COPD diagnoses made in primary care.

6.3.3 Policy

Healthcare policy decisions are based on multiple factors, which include clinical effectiveness, acceptability and cost-effectiveness.[227, 248] The integration of COPD specialists into primary care, has been shown in this thesis to be beneficial for the delivery of guideline adherent COPD care and to manage COPD misdiagnosis in primary care (effectiveness). Equally perceptions of integrated care from stakeholders that include patients and HCPs are positive and welcome clinical integration (acceptability). Cost-effectiveness has not been assessed in this thesis which weakens the ability of this thesis alone to inform future healthcare policy. However, the cost-effectiveness of integrating specialists into GP practices can be inferred from current literature. The delivery of non-guideline adherent COPD care has been shown to lead to added healthcare costs due to inappropriate prescribing.[249] Therefore, it can be assumed that improving guideline adherence, as demonstrated in Chapter 3, would lead to a cost saving. The systematic review by Rocks et al has shown that current evidence, although limited, suggests integrated COPD care interventions to be cost effective.[196] Therefore, although cost savings can loosely be inferred from existing evidence, further cost-effectiveness analysis of the INTEGR COPD cohort is required prior to informing changes to healthcare policy.

6.3.4 Education

Although not the primary function of the integrated care intervention, education and training were perceived by HCPs as positive impacts of integrating specialists into GP practices. The sharing of experiences and knowledge was interpreted to benefit both primary and secondary care clinicians. Focus was particularly placed on training regarding the performing and interpretation of spirometry. Current guidelines recommend spirometry is completed by HCPs certified by an accredited national body.[44] However, although certified, primary care HCPs felt that due to lack of clinical exposure and experience they were not able to perform or interpret spirometry accurately. Difficulty interpreting spirometry was identified as one of the key causes leading

to patients being misdiagnosed with COPD Chapter 4. Therefore, additional training and experience with spirometry for primary care HCPs may improve spirometry skills amongst HCPs and potentially reduce the number of patients being misdiagnosed. The impact of spirometry training has been investigated previously and current literature does suggest training does improve diagnostic accuracy.[213, 250, 251] However, there is insufficient evidence in this thesis to imply that further training and education would improve quality of spirometry in primary care, as education was not the focus of this thesis. Although, what can be implied from this thesis is that integration of respiratory specialists into GP practices can promote COPD training and education in primary care.

6.4 Conclusion

Integrating COPD specialists into GP practices improves the delivery of guideline adherent COPD care as well as assisting in the identification and management of misdiagnosed patients in primary care. The INTEGR COPD study compared direct and indirect forms of integrated care and the findings from this thesis recommend the use of direct integration over indirect. Direct integration was more effective at providing guideline adherent care and resulted in better quality of life for patients. Direct integration also allowed misdiagnosed patients to be identified and correctly managed, whereas indirect integration relied on medical records to identify misdiagnosed patients. And finally, most patients preferred receiving specialist COPD care at their GP practice due to travel convenience as well as a sense of feeling at ease in familiar surroundings. The benefits of integrating specialists into GP practices identified in this thesis need to be balanced with cost effectiveness studies to determine financial viability of such a service.

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APPENDICES

Appendix 1: Full search strategy for mixed methods systematic review

Appendix 1.1 MEDLINE Database search strategy

Ovid MEDLINE(R) and In-Process & Other Non-Indexed Citations 1946 to December 13, 2019

Search terms
1. exp Pulmonary Disease, Chronic Obstructive/
2. copd.ti,ab.
3. Chronic Obstructive Pulmonary Disease.ti,ab.
4. Chronic obstructive airway$ disease.ti,ab.
5. chronic obstructive lung disease.ti,ab.
6. exp Emphysema/
7. exp Pulmonary Emphysema/
8. emphysema.ti,ab.
9. pulmonary emphysema.ti,ab.
10. exp Bronchitis, Chronic/
11. chronic bronchitis.ti,ab.
12. COAD.ti,ab.
13. chronic airflow obstruction.ti,ab.
14. exp Patient Care Planning/
15. patient care planning.ti,ab.
16. exp "Delivery of Health Care, Integrated"/
17. integrated care.ti,ab.
18. exp Primary Health Care/
19. primary health care.ti,ab.
20. primary care.ti,ab.
21. exp Community Health Services/
22. community care.ti,ab.
23. exp Patient-Centered Care/
24. patient cent$ care.ti,ab.
25. exp Patient Education as Topic/
26. patient education.ti,ab.
27. exp Self Care/
28. self care.ti,ab.
29. exp Diagnostic Errors/

30. diagnostic error$.ti,ab.
31. misdiagnosis.ti,ab.
32. hidden diagnosis.ti,ab.
33. undiagnosed.ti,ab.
34. alternat$ diagnosis.ti,ab.
35. exp Diagnosis, Differential/
36. differential diagnosis.ti,ab.
37. missed diagnosis.ti,ab.
38. diagnostic mistake.ti,ab.
39. or/1-13
40. or/14-28
41. or/29-38
42. 39 and 40
43. 39 and 41
44. limit 43 to "qualitative (maximizes specificity)"
45. 42 or 44
46. limit 45 to (humans and yr="1990 -Current")

Appendix 1.2 EMBASE Database search strategy

Ovid EMBASE 1974 to December 13, 2019

Search terms
1. exp chronic obstructive lung disease/
2. chronic obstructive lung disease.ti,ab.
3. copd.ti,ab.
4. chronic obstructive pulmonary disease.ti,ab.
5. Chronic obstructive airway$ disease.ti,ab.
6. exp emphysema/
7. exp lung emphysema/
8. exp cigarette smoke-induced emphysema/
9. emphysema.ti,ab.
10. exp chronic bronchitis/
11. chronic bronchitis.ti,ab.
12. COAD.ti,ab.
13. chronic airflow obstruction.ti,ab.
14. exp integrated health care system/
15. integrated care.ti,ab.
16. exp patient care planning/
17. patient care plan$.ti,ab.
18. exp primary health care/

19. primary healthcare.ti,ab.
20. exp primary medical care/
21. primary care.ti,ab.
22. community health services.ti,ab.
23. patient cent$ care.ti,ab.
24. exp patient education/
25. patient education.ti,ab.
26. exp self care/
27. self care.ti,ab.
28. exp diagnostic error/
29. diagnostic error$.ti,ab.
30. misdiagnosis.ti,ab.
31. hidden diagnosis.ti,ab.
32. undiagnosed.ti,ab.
33. alternat$ diagnosis.ti,ab.
34. exp differential diagnosis/
35. differential diagnosis.ti,ab.
36. missed diagnosis.ti,ab.
37. diagnostic mistake.ti,ab.
38. or/1-13
39. or/14-27
40. or/28-37
41. 38 and 39
42. 38 and 40
43. limit 42 to "qualitative (maximizes specificity)"
44. 41 or 43
45. limit 44 to (human and exclude medline journals and yr="1990 -Current")

Appendix 1.3 PsycInfo Database search strategy

OVID APA PsycInfo 1967 to December 13, 2019

Search terms
1. exp Chronic Obstructive Pulmonary Disease/
2. copd.ti,ab.
3. chronic obstructive pulmonary disease.ti,ab.
4. Chronic obstructive airway$ disease.ti,ab.
5. chronic obstructive lung disease.ti,ab.
6. coad.ti,ab.
7. exp Pulmonary Emphysema/
8. emphysema.ti,ab.
9. chronic bronchitis.ti,ab.
10. chronic airflow obstruction.ti,ab.
11. exp Integrated Services/

12. integrated care.ti,ab.
13. exp Treatment Planning/
14. treatment planning.ti,ab.
15. care plan$.ti,ab.
16. exp Primary Health Care/
17. primary care.ti,ab.
18. exp Community Services/
19. community services.ti,ab.
20. exp Client Centered Therapy/
21. patient cent$ care.ti,ab.
22. exp Client Education/
23. patient education.ti,ab.
24. exp Self-Care Skills/
25. self care.ti,ab.
26. exp Misdiagnosis/
27. misdiagnosis.ti,ab.
28. exp Errors/
29. diagnostic error$.ti,ab.
30. hidden diagnosis.ti,ab.
31. undiagnosed.ti,ab.
32. exp Differential Diagnosis/
33. differential diagnosis.ti,ab.
34. alternat$ diagnosis.ti,ab.
35. missed diagnosis.ti,ab.
36. diagnostic mistake.ti,ab.
37. or/1-10
38. or/11-25
39. or/26-36
40. 37 and 38
41. 37 and 39
42. 40 or 41
43. limit 42 to (human and yr="1990 -Current")

Appendix 1.4 Web of Science Database search strategy

Web of Science Core Collection database search completed on 13th December 2019.

Search terms	
# 29	#28 OR #27 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 28	#26 AND #24 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 27	#25 AND #24 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 26	#23 OR #22 OR #21 OR #20 OR #19 OR #18 OR #17 OR #16 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 25	#15 OR #14 OR #13 OR #12 OR #11 OR #10 OR #9 OR #8 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 24	#7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 23	TS=Missed Diagnosis *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 22	TS=Diagnostic mistake *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 21	TS=Alternate diagnosis *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 20	TS=Differential Diagnosis *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 19	TS=Undiagnosed *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 18	TS=Hidden Diagnosis *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 17	TS=Diagnostic error *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 16	TS=misdiagnosis *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 15	TS=Patient centred care *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 14	TS=Integrated disease management *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 13	TS=Self care *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 12	TS=Primary care *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 11	TS=community services *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 10	TS=Patient Education *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 9	TS=Care planning *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 8	TS=integrated care *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 7	TS=Chronic Airflow obstruction *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 6	TS=Chronic Bronchitis

	Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019
# 5	TS=Pulmonary Emphysema *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 4	TS=Chronic Obstructive Lung Disease *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 3	TS=Chronic Obstructive Airway Disease *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 2	TS=Chronic Obstructive Pulmonary Disease *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*
# 1	TS=COPD *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=1990-2019*

Appendix 1.5 CINAHL Database search strategy

CINAHL database searched on 13th December 2019.

#ID	Search Terms	Search Options
S39	S35 OR S37	**Limiters** - Published Date: 19900101-20191231; Exclude MEDLINE records; Human
		Expanders - Apply equivalent subjects
		Search modes - Boolean/Phrase
S38	S35 OR S37	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S37	S32 AND S34	**Limiters** - Clinical Queries: Qualitative - High Specificity
		Expanders - Apply equivalent subjects
		Search modes - Boolean/Phrase
S36	S32 AND S34	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S35	S32 AND S33	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S34	S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S33	S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S32	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S31	AB missed diagnosis	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S30	AB diagnostic mistake	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase
S29	AB alternate diagnosis	**Expanders** - Apply equivalent subjects
		Search modes - Boolean/Phrase

S28	AB differential diagnosis	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S27	(MH "Diagnosis, Differential")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S26	AB undiagnosed	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S25	AB hidden diagnosis	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S24	AB misdiagnosis	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S23	AB diagnostic errors	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S22	(MH "Diagnostic Errors+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S21	AB patient education	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S20	(MH "Patient Education+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S19	AB self care	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S18	(MH "Self Care+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S17	AB community services	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S16	AB primary care	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S15	(MH "Primary Health Care")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S14	AB care plan	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S13	(MH "Patient Care Plans+") OR (MH "Nursing Care Plans+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S12	AB Integrated care	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S11	(MH "Health Care Delivery, Integrated")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase

S10	AB chronic airflow obstruction	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S9	(MH "Bronchitis, Chronic")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S8	AB emphysema	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S7	(MH "Emphysema+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S6	AB chronic obstructive lung disease	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S5	AB chronic obstructive airway disease	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S4	AB chronic obstructive pulmonary disease	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S3	AB copd	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S2	(MH "Lung Diseases, Obstructive+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
S1	(MH "Pulmonary Disease, Chronic Obstructive+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase

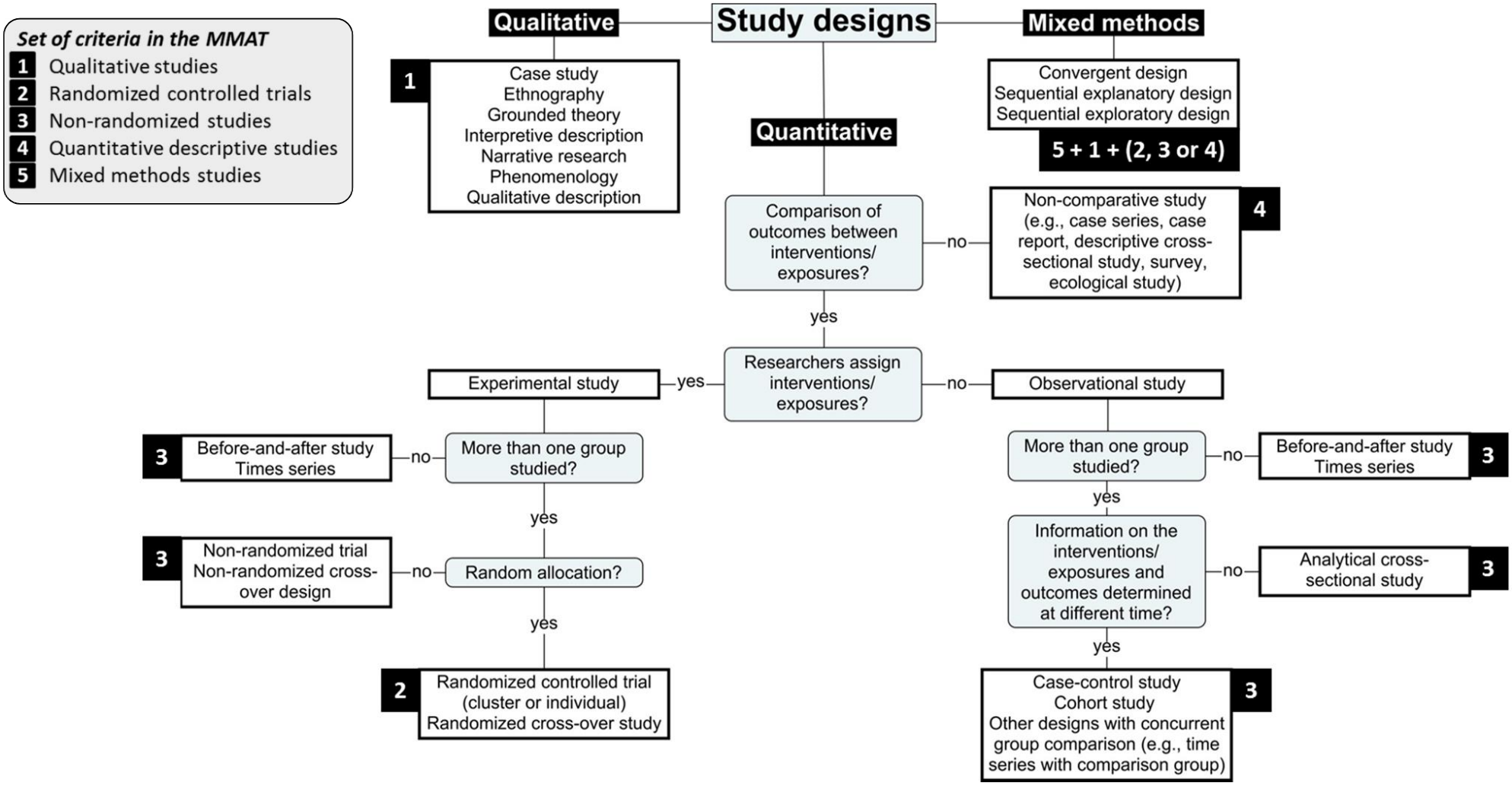
Appendix 2: Mixed methods systematic review data extraction form

GENERIC DATA	Article title/ID			
	Journal Name			
	Author (s)		Publication year	
	Study design	Type of study		
		Methodology		
		Country of origin		
		Inclusion Criteria		
		Exclusion Criteria		
		Setting	Primary Care [ ] Community [ ] Secondary Care [ ]	
		Aim / Phenomenon of interest		
	Participants	Number of participants		
		Demographic data of participants		
QUANTITATIVE DATA	**Intervention**	Description of integrated care design		
		Focus of integrated care intervention		
		Main component(s) of integrated care design:	Education [ ] Self-management [ ] Spirometry [ ] Exercise [ ] Smoking cessation [ ] Other:	Multi-Disciplinary [ ] Nutrition [ ] Follow up [ ] Case management [ ] Medication optimisation [ ]
		Method of COPD Diagnosis review	Clinical only [ ] Spirometry only [ ] Clinical and Spirometry [ ] Diagnosis not reviewed [ ] Not stated [ ] Other:_____	
		Diagnostic criteria		
	Quantitative outcome	Number of cases of COPD misdiagnosis identified:		
	Quantitative outcome	Alternative diagnoses found and number:		

	Quantitative outcome	Author's narrative regarding cause of misdiagnosis:	
QUALITATIVE DATA	**Qualitative outcome**	**Reported theme (finding)**	**Quote/evidence (illustration)**
	Reviewer comments:		

Appendix 3: Mixed Methods Appraisal Tool (MMAT) and study category selection algorithm

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	S1. Are there clear research questions?				
	S2. Do the collected data allow to address the research questions?				
	Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.				
1. Qualitative	1.1. Is the qualitative approach appropriate to answer the research question?				
	1.2. Are the qualitative data collection methods adequate to address the research question?				
	1.3. Are the findings adequately derived from the data?				
	1.4. Is the interpretation of results sufficiently substantiated by data?				
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?				
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed?				
	2.2. Are the groups comparable at baseline?				
	2.3. Are there complete outcome data?				
	2.4. Are outcome assessors blinded to the intervention provided?				
	2.5 Did the participants adhere to the assigned intervention?				
3. Quantitative non-randomized	3.1. Are the participants representative of the target population?				
	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?				
	3.3. Are there complete outcome data?				
	3.4. Are the confounders accounted for in the design and analysis?				
	3.5. During the study period, is the intervention administered (or exposure occurred) as intended?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question?				
	4.2. Is the sample representative of the target population?				
	4.3. Are the measurements appropriate?				
	4.4. Is the risk of nonresponse bias low?				
	4.5. Is the statistical analysis appropriate to answer the research question?				
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?				
	5.2. Are the different components of the study effectively integrated to answer the research question?				
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?				
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?				
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?				


Set of criteria in the MMAT
1 Qualitative studies
2 Randomized controlled trials
3 Non-randomized studies
4 Quantitative descriptive studies
5 Mixed methods studies
Study designs
Qualitative
1
Case study
Ethnography
Grounded theory
Interpretive description
Narrative research
Phenomenology
Qualitative description
Quantitative
Mixed methods
Convergent design
Sequential explanatory design
Sequential exploratory design
5 + 1 + (2, 3 or 4)
Comparison of outcomes between interventions/ exposures?
no
Non-comparative study (e.g., case series, case report, descriptive cross-sectional study, survey, ecological study)
4
yes
Researchers assign interventions/ exposures?
yes
Experimental study
no
Observational study
More than one group studied?
no
3
Before-and-after study
Times series
yes
Random allocation?
no
3
Non-randomized trial
Non-randomized cross-over design
yes
2
Randomized controlled trial (cluster or individual)
Randomized cross-over study
More than one group studied?
no
Before-and-after study
Times series
3
yes
Information on the interventions/ exposures and outcomes determined at different time?
no
Analytical cross-sectional study
3
yes
Case-control study
Cohort study
Other designs with concurrent group comparison (e.g., time series with comparison group)
3

Appendix 4: Summary of studies included in Mixed Methods systematic review

Appendix 4.1 Studies included in mixed methods systematic review

Study ID	Ref #	Authors	Year	Title	Journal	Country of Origin
1	[181]	R. M. Angus, E. B. Thompson, L. Davies, A. Trusdale, C. Hodgson, E. McKnight, A. Davies and M. G. Pearson	2012	Feasibility and impact of a computer-guided consultation on guideline-based management of COPD in general practice	Primary Care Respiratory Journal	UK
2	[173]	J. Bourbeau, R. Farias, P. Z. Li, G. Gauthier, L. Battisti, V. Chabot, M. F. Beauchesne, D. Villeneuve, P. Cote and L. P. Boulet	2018	The Quebec Respiratory Health Education Network: Integrating a model of self-management education in COPD primary care	Chronic Respiratory Disease	Canada
3	[191]	A. Casas Herrera, M. Montes de Oca, M. V. Lopez Varela, C. Aguirre, E. Schiavi, J. R. Jardim and P. Team	2016	COPD Underdiagnosis and Misdiagnosis in a High-Risk Primary Care Population in Four Latin American Countries. A Key to Enhance Disease Diagnosis: The PUMA Study	PLoS ONE [Electronic Resource]	Argentina, Colombia, Venezuela, Uruguay
4	[175]	M. J. Cawley, R. Pacitti and W. Warning	2011	Assessment of a pharmacist-driven point-of-care spirometry clinic within a primary care physicians office	Pharmacy Practice	USA
5	[183]	G. J. Diaz-Gravalos, G. Palmeiro-Fernandez, M. D. Valino-Lopez, A. Robles-Castineiras, M. J. Fernandez-Silva, S. Reinoso-Hermida and I. Casado-Gorriz	2012	[The adequacy of the diagnostic in chronic obstructive pulmonary disease]	Revista de Calidad Asistencial	Spain
6	[176]	C. Ghattas, A. Dai, D. J. Gemmel and M. H. Awad	2013	Over diagnosis of chronic obstructive pulmonary disease in an underserved patient population	International Journal of Copd	USA
7	[161]	E. Heffler, C. Crimi, S. Mancuso, R. Campisi, F. Puggioni, L. Brussino and N. Crimi	2018	Misdiagnosis of asthma and COPD and underuse of spirometry in primary care unselected patients	Respiratory Medicine	Italy
8	[178]	R. C. Jones, M. Dickson-Spillmann, M. J. Mather, D. Marks and B. S. Shackell	2008	Accuracy of diagnostic registers and management of chronic obstructive pulmonary disease: the Devon primary care audit	Respiratory Research	UK
9	[194]	J. Liang, M. J. Abramson, N. A. Zwar, G. M. Russell, A. E. Holland, B. Bonevski, A. Mahal, K. Phillips, P. Eustace, E. Paul, S. Wilson and J. George	2018	Diagnosing COPD and supporting smoking cessation in general practice: evidence–practice gaps	Medical Journal of Australia	Australia
10	[184]	A. E. Lucas, F. J. Smeenk, I. J. Smeele and O. P. van Schayck	2012	Diagnostic accuracy of primary care asthma/COPD working hypotheses, a real life study	Respiratory Medicine	Netherlands

11	[185]	A. E. Lucas, F. J. Smeenk, B. E. van den Borne, I. J. Smeele and C. P. van Schayck	2009	Diagnostic assessments of spirometry and medical history data by respiratory specialists supporting primary care: are they reliable?	Primary Care Respiratory Journal	Netherlands
12	[186]	S. Nardini, I. Annesi-Maesano, M. Simoni, A. D. Ponte, C. M. Sanguinetti and F. De Benedetto	2018	Accuracy of diagnosis of COPD and factors associated with misdiagnosis in primary care setting. E-DIAL (Early DIAgnosis of obstructive lung disease) study group	Respiratory Medicine	Italy
13	[179]	M. Pearson, J. G. Ayres, M. Sarno, D. Massey and D. Price	2006	Diagnosis of airway obstruction in primary care in the UK: the CADRE (COPD and Asthma Diagnostic/management REassessment) programme 1997-2001	International Journal of Copd	UK
14	[140]	D. Spyratos, D. Chloros, D. Michalopoulou and L. Sichletidis	2016	Estimating the extent and economic impact of under and overdiagnosis of chronic obstructive pulmonary disease in primary care	Chronic Respiratory Disease	Greece
15	[187]	E. Stafyla, O. S. Kotsiou, K. Deskata and K. I. Gourgoulianis	2018	Missed diagnosis and overtreatment of COPD among smoking primary care population in Central Greece: old problems persist	International Journal of Copd	Greece
16	[180]	M. Strong, A. Green, E. Goyder, G. Miles, A. C. Lee, G. Basran and J. Cooke	2014	Accuracy of diagnosis and classification of COPD in primary and specialist nurse-led respiratory care in Rotherham, UK: a cross-sectional study	Primary Care Respiratory Journal	UK
17	[195]	M. S. U, W. K. Leong, Y. T. Wun and S. F. Tse	2015	A study on COPD in primary care: Comparing correctly and incorrectly diagnosed patients	Hong Kong Practitioner	China
18	[188]	M. Vukoja, P. Rebic, Z. Lazic, M. Mitic Milikic, B. Milenkovic, B. Zvezdin, I. Cekerevac, M. Jovancevic Drvenica, S. Hromis and I. Kopitovic	2013	Early detection of asthma and chronic obstructive pulmonary disease in primary care patients	Medicinski Pregled	Serbia
19	[182]	P. P. Walker, P. Mitchell, F. Diamantea, C. J. Warburton and L. Davies	2006	Effect of primary-care spirometry on the diagnosis and management of COPD	European Respiratory Journal	UK
20	[192]	J. A. Walters, E. H. Walters, M. Nelson, A. Robinson, J. Scott, P. Turner and R. Wood-Baker	2011	Factors associated with misdiagnosis of COPD in primary care	Primary Care Respiratory Journal	Australia
21	[162]	H. Wolfenden, L. Bailey, K. Murphy and M. R. Partridge	2006	Use of an open access spirometry service by general practitioners	Primary Care Respiratory Journal	UK
22	[177]	B. P. Yawn, P. L. Enright, R. F. Lemanske, Jr., E. Israel, W. Pace, P. Wollan and H. Boushey	2007	Spirometry can be done in family physicians' offices and alters clinical decisions in management of asthma and COPD	Chest	USA
23	[193]	N. A. Zwar, G. B. Marks, O. Hermiz, S. Middleton, E. J. Comino, I. Hasan, S. Vagholkar and S. F. Wilson	2011	Predictors of accuracy of diagnosis of chronic obstructive pulmonary disease in general practice	Medical Journal of Australia	Australia
24	[174]	M. Ferrone, M. G. Masciantonio, N. Malus, L. Stitt, T. O'Callahan, Z. Roberts, L. Johnson, J. Samson, L. Durocher, M. Ferrari, M. Reilly, K. Griffiths and C. J. Licskai	2019	The impact of integrated disease management in high-risk COPD patients in primary care	npj Primary Care Respiratory Medicine	Canada

25	[189]	H. Melbye, Drivenes, Dalbak, Leinan, Ostrem and H. Hoegh	2011	Asthma, chronic obstructive pulmonary disease, or both? Diagnostic labeling and spirometry in primary care patients aged 40 years or more	International Journal of Chronic Obstructive Pulmonary Disease	Norway
26	[124]	E. S. Starren, N. J. Roberts, M. Tahir, L. O'Byrne, R. Haffenden, I. S. Patel and M. R. Partridge	2012	A centralised respiratory diagnostic service for primary care: a 4-year audit	Primary Care Respiratory Journal	UK
27	[190]	M. C. D. C. A. M. D. Queiroz, M. A. C. Moreira and M. F. Rabahi	2012	Subdiagnóstico de DPOC na atenção primária em Aparecida de Goiânia, Goiás	Jornal Brasileiro de Pneumologia	Brazil
28	[163]	K. Gillett, K. Lippiett, C. Astles, J. Longstaff, R. Orlando, S. X. Lin, A. Powell, C. Roberts, A. J. Chauhan, M. Thomas and T. M. Wilkinson	2016	Managing complex respiratory patients in the community: An evaluation of a pilot integrated respiratory care service	BMJ Open Respiratory Research	UK
29	[168]	J. Ure, H. Pinnock, J. Hanley, G. Kidd, E. McCall Smith, A. Tarling, C. Pagliari, A. Sheikh, W. MacNee and B. McKinstry	2012	Piloting tele-monitoring in COPD: a mixed methods exploration of issues in design and implementation	Primary Care Respiratory Journal	UK
30	[170]	J. A. Walters, E. C. Hansen, D. P. Johns, E. L. Blizzard, E. H. Walters and R. Wood-Baker	2008	A mixed methods study to compare models of spirometry delivery in primary care for patients at risk of COPD	Thorax	Australia
31	[172]	J. A. Walters, E. C. Hansen, E. H. Walters and R. Wood-Baker	2008	Under-diagnosis of chronic obstructive pulmonary disease: a qualitative study in primary care	Respiratory Medicine	Australia
32	[164]	E. Lanning, J. Longstaff, T. Jones, C. Roberts, D. Neville, R. DeVos, W. Storrar, B. Green, T. Brown, A. Leung, C. Fogg, R. Dominey, P. Bassett, P. Meredith and A. J. Chauhan	2019	Modern Innovative Solutions in Improving Outcomes in Chronic Obstructive Pulmonary Disease (MISSION COPD): Mixed Methods Evaluation of a Novel Integrated Care Clinic	Interactive journal of medical research	UK
33	[167]	S. Dennis, H. K. Reddel, S. Middleton, I. Hasan, O. Hermiz, R. Phillips, A. J. Crockett, S. Vagholkar, G. B. Marks and N. Zwar	2017	Barriers and outcomes of an evidence-based approach to diagnosis and management of chronic obstructive pulmonary disease (COPD) in Australia: a qualitative study	Family Practice	Australia
34	[134]	S. Haroon, R. E. Jordan, D. A. Fitzmaurice and P. Adab	2015	Case finding for COPD in primary care: a qualitative study of the views of health professionals	International Journal of Copd	UK
35	[171]	M. J. Joo, L. K. Sharp, D. H. Au, T. A. Lee and M. L. Fitzgibbon	2013	Use of spirometry in the diagnosis of COPD: a qualitative study in primary care	Copd: Journal of Chronic Obstructive Pulmonary Disease	USA
36	[165]	R. H. Summers, T. Sharmeen, K. Lippiett, K. Gillett, C. Astles, L. Vu, M. Stafford-Watson, A. Bruton, M. Thomas and T. Wilkinson	2017	A qualitative study of GP, nurse and practice manager views on using targeted case-finding to identify patients with COPD in primary care	NPJ Primary Care Respiratory Medicine	UK
37	[166]	P. M. Wodskou, D. Host, N. S. Godtfredsen and A. Frolich	2014	A qualitative study of integrated care from the perspectives of patients with chronic obstructive pulmonary disease and their relatives	BMC Health Services Research	Denmark
38	[169]	A. B. Zakrisson, K. Theander and A. Anderzen-Carlsson	2013	The experience of a multidisciplinary programme of pulmonary rehabilitation in primary health care from the next of kin's perspective: a qualitative study	Primary Care Respiratory Journal	Sweden

Appendix 4.2 Characteristics of studies included in quantitative synthesis

Study ID	Study design using MMAT classification	Setting	Inclusion criteria	Description of integrated care intervention	Number of participants with a pre-existing diagnosis of COPD	Mean Age (SD)	% Male	COPD Diagnostic criteria
1	3 - Non-randomised trial	GP	Prior diagnosis of COPD.	Specialist software guiding COPD review in primary care, embedded with guidelines and treatment algorithms	236	69.7 (SD10.1)	55.60%	NICE 2010, Fixed ratio
2	3 - Observational (Before and After study)	GP	Probable diagnosis of COPD, History of exacerbation, uncertain diagnosis of COPD, Age ≥40, History of smoking, Symptoms of chronic bronchitis.	Self-management coaching by specialist in primary care.	54	66.2 (SD9.0)	59.30%	GOLD 2016, Fixed ratio
3	4 - Non comparative	GP	Age ≥40, ≥10 Pack years or exposure to biomass smoke.	Diagnosis confirmation with spirometry.	102	Not available for all participants with a pre-existing diagnosis of COPD	Not available	Post BD <0.7 and LLN
4	4 - Non comparative	GP	Age >8, History of cough or shortness of breath, pulmonary diagnosis or symptoms warranting spirometry.	Community based pharmacist led spirometry service.	11	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2009, Fixed ratio
5	4 - Non comparative	GP	Prior diagnosis of COPD.	Virtual review of COPD diagnosis.	382	Age >60 = 166, Age ≤60 = 48	77.75%	GOLD 2010 & SEPAR 2009, Fixed ratio
6	4 - Non comparative	Community	Prior diagnosis of COPD or treated for COPD.	Specialist led spirometry in community hub to confirm diagnosis.	80	52.9(SD7.7)	40%	GOLD 2011, Fixed ratio
7	4 - Non comparative	Community	None stated.	Specialist led spirometry for primary care.	75	67.9(SD10)	82.70%	GOLD 2017, Fixed ratio
8	4 - Non comparative	GP	Prior diagnosis of COPD.	Specialist nurse led diagnosis review.	580	Not available for all participants with a pre-existing diagnosis of COPD	Not available	NICE 2004, Fixed ratio
9	2 - Cluster RCT	GP	Prior diagnosis of COPD or treatment for COPD, Age ≥40, ≥ 10 pack years, 2 clinic visits in past 12 months.	MDT integrated care in primary care with structured follow up.	245	67.1(SD10.6)	53.50%	Australian & NZ COPD Guidelines 2017, Fixed ratio
10	4 - Non comparative	Community	None stated.	Community based respiratory hub to confirm diagnosis.	57	Not stated	Not available	GOLD 2005, Fixed ratio
11	4 - Non comparative	Community	None stated.	Community based respiratory hub to confirm diagnosis.	87	Not stated	Not available	GOLD 2005, Fixed ratio
12	4 - Non comparative	Secondary care	None stated.	Hospital based diagnostic service for primary care.	128	Not available for all participants with a pre-existing diagnosis of COPD	Not available	2 guidelines used: Post BD ratio <0.7 or Pre BD ratio <0.7 + <LLN

13	4 - Non comparative	GP	Age >40, >1 prescription for bronchodilators in past 12 months, at least one respiratory symptom, or lung function outside normal range.	Specialist nurse led review clinics in primary care to review diagnosis.	14572	Misdiagnosed: 68.4(SD10) Correct Diagnosed: 69.9 (SD9.1)	58.73%	BTS COPD 1997, Fixed ratio
14	4 - Non comparative	GP	Age >40, >10 Pack years.	Specialist physician led spirometry.	275	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2014, Fixed ratio
15	4 - Non comparative	GP	Age >40, Current or Ex-Smoker.	Specialist led spirometry surveillance in primary care.	113	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2016, Fixed ratio
16	4 - Non comparative	Community	Referral to assessment centre from primary care.	Specialist nurse led respiratory hub based in the community.	1044	Not available for all participants with a pre-existing diagnosis of COPD	Not available	NICE 2004, Fixed ratio
17	4 - Non comparative	GP	Prior diagnosis of COPD, Age 40-85.	Specialist led spirometry in primary care.	152	67.8	76.30%	GOLD 2014, Fixed ratio
18	4 - Non comparative	Secondary care	Current/Ex-smoker, or Morning cough, or Dyspnoea, or Nocturnal cough, or exercise induced cough/wheeze, or Allergen induced cough/wheeze/dyspnoea.	Specialist led diagnosis review through clinical exam and spirometry.	394	Not available for all participants with a pre-existing diagnosis of COPD	Not available	ATS/ERS 2005, Fixed ratio
19	3 - Observational (Before and After study)	Community	None stated.	Community based specialist led spirometry for diagnosis review.	63	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2005, Fixed ratio
20	3 - Observational (Before and After study)	GP	Prior diagnosis of COPD.	Specialist led spirometry to provide accurate respiratory diagnosis in primary care.	341	Misdiagnosed: 58.7(SD8.5) Correct Diagnosed: 64.0 (SD8.1)	53%	GOLD 2008, Fixed ratio
21	3 - Observational (Before and After study)	Secondary care	None stated.	Open access spirometry service for primary care based in secondary care.	101	Not stated	Not available	Not stated
22	3 - Observational (Before and After study)	GP	Age >7, prior diagnosis of COPD or Asthma, attending GP for COPD or Asthma.	Intervention was spirometry administration and interpretation training provision to GP clinicians, spirometry results were checked by specialists to confirm diagnosis.	100	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2007, Fixed ratio
23	3 - Observational (Before and After study)	GP	Age 40-80, Prescribed COPD medications, and seen GP in past 12 months. Prior diagnosis of COPD, or Emphysema, or chronic bronchitis.	Specialist led spirometry in primary care.	445	65	48.80%	GOLD 2001, Fixed ratio
24	2 - RCT	GP	Prior diagnosis of COPD, Age >40, 10 pack years, >2 Exacerbations in past 3 years, Post BD FEV1 <70%, FEV1/FVC Ratio <0.7.	Combined self-management education and case management in primary care.	1186	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2017, Fixed ratio

25	3 - Observational (Before and After study)	GP	Age >40, Prior diagnosis of Asthma or COPD.	Specialist led spirometry in primary care to clarify diagnosis.	128	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2007, Fixed ratio
26	4 - Non comparative	Secondary care	Referral to assessment centre from primary care.	Open access spirometry service for primary care based in secondary care.	180	Not stated	Not available	Fixed ratio
27	4 - Non comparative	GP	Age >40, >20 Pack years or ≥80hour-year history of exposure to biomass smoke.	Specialist led spirometry in primary care.	38	Not available for all participants with a pre-existing diagnosis of COPD	Not available	GOLD 2011, Fixed ratio
30	5+1+2 - Mixed Method - RCT	GP	Age >35, smoker or ex-smoker.	Specialist nurse led spirometry in primary care.	41	Not available for all participants with a pre-existing diagnosis of COPD	Not available	Australia and NZ guidelines and GOLD, Fixed ratio
31	5+1+4 - Mixed Method – Non comparative	GP	Prior diagnosis of COPD.	Specialist led clinical assessment and spirometry.	32	Interviewed: 67(SD16) No interview: 72.5(SD15)	40.63%	GOLD 2005, Fixed ratio
32	5+1+3 - Mixed Method - Observational	GP	BMI <21, GOLD Stage ≥2, ≥2 Exacerbations in past 2 years.	MDT approach to COPD care based in primary care.	58	64 (IQR 54-72)	37.50%	NICE 2010, Fixed ratio

Appendix 4.3 Characteristics of studies included in qualitative synthesis

Study ID	Methodology	Inclusion Criteria	Setting	Qualitative Focus	Interview participant role	Male n (%)	Mean Age (SD)	Number of participants	Method of participant feedback
28	Mixed methods	Poorly controlled asthma or COPD.	GP	Patient and staff feedback on MDT integrated care intervention.	Patients	NR	NR	50	Unstructured written feedback from patients
					Specialists, GPs, Practice nurses	NR	NR	NR	Informal feedback
29	Mixed methods	Moderate/Severe COPD. Excluded if moderate/severe dementia.	GP	Assess staff and patient feedback on telemonitoring for COPD.	Patient	13 (65%)	68.9 (9.1)	20	Semi structured interview
					GP -4, Practice Nurses -4, Hospital based Respiratory Nurses -2, Nurse managers -2, Physiotherapy managers -2, Physiotherapists -3, Non clinical managers -2	7 (35%)	NR	20	Semi structured interview
					Community nurse managers	0 (0%)	NR	6	Focus group
30	Mixed methods	Age >35, smoker or ex-smoker.	GP	Assess GP feedback on specialist spirometry.	GP - Intervention site	NR	NR	15	Focus group
					GP - Control site	NR	NR	13	Focus group

31	Mixed methods	Prior diagnosis of COPD. Excluded if cognitive impairment.	GP	Perceptions of diagnosis and spirometry for COPD.	Patients	5 (36%)	67 (16)	14	Semi structured interviews
					GP (3 interviewed, 13 focus group)	10 (63%)	NR	16	Focus group and semi structured interviews
33	Qualitative Study using Theoretical Domains Framework analysis	Purposive sampling of GPs and Nurses in intervention group.	GP	Qualitative feedback of integrated care service focused on COPD case finding.	GP	3 (75%)	NR	4	Semi structured interviews
					Practice nurse	0 (0%)	NR	7	Semi structured interviews
34	Qualitative - Thematic analysis	Purposive sampling of HCPs from practices included in integrated care study.	GP	Qualitative staff feedback on case finding intervention.	GP	7 (70%)	44.7	10	Semi structured interviews
					Practice nurse	0 (0%)	46.7	7	Semi structured interviews
					Practice manager	0 (0%)	57.7	3	Semi structured interviews
35	Qualitative - Thematic analysis	Primary care physicians from an urban academic medical centre.	Community	GP perceptions of COPD diagnosis and spirometry.	GP	NR	40 (8.3)	12	Focus group
36	Qualitative - Thematic Framework analysis	Primary care staff in Wessex region of UK. Snowballing sampling.	GP	GP perceptions on COPD case finding and diagnosis of COPD - prior to intervention.	GP	7 (58%)	45	12	Semi structured interview
					Nurse	0 (0%)	49	14	Semi structured interview
					Practice manager	1 (10%)	42	10	Semi structured interview
37	Qualitative	Purposive sampling to include patients receiving and not receiving pulmonary rehabilitation and their relatives.	Hospital	Patient and relatives' perceptions of integrated care	Patients: PR in municipality- 8 PR in hospital- 12 PR in municipality and hospital- 2 Never had PR- 14	15 (44%)	72 Median (48-87 range)	34	Focus groups
					Relatives	3 (38%)	NR	8	Focus group
38	Descriptive Qualitative study	Next of Kin nominated by patients with COPD GOLD 2-3 enrolled in pulmonary rehabilitation intervention. 26 invited.	Community	Perceptions of an integrated care multidisciplinary pulmonary rehabilitation service in the community from relatives of patients with COPD	Relative	6 (30%)	66	20	Semi structured interview

Appendix 4.4 Methodology quality report using MMAT

	1. QUALITATIVE STUDIES					2. RANDOMIZED CONTROLLED TRIALS					3. NON-RANDOMIZED STUDIES					4. QUANTITATIVE DESCRIPTIVE STUDIES					5. MIXED METHODS STUDIES				
Study ID	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5
1											Yes	Yes	Yes	Can't tell	Yes										
2											Yes	Yes	Yes	Yes	Yes										
3																Yes	Yes	Yes	Yes	Yes					
4																Yes	Yes	Yes	Yes	Yes					
5																Yes	Yes	Yes	Yes	Yes					
6																Yes	Yes	Yes	Yes	Yes					
7																Yes	No	Yes	Yes	Yes					
8																Yes	Yes	Yes	Yes	Yes					
9						Yes	Yes	Yes	Yes	Yes															
10																Yes	Yes	Yes	Yes	Yes					
11																Yes	Yes	Yes	Yes	Yes					
12																Yes	Yes	Yes	Yes	Yes					
13																Yes	Yes	Yes	Yes	Yes					
14																Yes	Yes	Yes	Yes	Yes					
15																Yes	Yes	Yes	Yes	Yes					
16																Yes	Yes	Yes	Yes	Yes					
17																Yes	Yes	Yes	Yes	Yes					
18																Yes	Yes	Yes	Yes	Yes					
19											Yes	Yes	Yes	Yes	Yes										
20											Yes	Yes	Yes	Yes	Yes										
21											No	Yes	Yes	Yes	Yes										
22											Can't tell	Yes	Yes	Yes	Yes										
23											Yes	Yes	Yes	Yes	Yes										
24						Yes	Yes	Yes	Yes	Yes															

25											Yes	Yes	Yes	Yes	Yes											
26																Yes	Yes	Yes	Yes	Yes						
27																Yes	Yes	Yes	Yes	Yes						
28	Yes	Yes	Can't tell	No	No						Yes	Yes	Yes	Yes	Yes						Yes	Yes	Yes	Can't tell	Yes	
29	Yes	Yes	Yes	Yes	Yes						Yes	Yes	Yes	Yes	Yes						Yes	Yes	Yes	Yes	Yes	
30	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes											Yes	Yes	Yes	Yes	Yes	
31	Yes	Yes	Yes	Yes	Yes											Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
32	Yes	Yes	Can't tell	No	No						Yes	Yes	Yes	Yes	Yes						Yes	No	No	No	Can't tell	
33	Yes	Yes	Yes	Yes	Yes																					
34	Yes	Yes	Yes	Yes	Yes																					
35	Yes	Yes	Yes	Yes	Yes																					
36	Yes	Yes	Yes	Yes	Yes																					
37	Yes	Yes	Yes	Yes	Yes																					
38	Yes	Yes	Yes	Yes	Yes																					

Appendix 5: Study variables with associated data format and Read coding

Variable	Variable sub-set	Data format	Read v2
First Name	N/A	Text	9151.
Surname	N/A	Text	9152.
Date of Birth	N/A	DD/MM/YYYY	9155.
Gender	Male	Text	1K0..
	Female	Text	1K1..
NHS Number	N/A	Number	915B.
Postcode	N/A	Text	9153.
Mortality	N/A	DD/MM/YYYY	22J..
Date of COPD Assessment	N/A	DD/MM/YYYY	66YM.
CAT Score	N/A	Number 0-40	38Dg.
Smoking status	Current smoker	Text	137.. 137R. 137e. 137Q.
	Ex-Smoker	Text	1377. 1378. 1379. 137A. 137B. 137F. 137j. 137I. 137N. 137O. 137S.
	Never smoker	Text	1371. 137L.
Smoking pack year	N/A	Number	388B. 137g.
Smoking cessation offered	Yes	Text	6791. 67A3. 8B2B. 8HTK. 8B3f. 8B3Y. 67H1. 8H7i. 9N2k. 8CAL.
	Declined	Text	8IAj. 8IEK. 8IEM. 8IEM0 8IEo. 9Ndg. 9NdY. 9NdZ.
	No	Text	No read code – No entry of offer or decline indicates not offered.
Spirometry completed	Yes	Text and Date DD/MM/YYYY	745C1 745D4
	Declined	Text and Date DD/MM/YYYY	33720 8I3b. 8I2j. 9NiV.

	No	Text	No read code – No entry of completion or decline indicates not offered.
FEV1	N/A	Number (L)	339b. 339a. 339e. 339f.
FEV1 % of predicted	N/A	Number (%)	339S0 339S.
FVC	N/A	Number (L)	3396. 33963 339h. 339s.
FEV1/FVC	N/A	Number (%)	339M. 339m. 339j. 339k. 339I.
Oxygen Saturations	N/A	Number (%)	44YA0
Significant Reversibility	Yes	Text	33G1. 33G.. 33H.. 33I.. 33J.. 663J.
	No	Text	33G0. 663K.
	Unknown	Text	No read code – No entry of Yes or No reversibility indicates not tested.
Medical History	Coronary Artery Disease	Text	G3… G30%. G31%. G33.. G33z% G34.. G340% G342. G34y% G34z% G3z.. Gyu3%
	Cerebrovascular disease	Text	G66%. G63y0 G63y1 G64%. G6760 G6W.. G6X.. G65.. G65y. G65z. G65zz
	Hypertension	Text	G2… G20%. G2z..
	Diabetes	Text	C10E% C10F%
	Asthma	Text	H33%.
	Obstructive Sleep Apnoea	Text	Fy03. H5B0.
	Osteoporosis	Text	N330.

			N3300 N330z NyuB1 NyuB2
	Osteoarthritis	Text	N05..
	Depression	Text	E112% E113% E118% Eu32% E2B%. E135. Eu341 E2003 Eu412 E130. E0021 E291. Eu920 Eu204
	Irritable Bowel Syndrome	Text	J521.
	GORD	Text	J10y4
Date added to COPD register		DD/MM/YYYY	H3 H31% H32% H36 H37 H38 H3y H3y0 H3y1 H3z
Medication review	Yes- Medication continued	Text	8B3E1
	Yes- Medication changed	Text	8B316 8BMa0
	Yes- Unknown outcome	Text	8B314 8B3S. 8B3V. 8B3x. 8BIy. 8BIH.
	No	Text	No read code- If no review read code then review not done.
Medications	N/A	Text	No read code All medications issued within selected timeframe extracted using audit function.
Long term Oxygen Therapy	Yes	Text	6639. 8776.
	No	Text	No read code- If LTOT not recorded then no LTOT
Ambulatory Oxygen	Yes	Text	8778.
	No	Text	No read code- If Ambulatory oxygen not recorded then no ambulatory oxygen
Influenza vaccination	Yes	Text and Date DD/MM/YYYY	65E.. 65E2. 65ED. 65ED0 65E20

			65E21 65E22 65E23 65E24 65ED0 65ED1 65ED2 65ED3
	Declined	Text and Date DD/MM/YYYY	9OX5. 9OX50 9OX51 9OX52 9OX53 9OX54 9OX55 9OX56 9OX57
	No	Text	No read code – No entry of offer or decline indicates not offered.
Pneumococcal vaccination	Yes	Text and Date DD/MM/YYYY	6572. 65720 657L. 657M. 657N. 657P. 657R. 67In. 9mY.. 9Oo0. 9Oo1. 9Oo2. 9Oo3. 9Oo4.
	Declined	Text and Date DD/MM/YYYY	8I3Q. 9NiQ. 9NiQ0 9NiQ1
	No	Text	No read code – No entry of offer or decline indicates not offered.
Pulmonary rehabilitation	Referred	Text	8H7u. 9NSL.
	Declined	Text	8IA9.
	Unsuitable	Text	9kf0.
	Completed	Text	8FA2.
	Commenced	Text	8FA1.
	Did not complete	Text	8I86.
	Not offered	Text	No read code – No entry regarding pulmonary rehabilitation indicates not offered.
Self-management plan discussed	Yes	Text	661M3 661N3 66YI. 8IEy.
	No	Text	No read code – No entry regarding self-management indicates not discussed.
Rescue medications	Issued	Text	8BMW.
	Declined	Text	8IEZ.
Number of respiratory outpatient appointments	N/A	Number	Extracted from secondary care records.

Number of hospital admissions for COPD	N/A	Number	Extracted from secondary care records.
Number of COPD Exacerbations	N/A	Number	66Yf.
MRC Dyspnoea score	MRC 1	Number	173H.
	MRC 2	Number	173I.
	MRC 3	Number	173J.
	MRC 4	Number	173K.
	MRC 5	Number	173L.
Haemoglobin level	N/A	Number and date of result DD/MM/YYYY	423..
Eosinophil level	N/A	Number and date of result DD/MM/YYYY	42K..
Neutrophil level	N/A	Number and date of result DD/MM/YYYY	42J..
Total White Cell Count	N/A	Number and date of result DD/MM/YYYY	42H..
Sodium level	N/A	Number and date of result DD/MM/YYYY	44I5.
Potassium level	N/A	Number and date of result DD/MM/YYYY	44I4.
Urea level	N/A	Number and date of result DD/MM/YYYY	44J8.
Creatinine level	N/A	Number and date of result DD/MM/YYYY	44J3.
Alkaline Phosphatase	N/A	Number and date of result DD/MM/YYYY	44F..
Alanine Aminotransferase	N/A	Number and date of result DD/MM/YYYY	44GB.
Bilirubin	N/A	Number and date of result DD/MM/YYYY	44E..
Total protein	N/A	Number and date of result DD/MM/YYYY	44M3.
C- Reactive Protein	N/A	Number and date of result DD/MM/YYYY	44CS.
Alpha 1 Antitrypsin level	N/A	Number and date of result DD/MM/YYYY	4Q3M.
Alpha 1 phenotype	N/A	Text	4L00.
Sputum culture	N/A	Date of test DD/MM/YYYY	4E4.. R1531 41D4. 4E11. 4E3..
Chest X-Ray	Yes	Date DD/MM/YYYY	535.. ZV725 7P042
	No	Text	No read code – If no entry then indicates no chest x-ray.
CT Chest	Yes	Date DD/MM/YYYY	5678. 56780 56781 56G0.
	No	Text	No read code – If no entry then indicates no chest CT.

Appendix 6: Per protocol data analysis outputs

	Baseline		Between group odds ratio at baseline* (95%CI)	12 month Follow up		Between group odd ratio at 12 month follow up* (95%CI)
	Control	Intervention		Control	Intervention	
GA2017	77%	73%	0.72 (0.26-1.92) **p=0.499**	79%	95%	5.45 (2.26-13.12) **p=<0.0001**
GA2019	81%	78%	0.57 (0.18-1.76) **p=0.324**	84%	98%	9.62 (3.29-28.10) **p=<0.0001**

Table 3 Guideline adherence at baseline and follow up (per protocol). Control n=574; Intervention n=443; GA2017: Guideline adherence with 2017 guideline; GA2019: Guideline adherence with 2019 guidelines; CI: Confidence interval. *- adjusted for clustering, age, gender, and deprivation

	Control (n=574)		Intervention (n=443)	
	Baseline	Follow up	Baseline	Follow up
Influenza vaccine	451 (79%)	526 (92%)	407 (92%)	435 (98%)
Pneumococcal vaccine	479 (83%)	506 (88%)	345 (78%)	416 (94%)
Offer of pulmonary rehabilitation	441 (77%)	421 (73%)	310 (70%)	438 (99%)
Offer of smoking cessation	554 (97%)	497 (87%)	410 (93%)	442 (99%)
Medication 2017 guidance	454 (79%)	428 (75%)	288 (65%)	299 (67%)
Medication 2019 guidance	526 (92%)	517 (90%)	347 (78%)	389 (88%)

Table 4 Adherence to each guideline item at baseline and follow up (per protocol).

	Referred	Completed	Commenced	Unsuitable	Declined	Did not complete	NR
Intervention	32%	9%	3%	24%	31%	1%	0.4%
Control	24%	6%	0%	1%	18%	0%	51%

Table 5 Outcomes following offer of pulmonary rehabilitation in patients with an MRC score >3 (per protocol). Intervention n=240; Control n=260; NR: Not recorded.

CAT score outcome	Control				Intervention				Between-group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	244	14.15 (8.29)	13.82 (7.53)	-0.33 (-1.18 – 0.52)	442	17.27 (9.66)	14.02 (9.68)	-3.24 (-3.96 – -2.52)	-1.86 (-2.92 – -0.810	0.001

Table 6 CAT score outcome: comparison between and within control and intervention groups (per-protocol). SD: Standard deviation; CI: Confidence interval; *calculated using coefficient and adjusted for clustering, age, gender, deprivation, and baseline CAT score.

COPD-related hospitalisations outcome	Control				Intervention				Between group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	574	0.17 (0.49)	0.25 (0.73)	0.08 (0.02 – 0.14)	443	0.12 (0.48)	0.30 (1.30)	0.18 (0.06 – 0.30)	1.29 (0.91 - 1.85)	0.16

Table 7 COPD-related hospitalisations outcome: comparison between and within control and intervention groups (per-protocol). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline COPD-related hospitalisations.

COPD-related hospitalisations outcome – Adjusted for zero counts	Control				Intervention				Between group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	74	0.77 (1.33)	1.31 (0.62)	-0.54 (-0.86 – -0.22)	38	1.39 (0.95)	1.11 (2.44)	-0.28 (-1.03 – 0.46)	2.59 (1.78 – 3.76)	<0.001

Table 8 COPD-related hospitalisations outcome adjusted for excess zero count: comparison between and within control and intervention groups (per-protocol). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline COPD related hospitalisations.

COPD Exacerbations outcome	Control				Intervention				Between group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	209	0.89 (1.34)	1.00 (2.18)	0.11 (-0.19 – 0.42)	428	1.44 (2.03)	1.40 (1.96)	-0.04 (-0.22 – 0.14)	1.15 (0.87 – 1.50)	0.33

Table 9 COPD exacerbations outcome: comparison between and within control and intervention groups (per-protocol). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline number of exacerbations.

Respiratory outpatient attendance outcome	Control				Intervention				Between group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	574	0.32 (0.87)	0.28 (0.73)	-0.04 (-0.11 – 0.01)	443	0.20 (0.71)	0.18 (0.71)	-0.02 (-0.11 – 0.07)	0.71 (0.42 – 1.20)	0.20

Table 10. Respiratory outpatient attendance outcome: comparison between and within control and intervention groups (per-protocol). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline respiratory outpatient attendances.

Respiratory outpatient attendance outcome – Adjusted for zero count	Control				Intervention				Between group difference*	
	Number of patients	Baseline Mean (SD)	12 Month Follow up Mean (SD)	Mean change from baseline (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Mean change from baseline (95%CI)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	99	1.88 (1.22)	1.18 (1.160	-0.70 (-0.96 – -0.43)	49	1.84 (1.26)	0.51 (0.92)	-1.33 (-1.77 – -0.89)	0.76 (0.49 – 1.19)	0.23

Table 11. Respiratory outpatient attendance outcome adjusted for excess zero counts: comparison between and within control and intervention groups (per-protocol). SD: Standard deviation; CI: Confidence interval; *calculated using incidence rate ratio and adjusted for clustering, age, gender, deprivation and baseline respiratory outpatient attendances.

Impact of adherence/non-adherence at baseline	2017 Guidelines			2019 Guideline		
	Coeff (95%CI)	IRR (95%CI)	*p*-Value	Coeff (95%CI)	IRR (95%CI)	*p*-Value
CAT Score	-2.60 (-4.17 - -1.03)	N/A	0.001	-1.75 (-3.48 – -0.03)	N/A	0.05
COPD-related Hospitalisations*	0.11 (-0.08 – 0.31)	1.12 (0.92 – 1.36)	0.25	0.07 (-0.13 – 0.26)	1.07 (0.88 – 1.30)	0.51
COPD exacerbations	-0.32 (-0.47 – -0.17)	0.73 (0.62 – 0.84)	<0.001	-0.21 (-0.38 – -0.05)	0.81 (0.69 – 0.95)	0.01
Respiratory outpatient attendances*	-0.01 (-0.27 – 0.24)	0.99 (0.76 – 1.27)	0.92	-0.01 (-0.30 – 0.27)	0.99 (0.74 – 1.32)	0.94

Table 12. Impact of adherence to 2017 and 2019 guidelines: comparison of secondary outcomes between guideline adherent and non-adherent patients at baseline (per-protocol). Coeff: Coefficient; CI: Confidence Interval; IRR: Incidence rate ratio. All outcomes have been adjusted for clustering, age, gender, deprivation, and randomisation group. *adjusted for excess zero count. Coefficients and IRRs are of guideline adherence to non-adherence.

Impact of adherence/non-adherence at follow up	2017 Guidelines			2019 Guideline		
	Coeff (95%CI)	IRR (95%CI)	*p*-Value	Coeff (95%CI)	IRR (95%CI)	*p*-Value
CAT Score	-1.89 (-4.50 – 0.72)	N/A	0.16	-2.60 (-6.26 – 1.05)	N/A	0.16
COPD-related Hospitalisations*	-0.31 (-0.67 – 0.04)	0.73 (0.51 – 1.04)	0.09	-0.21 (-0.70 – 0.29)	0.81 (0.50 – 1.33)	0.41
COPD exacerbations	-0.12 (-0.45 – 0.20)	0.88 (0.64 – 1.23)	0.46	-0.13 (-0.59 – 0.32)	0.88 (0.56 – 1.38)	0.57
Respiratory outpatient attendances*	-0.06 (-0.47 – 0.36)	0.94 (0.62 – 1.43)	0.79	0.05 (-0.45 – 0.55)	1.05 (0.64 – 1.74)	0.85

Table 13. Impact of adherence to 2017 and 2019 guidelines: comparison of secondary outcomes between guideline adherent and non-adherent patients at 12 months follow up (per-protocol). Coeff: Coefficient; CI: Confidence Interval; IRR: Incidence rate ratio. All outcomes have been adjusted for clustering, age, gender, deprivation, and randomisation group. *adjusted for excess zero count. Coefficients and IRRs are of guideline adherence to non-adherence.

Appendix 7: Analysis of CAT score variable with multiply imputed datasets

CAT score outcome	Control			Intervention			Between-group difference*	
	Number of patients	Baseline Mean (95%CI)	12 Month Follow up Mean (95%CI)	Number of patients	Baseline Mean (SD)	12 month follow up Mean (SD)	Adjusted difference (95%CI)	*p*-Value
Whole cohort	656	14.40 (13.64 – 15.16)	14.28 (13.45 – 15.10)	586	17.49 (16.70 – 18.28)	14.40 (13.59 – 15.22)	-2.05 (-3.23 – -0.87)	0.001

Table 14 CAT score outcome: comparison between and within control and intervention groups using multiply imputed datasets (intention-to-treat). SD: Standard deviation; CI: Confidence interval; *Adjusted difference represented by using coefficient and adjusted for clustering, age, gender, deprivation and baseline CAT score.

Impact of adherence/non-adherence on CAT score	2017 Guideline		2019 Guideline	
	Coeff (95%CI)	***p*-Value**	**Coeff (95%CI)**	***p*-Value**
At Baseline	-2.10 (-3.52 - -0.68)	0.004	-1.31 (-2.88 – 0.25)	0.10
At Follow up	-2.00 (-4.18 – 0.17)	0.07	-2.42 (-5.11 – 0.27)	0.08

Table 15. Impact of adherence to 2017 and 2019 guidelines on CAT score using multiply imputed datasets (intention-to-treat). Coeff: Coefficient; CI: Confidence Interval. All outcomes have been adjusted for clustering, age, gender, deprivation, and randomisation group. Coefficients are of guideline adherence to non-adherence.

Appendix 8: Misdiagnosis topic guide prompts

Topic 1: Diagnosing COPD (only applies to HCPs)
-Aim is to obtain information regarding clinician views on the diagnostic process for COPD
Prompt questions:
"How do you normally go about diagnosing a patient with COPD?"
"What normally prompts you to investigate a patient for COPD?"
"How often do you see patients with COPD?"
"How often do you diagnose patients with COPD?"
"Do you feel confident making a diagnosis of COPD?"
"Who do you think should be making a diagnosis of COPD and why? (GP or Specialists)"

Topic 2: Spirometry (only applies to HCPs)
-Aim is to obtain clinician views on spirometry use
Prompt questions:
"Do you feel confident using a spirometer?"
"Do you feel comfortable interpreting a spirometry reading?"
"How do you feel about the use of spirometry in COPD?"
*"If spirometry was no longer a QOF outcome would you still perform spirometry?" -**GPs ONLY***
"Do you think there is a difference between spirometry completed in GP vs Hospital? If so what do you think the difference is?"
"Tell me what you know of using lower limit of normal to assist in diagnoses when assessing elderly patients?"

Topic 3: Exploring differentials (only applies to HCPs)
-Aim is to obtain clinician perspective regarding how they consider alternative diagnoses
Prompt questions:
"When diagnosing patients with COPD what alternative diagnoses do you consider?"
"How do you investigate for alternative diagnoses?"
"Do you think it is important to consider alternative diagnoses to COPD?"
"What factors influence whether you investigate for alternative diagnoses?"

Topic 4: COPD misdiagnosis (only applies to HCPs)
-Aim is to obtain the clinicians opinion on misdiagnosis
Prompt questions:
"Are you aware of any issues regarding misdiagnosis of COPD?"
"What do you think are the causes of patients being misdiagnosed/mislabelled with COPD?"
"Do you think COPD misdiagnosis is a serious issue? And why?"
"Have you taken any actions in the past to reduce the number of patients misdiagnosed with COPD? if so what actions?"

Topic 5: Solution to misdiagnosis (only applies to HCPs)
-Aim is to identify how clinicians feel misdiagnosis can be prevented
Prompt questions:
"Do you have any thoughts on how misdiagnosis with COPD can be prevented?"
"Do you feel national standards regarding spirometry will help prevent misdiagnosis?"
"Do you think further training for healthcare professionals would help?"
"Is COPD too complex to be diagnosed in primary care? And why?"

Topic 6: Misdiagnosis (only applies to misdiagnosed patients)
-Aim is to explore patients' feelings and thoughts about being misdiagnosed
Prompt questions:
"How do you feel now that your diagnosis is no longer COPD?"
"Do you have any concerns about being diagnosed incorrectly?"
"How has this (misdiagnosis) impacted you if at all?"

Appendix 9: Misdiagnosis qualitative data category summaries

Category 1: Misdiagnosing COPD

Definition

The perceived processes involved in misdiagnosing patients with COPD and the outcome of such misdiagnoses.

Codes:

"Preventing COPD misdiagnosis", "Managing COPD misdiagnosis", "Causes of COPD misdiagnosis", Impact of COPD misdiagnosis", "Patient relief"

Summary of data

Misdiagnosis pathway:

Sense of anchor bias, whereby a historical diagnosis of COPD without spirometric evidence would lead to tunnel vision and prevent consideration of alternative diagnoses in patients already diagnosed with COPD. ***"And the issue, I think most of the patients that have that from here were historic patients that were been diagnosed ages ago without correct testing, or they were admitted to hospital and they get a TTO saying exacerbation of COPD, and I go they haven't got COPD. But of course, when that happened 5-10 years ago, it was just coded.... And that code just appears." – SIN008 GP.*** Errors in historical diagnoses attributed to diagnoses being based on clinical findings and symptoms. ***"Okay, some of them may have been historically misdiagnosed. We only started doing spirometry about five years ago, I think or something like this. I'm certain about it. Because I was diagnosing COPD on history in the past.. smoker who's got recurrent infections, wheezing etc and lots of things over there. And I'm talking about more than 10 years ago, or even 15 years ago, spirometry started coming in."- SIN007 GP.*** Secondary care participants corroborated the perceptions of primary care ***"they do presumed COPD, but I'm not confident that it always the surgeries go back to reassess that. I think they just once they mentioned COPD on their read codes.... it's hard, isn't it to pick up where the diagnosis and when the diagnosis occurred" -SIN013 Respiratory Nurse.*** Secondary care participants focused on the lack of spirometry use in primary care leading to patients being misdiagnosed initially ***"people referred up to the clinic or they come into hospital with a label of COPD. There's no spirometry on the system, or they've come in with breathlessness and someone's given them a diagnosis of COPD. And actually when they come back to outpatients they've got normal spirometry."- SIN023 Respiratory Consultant.***

Participants focused on regular review and challenging historical COPD diagnoses as a method of reducing the extent of misdiagnosis in primary care. ***"not just making a diagnosis, but making sure they have regular reviews, even those that don't seem to be having a frequent exacerbations. Perhaps having a standard whereby you review them once a year, at the very minimum and when you review them, it could very well be that it comes to light then that the diagnosis wasn't made correctly"- SIN022.*** Specialist support and education was perceived as an important intervention to assist in correcting misdiagnosed cases and preventing future misdiagnosis. ***"I think it's working together primary care, secondary clinicians, you know, keeping up to date having someone here helps in that in that we're aware more. Therefore, we're actually looking at where, perhaps more educated on looking at for the right symptoms and signs of COPD and asthma and distinguishing between the two."- SIN005 GP.***

The perceived misdiagnosis pathway therefore being: Initial misdiagnosis due to lack of spirometry → no diagnostic review in primary care → persistent population of misdiagnosed patients in primary care.

Misdiagnosis outcome:

Patient participants focused on the sense of relief for not having COPD, the perception of COPD was often negative and assumed to limit their life ***"Well, COPD that's where your tubes are shrinking and you know and I thought that was it .. the beginning of the end if you get what I mean. Now we know that it's not, it's taken that bit of weight off my mind"- IN16038 Patient.*** HCP participants focused their concerns for the impact

misdiagnosis had on the patient's health, mental and social wellbeing ***"it can impact on people's life insurance, travel insurance. Have they been taking steroids that perhaps they didn't need to take? Has that put them at higher risk of getting pneumonia? You know, you know, have been given lots of courses of steroids that, that didn't need putting them at risk of osteoporosis, you know, so suppose and I don't know, maybe psychologically, the thing, they've got this sort of, not death sentence, but it's a long term condition, isn't it that's progressively gets worse over time. You don't know whether that perhaps has a psychological effect on some people and, you know, and, and people's occupation, if they if they put it down to they can't do the job because they've got COPD, whereas actually, it could be something else."- SIN021 ACP.***

Deviant case:

One GP (SIN016) focused on misdiagnosis being inevitable and that it was "part and parcel" of being a GP, but the focus should be to ensure quality of life is improved not getting the label correct.

Final points:

Misdiagnosis is prevalent in primary care due to inadequacies in the diagnostic review process and historical diagnoses often lead to anchor bias. Historical diagnoses were often made on clinical grounds only without spirometry. Patients often felt relief when told they do not have COPD, and HCPs were concerned that misdiagnosis has the potential to have a significant impact on a patients life. Combination of specialist input and diagnosis review were perceived as an intervention to reduce misdiagnosis in primary care.

Category 2: Spirometry

Definition

Thoughts or perceptions surrounding spirometry in primary care.

Codes:

"Spirometry experience", Spirometry interpretation", Spirometry- Patient technique", "Spirometry procedure", "Spirometry quality", "Spirometry resources", "Spirometry skills", "Spirometry training", "Impact of COVID – Spirometry", "Use of spirometry", "Access to spirometry".

Summary of data

Role of spirometry in primary care:

Spirometry was perceived as a useful tool to help with the management of patients with COPD in primary care ***"You know, to have a spirometry done every year or two. And certainly, if there's a deterioration in symptoms, you know, doing another one at that point, just so that we can see clearly what is happening (…) So yeah, I quite like to be able to look back over several different readings and see how it's changed over a period of time" -SIN020 GP.*** However, there were opposing views regarding the necessity of spirometry to diagnose COPD. It was perceived by some as essential ***"I say that COPD is a physiological diagnosis, you wouldn't treat blood pressure without first... you wouldn't treat hypertension without first measuring the blood pressure. So you need to do the diagnostic test which is spirometry" -SIN023 Respiratory Consultant.*** However, it was also perceived as a "tick-box exercise", ***"if it's easy, you almost don't need this spirometry like you look at them and clinically, you make the diagnosis and you are almost certain, and you're like, "Yeah, you've got COPD" and you do spirometry to tick a box" -SIN009 GP***. Significant clinical history alone was perceived as sufficient to diagnose COPD, but there was an appreciation that spirometry was useful when there was diagnostic doubt ***"with COPD, you've got people that might have a mixed mixture, and there are other things that could be going on, so I think you really need to have the spirometry to determine what's going on." -SIN022 GP.***

Within primary care, performing and interpreting spirometry was perceived as part of the nursing role, with nurses discussing their experience doing spirometry and doctors describing referring patients to nurses to have

spirometry ***"..refer this patient to the nurse to get a spirometry done. And then based on the spirometry, we would see what the FEV1, and then the ratio and then we decide if it is COPD" -SIN015***. Whereas the decision to investigate with spirometry was perceived as a doctor's responsibility ***"But we only do that if that comes from the GP. So, it's the GP that decides whether we do spiros, on which patients and when" -SIN010 Practice nurse*** as was labelling the patient with COPD "***the nurse because of their expertise might actually be able to help the GP or the GP trainee, because we're a training practice, might help them to interpret the results (…) but in terms of putting their firm diagnosis on the record, it will be done to a doctor" -SIN022 GP***. Annual COPD reviews were completed by practice nurses and as a result it was perceived they had greater experience with spirometry and COPD ***"I am confident but not as good as my nurse. My practice nurse in surgery, she's, she's excellent at reading this spirometry; a lot better than me" -SIN015 GP.***

However, there were doubts amongst secondary care HCPs regarding the quality of spirometry results obtained in primary care ***"in terms of the spirometry, if it's been done in primary care, then I don't think they get I'm not confident that they have reproducible traces I'm not confident that it's done when they are, you know, at least four to six weeks post exacerbation. I'm not confident that they will out any alternative diagnoses with reversibility, like asthma, just because of the timing that it takes for the reversibility testing" -SIN013 Respiratory nurse***.

Enabling factors and barriers:

Participants focused on the training and accreditation as an enabling factor, knowing that nurses had been trained or had attended courses led to GPs having greater confidence in their ability and felt comfortable seeking their advice with COPD. ***"she was actually doing another course to update herself. And she's done the exam as well. And she passed it. So she's the one who's up to speed on spirometry, probably, actually, to be honest, I would say much more than I am. I have to sort of go back and look up guidelines and remember how to, to interpret the results, actually, because she does so much of it in practice" -SIN018 GP***.

Having "in-house" spirometry was deemed as cost-effective and easy for patients, thus was perceived as an enabling factor to its use in primary care ***"if we just provide it in house well then we're not paying for it.. we get the money for providing the service. But it also means that patients get it quicker because we can just book it rather than referring and waiting however long it takes to get it" -SIN008 GP***. Easy access to community hubs were also seen as an enabling factor as they were deemed cost effective ***"number of COPD patients that probably no more than 15 I think. Thus, to provide the equipment, run the service is financially not viable (…) So we entered into a contract with a community respiratory team who, in return for a charge, they would do it because they have clinic not far from us" -SIN017 GP***. One participant did suggest a re-organisation of services such that spirometry was provided in hubs to maintain skills and improve access for all patients ***"So with the GPs choosing their services, you should have, say one of the bigger practices where you've got a GP who's got big respiratory interest. And, you know, he's trained and confident with the diagnosis. And they've got someone who accurately performs the spirometry correctly, even undertaken the ARTP course. And that those surgeries can link in with them. And they have an arrangement to send their patients for spirometry, to either rule it in or out" -SIN013 Respiratory nurse***. The COVID 19 pandemic was perceived as the main barrier to spirometry through preventing training courses and leading to deskilling amongst primary care HCPs ***"I was supposed to start the training and haven't started doing anything, because we've had to stopped doing as much face to face. And we still haven't caught up with the COPDs yet" -SIN001 Practice nurse***. This was perceived to have a potential knock-on effect on the integrity of the diagnoses made based on clinical history alone ***"Obviously, it's effected diagnosis for new patients or patients with new symptoms. Because there's no spirometry" -SIN013 Respiratory nurse.***

Final points:

The role of spirometry was perceived as one to assist in the management of patients with COPD, which is primarily the role of the practice nurses. Spirometry was perceived as essential to make a COPD diagnosis by some HCPs but also seen as a confirmation investigation once diagnosis made with clinical history, but appreciated its role with difficult to diagnose cases. Having adequate training and easy access to spirometry

were key enabling factors to its use, however, COVID 19 was perceived as the predominant barrier to its use, with concerns about potential long term impacts.

Category 3: Diagnosing COPD

Definition

Thoughts and perceptions surrounding how and where COPD should be diagnosed and difficulties differentiating COPD from other pathologies.

Codes:

"Diagnostic differentials" and "Diagnosing COPD"

Summary of data

Generalist Vs Specialists:

Diagnosing patients with COPD was perceived as an activity best suited to a primary care setting with primary care clinicians taking the lead due to perceived limited access in secondary care as well as a perception of regular interactions with patients ***"both can diagnose. So if specialists are, if only a diagnosis can be made from secondary care, you might increase your ability to diagnose, but you will have really long waiting lists and wait for that will be much, much longer" -SIN016 GP.*** Participants felt that the responsibility of diagnosing COPD fell with the primary care clinicians rather than secondary care specialists ***"Umm general practitioners, nursing staff, I think practice nurses. And I don't necessarily think this is just something that specialists should do, it should be something we pick up in primary care. And because we're the people who tend to see patients more regularly, and so if they're coming to us with recurrent symptoms of spastic chest infections, and coughing, wheezing, then we should look forward to making that diagnosis" -SIN018 GP*** Participants perceived primary care HCPs as being capable of diagnosing COPD, with appropriate guidance ***"So mentally, I think I think it's nice to have a specialist who can focus on it. And then we can have that discussion its useful to have a with our situation healthcare assistant who is very interested in COPD and chest medicine, and then GP with ongoing kind of interest and then having the specialist so we kind of bounce the ideas that description... that is what a multidisciplinary team is. And I think I think the days of having have one I'm the GP and I made a diagnoses, it doesn't hold you know.. we should discuss it in a multidisciplinary team kind of way" -SIN012 GP.***

Asthma Vs COPD:

Participants focused on the difficult of differentiating COPD from asthma due to similar symptoms ***"I feel that sometimes, they come in being treated for asthma, and it's not relieved from the inhalers that they're on is not relieving. And you know that they're a smoker, and you just feel is it asthma or is it COPD, you know have they got there. Whereas then when we've queried it with the doctors, I think they haven't quite been certain themselves at the time" -SIN010 Practice nurse***. Participants perceived specialists as having more experience with respiratory conditions, thus enabling them to differentiate easily ***"I think that occasionally COPD is difficult to diagnose (…) I'm suspecting it COPD or possibly asthma or possibly overlap, and I don't either have the knowledge for it or, or is my suspicion, I definitely think that my senior My, my, my colleagues who are specialists in it should give me feedback, they should see that person they should advise me" -SIN007 GP.*** COPD was perceived as the default diagnosis when unsure of causes of breathlessness in smokers and ex-smokers ***"it does kind of make us go into a one track mind. So if someone presents with breathing difficulty or whatever, we would probably just give them antibiotics and steroids and just let them get on their way and review them in a week and a half or two weeks. But there are patients who aren't that clear cut and actually, I think we do them a bit of a disservice by just thinking they have COPD, they can get other things. And that treatment may be slightly different" -SIN018 GP.*** Difficulty differentiating COPD from other respiratory conditions was perceived as a factor leading to misdiagnosis ***"Ah yeah, we've had that lots of times, where we think the patient is, for example, asthmatic, and we've been treating him for asthma. And***

then we had MDTs, or consultants, have gone into hospital and the diagnosis had been COPD all along. So yes, we've had a few of those over the years where we've obviously labelled the person has one condition, but they've got something else" -SIN015 GP.

Final points:

Participants felt strongly about primary care being the idle setting and GPs being best suited to diagnosing patients with COPD, however, appreciated specialist input is needed with difficult cases. Difficulty predominantly focused on differentiating asthma from COPD, where specialist experience and knowledge was perceived to ease that confusion.

Appendix 10: INTEGR COPD Qualitative study topic guide

Topic 1: Systematic integration (HCPs only)

Aim is to identify thoughts regarding using shared local COPD guidelines developed by primary and secondary care teams.

Prompt questions:
"Are you aware of shared COPD guidelines within the area?"
"What are your thoughts about shared guidelines?"
"Do you feel comfortable following current local guideline? And why?"

Topic 2: Normative integration (HCPs only)

Aim is to explore thoughts regarding co-ordination and collaboration between primary and secondary care.

Prompt questions:
"What are your thoughts on working closely with secondary care specialists?"
"Do you think collaborating with secondary care is helpful? And why?"
"What are your thoughts on the current collaborative links the practice has with secondary care?"
"Do you think having specialist led clinics in the practice helped improved collaboration between primary and secondary care? And why?"

Topic 3: Organisational integration (HCPs only)

Aim is to determine opinions regarding current level of integration.

Prompt questions:
"How much do you know about integrated care?"
"How do you feel about the current level integration between your practice and secondary care?"
"Do you think more or less integration would be beneficial? And why?"
"What are your thoughts on specialists conducting clinics in your practice? For COPD and other chronic illnesses"

Topic 4: Clinical and Service integration (HCPs only)

Aim is explore views regarding services provided as part of INTEGR COPD, normally done by GP staff.

Prompt questions:
"What are your views on spirometry being completed by specialists as part of INTEGR COPD"
"What are your views on COPD specialists completing the annual COPD review for your patients?"
"Do feel patients have benefitted from specialist led clinics? And why?"

Topic 5: Functional integration (HCPs only)

Aim is to determine the views regarding the impact of INTEGR COPD on back-office processes.

Prompt questions:
"How much impact did the specialist led clinic have on the admin team?"
"Going forward what back office support do you think is needed for the specialist led clinics?"
"Were there any administrative challenges in setting up the specialist led clinics? If yes please expand"

Topic 6: Knowledge of disease (Patients only)

Aim is to explore thoughts regarding self-management and knowledge of COPD.

Prompt questions:
"What is your understanding of COPD and how it affects your body?"
"Tell me about how you take care of yourself during an infection?"
"If you wanted to know more about COPD where would you go?"

Topic 7: Specialists (Patients only)

Aim is to explore patient's thoughts regarding specialists versus GP and the involvement of specialists in their care.

Prompt questions:
"Can you tell me about the different healthcare professionals that are involved in your care?"
"How would you describe a COPD specialist?"
"What do you think COPD specialists are able to do different to your GP?"
"Are there aspects of your COPD care that you think either specialists or the GP know more about?"
"Do you ever get nervous or anxious when seeing someone about your COPD? if yes – What is it that makes you nervous – tell me more about that"
"What are your opinions about seeing different doctors and nurses at your appointments?"

Topic 8: Location (Patients only)
Aim is to explore patient's opinions regarding setting and continuity of care.

Prompt questions:
"Is location of your appointment important to you? And why?"
"How do you feel about seeing specialists at your GP surgery?"
"Where do you feel most comfortable to discuss your medical issues?" – why ?"

Topic 9: Service (Patients only)

Aim is to explore patient's opinions regarding integrated care services

Prompt questions:
"If you were putting together a COPD review that was perfect for you, what sort of things would you include?"
"How easy or hard is to access a specialist to help you with COPD?"
"What is your understanding of integrated care?"
"Do you feel this service has had any positive or negative effects on your care?"

Topic 10: Impact of COVID on care (Patients only)

Aim is to explore how COVID lockdown has affected them

Prompt questions:
"How has COVID affected you?"
"How has COVID changed your thoughts or how you see hospitals and GPs?"
"How had COVID affected how you get medical help?"
"What are you thoughts on telephone consultations?"
"How has COVID affected your breathing or COPD?"

Appendix 11: INTEGR COPD Qualitative study category summaries

Category 1: Healthcare access

Definition

Participant perceptions of ability to access healthcare services and perceived barriers impacting access.

Codes: "Access to secondary care advice", "Travel", "Healthcare access", "Use of technology"

Summary of data

Patient perspective:

Patients made comparison between access to their GP practice and local hospital. Patients perceived access to their GP surgery was easier than hospitals due to GP practices often being geographically closer with familiar transport links, whereas hospitals required patients to take unfamiliar public transport or to drive. ***"Because you have people walking about on trains and whatever, that can't get to an hospital. So it's easier for them to be able to talk to somebody at the doctor's surgery rather than go all the way to the hospital" -IN16038 Patient***

Driving came with the additional barrier of parking costs that are not present at GP practices ***"I live quite close to the hospital so driving, there's is not a problem. I had to go. I went the other Sunday for a test. Nine o'clock in the morning. And I was sitting there 36 minutes, I came out and it was a £3.60 parking charge on a Sunday morning and that is expensive.. thats a lot of money.." -IN5144 Patient***

Due to the perceived travel barriers to secondary care, patients appreciated seeing specialists in their own GP practices as part of the integrated care intervention ***"Well, I think it's a good idea that people able to come to the surgery to see people like us like us about what's going on with our problems anyway, than finding that we have to go all the way down to the hospital." -IN20002 Patient***

Access in the form of booking appointments with their GP practices varied between practices, with some having no issues, to some perceiving the lack of available appointments and reception team acting as barriers to accessing primary healthcare services. ***"Oh, well, sometimes it's easy. Other times, it's difficult for me, sometimes the receptionist think they are doctors you know what I mean.. they want to know why you want to see a doctor and what have you... I know thats the way they are all taught but sometimes, you know, you just you feel that you need to see the doctor" -IN20032 Patient***

However, patients that did find accessing GP services difficult still perceived access to primary care easier than secondary care due to travelling convenience. Suggesting easy travelling access is an important factor for patients when deciding where services should be based.

HCP perspective:

HCPs also perceived access to secondary care locations to be difficult due to travel barriers experienced by patients and suggest that primary care locations are easier for patients. ***"instead of having to go to hospital, they can just come to the practice, which for the vast majority of them is a lot easier. And some patients actually would be able to walk to the practice as opposed to get in on numerous buses and then you've got the issue of parking at the hospital" – SIN022 GP***

Integrated care was perceived to improve access to specialists for patients who could not easily attend hospitals. ***"The sort of patient population that we look after are often socio economically disadvantaged and if you see patients in a hospital setting, it may involve them having a journey to hospital. If they're lucky enough to have a car, there might be expensive car parking fees. And if they don't have a car, they're very breathless, they may need to come on one or two bus journeys to come to hospital. So there's certainly benefits from taking care nearer to patients homes." -SIN023 Respiratory Consultant***

HCPs also discussed access to specialist advice, and found that there were multiple options, however, developing rapport between GPs and specialist was perceived to make communication and access to specialist advice easier.

Final summary

Travelling outside of familiar locale and car parking charges at hospitals are perceived to be significant barriers that impact a patient's ability to access specialist care that is usually delivered in hospitals. Integrated care was perceived to break down this barrier and enable patients to access specialist care who potentially may not have been able to access it previously.

Category 2: Clinician knowledge

Definition

Participant perceptions regarding knowledge and skills of clinicians involved in COPD management as part of INTEGR COPD.

Codes: "Specialist knowledge and skills", "GP knowledge and skills", "Nursing knowledge and skills", "Specialist vs Generalist knowledge and skills", "Roles and Responsibilities of HCPs", "Confidence in other HCPs", "Escalation to specialist", "Shared guidelines"

Summary of data

Patient perspective:

Patients perceived specialists as having greater knowledge of COPD and this perception led to patients feeling reassured about the care they are receiving. ***"I like seeing the specialist, well, listening to the specialist because I'll tell him everything he specialises in what's the matter with you, Whereas the general practitioner, He is for mostly for everything else, you know, what I mean, if you're talking to somebody who specialises in what you've got, I feel comfortable." -IN20025 Patient***

They perceived the COPD management advice from specialists was superior to that of advice from GPs. "***Well he specialises in the treatments and I suppose he's more (pause) savvy about what's happening and he can tell more than your GP I mean your GP can only just refer you to a specialist which most of them do." - IN5025 Patient***.

Patients appreciated that nurses completed the annual COPD review, however, felt reassured when the review was completed by a specialist due to the perception of getting more information and reassurance. ***"Yeah the nurse is great.. But seeing a specialist you had more in depth information, if you know what I mean ... where she (nurse) went through the motions, she knew what she did.. [REDACTED name](specialist) knew more answers if you like, that the nurse couldn't really answer. And I'm not downgrading nurses at all they are doing a great and fantastic job." -IN5048 Patient***

However, patients appreciated the role that GPs play in their care and felt GPs were able to provide more personalised general care due to their skill mix and familiarity with the patient. ***"No, no, because if they suspect something, they will push it further pushing to being examined by somebody higher than them. So if they consider it to be out ot their league, then fine. But generally I've got great trust in the GPs, they're great." -IN5080 Patient***

HCP perspective:

HCPs felt that primary care clinicians had greater familiarity with the patients due to regular contact and the nature of general practice. ***"You only see them once in clinic and that's it. Yeah. Whereas, but also, I will know, the mother, the brother, whoever they are, but yeah, sometimes families. But yeah, so we've got a bit more of that knowledge as well." -SIN008 GP***

Practice nurses were perceived to have greater COPD knowledge than GPs due to more exposure to COPD patients and experience with COPD reviews. ***"She (nurse) does the interpretation as well, actually, she's done... before the pandemic was happening, she was actually doing another course to update herself. And she's done the exam as well. And she passed it. So she's the one who's up to speed on spirometry, probably, actually, to be honest, I would say much more than I am. I have to sort of go back and look up guidelines and remember how to, to interpret the results, actually, because she does so much of it in practice." -SIN018 GP***

Primary care clinicians felt able to manage most COPD related issues, however, were reassured by the perception that specialists had greater COPD knowledge and skills, therefore, patients were receiving the optimum management when involved. ***"Now, you're speaking to a doctor who doesn't necessarily is a specialist in COPD, I manage it when they have exacerbation. I do change their inhalers, etc, and so on and so forth. But I'm not a specialist. So for me, it was an extremely beneficial and I think from patient point of view, very safe approach to dealing with patients. COPD is very difficult to manage when they are in later stages. And, and I think that I couldn't, couldn't appreciate the service enough" -SIN007 GP.*** However, when specialists were not available, GPs were reassured by the access to locally developed and nationally developed COPD management guidelines ***"Well I think its really useful to getting the consultants opinion on how they would manage certain conditions, and then ensuring that we're working in the same way, and we are following the same guidance and same prescribing guidance as well. And if we all follow that we'll be providing better care in the community, because obviously, many GPs don't have the expert knowledge in respiratory conditions. But if we can follow guidance, which is generated by consultants, who we're working with then we are more likely to be singing from the same hymn sheet essentially." -SIN008 GP***

A GP with a special interest in COPD felt that having specialist involved in COPD reviews led to patients feeling more reassured, simply because the review was completed by a specialist rather than a GP. ***"I mean, the patients liked the fact they were seeing a specialist, because although I may be the respiratory lead, I'm not a specialist in that field. But also, the patients see me as a GP who deals with everything else as well. Whereas when they were told, "Oh, you've got an actual consultant or registrar, who's a specialist" they were quite happy to see them and also those because I know obviously it was yourself coming in or somebody with you was that they had continuity as well and they got to know you, which was good." -SIN008 GP***

Deviant case

One patient felt there was no difference in COPD skills between nurses and specialists. ***"Well I think they are on par because my practice nurse listens to what I've got to say, and then if they feel I need more medicine, medication change, you know, whatever they do that as for yourselves yeah it's is basically I joined the scheme just to see if there was any difference and I don't think there was really.." -IN5112 Patient.*** This aligns with the perception of nurses amongst GPs, that due to their experience and exposure to COPD they have develop skills making them specialist in COPD ***"the COPD reviews are done by the nurse, who therefore is obviously a specialist in COPD, relatively. relatively few of it is done by the doctors in terms of the services" -SIN016 GP***

<u>Final summary</u>

Overall reassurance is the key finding in this category, whereby patients are reassured when being reviewed by a specialist due to the perception that specialists are able to offer a more in depth assessment. GPs felt comfortable with managing common COPD related issues, but perceived specialists as having additional knowledge due to experience and exposure and felt reassured that this led to optimal patient care. Some GPs viewed practice nurses as COPD specialist due to their experience and exposure to COPD and spirometry.

Category 3: HCP to HCP interaction

Definition

Participant's thoughts and perceptions regarding factors that impact how they interact and communicate with HCPs in different healthcare settings. And the impact integrated care has had.

Codes: "HCP Collaboration", "HCP Communication", "Primary-Secondary care relationship"

Summary of data

Cultural differences between primary and secondary care were perceived to act as a barrier to communication and collaboration between the two. "***GPs are quite antagonistic towards hospital consultants and there's a bit of a 'them and us' so there's that understanding of what each discipline brings to the party and some suspicion and some hostility in some cases." -SIN023 Respiratory Consultant***

These differences were thought to be born from HCPs in secondary care lacking insight into the working culture of HCPs in primary care and vice-versa. ***"Um, I think there's a bit of a cultural issue if I'm going to be honest, I think, as GPs, some GPs, I don't want to say, you know, all GPs, but some GPs feel that specialists don't understand how generalists work, what our workload is like, similarly, and I feel that, you know, the way specialists are, you know, may not be so sure what we can do what we can offer, and there is so much we can do, we can, you know, organise our time effectively, and, and see patients in a way, that specialist may not be able to do we follow, we can follow them up nearly every day if we had the time to do that. And specialists can't always do that, because of their limited clinic resources. And they're having to do Ward rounds and things as well." -SIN018 GP.***

Primary care HCPs were often left frustrated that communication from hospital was poor as they were reliant on formal clinical letters and often led to additional work for the GP. ***"In terms of communication, like is, yeah, we don't always get hospital letters, we have patients, contacting us saying, I've been to hospital, I've been asked to tell my GP this, or I've been asked to do this. And we have no communication, no correspondence from secondary care, find it particularly, annoying, is a word to use (…) that's why that in terms of integrated care system, we should be communicating directly with each other, not asking patients to do that" -SIN022 GP.***

Integration of specialist into primary care was perceived as an effective method of breaking down this barrier and improve patient care. ***"By having this integrated care, I think it does help. In that case, if you're having a problem with a patient, I'm uncertain what to do. You know, you can just pick up the phone and say, "Look, what would you do with this situation?" And that does help to manage a patient a lot better." -SIN015 GP.***

Integrated care was perceived to allow relationships to form between primary and secondary care HCPs so that informal channels of communication could form i.e., patients not requiring formal referrals. ***"And they built a really strong relationship with them. Knowing that that helps with, you know, sometimes something doesn't need to be a formal referral, it can be an informal conversation. Again, that just makes everything easy for everybody." -SIN004 GP.*** Informal communication between primary and secondary care was perceived to reduce delays in patient care as advice could be obtained quicker. ***"Definitely speeds up care, because obviously, with emails now, or even phone calls, you can get it straightaway and give them that changing care within a week rather than waiting eight weeks, 10 weeks for an actual appointment. The other thing is, is by that communication, sometimes the consultant can, then say, Well, actually, we'll get the community team to see them, who again, works with the consultant, and then the patient gets better care that way." -SIN008 GP.*** Forming relationships between primary and secondary care was also perceived to boost the confidence of primary care HCPs and reduce their anxiety about calling a specialist ***"No, I'll be honest, not not very comfortable at all. Because, because I felt inadequate of my skills and a few of the other nurses have said that nobody really feels that confident with COPD, but since you've been coming in, and the team, you've built up confidence around us that we can actually speak we can, it's easy to ask anything, you know, and yeah we feel much better that you've been coming in." -SIN010 Practice Nurse.***

Collaborative working that was achieved in the intervention arm of INTEGR COPD was perceived to provide patients with better care as it melded together both the specialist's knowledge the GP's knowledge of the patient as a whole. ***"The GP generally knows the patient very well, on a day to day basis, but you need to be practicing the acute side of the service, I think they complement each other very well. And I think for the benefit of patients, and often to the practitioner as well, you learn things from each other, be that clinical or about the patient, and so definitely a beneficial tool." -SIN014 Respiratory Physiotherapist.***

Final summary

The existing system in place requires formal referral between primary and secondary care which is perceived to add additional workload to HCPs and delay the patient receiving optimal management for COPD. Participants felt that integrated care was effective and cutting through the bureaucracy of formal referrals and broke the barriers to communication and collaborative working between primary care and secondary care HCPs.

Category 4: Patient and HCP interaction

Definition

Participant thoughts regarding factors that impact a patient's relationship with their HCP and the health service as a whole.

Codes: "Clinician-patient communication", "Preference of consultation modality", "HCP-patient relationship", "Continuity of care", "Clinical environment", "Appointment length".

Summary of data

Patient perspective:

Visual communication was perceived as significant factor in interactions with HCPs, during the time of this study a pandemic led to patients being required to use telephone consultations. Telephone consultations were perceived as inferior to face-to-face or video consultations. ***"just a telephone conversation. You can't see anybody you can't. You can't get a feeling for it you just don't know what it is that you can't see them, they can't see you. If you could do it on zoom or teams, Microsoft Teams it'd be fine than just talking to somebody" -IN5114 Patient.*** Patients were concerned that their clinical concerns could not be relay reliably through the medium of telephone consultation ***"Obviously, I would rather speak face to face. Because nobody, nobody can describe how you actually feel rather than yourself. If you're not talking to somebody face to face, it is difficult to try get them to understand exactly how your body's reacting." -IN5089 Patient.*** Patients perceived visual inspection to be part of a basic clinical review, and were reassured when visually reviewed by HCPs. ***"A video call I mean, I think would be better because you are there with the doctor he can see you, you can see him, and you can tell him on a videophone call it hurts me here. So at least then the doctor can see what you're pointing at really taking in so forth so he can say can you do this for me can you do that for me. And then if he thinks I definitely need to come in you know what I mean to see him .. then he can make that decision." -IN14047 Patient.***

Feeling comfortable in their clinical surroundings was deemed to be an important factor in deciding location of their healthcare. ***"I think it's very important for the patient to feel relaxed and comfortable, and know their surroundings, especially with somebody with breathing difficulties, they don't want to be going too far, and they want to be familiar with people that they know." -IN5012 Patient.*** Patients had a sense of feeling at ease and comfortable at their local GP practice rather than the hospital due to the GP practice being familiar surroundings. ***"No, I can wait around. But it's just a completely different atmosphere, isn't it if you'd have to, you're at your local GP you're comfortable because you know them there. But if you go into the hospital, you're in amongst complete strangers, because you don't know them." -IN20025 Patient.***

Clinician continuity was perceived to lead to building an effective doctor-HCP relationship ***"if you talk a bit of privacy to your GP, you seem to get on better. If you know what I mean... you seem to relax.. well, I'm always relaxed anyway it doesn't bother me to go and see a specialist or doctor (GP), but you seem to get attached to one doctor" -IN5046 Patient.*** However, feedback from patients was mixed with some stating seeing the same clinician was important ***"Oh that's a big 50/50 I think when I see the specialist once a year that's nice to see the same person. Like I've seen you twice haven't I, no I think that's better to see the same person they're beginning to know you a little bit and just as wise" -IN5066 Patient. O***thers suggested that if all their clinical information is available to the doctor, then continuity is not needed ***"No, I don't think it matters, as long they are specialists they got all the paperwork there, they've got all the information there.. And I think you can have four different specialists and have all got the same information in front of them anyways." -IN5048 Patient.***

Patients expressed the need to have sufficient time to discuss their issues and perceived the specialists as having more time to discuss their issues than a GP or nurse. ***"I prefer the specialist myself because it's, it's a one to one, it's a one to one exactly like with a nurse, but they're not rushing it. You know, I need to stand here I need to do this blow into this affecting your blood pressure. Calm down, relax, you know with a specialist its, he's not rushing to get rid of you, you know in the door and out the door because, you know, they're waiting for the next patient and the next patient. With a specialist who is there, you can explain to him what's wrong with you what you're doing what we can do" -IN14047 Patient.*** Patients perceived that a GPs time was always limited and that they needed to rush, whereas a specialist was thought to have more time ***"Yes, Yes, I think so. Or ask them questions, you ask them more questions, you feel as if that's specially for you, so you're not wasting their time. Whereas with a doctor (GP), you're have to just say, What's the problem, is there and then come away, because personally, you feel as if you should perhaps hurry up a bit." -IN5066 Patient.*** This sense of being rushed was also fed back to HCPs through surveys ***"I think often the feedback that we tend to get, especially when we do surveys is they will, you know, sometimes they feel rushed, they don't get enough time to sort of like, discuss everything they want to discuss" -SIN002 Practice Manager.***

HCP perspective:

HCPs appreciated that clinician continuity is something to aspire for, however, feel that in the current climate it would be difficult to attain. ***"100%. I think, you know, that would make life easier for everyone. But I do realise that the reality of the life we live, especially with lack of resources, and everybody been under pressure, and that probably isn't achievable at this stage. But yes, that would be that would be a great ideal to, to aim for, you know, every patient to have named clinicians that were dealing with their case, so that it was easier for us, it would be easier for us, to communicate with each other and provide a good package of care." -SIN022 GP***

HCPs felt that patients preferred the integrated care clinics taking place in primary care as they were receiving expert care in a comfortable and familiar environment. ***"It means, I mean, for example, that it's, it's more personalised for the patients, because then they're seen here, or at home, whichever one is easier, rather than going to a foreign situation, essentially, in the hospital.. And it's, you know, it's, they're less comfortable... For patient's obviously for them to access, it is easier to get to the practice." -SIN008 GP. "There's an issue about having expert care provided in a locality they may already be familiar with, so their own GP surgery. And so I think it's good in that sense," – SIN023 Respiratory Consultant.***

Deviant case:

Most patients had either no preference with location of appointments, or preferred the GP practice, however, this case preferred the hospital due to clinical setting being larger and well equipped ***"I mean the hospital would be better because more room you know what I mean.... You know you feel a lot more comfortable because the cubicles of the doctors that you know do interviews are slightly bigger than in the surgery because you're limited with space at the surgery." -IN14047 Patient.*** However, this opinion was not shared by other patients from the same GP practice.

Final Summary

The opinions of patients and HCPs were aligned regarding the perception of the GP practice being more comfortable due to familiar surroundings and people and was felt to be an important factor to consider when deciding the location of clinics. Clinician continuity was perceived to be difficulty to attain especially for specialists who work in multiple sites, however, its importance amongst patients was mixed. Patients focused on the need to appointments to be visual rather than only telephone consultations and that they felt rushed with GPs but relaxed with specialists due to the longer appointment time slot.

Category 5: Patient's relationship with COPD

Definition

How patients perceive COPD as a disease and the impact it has on them.

Codes: "Psychological COPD symptom", "Patient knowledge of disease", "Preconception of COPD", "COPD social impact", "Impact on lifestyle", "Self-independence", "Ageing", "Fear of investigations", "Fear of illness", "Physical COPD symptom", "Patient relief".

Summary of data

Patients perceived COPD as a terminal illness and attached negative connotations to being diagnosed with COPD. ***"Well, COPD that's where your tubes are shrinking and you know and I thought that was it .. the beginning of the end if you get what I mean." -IN16038 Patient***

Patients felt COPD was noticeably impacting their daily routine ***"I'm no good at pushing a vacuum around or anything like that I get so out of breath.. Coming up and down the stairs, I get very breathless, to change the duvet cover that really takes it out of me as well. Bending down, sometimes like sometimes when I put washing in the washing machine or just bending down for something, maybe to pick something up, and things like that I'd have sometimes like oh gosh thats took it out of me just doing that. Simple tasks really.." -IN20032 Patient.*** However, patients were keen to maintain their independence and adjusted to a slower pace ***"Essentially, it's slowed me down on the fact because I'll get out of breath, quite easily, and just stop and get my breath back. So it doesn't stop me doing anything, but it takes me longer." -IN5030 Patient.*** Breathlessness was the key symptom that patients attributed to COPD and impacting their life ***"Yeah makes me cough a lot. And I get very tired and breathless. It sometimes feels like I'm being crushed and my lungs have been crushed and then my breathing goes and my lungs get tired of breathing sometimes where I feel I've had enough of breathing and can be quite painful to breath at times and just even just doing general housework is tiring for me" -IN5044 Patient.***

Patients deemed having knowledge of their COPD and symptoms as an important factor to help maintain a good quality of life ***"I think the only one that needs to know a lot about managing the breathing is the actual patient themselves." -IN16038 Patient.*** Patients felt that being taught how to breath effectively and manage COPD exacerbations empowered them to take control of their disease ***"Well, it's better because you know, what you're looking for, you've had all the information so you can sort of monitor when things are going a bit askew or when you're in a flare up, and that so yes" -IN20025 Patient.***

Participation in the INTEGR COPD study was thought to have been beneficial in improving their knowledge of COPD ***"Well I really never delved into that as a situation when I was first found out to be suffering from COPD naturally I followed the GPs instruction And whoever came to check my COPD on occasion but I have to admit this since I have been involved with you for the second time now I have a lot more information" -IN14051 Patient.*** As was participation in pulmonary rehabilitation services ***"So as I say it was all information from that as I say. The doctor tells me things and what have you... I've been on rehabilitation.. I did rehabilitation as well and they spoke a lot about the COPD and how it affects you so yeah.. I feel confident with it." -IN20032 Patient.***

Final summary

Patients felt the impact of COPD on their day-to-day activities and have been adjusting their lifestyle to maintain independence. Having knowledge of the disease and was perceived to help improve and maintain their lifestyle. Patients felt involvement with the integrated care service led to being given relevant information about COPD.

Category 6: Implementing integrated care

Definition

Thoughts regarding the implementation of the integrated service as part of the INTEGR COPD study.

Codes: "Definition of integrated care", "Perceived patient acceptability of integrated care", "Acceptability of integrated care", "Barriers to integrated care", "Logistics of integrated care", "Access to integrated care", "Organisational integration", "Infrastructure integration".

Summary of data

Support for integration:

The integration of specialist into primary care to provide annual COPD reviews for patients was widely welcomed by patients due to the reassurance that their COPD care was being delivered with specialist oversight. ***"Yeah I would love to see this carry on because it gives me reassurance and the fact that I am doing things right also it also gives me reassurance I can chat to you and say look I'm doing this and I'm doing this, am I doing this right? am I doing is wrong? Can you advise me give me? and you can give me advice.....because if you normally go to a doctor, you say to him, look I've got COPD, am I doing this right am I doing this wrong? then they have to consult a specialist... or look it up to find and give me the answer ..."Okay I can't answer this question yet, but I will phone the specialist and ask him and then once he's once he's told me, I will have to probably call you"." -IN14047 Patient.***

Patients also appreciated that specialists were coming to them and reduced the need for patients to make additional journeys to the hospital ***"Well, I think it's a good idea that people able to come to the surgery to see people like us like us about what's going on with our problems anyway, than finding that we have to go all the way down to the hospital." -IN20002 Patient***

Patients voiced that they felt the service provided by INTEGR COPD should be continued as they felt some benefit from it ***"In my case, I wanted it to go on I like, I like the yearly check. I like the depth of the investigation. So to me, I like this. I like this yearly check by doctors coming from the hospital to my GP surgery. I'm more than happy with that." -IN5080 Patient.***

The integrated care clinics as part of the intervention arm of INTEGR COPD was perceived to have been a success due to positive patient and staff feedback ***"My thoughts are, I mean, I think the biggest thing is patient feedback. The patients.. we're a PPG group, and there's a couple of people in PPG group that have been in the study, or have been asked to take part in the study or have been spoken to. And they talked about that, and they felt they had close one to one care that was local, easy for them to access." -SIN003 Practice manager***

HCPs in primary care involved in the intervention arm felt that due to the perceived benefits, the intervention should be continued ***"Yes, definitely. Like I said it, it worked very well, with the COPD clinics. We're actually missing the inputs from that clinic. It was it was very helpful. Our patients liked it. Our staff liked it. The clinician that was coming here was very friendly, very knowledgeable. So yes, so that that worked very well. And I'd quite happily support having more clinics later." -SIN022 GP***

Primary care HCPs that were not involved in the intervention arm of INTEGR COPD also welcomed clinical integration between primary and secondary care due to the perceived benefits for patients. ***"I'm in favour of***

integrated care. Because I feel that in especially in general practice, we are left alone quite a bit. And when there's integrated care being the patient care improves. So yes, I'm very much in favour of it." -SIN015 GP.

However, the extent of integration was raised as a concern, GPs were in favour of clinical integration, however, organisational integration was seen as a threat to primary care autonomy. ***"my impression of vertical integration involves is basically, hospital trust taking over GP practices. And the reason why I would be concerned about that is because, because I'm thinking about small units of delivery, where there's a local person who's responsible for a local area, so or a local, you know, something that just needs to happen. For example, if I put broken chairs in the waiting room, I say, "fix those chairs", and it happens. Or if we need, you know, we need if something needs to happen, if something needs to change, we can do it quickly. Because we feel responsible for it. Whereas, I think if you've got whole hospital system, you've got a huge bureaucracy, and a number of processes of forms that you have to fill in and procedures that you have to go through before something can change. That's, that's, that's one of my concerns. So it's about loss of control really." -SIN004 GP***

Implementing the intervention was not perceived to have posed a burden at logistical level for primary care admin teams. Administrative work to allocate rooms and book patients for the integrated care clinics were thought to be minimal and part of daily routine for the admin team at GP practice. ***"So I think it was minimal. And he didn't really ask us to do very much. And organising timetables and things, we were well informed, we were well informed in time, so we could organise them. So there was not much impact at all. Nobody sort of came in saying "I need another hour a day because I've got to help this person with the COPD clinic" so minimal impact" -SIN003 Practice manager & nurse.***

Barriers to integration:

Concerns about cultural differences between primary and secondary care was perceived as a potential barrier to integration. ***"Um, I think there's a bit of a cultural issue if I'm going to be honest, I think, as GPs, some GPs, I don't want to say, you know, all GPs, but some GPs feel that specialists don't understand how generalists work" -SIN018 GP.*** The organisational structure of the NHS was thought to be difficult to change thus making integration difficult ***"I think the way the healthcare, well, the NHS has been set up, doesn't lend itself to integration with GPs as separate organisations, separate businesses essentially standing by themselves. Secondary care providers putting competition with each other under payment by results. And then working separately, and also in a competitive fashion as well. We need to work in a much more collaborative fashion across the healthcare system." -SIN023 Respiratory Consultant.***

An integrated IT infrastructure was deemed to be necessary for integrated care to be effective, **"integration means when you're there, you sort everything out. And that to me is having the same IT system. So when I've seen your consultation, you then you don't have to write your letter, your secretary of letters when you've done all this, right, and I can see what you've written, I can see your plan and you put it on. And when I see the patient "Ah, I've seen this in you and you're on.. right what's the problem?"." -SIN012 GP.** However, NHS IT infrastructure was perceived to not be flexible enough to allow full IT integration across primary and secondary care sectors ***"No I think that's the mammoth part, anything that is integrated or anything where you try and combine community and acute care or different services and different systems, everyone is using different procedures, different protocols, different systems, different computer systems and to combine the two is a mammoth task." -SIN014 Respiratory Physiotherapist.***

Deviant case:

SIN005 GP when asked about organisational integration welcomed the idea of their practice being integrated into the secondary care organisational structure.

<u>Final summary</u>

All participants were supportive of clinical integration in the format experienced as part of the intervention arm of INTEGR COPD. There was no negative feedback pertaining to the intervention. Concerns about extent of integration and the ability to meld two different healthcare cultures were seen as potential barriers to

integrated care working well. IT infrastructure was seen as a potential reason for integration to fail due to perceived difficulty to integrate IT systems across primary and secondary care.

Category 7: Outcomes of integrated care

Definition

Participants perceptions and thoughts regarding the impact of integrated care on patients and HCPs.

Codes: "Impact of integrated care", "Staff education from integrated care", "Personalised integrated care", "Future integrated care".

Summary of data

HCPs had a sense of reassurance that patients were receiving optimal COPD care under specialist oversight. ***"And if I'm not in on one day, and they come to a nurse for their COPD then the nurse goes to a doctor who doesn't have that experience. I wouldn't then know... in there and something may have gone wrong, or the inhalers might have been changed incorrectly. Whereas being that I had yourself coming in, I felt confident that what was being done was going to be correct and helpful to patients and they were being assessed properly." -SIN008 GP.*** HCPs also felt reassured that they can confirm management plans with a specialist to ensure patients received the correct management for their COPD. ***"As a matter of fact, it was reassurance that the management that is happening is correct. If there is any optimising and I, I haven't thought of it as a as a primary care doctor, that someone is able to signpost me there or advise me and so on. And so so it's very beneficial. And I think that it was extremely important because you are always risk assessing patients and so on. And so it was very important from that point of view" -SIN007 GP.*** Patients also felt reassured that as the care they were receiving was optimal as it came with specialist oversight. ***"Well, yes because you were having another... its like.... Although you are you seeing somebody at the surgery, for COPD, its like another opinion... It's like... How would I put it... like a second check in case.. because some people do miss things out. ... they do miss by accident so, you know, it's like a second opinion to me sort of thing." IN14076 Patient.***

Patients felt more informed following participation in the trial and being reviewed by a specialist, which was perceived as beneficial to help manage their COPD symptoms. ***"they put me at ease, told me what I need to do, what I've got, what was the cause of it, which I thought was really helpful because the doctors(GP) didn't mention what caused asthma and shortness of breath and so forth (…) Because when I first started, I was very shortness of breath, I found it very difficult to breath and stopped me where I was standing. Now its fine now where I said I'm slowly getting used to working... physically and its seems well." -IN14047 Patient.***

HCPs in primary care felt that the integration of specialist into GP practice provided an educational opportunity for staff. ***"*raising the competency, raising the skill base in primary care is what it's about. So, working jointly, we, we understand each other, and we have a lot more information about patients in primary care than you would have in secondary care, we don't just treat COPD, or asthma, we treat the whole family*" -SIN012 GP.*** Updating HCPs was perceived to be an important function of integrated care, as it was assumed this would eventually lead to better patient care. ***"So I think it's really good to have contact with the clinicians. I think that i think i think what was one of the things that's happening in medicine is that care is sort of.. the boundaries are constantly being pushed. So that has a knock on like a domino effect further down the system. So things are further pushed out from hospital to general practice, but we're not necessarily we haven't necessarily followed that, that journey. And it's easy for us to get left behind in certain areas. So what whilst we're generalist we can't necessarily stay completely up to date in all of the specialist areas, and I think I think it's better for patient care if there is a still a specialist area because that helps to drive research and it helps drive improvements. So I do think I think you need that balance." -SIN004 GP.*** Community nurses perceived GPs to be better at recognising and treating exacerbations following the intervention due to the educational element of integrated care ***"after the MDT side, or obviously clinics, that yourself and the consultant, were doing.. GPs seem to be better at exacerbation recognition, management was, you know,***

those exacerbations were dealt with in a more timely manner. I would say more targeted antibiotic prescribing. And in a fair few cases, the practices where, I think yourselves had been in the GPs weren't quite as what's the word in terms of dishing out? They weren't? They didn't just give steroids and antibiotics out willy nilly or just because I think they were a little bit more, let's be sure is a true exacerbation." -SIN013 Respiratory Nurse Specialist.

However, concerns about potential deskilling were raised due to specialists taking over the entire management of COPD in primary care, joints clinics were thought to be a way of avoiding this as both specialists and GPs can learn from each other and maintain their skillset. ***"I think my only my only concern is that whether we let you do too much. So I think I think, I think one of the things that attracted us to start with was great, it will help us with our patients getting good quality reviews, which will also have obviously helped us with our targets, our contract targets. But but it is not right, that we should just stand back and let you carry on and do everything." -SIN004 GP.***

GPs also felt that their workload was made lighter through integrating specialists into GP practice due to reduced paperwork for formal referrals. ***"in fact, it reduced my workload in the sense that I didn't have to wait for a, I didn't have to do a referral somewhere, and then wait for for a long time for for appropriate answers to come through" -SIN007 GP.*** And as specialist were reviewing patients with COPD, QOF targets were being attained without the GP having to be significantly involved. ***"Benefits for the practice? Yes, in terms of QOF registers, our COPD patients the spirometry, etc, we haven't had to worry so much about those things and getting the patients back in again. Whereas you would see them in sort of manage those things with them. So yeah, it has benefited us in that way." -SIN006 Practice Manager & Nurse***

<u>Final summary</u>

Patients and HCPs felt a sense of reassurance that their COPD care had specialist oversight as that was assumed to lead to better patient care. Practice felt they benefited from the integrated care intervention through educational input provided by the specialists as well as reducing the workload for GPs and nurses to focus on other areas. However, deskilling of primary care HCPs was a potential risk that was identified by HCPs.

Appendix 12: Personal reflection summary

I am a 34 year old male of Indian descent, the son of parents who came to the UK as migrants from East Africa. My mother having migrated from Kenya and my father migrating from Uganda as a refugee during the expulsion of Asians in 1972. This aspect of my background is likely to have made it easier for me to relate and speak to patients included in the INTEGR COPD study, as a large proportion of patients in the East Birmingham region are migrants of Asian descent. My childhood was spent growing up in a deprived area of Essex, and going to state schools in deprived areas, as a result I found it easier to relate with some of the struggles patients in East Birmingham experienced.

I have completed eight years of post-graduate medical training of which one was spent specialising in primary care medicine and three were spent specialising in respiratory medicine I have experience of caring for patients with COPD both in the primary care and secondary care setting. Although having cared for patients with COPD, I have no personal experience of COPD, namely neither I nor any one close to me has been diagnosed with COPD or received treatment for COPD. Therefore, my only viewpoint of COPD is as the care-provider, and this may have influenced my interpretation of responses from participants during the interviews. The patients and HCPs being interviewed were aware of my professional background of being a physician training to specialise in respiratory medicine with a specialist interest in COPD, which may have influenced their perception of me and engagement in the interviews.

My background as a physician, whereby my interactions with patients have always been to problem solve made interviewing to explore difficult. This was overcome through the use of the topic guides to keep interviews on track and discussion and critique of pilot interview transcripts with my qualitative supervisor (NG), helped identify areas to improve my interview technique to allow participants to tell their experience.