Active case finding of COPD in primary care – a quality-improvement project

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Table of Contents

Abstract 4

List of abbreviations 6

Introduction 7
- Literature research strategy 7
- Definition, pathophysiology and epidemiology of COPD 7
- Diagnosis of COPD 8
- Classification of COPD 9
- Treatment and prevention of COPD 9
- Spirometry 11
- Spirometry in the primary care setting 12
- Importance of early diagnosis 13
- Screening vs. active case finding 13

Methodology 15
- Find problem 15
- Organise meeting 15
- Clarify problem 15
- Understand/Uncover 16
- Start project 17
- Plan 17
- Do 18
- Check and Act 18

Results 18
- Questionnaires and spirometries 18
- Smoke status 21

Discussion and conclusion 22

Attachments 25
- Attachment 1 - mMRC Dyspnoea Scale 25
- Attachment 2 – CAT assessment 26
- Attachment 3 – COPD risk-test 27
- Attachment 4 – Approval from the Ethical Commission of UZ Brussel 29

Bibliography 31

Abstract

Inleiding
COPD is een chronische longaandoening die gepaard gaat met een irreversibele obstructie van de luchtwegen, grotendeels veroorzaakt door roken. De globale prevalentie wordt op 11.7% geschat, maar de echte prevalentie ligt waarschijnlijk veel hoger door onderdiagnostiek van deze ziekte. Het 'gouden standaard' onderzoek voor de diagnose van COPD is spirometrie. Volgens **de** Wereldgezondheidsorganisatie (WGO) is COPD momenteel de vierde belangrijkste doodsoorzaak ter wereld. Deze aandoening is ook een belangrijke bron van socio-economische kosten. Volgens experts zal de prevalentie nog sterker toenemen tijdens de komende jaren, wat van vroegtijdige detectie van COPD een prioriteit maakt. Hiertoe bevelen verschillende richtlijnen een 'active case finding' strategie aan. Dit project voerde een dergelijke strategie uit in onze huisartsenpraktijk. Het primair doel was om vroege gevallen van COPD op te sporen door gebruik te maken van een vragenlijst en spirometrie. Het secundair doel was om de rookstatus van patiënten in onze praktijk beter te registreren.

Methodologie
Tussen mei en december van het jaar 2018, werd een case finding project in onze huisartsenpraktijk te Brussel uitgevoerd. Gedurende deze periode werd de rookstatus van patiënten tussen 40 en 69 jaar oud nagevraagd wanneer ze op consultatie kwamen. Indien ze rokers of ex-rokers waren, werden ze uitgenodigd om de 'COPD risico-test' in te vullen. Deze vragenlijst beoordeelt de aanwezigheid van risicofactoren voor en typische symptomen van COPD. Patiënten met een score van 20 punten of meer kregen een spirometrie aangeboden.

Resultaten
Gedurende de projectduur van 8 maanden werden 98 vragenlijsten ingevuld. Op 15 vragenlijsten werd een score van 20 of meer punten behaald. In totaal werden er 12 spirometrieën uitgevoerd. Er werd geen nieuwe diagnose van COPD of een andere longaandoening gesteld. Wat het registreren van de rookstatus betreft: bij aanvang van het project was slechts 10% van de elektronische medische dossiers van patiënten tussen 40 en 69 jaar volledig ingevuld. Na 8 maanden was dit aandeel tot 70% gestegen.

Besluit
Het feit dat er geen nieuwe diagnose van COPD gesteld werd, toont aan dat het primaire doel van dit project niet werd bereikt. Er zijn verschillende factoren die dit resultaat kunnen verklaren. De relatief jonge leeftijd van ons patiënteel, het lage aantal patiëntencontacten en de lage kwaliteit van de uitgevoerde spirometrieën – weliswaar vergelijkbaar met de kwaliteit in andere studies, maar zeker niet optimaal. Het medisch team beschouwde het systematisch gebruiken van de vragenlijst als tijdrovend en dus werd besloten om de 'active case finding' strategie niet te implementeren in onze praktijk. Niettegenstaande dit feit is de rookstatusregistratie sterk verbeterd gedurende de periode waarin het project liep. Ondanks het feit dat het primair doel niet bereikt werd, is dit project er in geslaagd om het team bewust te maken van het belang van een correcte registratie van de rookstatus in het elektronisch medisch dossier. Het project heeft COPD onder de aandacht gebracht als een heel belangrijke diagnose die maar al te vaak vergeten wordt.

Introduction

COPD is a chronic respiratory disease characterised by an irreversible obstruction of the airways, caused in a large part by cumulative tobacco use. Its global prevalence is estimated at 11.7%, but it has been suggested that this number is highly underestimated due to the existence of an important underdiagnosis of this condition. The gold-standard test for the diagnosis of COPD is spirometry. According to WHO, COPD is currently the 4th leading cause of death worldwide and it is responsible for very important socioeconomic costs. Most experts agree that its prevalence will continue to increase in the future, making early detection of COPD a fundamental point. To this end, several guidelines recommend an active case finding strategy. This project was made to put in place such a strategy in our primary care practice. The main objective was to detect early cases of COPD among our patients by administering a questionnaire and performing spirometries. The secondary objective was to improve smoke status registration within our practice.

Methodology

Between the months of May and December 2018, a case finding project was done in our primary care practice in Brussels. During this time, patients between 40 and 69 who came to the consultation were questionned about their smoke status. If they were smokers or ex-smokers, they were invited to fill in the COPD risk-test. This questionnaire evaluates risk factors and the presence of typical COPD symptoms. The patients who scored 20 points or higher were then referred for a spirometry.

Results

During the 8 months in which this project took place, a total of 98 questionnaires were filled in, and 15 of them had a score of 20 or higher. In total, 12 spirometries were performed, and no new cases of COPD or other respiratory disease were detected. In terms of smoke status registration, in the beginning of this project, 10% of the patients between 40 and 69 years of age had a complete file, compared to 70% at the end of the 8 months.

Conclusion

With no new diagnoses of COPD, it is clear that the main objective of this project was not achieved. Several reasons can be found for this fact, namely the relative young age of our patients, a low number of patient contacts, and the low quality of the spirometries themselves – even though the quality is in line with what has been found in other studies, it is certainly not optimal. The medical staff also found that systematically administering the questionnaire was too time-consuming, so it was decided that the case finding strategy would not be implemented in our practice on these terms. However, smoke status registration has drastically improved in the duration of the project. Even if the main objective was not attained, this project succeeded in raising awareness amongst our team to the importance of correctly registering tobacco use in our medical files, and also to COPD as an extremely important diagnosis that is often overlooked.

List of abbreviations

- ATS – American Thoracic Society
- BD – Bronchodilation
- CA – Chronological Age
- CAT – COPD Assessment Test
- CDQ – COPD Diagnostic Test
- COPD – Chronic Obstructive Pulmonary Disease
- DALYs – Disability-Adjusted Life Years
- ERS – European Respiratory Society
- FEV1 – Forced Expiratory Volume in 1 second
- FEV6 – Forced Expiratory Volume in 6 seconds
- FVC – Forced Vital Capacity
- GMD – Global Medical File
- GOLD – Global Initiative for Chronic Obstructive Lung Disease
- ICHO – Interuniversitair Centrum voor Huisartsen Opleiding
- ICS – Inhaled Corticosteroids
- IPAG – International Primary Care Airways Group questionnaire
- KCE – Belgian Healthcare Knowledge Centre
- LA – Lung Age
- LABA – Long-Acting Beta Agonist
- LAMA – Long-Acting Muscarinic Antagonist
- LLN – Lower Limit of Normal
- mMRC – Modified Medical Research Council dyspnoea scale
- NHG – Nederlands Huisarts Genootschap
- NICE – National Institute for Health and Care Excellence
- NCGC – National Clinical Guideline Centre
- PEF – Peak Expiratory Flow
- QC – Quality Control
- RHSQ – Respiratory Health Screening Questionnaire
- SABA – Short-Acting Beta Agonist
- SAMA – Short-Acting Muscarinic Antagonist
- USPSTF – United States Preventive Services Task Force

Introduction

Literature research strategy

A sequential strategy has been used when researching the relevant literature for this paper. This implies beginning with finding current guidelines available that pertain to the subject. In this case, the guidelines of NHG[1], WHO[2,3], GOLD[4], NCGC/NICE[5], USPSTF[6,7], KCE[8], and ATS/ERS[9] were consulted.

Subsequently, the PubMed search engine was used in November 11th, 2018 to research individual papers, systematic reviews, and meta-analyses relevant to the theme. The keywords used to research were "COPD" and "spirometry", present in the title or abstract of the article, and "case finding", "primary care" or "general practice" in the body of the article, and the search was limited to articles that had been published in English in the last 10 years. After selecting the relevant articles based on the content of the abstract, a total of 38 articles were kept for analysis.

Afterwards, the ICHO database of master's theses was searched to find similar projects that had previously been done by other generalists in training. A total of 11 projects were found around the subjects of COPD and spirometry use.

Relevant articles that had been cited in all of these information sources were also used to complement the literature research.

Definition, pathophysiology and epidemiology of COPD

COPD is a common disease characterised by persistent and not fully reversible respiratory problems and airflow limitation due to structural abnormalities in the airways and/or the alveoli. These problems are usually caused by a long-term exposure to noxious particles and gases[4]. In more technical terms, this airflow limitation can be defined as an obstruction seen in a spirometry, which shows a post-bronchodilation FEV1/FVC ratio of < 0,7 or <5% of the LLN, depending on the sources[5]. By far the most common risk factor for the development of COPD is active smoking. Other risk factors include environmental and professional exposure to small particles and aerosols, low birth weight and prematurity, exposure to tobacco in utero and during childhood, and alpha-1-antitrypsin deficiency[1]. The most common symptoms of COPD are dyspnoea, cough, and sputum production, although these symptoms tend to be underreported by patients as "natural" consequences of smoking and aging[4,10]. Smokers have a risk of circa 25% of developing COPD in their lifetime[11], but this risk drops by around half after smoke cessation occurs[10].

Lung function as measured by the FEV1 decreases physiologically in every individual after the age of 30, but smokers lose lung function at almost double the rate of their non-smoking counterparts. This loss tends to normalise and become equal to non-smokers once smoke cessation takes place[1]. Besides exposure to risk factors, poverty and socioeconomic status also seem to influence both the prevalence and the severity of COPD around the world, due to the influence of these factors in the environmental conditions and in the ease of access to appropriate care and treatment[2]. Globally, the prevalence of COPD was estimated to be around 11,7% in 2010[4], and tends to increase with age[3]. However, it is hard to say whether the prevalence numbers are accurate due to the fact that COPD diagnosis requires an objective measurement of airway obstruction

via a spirometry, which is still not routinely done worldwide. As such, most sources agree that there is likely an under-diagnosis of this condition, with as many as 75% of COPD patients in Europe being under-diagnosed[12]. It is also suggested that the global prevalence of COPD will increase in the coming years[2], also due to the increasing exposure to tobacco smoke (mostly in developing countries), and the ageing of the general population in developed countries[4].

In 2018, COPD was the 4th global leading cause of death, and it is estimated that it will reach 3rd place as soon as 2020[4]. As many as 85% of COPD-related deaths can be attributed to the exposure to tobacco smoke, and COPD patients lose, on average, between 1.1 and 4.1 years of life when compared to a COPD-free population[5]. It is also the 5th most common cause of lost DALYs[4] and the 7th biggest cause of worldwide burden of disease[3], with direct (medication, admission to hospitals, …) and indirect (absenteeism, work incapacity, …) healthcare costs reaching as much as 52.4 billion US dollars per year in the United States and 6% of the total healthcare budget in the European Union[4].

Diagnosis of COPD

Physicians should clinically suspect COPD in smokers or ex-smokers over the age of 35-40 years, who present a history of one or more progressive respiratory symptoms[1]. However, a definitive diagnosis should only be given after a spirometry has been done which confirms the existence of an irreversible airway obstruction[8]. Symptoms are important for clinical suspicion but are not reliable as a diagnostic tool: as mentioned before, patients tend to underreport their respiratory symptoms, and there is a weak correlation between the perceived severity of the symptoms and the objective severity of the diagnosed illness[10]. However, most sources agree that the presence of respiratory symptoms should be one of the defining factors of COPD, since patients with mild but asymptomatic airway obstruction seem to have a lung function decline comparable to that of a healthy population[10,13]. Differential diagnoses for COPD include asthma and heart failure, hence the importance of an accurate diagnosis using a spirometry.

As previously mentioned, the gold-standard test for the diagnosis of COPD is spirometry. This test will measure, among other parameters, the FVC (the volume of forcefully exhaled air after a maximal inhalation) and the FEV1 (the volume of air exhaled in the 1st second of this manoeuvre). These values are then compared to reference values, which have been adapted to several factors such as age, weight, height, sex, and race[4]. According to the GOLD guidelines, irreversible airway obstruction is defined as a post-brochodilation FEV1/FVC ratio of ≤ 0.7. This fixed cut-off is the "classic" definition of COPD; however, in 2004, the ATS and the ERS have started encouraging the use of LLN <5% as a diagnostic criterion, rather than the fixed cut-off[13] (which is to say, people with spirometric results lower than the 5th percentile of the LLN would be diagnosed with COPD). This suggestion was due to the fact that using a fixed cut-off leads to a higher prevalence of false-positives in an older population, and of false-negatives in a younger population, both of which could be fixed using the more flexible LLN <5% approach. However, GOLD keeps recommending the use of the fixed cut-off value. They argue that this method makes it simpler for healthcare providers to interpret spirometries and diagnose COPD, and that the risk of over- and under-diagnosis in different age groups is limited due to the fact that physicians also need to take into account the presence of symptoms and exposure to risk factors when making a diagnosis. Furthermore, they claim that the values for LLN<5% can be highly variable

depending on the reference equations used, and that there are not enough studies done to validate the use of LLN <5% as an alternative to the fixed cut-off[4]. Another Dutch review[13] determined that there was a greater risk of underestimation of COPD and of missed diagnosis in mild cases using LLN <5%.

Classification of COPD

There are two main ways of characterising COPD severity – an objective scale based on spirometric values, and a more subjective scale based on the amount of exacerbations, admissions to hospitals and questionnaires about symptoms/quality of life (the mMRC or the CAT – see attachments 1 and 2). These two scores put together give physicians a holistic idea about the severity of airway obstruction, the risk of exacerbation, and of the burden of disease as perceived by COPD patients. The scales are described in Tables 1 and 2.

Table 1 – GOLD staging for COPD severity (adapted from GOLD, 2019[4])

FEV1/FVC ratio	Always ≤ 0.7 to define obstruction.
Mild obstruction – GOLD I	FEV1 ≥ 80%
Moderate obstruction – GOLD II	FEV1 50-79%
Severe obstruction – GOLD III	FEV 30-49%
Very severe obstruction – GOLD IV	FEV <30%

Table 2 – ABCD assessment tool (adapted from GOLD, 2019[4])

A	0-1 exacerbations **and** 0 admissions to hospital
	mMRC <2 / CAT <10
B	0-1 exacerbations **and** 0 admissions to hospital
	mMRC ≥ 2 / CAT ≥ 10
C	≥ 2 exacerbations **or** ≥ 1 admissions to hospital
	mMRC <2 / CAT <10
D	≥ 2 exacerbations **or** ≥ 1 admissions to hospital
	mMRC ≥ 2 / CAT ≥ 10

Treatment and prevention of COPD

Management of COPD usually requires medication, unless it is in an early stage and patients do not experience too many symptoms. The therapy is basically comprised of inhaled medication, which is adapted in function of the progression of disease and of the severity of symptoms and amount of exacerbations experienced by patients. The cornerstone of COPD treatment is based on bronchodilation[4]. To determine which initial bronchodilating treatment to follow, the ABCD assessment tool is also used. This is summarised in Table 3.

Table 3 – Initial treatment options for COPD according to ABCD assessment tool (adapted from GOLD, 2019[4])

A	SABA or SAMA
B	LABA or LAMA
C	LAMA
D	LAMA ± LABA (if highly symptomatic) **or**
	ICS + LABA (if blood eosinophile count ≥300)

If the response to the initial treatment is sufficient, then it should be continued without change. If dyspnea and/or exacerbations are present, inhalation technique and the existence of possible obstacles to the effective management of the disease should be evaluated before moving on to a follow-up treatment[4], presented in Images 1 and 2.

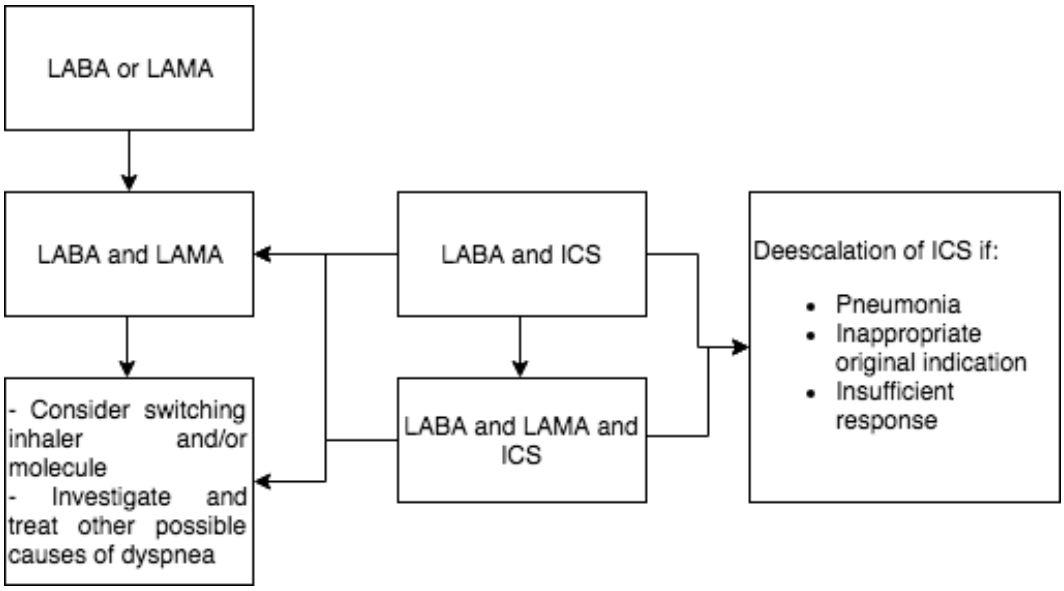


Image 1 – Follow-up treatment of COPD in case of persistent dyspnea (adapted from GOLD, 2019[4])I

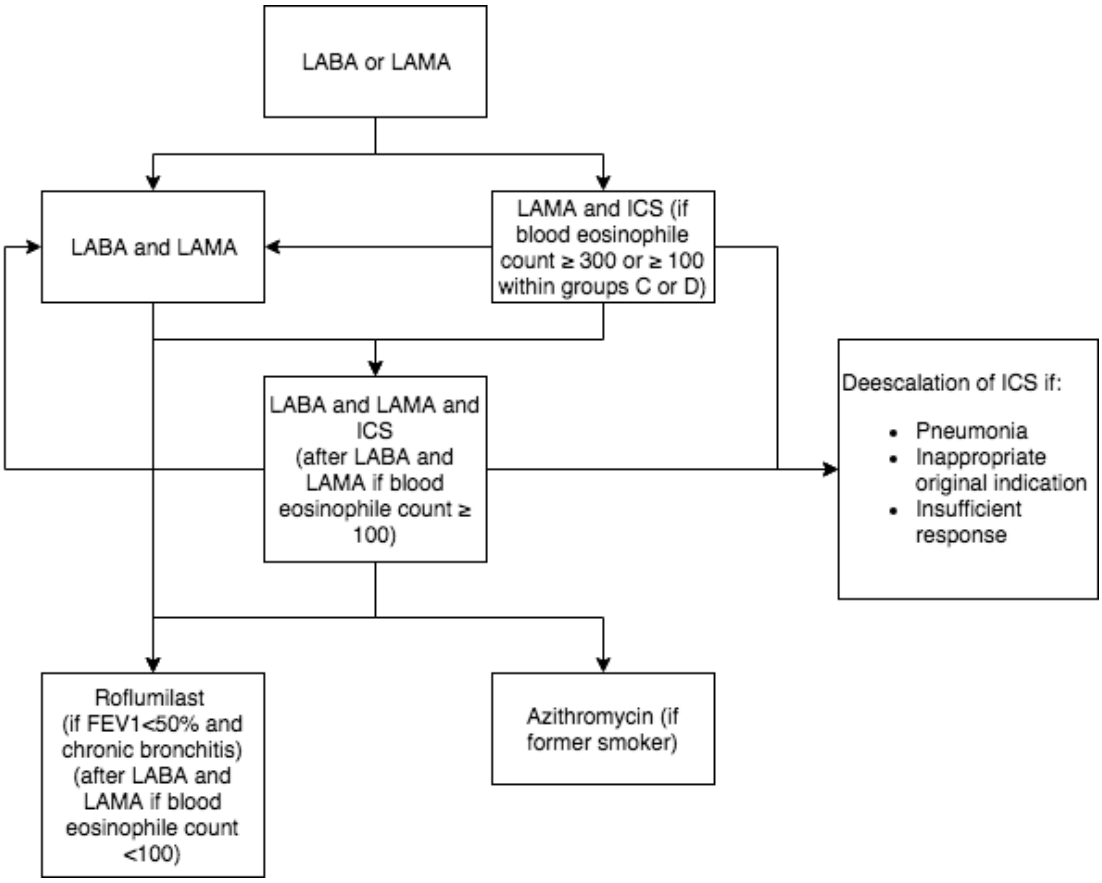


Image 2 – Follow-up treatment of COPD in case of exacerbations (adapted from GOLD, 2019[4])

Prevention of COPD and of its advancement is basically comprised of preventing exposure to its greatest risk factor – tobacco smoke. This can be done as a primary (i.e. preventing the population from starting to smoke in the first place) or as a secondary prevention strategy (i.e. promoting smoke cessation)[2]. This also seems to be the only intervention that affects positively the progression of COPD, since it will slow down the loss of FEV1[11]. Pharmacological interventions with bronchodilating medication affect the symptomatological component of the illness and the frequency of exacerbations, but do not significantly alter the rate of lung function decline[14]. Spirometry results by themselves do not seem to affect smoke cessation rates, but one study suggests that telling a patient his or her "lung age" as determined by spirometric values[15] does help them to stop smoking and positively affects the rates of relapse[10].

Spirometry

A diagnostic spirometry needs to comply with several quality criteria in every step, from the preparation of the test to its interpretation. These criteria are summarised in Table 4.

Table 4 – Quality assurance when performing spirometry (adapted from GOLD, 2019[4] and Miller, 2005[9])

Preparation	Proper calibration of spirometer.
	Spirometers should display curve for detection of errors and unsatisfactory tests or should automatically detect them.
	Proper training of the supervisor of the test.
	Maximal patient effort.
Bronchodilation	400 mcg of SABA, 160 mcg of SAMA, or a combination.
	Post-BD measurement 10-15 mins after SABA administration, or 30-45 mins after SAMA/combination administration.
Performance	Performance of manoeuvre using techniques that meet published standards.
	The curves and the test as a total should meet specific acceptability criteria (see Table 2).
	The FEV1/FVC ratio should be calculated using the values from the acceptable curves with the largest FVC and FEV1, even if the values do not come from the same curve.
Evaluation	The evaluation of results is done by comparing them with the appropriate reference values.
	Confirmation of airflow obstruction if post-BD FEV1/FVC ≤ 0.7.

For a high-quality spirometry, individual curves, as well as the test as a whole, need to meet the ATS/ERS acceptability criteria, which are described in Table 5.

Table 5 – Acceptability criteria (adapted from Miller, 2005[9])

Within-manoeuvre criteria	Absence of significant artefacts in flow-volume curve (cough in 1st second, Valsalva manoeuvre, early termination, non-maximal effort, leak, obstructed mouthpiece)
	Rapid start of exhalation (extrapolated volume <150 mL or 5% of FVC, whichever is greatest) – start-of-test
	Prolonged exhalation (longer than 6 seconds or with an end-expiratory flow near to 0) – end-of-test
Between-manoeuvre criteria	At least 3 acceptable individual curves must be recorded.
	The difference between the 2 largest values for both FEV1 and FVC in the recorded acceptable curves must be less than 150 mL – repeatability
	If these criteria are not met, testing should continue until: - Criteria are met, - A maximum of 8 tests have been done, or - The patient cannot continue the test

Although the ATS/ERS criteria are considered to be crucial to the correct interpretation of spirometries, some critics consider that they are too strict to be used in a primary care setting, with individual criteria, particularly the end-of-test criterion, being difficult to achieve for elderly patients or those with significant lung function alterations[12]. However, no studies have yet been done about the validation of less strict quality criteria. The ATS/ERS guideline itself does suggest that technicians can eventually use "usable" curves for the extraction of some important clinical information. Usable curves, in contrast with acceptable ones, only need to present an acceptable start-of-test with a low extrapolated volume and an absence of cough in the 1st second of exhalation[9].

Another way of grading spirometry quality is through a letter-grade scale that is usually automatically calculated by the spirometry software as a way of giving the technician a quick view on the general quality of the test. This scale is represented in Table 6.

Table 6 – Quality control grades (adapted from Ferguson, 2000[16])

A	At least 2 acceptable curves
	Repeatability ≤100 mL
B	At least 2 acceptable curves
	Repeatability ≤150 mL
C	At least 2 acceptable curves
	Repeatability ≤200 mL
D	At least 1 acceptable curve
	No repeatability
F	No acceptable curves

Spirometry in the primary care setting

Several studies have been done in regards to the use of spirometry by primary care providers, and most seem to agree that, globally, the use of the test for the diagnosis of COPD is limited, with only around one third of new COPD diagnoses being confirmed with a spirometry. Furthermore, COPD diagnoses done without the use of spirometry

only seem to be correct in about 50% of the times. Interestingly enough, one American study also discovered that history of tobacco use did not seem to influence providers to use spirometry, but rather only the presence of suggestive symptoms[17]. Primary healthcare providers seemed to worry about incorrectly interpreting spirometry results and about not having enough experience or the appropriate technique to correctly carry them out[18].

In fact, Eaton et al.[19] discovered that only 3.4% of spirometries performed by untrained primary care providers were in line with all the acceptability criteria as described by ATS/ERS, and that 12.5% had at least 2 curves that complied with those criteria. These numbers increased to respectively 13.5% and 33.1% when trained primary care personnel was observed. More recent studies show that adequately trained GPs are capable of interpreting spirometries at an equivalent level to pneumologists[18], reaching as much as around 90% of reliability and acceptability in their tests[6].

Appropriate training seems to decrease the underuse of spirometry in patients with obstructive disease, leading to more and better COPD diagnoses[12]. It also seems to be more important than experience in performing the test, since there seems to be a decrease in spirometry quality with time passed since the last training. This confirms the need for refreshing courses to maintain a high quality of testing[20].

Importance of early diagnosis

A Canadian study[21] has showed that undiagnosed COPD patients had, in general, a lower burden of disease (i.e. lesser airflow obstruction and respiratory symptoms) than their diagnosed counterparts. This is one explanation as to why the diagnosis of COPD is often deferred until more severe stages. Furthermore, several studies done worldwide have concluded that most undiagnosed COPD patients have mild to moderate disease, as defined by the GOLD criteria[6]. However, it is recognised that early diagnosis is of the utmost importance in COPD, since that the moment of biggest lung function decline seems to happen relatively early in the development of the disease, at around stage II, which justifies more aggressive strategies in treating COPD and encouraging smoke cessation. The earlier the diagnosis is done, the earlier COPD exacerbations will be recognised as such (instead of being misdiagnosed as airway infections) and appropriately treated, which in turn leads to a decrease in loss of pulmonary function[11] and of general morbidity[14]. It is also been found that as many as 85% of COPD patients presented missed opportunities for diagnosis of the disease in the 5 years preceding the actual diagnosis[22]. Since primary care providers are, in general, the ones with closest and most regular contact with patients, it makes sense that the responsibility of early COPD diagnosis might fall on them. In order to achieve this objective, two different strategies have been discussed – screening and case finding within the general population.

Screening vs. active case finding

When a screening strategy is applied, providers within the healthcare system will examine an entire population or a subgroup within it to detect a specific problem before its symptoms appear. Examples of such strategies include screening for cervical cancer in women or colon cancer in all people after a certain age. Active case finding is the use of certain instruments (like diagnostic tests or questionnaires) to detect an illness in a group of high-risk patients who present themselves in consultation for any reason[23].

Multiple studies have been done with the purpose of determining which is the most (cost-) effective strategy for detecting COPD and diminishing the significant problem of its underdiagnosis.

The majority current clinical practice guidelines, including the ones from NICE/NCGC[5], GOLD[4], NHG[1], KCE[8], USPSTF[7], and a joint advice from the ACP, ACCP, ATS and ERS[24] prefer an active case finding approach for the detection of COPD to the alternative of screening of an asymptomatic population. They tend to favour case finding because studies do not seem to show enough advantages, namely in smoke cessation[8] and NNT[11], in relation to the financial and workload surcharge that a screening strategy involves. There is also a risk of overdiagnosis, which in turn leads to unnecessary psychological stress for patients, side effects from treatments, and increased healthcare costs. Another concern is that, by screening a population that does not present symptoms, a negative screen result can be perceived as reassuring by patients and incentive them not to change unhealthy lifestyles[11]. As such, it is generally advised to proceed with active case finding in patients over a certain age (usually 35 or 40 years old), who present with significant exposure to risk factors and respiratory symptoms compatible with COPD.

However, some studies[25–27] seem to indicate that a screening model might be more effective than an active case finding one, due to higher detection rates found in the former. However, they do recognise that the availability of economic resources might be a hindrance to the implementation of COPD in every smoker, independently of the presence or absence of symptoms. Considering the observed absence of net benefits to screening, the cost measured in effort and time put in by healthcare providers might be considered too high[7].

Although there does not seem to be sufficient evidence to encourage diagnosis of asymptomatic COPD, it is known that patients with undiagnosed but symptomatic COPD experience a decrease in their quality of life. While active case finding and subsequent early diagnosis might not lead directly to smoke cessation[6], it at least allows for appropriate treatment to take place in order to improve patients' quality of life and prevent exacerbations[28].

Several qualitative studies have been done to assess the thoughts on the utility and barriers to the implementation of active case finding strategies, both in healthcare providers[29–31] and in patients[32]. They all found that the majority of the inquired parties understood the potential benefits and the importance of such strategies. Patient-related barriers included lack of awareness about COPD[30] and denial or failure to recognise symptoms, as well as practical difficulties such as an inability to attend appointments due to work or care for other people[32]. Healthcare providers were mostly concerned about having insufficient knowledge and expertise to correctly diagnose COPD, and about an increase in workload and financial costs[29,30]. However, a Dutch study found that all of the participating healthcare providers considered the active case finding model to be acceptable if there were to be an appropriate financial compensation[31].

In terms of specific strategies applied to implement active case findings, studies have evaluated and compared the effectiveness of several techniques, such as direct invitation to diagnostic spirometries in the presence of risk factors and respiratory symptoms[33–35], the use of alternative ways to detect airway obstruction (e.g. PEF measurement[36–40], FEV1/FEV6 measurement[41], or microspirometry[39]), or the use of a myriad of pre-

spirometry questionnaires with the goal of detecting high-risk patients[40,42–49]. Regardless of the chosen approach, all active case finding strategies seem to detect a higher prevalence of COPD when compared with routine practice[33].

Methodology

This quality improvement project took place in a multidisciplinary clinic in Brussels, with around 4600 medical files, of which about 1700 are subscribed to our GPs and have a GMD. All members of the medical team (three GPs, two GPs-in-training, and one nurse) participated in the project, which was created using the FOCUS/PDCA method[50]. According to this method, clearly defined steps are followed through two different cycles to respectively define (FOCUS) and try to solve (PDCA) an identified problem.

FOCUS stands for:

- F – Find problem
- O – Organise meeting
- C – Clarify problem
- U – Understand/Uncover
- S – Start PDCA cycle

PDCA stands for:

- P – Plan
- D – Do
- C – Check
- A – Act

Find problem

In a discussion with my tutor shortly after the start of my specialisation in this clinic, interest was shown in starting a project that encouraged the use of the spirometer, which had been bought several years before but rarely used up to that point. It was also noted that the medical files were, in their majority, incomplete when it came to patients' smoke status.

Organise meeting

Having found a problem in the day-to-day working of our clinic, a meeting was held with all of the members of the medical team in which the current status quo regarding smoke status registration and spirometer use was presented. The entirety of the team agreed that this was an important subject worth improving on, and we proceeded to decide exactly what our focus would be.

Clarify problem

After some discussion, it was decided that a good way to maximise the use of a spirometer would be to use it for the diagnosis of COPD. Searching for this pathology in particular would also work as a reminder for doctors to actively ask patients about their

smoke status and, subsequently, to complete their medical files. There was also some thought given to focusing on smoke cessation strategies; however, it was decided that this would broaden too much the scope of the project, and would work best as a separate project to be done at a later time.

Understand/Uncover

In this step, the goal is to analyse the situation and discover and interpret the reasons why the problem exists in the first place. The results of the brainstorming are summarised in Image 3, a fishbone diagram representing the different barriers experienced by our team to the realisation of spirometries. Further clarification about these barriers is provided hereunder.

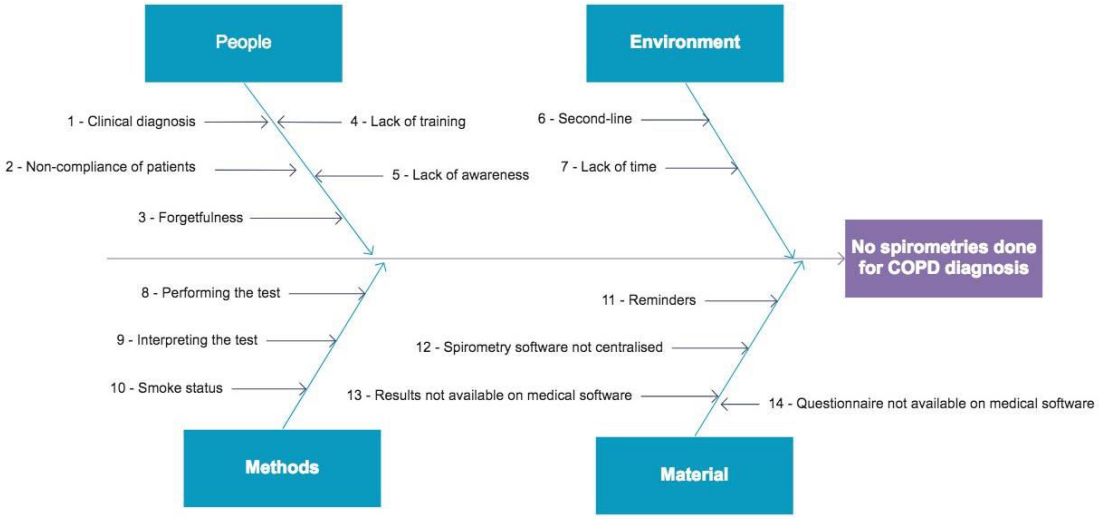


Image 3 – Fishbone analysis of the problem

1. Doctors admit to relying mostly on the presence of clinical symptoms for making a COPD diagnosis.
2. Smoking patients might not be compliant enough to return for an extra consultation.
3. Doctors often forget that a spirometer is available for use, or they forget to ask a patient's smoke status due to focusing on other problems during a consultation.
4. Most doctors have not been trained to perform and interpret a spirometry, and there is also a lack of interest to follow such trainings.
5. Most patients are not aware of COPD or of its symptoms, and as such do not mention them to the doctor.
6. Our clinic is located very close to several hospitals, and doctors find it easier to send patients directly to the specialist for full pulmonary function testing. Our known COPD patients are also normally followed by specialists, which means that the doctors in our clinic are not routinely faced with the management of COPD.
7. Consultations are 20 minutes long, and there are already several prevention schemes in place to be discussed with patients in that time, so doctors feel that there is a lack of time to discuss smoking and COPD with patients.
8. Who will perform the spirometry?

9. Who will interpret the spirometry?
10. How should the doctors fill in the smoke status in the medical file?
11. Is it possible to use the medical software as a reminder to check patients' smoke status?
12. Spirometries are performed in different offices according to the availability of the spaces, so the complete results of all tests are not easily accessible to everyone.
13. It is difficult, if not impossible, to code in spirometry results directly into the medical software.
14. It is impossible to input the questionnaire directly into the medical software.

Start project

This is done by entering the PDCA cycle.

Plan

The team decides that the project should take the form of active case-finding for COPD, using first a questionnaire to determine the level of risk and only afterwards performing a spirometry, if necessary. The questionnaire chosen is the "COPD risk-test"[1] (see attachment 3), which is the Dutch version of the CDQ/IPAG/RHSQ. The questionnaire is to be administered to every patient who is 40 years or older with a history of smoking.

As a way to remind doctors to determine the smoke status and, if needed, administer the questionnaire, a pop-up system is put in place for all patients who are 40 years or older, encouraging the doctors to actively ask and correctly fill in the medical file. This is done by using the dedicated field in the "Observations" tab of the medical software.

The GP-in-training regularly checks if there are enough copies of the questionnaire in every office. If patients score 20 points or more in the questionnaire, they are referred for a diagnostic spirometry. Patients with an already known diagnosis of COPD are excluded from participating in the project.

The only doctor with a spirometry diploma works part-time and, as such, is not always present, and, as previously mentioned, the other doctors do not feel comfortable performing and interpreting spirometries. Moreover, they feel they do not have enough time in their schedules to add a spirometry consultation. As such, it is decided that the nurse will perform the tests, with the GP-in-training present whenever possible for quality assurance and early interpretation of the results. The nurse has followed a short course of one day in a lung function lab in a hospital, whereas the GP-in-training was following a 10-hour course to obtain the spirometry diploma. The results are discussed with the doctor who has received a complete training to ensure a correct interpretation. The results of the spirometry, together with its interpretation, are scanned and uploaded into the medical software. If a diagnosis of COPD or any other pathology is made, a follow-up consultation is to be planned with one of the doctors to determine what steps need to be taken next.

Do

After approval from the Ethical Commission of the UZ Brussel (see attachment 4) was received in April 2018, the project was put into practice and data was collected between May and December 2018.

Check and Act

These steps of the PDCA cycle are described under the Results and Discussion sections.

Results

Questionnaires and spirometries

In the period between May and December 2018, a total of 518 contacts with patients between the ages of 40 and 69 years old were registered in our clinic, leading to a total of 98 questionnaires being filled in. Out of these, 15 patients scored 20 or more points on the questionnaire, and 12 of them agreed to perform a spirometry – 9 male patients and 3 female patients. The median[*] age of these 12 patients was 57.5 years old, and the median amount of pack-years smoked by them was 27.5.

The division of questionnaire results by age groups, patient characteristics and point total is summarised in Table 7. The compliance with the ATS/ERS quality criteria of the individual spirometries are presented in Table 8, whereas the total score and number of acceptable and usable curves are presented in Table 9. The difference between the patients' calculated lung age (as determined by the comparison between the actual and the predicted FEV1 values in their spirometry[15]) and their actual chronological age is also presented in Table 9.

[*] Due to the limited amount of data in this study, the median value was used instead of the mean to allow for a less biased interpretation.

Table 7 – COPD risk-test questionnaire results in patients aged 40-69 between May and December 2018

Age groups		40-49	50-59	60-69	TOTAL
# of questionnaires		50	37	11	98
Pack-years	**0-14**	26	14	2	42
	15-24	15	8	1	24
	25-49	7	14	6	27
	50+	2	1	2	5
BMI	**>29.7**	15	10	2	27
	25.4-29.7	10	9	5	24
	<25.4	25	18	4	47
Symptoms	**Cough affected by climate**	12	9	6	27
	Expectoration	17	10	3	30
	Absence of expectoration in the morning	40	28	8	76
	Wheezing	23	15	4	42
	Absence of allergies	31	26	7	64
Point total	**3**	2	0	0	2
	4	1	0	0	1
	5	0	0	0	0
	6	0	0	0	0
	7	6	0	0	6
	8	5	2	0	7
	9	1	0	0	1
	10	1	2	0	3
	11	6	2	0	8
	12	6	2	1	9
	13	2	1	0	3
	14	5	4	0	9
	15	7	4	0	11
	16	2	2	0	4
	17	1	4	0	5
	18	2	4	2	8
	19	1	2	2	5
	20+ (i.e. diagnostic spirometry indicated)	2	7	6	15

Table 8 – Compliance of performed spirometries (n=12) with ATS/ERS criteria

#	Total # of curves	Free from artefacts?	Start of test	End of test	Repeatability	Min. 3 acceptable curves?
1	5	2 curves	2 curves	3 curves	Yes	No
2	3	3 curves	3 curves	2 curves	Yes	No
3	5	3 curves	3 curves	1 curve	Yes	No
4	4	4 curves	4 curves	4 curves	Yes	Yes
5	3	1 curve	3 curves	1 curve	Yes	No
6	3	3 curves	2 curves	3 curves	Yes	No
7	4	3 curves	3 curves	3 curves	Yes	Yes
8	3	2 curves	2 curves	1 curve	Yes	No
9	3	3 curves	3 curves	3 curves	No	Yes
10	8	3 curves	3 curves	1 curve	Yes	No
11	3	3 curves	3 curves	2 curves	Yes	No
12	8	2 curves	4 curves	2 curves	No	No

Key – ATS/ERS criteria:

1. Free from artefacts – no cough in 1st second, no glottis closure, no early termination, maximal effort, no leak, no obstruction of mouthpiece
2. Start of test – back extrapolated volume <150 mL or 5% of FVC, whichever is greatest
3. End of test – Exhalation ≥6s, or until a plateau (i.e. no change in volume (<0.025 L) for ≥1 s in time-volume curve) is seen[†]
4. Repeatability:
    a. Difference between 2 greatest FVC values ≤ 150 mL **and**
    b. Difference between 2 greatest FEV1 values ≤ 150 mL
5. Minimum 3 curves that comply with criteria 1-3

[†] Because the software does not present an indication of whether or not a plateau has been reached regardless of time of exhalation, and because it is impossible to visually determine with full certainty and accuracy if there is a plateau, only the criterion of an exhalation of ≥6s was used in this study.

Table 9 – Spirometry score, number of acceptable and usable curves, and lung age (LA) compared to chronological age (CA)

#	ATS/ERS score	# acceptable curves	# usable curves	LA vs. CA
1	2/5	2	2	+28
2	3/5	2	3	+5
3	3/5	1	3	-10
4	5/5	4	4	+17
5	2/5	1	3	-12
6	3/5	2	2	-24
7	5/5	3	3	+19
8	1/5	0	2	-1
9	4/5	3	3	+2
10	3/5	1	3	-31
11	3/5	2	3	+16
12	1/5	1	4	+29

Key :

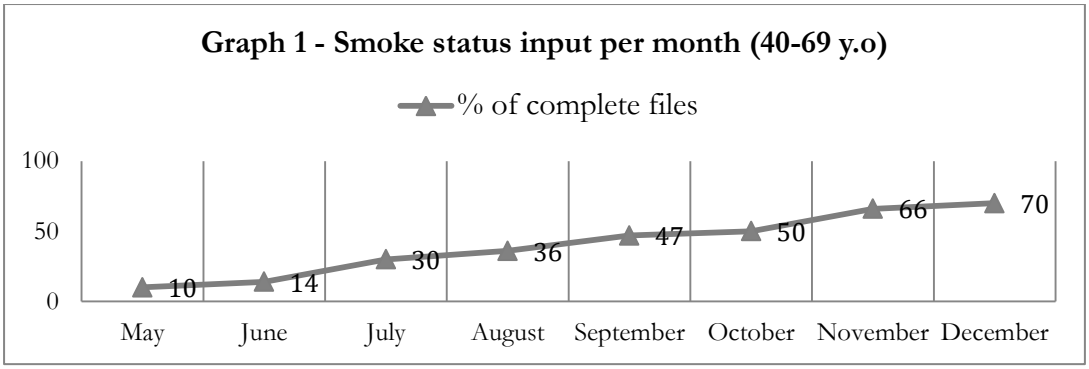
- **Acceptable and usable curves :**
  - Acceptable curve – a curve that complies with all ATS/ERS criteria
  - Usable curve – a curve that presents an absence of cough in the 1st second **and** that complies with the start of test criterium
- **Lung age versus chronological age :**
  - Comparisons are presented in years (e.g. if a patient's lung age is 5 years higher than their chronological age, the result is presented as « +5 »)

According to the ATS/ERS criteria, a spirometry can be interpreted if there are at least 2 acceptable curves in the test. This means that, technically, only 7 out of the 12 spirometries performed would allow for interpretation. However, we chose to interpret also based on usable curves whenever there weren't enough acceptable ones, since that every test yielded at least 2 usable curves and, as previously mentioned, these curves can also provide us with useful clinical information.

Out of the 12 completed spirometries, 10 of them presented normal results, 1 had a possible restrictive pattern, and 1 could be interpreted as a possible intra-thoracic obstruction. However, after further diagnostic tests were carried out on these 2 patients, no pathological situations were uncovered. Even though their spirometries were normal, in 7 patients the lung age was higher than their chronological age.

Smoke status

During the period of the study, a total of 265 files of patients aged between 40 and 69 years were completed in regard to smoke status. The monthly evolution of the percentage of patients between 40 and 69 years of age who have consulted and who had a correct registration of their smoke status in their file is presented in graph 1.



Discussion and conclusion

Before this project took place, we had a total of 14 patients registered with a diagnosis of COPD. Representing a prevalence of circa 0.3% in a universe of about 4600 patients, and considering that the prevalence of COPD in Belgium is estimated to be between 5 and 8%[51], we had expected the project to be an opportunity to detect previously missed cases of this condition. However, this was not the case, since we were not able to make any new COPD diagnoses in the course of the 8 months in which the study took place. These results are not in line with the ones that were previously established in literature and in similar projects done by other master's students, which are summarised below in Table 10.

Table 10 – Results of case-finding in other studies

Authors (year)	**# of spirometries**	**% of new COPD diagnoses**
Tinkelman et al. (2007)[52]	818	18.9%
Vandevoorde et al. (2007)[53]	146	29.5%
Laniado-Laborín et al. (2011)[46]	2293	20.6%
Mintz et al. (2011)[47]	849	20.6%
Ulrik et al. (2011)[34]	3095	34.8%
Dirven et al. (2013)[31]	39	23%
Haroon et al. (2013)[42]	98	16.3%
Sansores et al. (2013)[25]	1999	10.1%
Fu et al. (2016)[48]	731	14.6%
Jordan et al. (2016)[43]	32789	3.9%
Lee et al. (2016)[49]	11	36.4%
Hemmingsen et al. (2017)[35]	1499	30.4%
Ronaldson et al. (2018)[39]	216	20.8%
Soriano et al. (2018)[40]	802	16.2%
Stafyla et al. (2018)[54]	186	7.5%
ICHO Master's Theses		
Aerts (2011)[55]	40	22.5%
Nijs (2013)[56]	46	32.6%
Van Hooland (2015)[57]	12	33%
De Graaf (2016)[58]	52	19.2%
Tepaeva (2016)[59]	45	20%
Peleman (2017)[60]	34	28%
Vanslembrouck (2017)[51]	31	22.6%
Deturck (2018)[61]	50	28%
Hordies (2018)[62]	49	16.3%

Some explanations can be given as to why our results are dissonant from the ones found by other studies. First of all, the population in our clinic is younger than average, with around 70% of our patients being younger than 40 years old and only 28% being aged between 40 and 69. Seeing that both the prevalence and the severity of COPD increase vastly with age, this fact can explain why so few patients in our practice scored more than 20 points in the questionnaire, leading to a very small number of spirometries performed when compared to similar projects and, consequently, to the absence of new diagnoses.

Even though there is a total of 5 doctors working in our practice, only the 2 GPs-in-training work full-time, one of whom only joined the team in the final 3 months of the project. This means that the number of patients seen per week in the practice is fairly low compared with what might be expected from such a large team – in the 8 months of the study, there was an average of 125 patient contacts each week, with only about 12% of them being with patients who fell within the study's age range. It is also worth noting that some patients had more than one contact in the duration of the project. Adding this to the fact that the administration of the questionnaire was sometimes forgotten by the doctors or not done due to a lack of time, this might be a possible explanation as to why only a relatively small number of questionnaires were filled in in the time period in which this project was carried out.

The quality of the spirometries themselves also likely play a role in the fact that no new cases of COPD were detected – 58.3% of them comply with the minimum criteria for interpretation, presenting at least 2 acceptable curves, and only 16.7% are fully compliant with the ATS/ERS criteria. However, these results are in line with other studies: Eaton et al.[19] found that untrained personnel attained 5.1% of fully compliant tests and 12.5% of minimally compliant tests, a number that increased to 18.9% and 33.1%, respectively, after training. ICHO master student Vranken[63] saw an increase of interpretable spirometries (i.e. with at least 2 acceptable curves) in her clinic from 21.57% to 53.65% after training was provided to the GPs. These examples show the absolute importance of providing proper training to the staff that will be in charge of performing spirometries, which is a working point in our clinic.

In terms of individual criteria, the most difficult one to achieve was the end of test, with only 41.7% of tests presenting 3 curves with 6 or more seconds of exhalation. In turn, this has also lead to it also being difficult to obtain 3 acceptable curves. In other studies[19,57,60,63,64], the end of test was also consistently found to be the most difficult criterion to comply with. However, it is also a very important one, since an incomplete exhalation can lead to an underestimation of the FVC and, as a consequence, to false negative results in the interpretation of spirometries[65]. As such, one can speculate that the poor outcomes in terms of the end of test criterion in the spirometries performed in the context of this project might have lead to false negative results.

In terms of smoke status registration, this project was a clearer success – in the beginning only 10% of patients between 40 and 69 years who consulted had their smoke status correctly filled in. Through reminders to GPs incorporated into the software, this number was increased to 70% 8 months later. This is clearly a point of the utmost clinical importance, considering that tobacco exposure is one of the biggest modifiable health risk factor. As such, it was decided to expand the use of the pop-up reminder for all patients aged over 18, and to set a reminder to annually revisit the subject.

Another strong point of this project was the choice of its relevant and important theme. Regardless of the lack of final diagnoses, the attention of the GPs and the nurse in our clinic was drawn to COPD, a disease that is underdiagnosed and often forgotten. By knowing the smoke status of our patients, and by being aware of the most common symptoms of COPD, healthcare personnel can be more quickly reminded to resort to spirometry use in case of diagnostic doubt. It has also raised the subject amongst the patients, most of whom are unaware of the existence of this condition. Even with a normal spirometry, the time was taken to discuss the results with them, most importantly the lung age, which in turn raises awareness to the severity of the consequences of tobacco use and might even lead to an attempt to stop smoking.

However, in the final discussion between the GPs, GPs-in-training, and nurse about the possible continuation of this project, it was seen that most colleagues found that administering a questionnaire to every smoker or ex-smoker above 40 years old who presented themselves in consultation was too time-consuming, especially knowing that there are already several preventive schemes in place (vaccination, cancer screening, …) that need to be discussed with patients. However, a specialised consultation might be put in place with the nurse for this population, if symptoms are present. At that moment, the questionnaire can be administered and, if necessary, a spirometry can be performed. Setting up this sort of consultation would be especially important in the future, as the population in our practice will inevitably get older and the risk of COPD will increase. Nonetheless, this can only be done once the nurse has received appropriate training.

Besides the issues with spirometry quality, some weak points of this study included the very small study population, the short follow-up time, and the fact that the spirometry was performed by someone with limited experience – in the 3 years before the project took place, the nurse had only performed about 15 spirometries. There was also no data collected regarding to smoke cessation among the patients who have participated in this project – this might be worth pursuing in a future moment.

Attachments

Attachment 1 - mMRC Dyspnoea Scale

Adapted from GOLD, 2019[4]

mMRC grade 0	I only get breathless with strenuous exercise.
mMRC grade 1	I get short of breath when hurrying on the level or walking up a slight hill.
mMRC grade 2	I walk slower than people on the same age on the level because of breathlessness, or I have to stop for breath when walking on my own pace on the level.
mMRC grade 3	I stop for breath after walking about 100 meters or after a few minures on the level.
mMRC grade 4	I am too breathless to leave the house or I am breathless when dressing or undressing.

Attachment 2 – CAT assessment

Your name:

Today's date:

CAT
COPD Assessment Test

How is your COPD? Take the COPD assessment test™ (CAT)

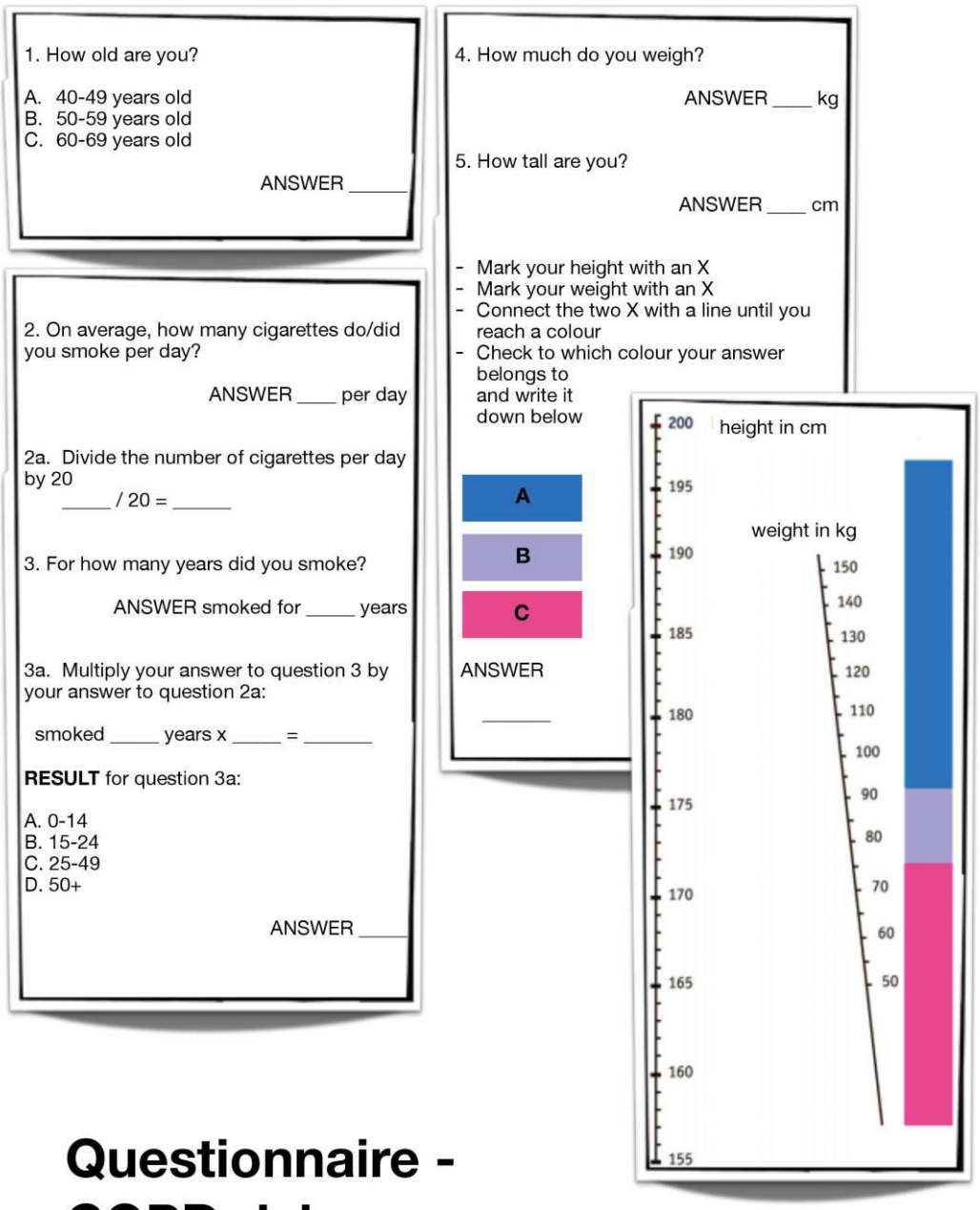
This questionnaire will help you and your healthcare professional measure the impact COPD (Chronic Obstructive Pulmonary Disease) is having on your well being and daily life. Your answers, and test score, can be used by you and your healthcare professional to help improve the management of your COPD and get the greatest benefit from treatment.

For each item below, place a mark (X) in the box that best describes you currently. Be sure to only select one response for each question.

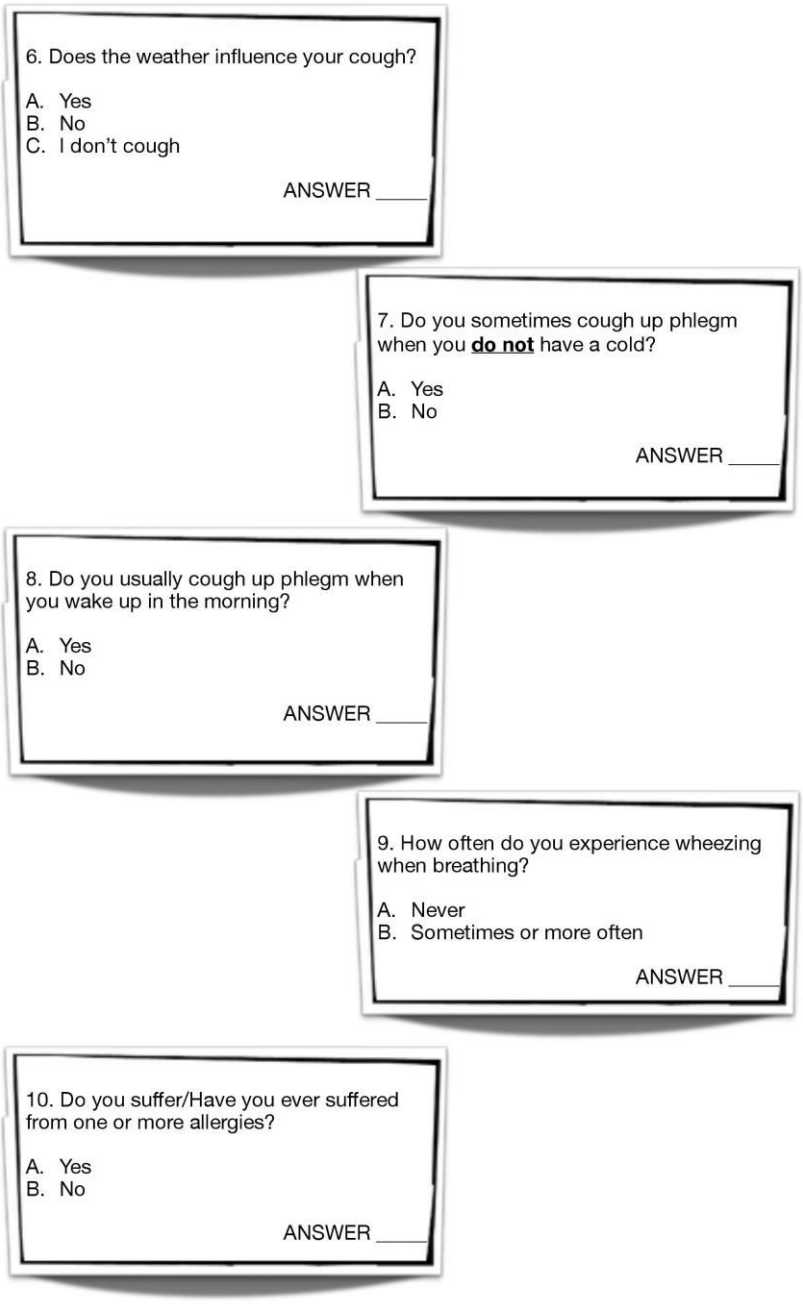
Example: I am very happy 0 X 2 3 4 5 I am very sad

		Score
I never cough	0 1 2 3 4 5 I cough all the time	
I have no phlegm (mucus) in my chest at all	0 1 2 3 4 5 My chest is completely full of phlegm (mucus)	
My chest does not feel tight at all	0 1 2 3 4 5 My chest feels very tight	
When I walk up a hill or one flight of stairs I am not breathless	0 1 2 3 4 5 When I walk up a hill or one flight of stairs I am very breathless	
I am not limited doing any activities at home	0 1 2 3 4 5 I am very limited doing activities at home	
I am confident leaving my home despite my lung condition	0 1 2 3 4 5 I am not at all confident leaving my home because of my lung condition	
I sleep soundly	0 1 2 3 4 5 I don't sleep soundly because of my lung condition	
I have lots of energy	0 1 2 3 4 5 I have no energy at all	
	Total score	

Source: The clinical and economic burden of chronic obstructive pulmonary disease in the USA - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Evaluative-questions-from-the-COPD-Assessment-Test-CAT-COPD-Assessment-Test-and-the_fig1_244482870 [accessed 2 Mar, 2019]



Questionnaire - COPD risk (source: Longfonds)


6. Does the weather influence your cough?
A. Yes
B. No
C. I don't cough
ANSWER _____
7. Do you sometimes cough up phlegm when you **do not** have a cold?
A. Yes
B. No
ANSWER _____
8. Do you usually cough up phlegm when you wake up in the morning?
A. Yes
B. No
ANSWER _____
9. How often do you experience wheezing when breathing?
A. Never
B. Sometimes or more often
ANSWER _____
10. Do you suffer/Have you ever suffered from one or more allergies?
A. Yes
B. No
ANSWER _____

Attachment 4 – Approval from the Ethical Commission of UZ Brussel

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PROF. DR. . J. VANDEVOORDE
VAKGROEP HUISARTSGENEESKUNDE
VUB

Brussel, 02-05-2018

Ons Kenmerk: **2018/086**

ADVIES VAN DE COMMISSIE MEDISCHE ETHIEK

Betreft:
Actieve case-finding voor COPD in de eerste lijn – een kwaliteitsbevorderend project
B.U.N. 143201835611

Na kennis genomen te hebben van de documenten betreffende het bovenvermelde project, inclusief het antwoord op de bijkomende vragen en de aangepaste informatie- en toestemmingsformulieren versie 2 dd 12-Apr-2018 in het Nederlands, Frans en Engels, besluit de Commissie Medische Ethiek tijdens haar vergadering van 2 mei 2018

dat de voorziene studie mag ondernomen worden.

Deze goedkeuring blijft geldig voor de duur van het project. De Commissie wenst een jaarlijks overzicht van de stand van zaken van het project te ontvangen. De studieresultaten dienen overgemaakt te worden aan de Commissie bij het beëindigen van de studie. Zij herinneren de verantwoordelijke van het experiment eraan dat dit experiment onder zijn persoonlijke verantwoordelijkheid zal worden uitgevoerd. Het gunstig advies van de Commissie betekent geenszins dat de Commissie de verantwoordelijkheid van het experiment op zich neemt. De Commissie Medische Ethiek werkt en is georganiseerd volgens de richtlijnen van ICH-GCP.

Met de meeste hoogachting,

prof. dr. M. Deneyer, voorzitter

Cc: FAGG, Departement R&D, Eurostation blok 2, Victor Hortaplein 40 / 40, 1060

454_01

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Meeting date: 02-05-2018
Ons kenmerk: 2018/086

MEMBERS OF THE MEDICAL ETHICS COMMITTEE UZ BRUSSEL - VUB
(since 28-02-2018)

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Prof. Dr. P. Lacor, MD	Internal Medicine UZ BRUSSEL	M
Mrs. A. Lintermans	Patient representative External Member	F
Prof. Dr. C. Schotte, PhD	Clinical Psychology UZ BRUSSEL	M
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Mrs. A. Van Scharen, LLM	Legal Expert Research & Development - VUB	F
Prof. Dr. I. Willekens, MD, PhD	Radiology UZ BRUSSEL	F

If member of the Ethics Committee, the investigator does not participate to the vote

454_01

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