

Telepulmonology and telespirometry

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Abstract. Taking and interpreting spirometry tests has proven difficult in primary care practice. This may lead to mis- or underdiagnosis of pulmonary diseases, among others chronic obstructive pulmonary disease. Telespirometry and telepulmonology consultation (TPC) may play a role in monitoring and improving the quality of the spirometry tests, supporting GPs in interpreting spirometry test results and reducing the number of physical referrals to the pulmonologist. In telespirometry up to 10% of spirometry results uploaded by GPs were randomly sent to a pulmonologist. Both the GP or practice nurse and the pulmonologist interpreted the spirometry results and gave their diagnostic findings. Additionally the pulmonologist assessed the quality of the test. In TPC a GP could digitally consult a pulmonologist for advice or referral of patients. On sending and closing the TPC consult the GP was presented a number of questions. Based on these questions the percentage of prevented physical referrals and the educational effect experienced by the GPs were determined. Almost a third of the 227 telespirometry tests was of *Moderate* or *Bad* quality. The Kappa of the interobserver agreement on diagnostic findings between GP and pulmonologist was 0.38. Between April 2009 and January 2014, GPS sent 4.488 TPCs to pulmonologists. Sixty-nine percent of the TPCs were sent to gain advice, the others were sent in order to prevent a physical referral. Overall telepulmonology reduced the number of physical referrals by 22%. In 90% of the TPCs the GPs indicated they had learned from the consult.

Keywords. telepulmonology, telespirometry, quality, efficiency

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a chronic lung disorder that currently constitutes the fourth leading cause of death worldwide and is thought to be the third leading cause of death by 2030 [1]. Spirometry is required to diagnose COPD. It is a lung function test that is commonly conducted in general practice to diagnose and monitor patients with respiratory diseases.

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COPD is often mis- or undiagnosed, partly due to the fact that taking spirometry tests of sufficient quality and correctly interpreting them has proven difficult in primary care practice [2-5].

In a study of White et al. clinically significant disagreements in the interpretation of spirometry test results between general practitioners (GPs) and pulmonologists were found in 49 out of 168 tests (Kappa = 0.39) [6]. In another study, in 20% of the 1.044 patients diagnosed with COPD in primary care practice the spirometry test results did not indicate COPD [5].

Telespirometry is a telemedicine application aimed to support in monitoring, and eventually improving, the quality of the spirometry tests taken in primary care practice. In telespirometry up to 10% of the spirometry tests are randomly send to a pulmonologist who then comments on the quality of the spirometry tests. Complementary to this telepulmonology is a telemedicine application in which the GP is supported by a pulmonologist in interpreting spirometry tests. Telepulmonology may also play a role in decreasing the number of physical referrals of patients to the pulmonologist.

The Italian Alliance study assessed the feasibility of store-and-forward telepulmonology and found it to be well accepted and easily performed by a large number of GPs [7]. Two other studies concluded that the web-based remote support of pulmonologists improved the quality of spirometry tests taken in primary care practice [8-9].

As described, the goal of telespirometry is to monitor and eventually improve the quality of the spirometry tests taken in primary practice. This study only assessed the quality of the spirometry tests according to the pulmonologist and compared the diagnostic findings of the GP or practice nurse with the diagnostic findings of the pulmonologist. The effect of telespirometry on quality improvement of the spirometry tests taken by GPs was outside the scope of this study.

Telepulmonology aims to support GPs in diagnosing patients and setting treatment plans, with or without the intention to prevent a physical referral of a patient to the pulmonologist. We therefore assessed whether the use of telepulmonology in daily primary care practice helped the GP in his decision making on diagnoses and treatment plans, whether the GP learned from the telepulmonology consult and whether physical referrals of the patient were prevented.

1. Methods

1.1. Inclusion

All GPs in the Netherlands, in possession of a spirometer that could be linked to a computer, could start using telepulmonology. The GPs themselves decided for which patients they found telepulmonology suitable. All data were collected from routine clinical practice. Eligible patients gave oral informed consent for the telepulmonology consultation.

1.2. Telespirometry

Spirometry tests were taken by a grader (GP or practice nurse) and subsequently uploaded as PDFs to a secured web-based teleconsultation system (KSYOS

TeleMedical Centre, Amstelveen, The Netherlands). The grader then interpreted the test results and added the diagnostic findings and some other patient data. At random up to 10% of these spirometry tests were sent to one out of 8 pulmonologists. The pulmonologist assessed the quality of the spirometry test and provided a diagnosis based on the spirometry test results. Additionally the pulmonologist could add comments or provide tips to GPs on how to improve the quality of the test. The telespirometry test could be converted into a telepulmonology consult (TPC) if the GP had a specific question to the pulmonologist.

In interpreting the spirometry results, both the grader and the pulmonologist could choose from 9 common diagnostic categories of pulmonary diseases. Kappa was calculated to assess the interobserver agreement on diagnostic findings between the grader of the spirometry test and the pulmonologist.

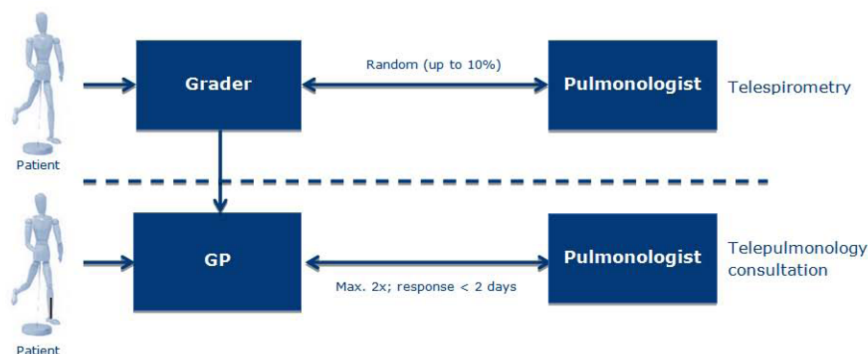


Figure 1. Overview of telespirometry and telepulmonology

1.3. Telepulmonology consultation

If a GP had a specific question a TPC could be sent to the pulmonologist. This could be done for two reasons: to ask for advice on a patient's diagnosis or treatment or to prevent a physical referral to the pulmonologist. A TPC consisted of a maximum of four PDFs of a patient's spirometry test results, medical history, relevant medication and the question of the GP to the pulmonologist. On sending (Q1) and closing (Q2,Q3,Q4) the TPC the GP received the following questions:

- Q1: Without telepulmonology, would you have physically referred this patient to the pulmonologist?
- Q2: Do you now refer this patient physically to the pulmonologist?
- Q3: Did you learn from the pulmonologist's response?
- Q4: Are you and your patient helped with the pulmonologist's response?

Based on Q1 and Q2 the percentage of prevented physical referrals could be calculated. A physical referral was prevented if a GP answered Q1 with *Yes* and Q2 with *No*. Q3 and Q4 could be answered with *Yes*, *No* or *Slightly*. Q3 informed us on the educational effect that was experienced by the GP's when using telepulmonology.

The pulmonologist received an e-mail notification as soon as a new TPC had arrived. The pulmonologist had to response within two working days. After receiving

the pulmonologist's answer, the GP could start one more round of communication with the pulmonologist.

2. Results

2.1. Telespirometry

Between December 2011 and January 2014, 227 telespirometry tests were presented to 8 pulmonologists. The quality of the spirometry test was classified as *Good* in 69% of the tests, *Moderate* in 23% of the tests and *Bad* in 8% of the tests. The Kappa for the interobserver agreement on patients' diagnostic findings was 0.38.

2.2. Telepulmonology consultation

Between April 2009 and January 2014, 4.488 telepulmonology consultations (TPCs) were sent by 342 GPs to 43 pulmonologists. The answers of the GPs on questions posed were available for 3.126 TPCs. For thirty-one percent ($n=955$) of these TPCs GPs indicated that these TPCs were sent to prevent a physical referral to the pulmonologist. Fifty-nine percent ($n=565$) of these 955 TPCs indeed prevented a physical referral of the patient to the pulmonologist. For 69% ($n=2171$) of the TPCs, GPs indicated that these results were sent to obtain the advice of a pulmonologist, not to prevent a physical referral. These patients would thus not have been physically referred without telepulmonology. However, as a consequence of using telepulmonology, sixteen percent of these 2171 patients was physically referred to the pulmonologist ($n=354$). When taking these extra physical referrals into account the use of telepulmonology lead to an overall decrease of physical referrals of 22%.

In 72% ($n=2241$) of the TPCs the GP indicated that (s)he and the patient were helped with the pulmonologist's response, in 24% ($n=746$) of the TPCs, they felt slightly helped and in 4% ($n=139$) of the TPCs, the pulmonologist's response did not help them. In 90% ($n=2807$) of the TPCs the GP indicated (s)he had (slightly) learned from the answer of the pulmonologist. In sixty-eight percent ($n=2120$) of the TPCs, the GP answered Q3 with *Yes*, in 22% ($n=687$) with *Slightly* and in 10% ($n=319$) with *No*.

3. Discussion

Approximately two thirds of the spirometry tests were classified as *Good* by the pulmonologist, meaning the quality of a third of the spirometry tests was *Moderate* or *Bad*. Additionally, the interobserver agreement between graders and pulmonologists on patients' diagnostic findings was only moderate. These results are consistent with the results of two other studies, illustrating an ongoing need for support among primary care workers in interpreting spirometry tests [6, 10].

The high percentage of TPCs sent by GPs for gaining advice from a pulmonologist likewise confirms a continuous need of support among GPs in interpreting spirometry results. In 90% of the TPCs the GP indicated (s)he had learned something from the TPC and in over 95% of the TPCs the GP indicated (s)he and the patient were helped with the response of the pulmonologist.

Telepulmonology thus seems an effective way to support GPs in interpreting spirometry results, making treatment decisions and diagnosing patients.

Additionally telepulmonology showed to decrease the number of physical referrals to the pulmonologist. Of the TPCs sent by GPs to pulmonologists to prevent a physical referral of patients, almost 60% indeed prevented a physical referral. The overall reduction in physical referrals was 22%, due to extra referrals in the group of TPCs sent by GPs with the primary aim to gain advice from the pulmonologist. On advice of the pulmonologist, these patients, who the GP would not have physically referred without telepulmonology, were physically referred to the pulmonologist. . Telepulmonology thus did not only reduce the number of unnecessary physical referrals, but also triaged the right patients to be physically referred to a pulmonologist.

Making the quality of the spirometry tests taken by GPs transparent can help in determining who of the GPs could benefit from additional training in taking spirometry tests of sufficient quality. Future research could study whether the combination of telespirometry and targeted additional trainings are effective in increasing the quality of the GPs spirometry tests. When these GPs would succeed in taking spirometry tests of satisfying quality, they may likewise be more successful in correctly interpreting the results and deciding on a patient's diagnosis and treatment. After targeted training of GPs performing less in taking spirometry tests, the impact of their learning on their ability to make wright decisions on patients' diagnosis and treatment could be studied.

When such learning effects among GPs could be achieved, the need for TPCs could diminish while the number of patients who would not be seen by a pulmonologist, but would nevertheless be diagnosed and treated adequately would increase.

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