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Telepulmonology: Effect on quality and efficiency of care

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Summary
Background: Interpreting spirometry results has proven challenging in primary care practice, among others potentially leading to under- and misdiagnosis of COPD. In telepulmonology a general practitioner (GP) digitally consults a pulmonologist to support the interpretation of spirometry results. This study assessed the effect of telepulmonology on quality and efficiency of care.
Methods: Quality of care was measured by five indicators, among others the percentage of TelePulmonology Consultations (TPCs) sent by GPs for advice, percentage of those TPCs resulting in a physical referral, and educational effect of telepulmonology as experienced by GPs. Efficiency was defined as the percentage of prevented unnecessary physical referrals of patients to the pulmonologist.
Results: Between April 2009 and November 2012 1.958 TPCs were sent by 158 GPs to 32 pulmonologists. Sixty-nine percent of the TPCs were sent for advice. Based on the advice of the pulmonologist 18% of these TPCs led to a physical referral of patients who would not have been referred without telepulmonology. Thirty-one percent of the TPCs were intended to prevent a physical referral, 68% of these actually prevented a physical referral to a pulmonologist.

Abbreviation list: GP, General Practitioner; TPC, TelePulmonology Consultation; COPD, Chronic Obstructive Pulmonary Disease.

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Conclusion: The results show telepulmonology can contribute to quality of care by supporting GPs and can additionally prevent unnecessary physical referrals.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a chronic lung disorder characterized by a not fully reversible airflow limitation that is usually progressive [1] and constitutes the fourth leading cause of death worldwide [2]. In the Netherlands the reported prevalence of diagnosed COPD is 1.8% in men and 1.6% in women [3]. However, a recent study in the Netherlands found a prevalence of COPD almost as high as 25% in a random sample of a population aged over 40 years [4]. The actual prevalence of COPD is higher than the reported prevalence due to the fact that COPD is often under- and misdiagnosed [5—7].

One of the reasons for the under- and misdiagnosis of COPD is that primary healthcare workers often have difficulty interpreting spirometry results [5,6]. Spirometry is a lung function test, resulting in a graph and lung function parameters required to diagnose COPD [8]. Spirometry is also used to detect and monitor other lung conditions such as asthma. White et al. identified clinically significant disagreements between general practitioners (GPs) and pulmonologists in the interpretation of spirometry graphs and consequent diagnosis in 49 out of 168 tests (Kappa = 0.39) and of quality of the spirometry test in 67 out of 212 tests (Kappa = 0.07) [9]. The main reason for disagreement on diagnosis was that COPD was not diagnosed by GPs, while according to international criteria the test results indicated COPD. A study of Yawn et al. likewise found disagreements between GPs and pulmonologists on the interpretation of spirometry results in 88 out of 368 tests (24%) [10]. Most common reasons for disagreement in this study were overreporting of airflow obstruction in patients with normal spirometry results by GPs, interpreting restrictive patterns in people with poor effort and diagnosing COPD in absence of spirometry results indicating COPD. Validity of spirometric testing in the general practice was studied by Schermer et al. They concluded that with sufficient training of the practice staff, performing of spirometric tests seemed justifiable [11]. However, practice staff is not always sufficiently trained in performing spirometric tests and interpretation remains difficult. Thus, as concluded by Poels et al., there is a need for ongoing support for spirometry interpretation among GPs [12].

Telepulmonology is an implementation of telemedicine that could support general practitioners in interpreting spirometry results. In telepulmonology a GP digitally consults a pulmonologist to gain support in diagnosing patients or to gain treatment advice concerning all kinds of lung conditions. There are two types of telepulmonology: store-and-forward (time and place independent) and real-time telepulmonology (only place independent). Until now few studies have been published that assessed the effect of telepulmonology on quality and efficiency of care. Real-time telepulmonology, using videoconferencing technology, has proven effective in some studies [13,14]. In one study 40 patients were seen by pulmonologists both face-to-face and via telepulmonology. For each condition, findings of the pulmonologists on the patient's medical history, physical examination, diagnostic impression and evaluation and treatment plan were reported and later on compared by two independent pulmonologists. Agreement between findings in both settings was rated on a scale of 1—4 with 1 representing complete agreement and 4 representing no agreement. Average agreement scores ranged from 1.32 to 1.81 [13]. In another study the use of real-time telepulmonology at a local clinic prevented a physical referral for 92% of the patients. Thus, besides supporting GPs in diagnosing patients through consultation of a pulmonologist, telepulmonology may also be used to prevent physical referrals of patients to the pulmonologist.

In the Italian Alliance study the feasibility of store-and-forward telepulmonology via telephone lines was assessed. Telepulmonology was found to be well accepted and easily performed by a large number of GPs (n = 937) [15]. Telepulmonology enabled pulmonologists to provide clinical information useful to GPs for decision making on diagnosis and clinical management of patients [16]. Another study concluded that the web-based remote support on interpretation of, and comment on the quality of, the spirometry results by pulmonologists to GPs generated a sustained increase in the quality of spirometry [17]. According to the participating GPs, pulmonologists' advices helped them to improve their performance in conducting and interpreting spirometry tests. Thus, previous studies showed telepulmonology can support GPs in performing and interpreting spirometry tests. However, to our knowledge no previous study assessed the effect of store-and-forward telepulmonology implemented in daily general practice on different aspects of quality of care and on the number of prevented physical referrals.

This study therefore focuses on the effect of store-and-forward telepulmonology implemented in daily practices of Dutch GPs, with regard to the quality of care and the number of prevented unnecessary physical referrals.

Materials and methods

Inclusion and exclusion criteria

All GPs registered in the Netherlands and in possession of a spirometer that could be linked to a computer, were eligible to start using telepulmonology. Each GP who started using the KSYOS TeleConsultation System (KSYOS TeleMedical Centre, Amstelveen, The Netherlands)for the first time received on-site training in the use of the system of approximately 1 h. GPs already working with the system

received a less extensive training. Additionally they could contact a dedicated helpdesk. GPs who participated in this study decided whom of their patients they considered suitable for a telepulmonology consult (TPC). They were not advised on the type of conditions for which to use telepulmonology, except that patients demanding urgent care were not suitable for telepulmonology.

Teleconsultation system

All TPCs were sent between a GP and a pulmonologist via the hypertext transfer protocol secured, web-based teleconsultation system. Users could access the system through a combination of username and password, by using the Dutch Unique Healthcare Identification card, or through a Single-Sign-On solution integrated in the GP information systems. Answers given by the pulmonologist were automatically and securely sent to the GP information system. The teleconsultation system also incorporated other telemedicine services such as teledermatology, teleophthalmology and telecardiology.

The telepulmonology consultation process

GPs logged in to the web-based teleconsultation system, after which they filled in mandatory patient information. Subsequently they uploaded up to four PDF's of the patient's spirometry results, filled in the patient's medical history, added relevant medication of the patient and asked the pulmonologist for advice. Additionally more detailed information on the patient's medical history could be added by the GP. The GP then sent the TPC to the local pulmonologist, who had to answer the TPC within two working days. Pulmonologists were reminded by e-mail and consequently by phone if they exceeded these two working days. The pulmonologist answered the TPC with regard to description of the findings, additional questions, diagnostic considerations and advice. In addition to this, the pulmonologist answered two mandatory questions: '*Diagnosis COPD?*' (Answer categories: Yes, No, Unsure) and '*Is a visit to the specialist required?*' (Answer categories: Yes, No, Inapplicable). After the GP had received the answer, the GP could start one more communication round with the pulmonologist. This round could be used by the GP to provide other (patient) information needed by the pulmonologist or to ask for clarification of the pulmonologist's answer when needed.

Data collection

All data were gathered from routine clinical practice. Telepulmonology consults sent via the teleconsultation system were included in this study. Patients gave oral informed consent for the telepulmonology consultation. On sending and closing a TPC a GP was asked a number of mandatory questions that were used to measure the effect of telepulmonology on quality and on the number of prevented physical referrals. Questions asked to GPs are shown in Fig. 1. Timestamps of TPCs sent were saved to derive the mean response time of the pulmonologists.

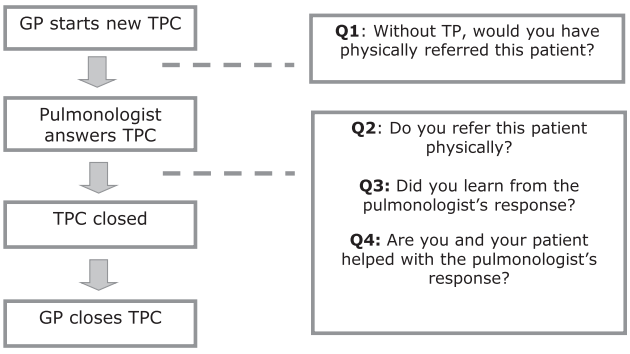

Figure 1 Questions asked to the GP during the TP process.

Quality of care

Five indicators were used to measure quality of care. The percentage of TPCs sent by GPs for which advice of a pulmonologist was requested was the first indicator. The second indicator was the percentage of patients physically referred by the GP to the pulmonologist, who would not have been referred without telepulmonology. This equaled the percentage of TPCs where question 1 (Q1) was answered with 'No' and question 2 (Q2) with 'Yes'. Question 3 (Q3) could be answered with the following three answers 'No', 'Slightly', 'Yes'. The last two answers were considered an educational effect experienced by the GP which was the third indicator. The fourth indicator was the percentage of TPCs in which the GP was helped with the pulmonologist's response (question 4 (Q4) answered with 'Slightly' or 'Yes'). The mean response time in working hours of the pulmonologists was the last indicator. Hours between 8.30 am and 5.30 pm on weekdays were counted as working hours.

Efficiency of care

Efficiency of care was expressed as the percentage of prevented physical referrals. The percentage of prevented unnecessary physical referrals in the group of patients that would have been physically referred without telepulmonology equaled the percentage of TPCs where Q1 'Without telepulmonology, would you have physically referred this patient?' was answered with 'Yes' and Q2 'Do you refer this patient physically?' was answered with 'No'.

The overall percentage of prevented physical referrals was calculated using Formula (1):

$$1 - \frac{\text{Total number of patients physically referred}}{\text{Total number of patients that would have been referred without TP}} * 100\% \quad (1)$$

The number of TPCs where Q1 was answered with 'Yes' was considered the total number of patients that would have been referred without telepulmonology. The total number of patients physically referred was defined as the number of TPCs where the answer to Q2 was 'Yes'.

The McNemar test was used to test whether the difference between the number of patients physically referred using telepulmonology significantly differed from the number of patients physically referred without telepulmonology. Statistical analyses were performed using the Statistical Package for Social Sciences SPSS (version 19).

Results

In total 1.958 TPCs of 1.828 patients were sent by 158 GPs and answered by 32 pulmonologists between April 2009 and November 2012. The mean age of the patients for whom a TPC was sent was 52.4 years. The youngest patient for whom a TPC was sent was 6 years; the oldest patient was 91 years. Forty-seven percent ($n = 917$) of the patients were male. Twenty-three percent ($n = 284$) of the patients were diagnosed with COPD. The pulmonologist answered 'Unsure' to the question '*Diagnosis COPD?*' in 16% ($n = 190$) and with 'No' in 61% ($n = 750$) of the cases. In 92.8% of the cases the pulmonologist's advice, concerning physically referring or not physically referring the patient, was followed by the GP. Answers to the questions asked to the GP were not available for approximately 25% of the TPCs, the number of answers available varied per question.

Quality of care

Sixty-nine percent ($n = 939$) of the teleconsultations were sent to gain advice, 18% ($n = 172$) of these teleconsultations eventually lead to a physical referral (Fig. 2). Seventy-five percent ($n = 1.062$) answered 'Yes' to the question 'Did you learn from the pulmonologist's response?', 17% ($n = 245$) answered 'Slightly' and 8% ($n = 120$) answered 'No'. Therefore overall 92% of the GPs indicated they learned from the pulmonologist's response. The question 'Are you and your patient helped with the pulmonologist's response?' was answered with 'Yes' in 67% ($n = 947$) of the TPCs, with 'Slightly' in 29% ($n = 417$) of the cases and with 'No' in 4% ($n = 54$) of the cases. Thus, in 96% of the TPCs the GP or the patient was helped with the answer of the pulmonologist. Pulmonologists answered the TPCs on average after 18.2 working hours ($n = 1212$).

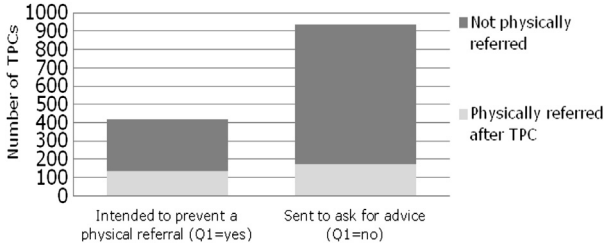

Figure 2 Physical referrals. Column 1 shows the number of TPCs intended to prevent a physical referral, divided into TPCs that indeed did not result in a physical referral and TPCs that did not prevent a physical referral. Column 2 shows the number of TPCs sent to ask for advice, divided into TPCs that did not results in a physical referral and those that did.

Efficiency of care

Thirty-one percent ($n = 420$) of the teleconsultations were intended to prevent a physical referral, 68% ($n = 285$) of these teleconsultations actually prevented a physical referral. Without telepulmonology 420 patients would have been referred to the pulmonologist. With the implementation of telepulmonology this number decreased to 307 patients. The overall percentage of prevented physical referrals thus was 27%.

The asymptotic significance of the McNemar test for the difference in physical referrals with and without telepulmonology was 0.000 and Chi-square was 27.880, thus the difference was significant.

Discussion

Telepulmonology facilitates the support of local pulmonologists to GPs in diagnosing patients, making decisions about their treatmentand deciding whether physical referral of patients might be required. The aim of the study was to identify the effect of telepulmonology on quality and efficiency of care. Results show that telepulmonology applied after patient selection by the GP triages additional patients to the pulmonologist and reduces physical referrals in others, while the GPs learn during the process. Telepulmonology therefore helps to ensure that GPs refer the right patients to the pulmonologist.

In this study, 18% of the patients who would normally not have been physically referred by a GP, now were physically referred after TPC on advice of the pulmonologist. This is likely to improve quality of care for these patients. Additionally telepulmonology supports GPs in interpreting spirometry results, diagnosing patients and making treatment decisions. GPs indicated they learned from the TPC in over 90% of the cases, while an even higher percentage said they or their patients felt aided by the answer of the pulmonologist. Furthermore, the high number of TPCs sent by GPs to ask for advice confirms the findings of Poels et al. that there is a need for ongoing support among GPs in interpreting spirometry results [12]. Without telepulmonology, GPs would not have had the support of the pulmonologist, while this seems to aid in preventing under- and misdiagnosis of COPD.

Within the group of TPCs sent by GPs with the aim to prevent a physical referral, 68% actually prevented a physical referral. Due to additional physical referrals of patients on advice of the pulmonologist, the overall decline in physical referrals was 27%. In the study of Raza et al. 92% of the patients did not need to be physically referred after telepulmonology consultation [14]. However, in this study it was not known whether the patients would have been physically referred without telepulmonology. It is therefore not clear how often telepulmonology actually prevented physical referrals in that study. Additionally teleconsultation did not take place at the GP's practice, but at a small rural hospital where subspecialty care was not

available. In our study, telepulmonology thus increased the efficiency of care substantially.

This study has some limitations. First, results are based on answers given by the GPs. These might not always have been objective. In addition, no follow-up data on patients were collected. It is therefore not known whether patients for whom GPs indicated they were not physically referred to a pulmonologist, did indeed not visit a pulmonologist. The same argument holds, but vice versa, for patients for whom GPs indicated they were physically referred. Another limitation is that questions were only posed to the GP when a TPC was actively closed by the GP. Therefore answers of GPs were not available for approximately 25% of the TPCs. This may have biased the results as well. The cost-effectiveness of the implementation of telepulmonology was not assessed, this could be studied in future research. However, the strength of the study is that it identified effects of telepulmonology implemented in daily general practice on quality and efficiency of care. To our knowledge these two aspects of telepulmonology have not been reported earlier. Another strength is that telepulmonology was implemented in real life daily general practice, not in a simulated research setting.

Conclusion

Telepulmonology provides a way to support the GPs in interpreting spirometry results, diagnosing patients and making decisions on the treatment of patients. GPs using telepulmonology experience an educational effect and they or their patients feel aided by the answer of the pulmonologist. Telepulmonology also ensures GPs physically refer the right patients to the pulmonologists. Additionally the results show that telepulmonology, by improving the communication between GP and pulmonologist, prevents unnecessary physical referrals. Thus, telepulmonology can contribute to a higher quality of care for COPD patients in a more efficient way.

Conflict of interest statement

L. Thijssing and J.P. van der Heijden are employed by KSYOS Health Management Research, and L. Witkamp is the Director of KSYOS Health Management Research. The remaining authors state no conflicts of interest.

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L. Thijssing contributed to the study design, data collection, data analysis and interpretation and writing of the manuscript.

J.P. van der Heijden contributed to the study design, data collection, data analysis, critical review of the manuscript and approval of the final draft.

N.H. Chavannes contributed to the study design, critical review of the manuscript and approval of the final draft.

C.F. Melissant contributed to the study design, critical review of the manuscript and approval of the final draft.

M.W.M. Jaspers contributed to the study design, critical review of the manuscript and approval of the final draft.

L.W. Witkamp contributed to the study design, critical review of the manuscript and approval of the final draft.

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