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Telemedicine in the Management of Chronic Obstructive Respiratory Diseases: An Overview

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Abstract: Non-transmissible chronic respiratory diseases (CRDs) are very prevalent. In this chapter, we focus on the different dimensions through which telemedicine can be delivered and used in the management of patients with chronic obstructive pulmonary disease (COPD) and asthma, the major obstructive CRDs. Telerehabilitation, health education, telemonitoring, early detection of exacerbations, psychosocial support, and smoking cessation through telemedicine programs allow the delivery of quality healthcare to COPD patients who have limited access to health services. In asthma patients, telemedicine is effective in improving inhalation technique, increasing adherence to medication/self-management, and health education. We discuss the importance of virtual visits and mobile/web-based tools in the management and monitoring of patients with CRDs, the rising promise of telespirometry performed outside the hospitals, and

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the most relevant limitations to expand the implementation of telemedicine, such as the lack of digital literacy in patients and the issues of privacy and security when sharing data online.

Keywords: telemedicine for asthma; telemedicine for chronic respiratory diseases; telemedicine for COPD; telemonitoring; telespirometry

INTRODUCTION

Telemedicine is defined as the use of electronic information and communication technology by medical personnel to provide and support health care to patients when they are far away from the health care institutions (1–3). It encompasses a wide range of technologies such as videoconferencing, wearable devices, internet platforms, mobile applications, store-and-forward devices, streaming media, and terrestrial and wireless communication. Telemedicine can be used for a wide range of purposes, such as to decrease the demand on existing hospital and healthcare services, to promote health education, to reduce the cost of care, to measure and endorse treatment adherence, to quickly identify disease worsening, and to extend the accessibility of services to patients living in remote locations. Telemedicine is therefore a broad concept that involves diagnosis, treatment, monitoring, education, health promotion, and disease prevention (4). Telehealth is thought to support self-management by providing access to information, and at the same time enables transference of monitored data (5).

The global market of telemedicine has been emerging as an effective alternative to the usual clinical management in chronic respiratory diseases. In addition, the development of new easy to use and inexpensive technologies will certainly increase the number of patients requesting telemedicine services. Some pointed disadvantages of these technologies are the fact that they supposedly change the interaction between patient and provider (6); also some questions remain uncertain, such as legal, safety, and privacy issues (1). In the context of the coronavirus disease 2019 (COVID-19) pandemic, telemedicine acquired special relevance, especially to assess patients with suspected infection or with chronic diseases, avoiding visits to health centers (7, 8). Face-to-face visits in controlled asthma patients have been broadly recommended to be postponed or replaced by virtual visits (9). Non-transmissible chronic respiratory diseases (CRDs) are very prevalent, with significant morbidity and mortality. In this chapter, we focus on the different dimensions through which telemedicine can be delivered and used in the management of patients with chronic obstructive pulmonary disease (COPD) and asthma, the major non-transmissible obstructive CRDs.

TELEMEDICINE IN THE MANAGEMENT OF COPD

COPD is a disease mainly characterized by a progressive non-reversible narrowing of the airways. COPD carries a vast economic and social burden worldwide (10, 11). Telemedicine encompasses a variety of telecommunication strategies to remotely deliver health information and interventions to participants. Telemedicine is expected to enhance remote communication between patients and practitioners, and it is especially recognized as a supplementary tool to increase healthcare access for individuals with transport difficulties or those living in rural and remote areas (12). Several studies have been published focusing on the effects of different telemedicine programs for patients with different phenotypes and stages of COPD.

Telerehabilitation

The benefits of pulmonary rehabilitation in COPD patients are well established (13). Recent studies showed home-based telerehabilitation programs to reduce healthcare consumption, due to a decrease in the number of COPD exacerbations, emergency department (ED) visits, and COPD-related hospitalizations (14, 15). Interventions are noted to be heterogeneous in design, however the most common form of telerehabilitation programs are based on delivery of exercise in a clinical or home-based setting using video conferencing. Walking and cycling are the most frequent form of aerobic training. The monitoring hardware generally includes a pulse oximeter, a laptop/tablet or smartphone, step counter or a wearable physical activity monitor. An emergency plan is mandatory and thresholds for discontinuing exercise usually use a combination of heart rate, oxygen saturation, and dyspnea monitoring. Telerehabilitation seems to have similar benefits to outpatient pulmonary rehabilitation improving health-related quality of life, respiratory symptoms, and exercise tolerance. Likewise, rehabilitation through telemedicine, especially by video platforms, seems safe and well accepted by COPD patients. Acute exacerbations of COPD, ED visits and hospital admissions reduce after a telerehabilitation program, and a video consultation prior to a pulmonary rehabilitation program seems an adequate alternative to a face-to-face consultation (15–20).

Health education and self-management

Health education and self-management is characterized by interventions that empower patients to manage their diseases with confidence (21). The complexity of the digital health for self-management of COPD has escalated with recent developments in technology. A faster and easier way to communicate with healthcare providers has the potential to improve self-management of CRDs by the patients; however, it is important that this change in the delivery of healthcare does not result in inferior or unsafe health care. The majority of the studies determined that telemedicine and e-health interventions have a positive impact in self-management, adherence to treatment and symptom management ability. Programs that include health education sessions seem more effective (22, 23); however, the number of COPD exacerbations and hospital-admissions have failed to reduce.

Telemonitoring

Telemonitoring in COPD is not generally accepted yet because of a lack of compelling evidence of its beneficial long-term effects. Studies report improvements in some outcomes assessed: quality of life (24), hospital readmissions at three months after discharge, and decrease in exacerbation rate but with limited or inconsistent evidence (24, 25). However, telemonitoring have not consistently reduced ED visits, hospitalizations, and time to readmission in recent studies (24). In addition, the designs of the various telemonitoring interventions that have been studied to date are heterogeneous, differing mostly in the number and types of vital parameters transmitted (pulse measurements, spirometry results, blood oxygen saturation), cut-offs to trigger a medical intervention, and COPD stage of the target population (24). Acute exacerbations of COPD are an important factor to disease progression and COPD-related mortality. In the future, interventional plans are important to increase the capacity of telemonitoring to early diagnose an acute exacerbation of COPD. The continuous monitoring of various physiological parameters of patients during everyday activities by digital devices and algorithms to differentiate between expectable progression of the disease and acute exacerbation seems vital. Relying on this information, physicians might be able to adapt medications to the specific needs of the patients and reduce the severity of COPD acute exacerbations (26). Recognizing acute exacerbations in COPD at an early stage and arrange timely countermeasures might be an effective way to reduce hospitalization rates due to COPD.

Psychosocial support

COPD, especially in advanced stages, is often followed by anxiety, depression, and lack of social support. COPD patients with mental disorders frequently have difficult-to-treat respiratory symptoms. This difficulty in controlling respiratory symptoms leads to a greater use of unscheduled health care. The majority of the reports about psychosocial support interventions in telemedicine have favorable outcomes. This effect seems related to a more regular communication between the patient and healthcare professionals (27). Allowing COPD patients to share experiences to other patients and medical staff seems helpful to achieve an improvement of respiratory symptoms and better mental health (28).

Smoking cessation

Cigarette smoking is the leading behavioral risk factor for COPD. Preventing progression of COPD via smoking cessation remains of paramount importance. Mobile applications as an add-on to psychopharmacological therapy seems effective to achieve smoking cessation. In addition, the easy integration of these tools in primary healthcare settings has the potential to improve knowledge about possible treatments and integrate smoking cessation into routine of care (29, 30).

TELEMEDICINE IN THE MANAGEMENT OF ASTHMA

The non-inferiority of telemedicine, when compared to standard care, seems an opportunity to deliver good quality health care to patients with asthma. Telemedicine can contribute to increased patient safety. A significant number of articles had been published validating the advantages and limitations of telemedicine in managing and monitoring asthma in multiple dimensions.

Inhalation technique and adhesion to inhalers

E-health and virtual education interventions seem valid alternatives to improve inhaler technique in asthma patients (31). Besides that, using e-health through mobile apps, short text messages and monitoring devices (trackers) increase adherence to inhalers in asthma patients, with good acceptance by the patients (32–44); however, benefits were not always found (45).

Portable spirometry and telespirometry

Regarding electronic portable spirometry, there are contradictory information on clinical outcomes for asthma patients (46–48). Electronic portable spirometers provide valuable information about lung function, but with limitations related to the lack of instructions on how to perform breathing maneuvers correctly; also, many devices are inaccessible due to high cost and lack of regulatory authority's approval (46). Nevertheless, for patients living in regions with poor access to specialty care, remote spirometry via telemedicine would allow guidelines-based recommendations to monitor lung function. There are reports of successful implementation of remote spirometry in rural settings with no adverse events. Rates of interpretable spirometry data resembles rates of in-person spirometry (47), and telespirometry was found to be effective in diagnosing and ruling out CRDs, detecting lung abnormalities, and managing patients with COPD and asthma (48).

Self-management and health education

Many reports tried to show the short and long-term benefits of telemedicine in patients with asthma, and most of them determined that telemedicine and e-health interventions have a positive impact on self-management (49), quality of life (50, 51), symptom management ability (52), and motivation to treatment adherence and medication use (53). The evaluated interventions were well accepted by patients (33), having the potential to facilitate patient-health care provider relationship (54, 55). Bruton et al. (51) showed that a breathing retraining program, delivered as a self-guided digital audiovisual program, besides improving quality of life, reduced health care expenses in patients with uncontrolled asthma. No reports found negative effects (49–59), but literature recommends further studies to consolidate the knowledge regarding the impact of these technologies in self-management and health education in patients with asthma.

Virtual visits versus face-to-face appointments

This field has been especially appealing for asthma, and it has been particularly developed to be implemented in schools and rural areas. Some studies demonstrated better outcomes, including asthma control, in patients receiving asthma care via telemedicine (symptom-free days, less emergency department visits or hospitalizations) (60, 61). Other studies reported a non-inferiority relation when compared to in-person visits (62), being an alternative to conventional appointments, which enables its occasional replacement, achieving the same outcomes in asthma control (63). One review established that teleconsultations in combination with telecase management could be effective in improving asthma control and quality of life (64). On the other hand, two reviews recognized that there is still too little evidence supporting its widespread use (65, 66), and one randomized controlled trial failed to demonstrate differences in outcomes, such as quality of life, self-efficacy, asthma knowledge or lung function in patients receiving asthma education via telemedicine; nonetheless an improvement in adherence to asthma medications was observed (67). A virtual asthma clinic for children was found as an effective and cost-effective eHealth intervention to improve asthma care (68). This intervention is an attractive option to optimize monitoring strategies in a more personalized way.

Telemonitoring

In contrast to what happens with COPD, where telemonitoring is well developed and applied for monitoring vital signs and other parameters that can detect deterioration or exacerbations at an earlier stage, in asthma, it is mainly used for monitoring symptoms and peak expiratory flow (PEF) (69). A recent Cochrane systematic review did not support telemonitoring as it was not superior to the usual care and the benefits pointed by the studies reviewed were a subject of significant risk of bias (70). Promising tools for telemonitoring are new wearable devices (71) that continuously measure personal physiologic parameters (heart rate, skin temperature, blood oxygen levels, and physical activity) which might predict and prevent exacerbations or help to diagnose other underlying health conditions. Utilization of health monitoring devices by patients will become an important aspect of self-care and preventive medicine. The data provided by these wearable devices will allow providing patients with personalized tools and tailored solutions to improve their health and encourage fitness and diet goals. They may also help to enhance accurate symptom reports, improve the accuracy of diagnosis, and streamline appropriate specialty referral when appropriate (71).

MOBILE APPLICATIONS AND WEBSITES

Mobile healthcare (mHealth) which includes apps running on consumer smart devices (i.e., smartphones and tablets), is becoming increasingly popular (72). Whether including mobile telephone or internet-based systems, mHealth will be an important part of the armamentarium needed for personalized medicine in the future (73). The majority of the currently available devices focus on medication adherence. For example, an application developed in Portugal (mINSPIRERS) aims to transform the process of adherence to inhaled medication for asthmatic patients into a positive experience through immediate and pleasant rewards (elements of gamification and social interaction) (74). From the available literature, data concerning outcomes are still limited. Most reports find overall benefit in the use of these tools in asthma management (35, 75, 76) and control (35, 75, 77), improving adherence to inhalers (10), patient acceptance (75), easy availability (35) and cost-effectiveness (76), and improved quality of life (78, 79).

Other studies state that the usefulness of these tools is still debatable and more quality research is needed to define how these tools can be part of routine care (80–82). Another report failed to demonstrate better improvements in asthma control test (ACT) and PEF in patients submitted to mobile and internet interventions when compared to usual care (83).

CONCLUSION

For COPD, telemedicine offers some benefits through telerehabilitation, health education, psychosocial support, and smoking cessation (24). Telemonitoring interventions have contradictory results, especially in long-term outcomes. The extent and significance of benefits to patients and healthcare organizations are not always consistent. Nonetheless, telemedicine can be a key add-on in COPD care, not only during but also after the COVID-19 pandemic, reducing both inpatient and outpatient health care burden (24). Patients' age, education, experience in technological devices, cognitive, motor, and visual abilities, along with their family and home environment play an important role in the use of these technologies (2). Therefore, technology-based interventions may not be as effective in some populations, which might limit the wider diffusion of telemedicine programs (84). The majority of the available trials are from high income countries which may not reflect the outcomes in less developed regions. Nevertheless, implementation of low-cost technology, its wider use throughout the world in different social/age groups, and additional training in communication technology of the population, might balance this matter in the near future. Also, future clinical trials must include a cost analysis in their reporting to provide financial insights related to the implementation of the intervention (85). The lack of detailed data on program costs and health care service savings makes it tricky for home-based telemedicine programs to make a solid economic case when considering reimbursement or investment in these programs (86).

Conflicting results have been pointed out regarding the use of telemedicine and telehealth tools in asthma management. From our analysis, it seems that a positive tendency is emerging and many asthma patients that we care for can be helped using telemedicine. These positive outcomes are mostly in improvement of inhalation technique, adherence to medication and self-management or health education of asthma patients. Combining teleconsultations (virtual visits and mobile or web-based tools) seems also effective in improving asthma control.

Telemonitoring used for prediction and early detection of asthma exacerbations is still not validated but promising tools are being evaluated, such as wearable devices. Unfortunately, scarce evidence is available regarding the use of telespirometry. Since home-based spirometry has several potential benefits, it could decrease the burden on hospital services, avoid gathering of patients in high-risk facilities, and obviate the need for transportations of patients to crowded health care centers (87). A high cost-effectiveness was previously identified (80, 88), but well-designed studies of cost-effectiveness is needed.

Apart from the above-mentioned advantages, telemedicine has some benefits in the context of the current pandemic, such as increasing social distancing, being a safer option for health care providers and patients (reducing potential infectious exposure), enabling maintenance of continuity of care, and avoiding negative consequences from delayed routine care. Thus, the uptake of telemedicine was recently hastened, but it is likely to be an important part of CRDs care practice in the post-pandemic era.

Patients report high levels of acceptance and satisfaction with telemedicine interventions (88–91). However, some patients and/or their parents might have poor digital literacy and lack of technological infrastructure to perform an adequate telemedicine visit (88). As the field grows, continued oversight in quality assurance, reimbursement, and regulations is needed (92). The issue of privacy and security for both data in transit and stored data remains a challenge and is yet to be thoroughly addressed (93). Also, there is still some misconceptions regarding telemedicine: the technology is untrustworthy, hard to use, insecure, and that a provider will not be paid if they use it (94). Regarding expenses, some authors state that telemedicine decreases the cost of medical care (95). Others claim high cost of using these technologies, and the need for more robust cost-effectiveness studies in this area. Governments and payers are rapidly expanding coverage and payment in an effort to ensure a wide public access to healthcare in the midst of an infectious pandemic (96–98). Safety of patients and providers is important; however, this should not be a demotivating factor for the implementation of telemedicine programs in daily practice.

Although asthma digital health is a promising area (99), current evidence is only of moderate quality, and there is significant heterogeneity in study end points and trials design (100). The non-inferiority of several telemedicine interventions and tools, when compared to standard care, seems to be an opportunity to offer the best possible quality of care to patients, without compromising patient safety and with no increase in costs (101). Technology-based interventions can improve asthma management by facilitating patient education, symptom monitoring, environmental trigger control, comorbid condition management, medication adherence, and overall patient-reported outcomes (102). A new era of precision digital medicine is emerging in health services with the potential to revolutionize the management of CRDs patients. Telemedicine could be a significant add-on in health care, reducing inpatient and outpatient health care burden (103–105).

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