Review / Derleme

The Role of E-health in COPD Monitoring: A Narrative Review for a New Perspective

E-sağlığın KOAH (Kronik Obstrüktif Akciğer Hastalığı) İzlemindeki Rolü: Yeni Bir Bakış Açısı için Anlatısal Bir İnceleme

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Abstract

Background: With the growing number of COPD patients, there is pressure on the quality, accessibility, and affordability of care. Telemedicine approaches, such as tele-monitoring and tele-education, can be effective in initiating an increase in treatment, when necessary, with feedback to healthcare providers about changes in clinical conditions. Tele-monitoring can also facilitate early diagnosis and treatment of accompanying co-morbid exacerbations, resulting in a decrease in the number of emergency room visits and hospital admissions. Digital tools have been shown to effectively support exercise programs in COPD, with positive perceptions and experiences among participants.

Methods: This review focuses on the potential benefits of using eHealth applications in the care of patients with chronic obstructive pulmonary disease (COPD).

Results: The review emphasizes the potential benefits of eHealth applications for the care of patients with COPD.

Conclusion: The COVID-19 pandemic has highlighted the importance of remote monitoring and effective self-management for patients with COPD. E-health tools can provide better care, especially for patients who are geographically or socially isolated, patients with time conflicts, or patients who cannot go to regular physician visits due to comorbid diseases. However, there is a need for larger-scale trials of self-management interventions delivered by tele-health, based on explicit self-management theory, linked with an evaluation that includes detailed descriptions of the intervention and the process delivery, intermediate outcomes such as self-efficacy and specific behavior changes, to gain more insight into the optimal combination of in-person care and eHealth-based self-management. To maximize the effectiveness of these tools, further research is needed to assess patient preferences, identify the best platform for patients that is easy to use and evaluating related costs. Pre-defined tags in self-management at a distance are also necessary to continue to evolve and innovate

Keywords: COPD, E-health, Remote monitoring, Chronic respiratory disease, Telemedicine

Özet

Giriş: Kronik obstrüktif akciğer hastalığı (KOAH) hastalarının sayısı artarken, bakım kalitesi, erişilebilirliği ve uygunluğu üzerinde baskılar oluşmaktadır. Tele-takip ve tele-eğitim gibi tele-tıp yaklaşımları, gerektiğinde tedaviyi takip konusunda etkili olabilir ve klinik durumda değişiklikler hakkında sağlık hizmeti sağlayıcılarına geri bildirim sağlayabilir. Aynı zamanda tele-takip, eşlik eden komorbid alevlenmelerin erken teşhis ve tedavisini kolaylaştırabilir, bu da acil servis ziyaretlerinin ve hastane yatışlarının sayısını azaltabilir. Dijital araçlar, KOAH hastalarının egzersiz programlarını etkili bir şekilde destekleyebilir ve katılımcılar arasında olumlu algılar ve deneyimler ortaya çıkarmıştır.

Yöntemler: Bu inceleme, KOAH hastalarının bakımında e-sağlık uygulamalarının faydalarına odaklanmaktadır.

Bulgular: İnceleme, KOAH hastalarının bakımı için e-sağlık uygulamalarının olası faydalarını vurgulamaktadır.

Sonuç: COVID-19 pandemisi, KOAH hastaları için uzaktan izleme ve etkili kendi kendine yönetimin önemini vurgulamıştır. E-sağlık araçları, coğrafi veya sosyal izolasyon içinde bulunan, zaman çatışması yaşayan veya komorbid hastalıklar nedeniyle düzenli doktor ziyaretlerine gidemeyen hastalar için daha iyi bir bakım sağlayabilir.

Anahtar Kelimeler: KOAH, E-sağlık, Uzaktan izleme, Kronik solunum hastalığı, Tele-tıp

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Introduction

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is characterized by persistent and typically progressive airflow limitation.[1,2] It is one of the leading causes of chronic disease-related morbidity and disability worldwide, with an increasing prevalence.[3] According to the World Health Organization (WHO), 251 million people in the world were affected by COPD in 2017.3 It is estimated that COPD causes over three million deaths annually, accounting for 6% of all deaths.[2]

Systematic reviews and meta-analyses have shown that the prevalence of COPD is significantly higher in smokers and ex-smokers compared to non-smokers, in individuals aged ≥40 years compared to those <40, and in men compared to women.[4] The estimated COPD-attributable death rate is 42 per 100,000 (4.72% of all-cause deaths) and the estimated disability-adjusted life years (DALYs) rate is 1068.02/100,000.[5]

COPD results from a complex interplay of long-term cumulative exposure to noxious gases and particles, combined with a variety of host factors including genetics, airway hyper-responsiveness, and poor lung growth during childhood.[6] Often, the prevalence of COPD is directly related to the prevalence of tobacco smoking. However, in many countries outdoor, occupational, and indoor air pollution (resulting from the burning of wood and other biomass fuels) are major COPD risk factors.[7] The prevalence and burden of COPD are projected to increase over the coming decades due to continued exposure to COPD risk factors and aging of the world's population; as longevity increases more people will express the long-term effects of exposure to COPD risk factors.[8]

Having COPD can significantly reduce the quality of life, and the disease poses a high economic burden on society, affected individuals, their families, and their daily lives.[9] COPD imposes substantial strain on healthcare budgets, with the largest expenditure on hospitalizations and emergency department (ED) presentations, which are common in the latter stages of the disease.[10] Hospital admissions for exacerbations not only burden the healthcare system but also negatively impact patients, who experience reduced physical activity, decreased exercise performance, and impaired quality of life, even in mild stages of the disease.[9] While rapid medical intervention can be provided at the early stage of the deterioration in the patient's condition, hospitalizations can be prevented and the cost and time spent on transportation to health centers can be reduced.[11]

Patients with COPD utilize more healthcare resources than those without the disease. On average, they visit their general practitioners (GPs) 12.7 times per year, with 2.1 of these visits specifically for COPD. In contrast, individuals without COPD visit their GPs 6.1 times per year. In 2005, the total cost for COPD- and asthma-related patient care in the European Union was estimated at €799 million, placing COPD and asthma among the top ten most expensive diseases.[12]

Electronic health

Electronic health (eHealth) is described as the use of information and communication technologies (ICT) for improving health, where health-improving intervention is delivered electronically. E-health; It is important to improve the clinical outcomes of patients, protect healthcare personnel, and support and improve the effectiveness and efficiency of healthcare services[13]. Telerehabilitation includes "the use of ICT to provide rehabilitation services from a distance" and can involve different types of eHealth tools.[14] Telehealth, which is defined as the use of information and communication technologies to provide clinical health care through remote methods, has gained popularity in all fields of actual pandemic-era medicine.[15]

This review aims to evaluate the current status, benefits, and challenges of eHealth applications in the management of Chronic Obstructive Pulmonary Disease (COPD).

Increasing Need for E-health

Two critical factors, healthcare costs and a shortage of healthcare workers, are exerting increasing pressure on the healthcare system, compromising its quality, accessibility, and sustainability. [16] To ensure the provision of adequate healthcare, a reorganization of responsibilities is necessary. Traditional care is reactive, primarily focused on treating episodes of disease or derailments. However, evolving care demands necessitate a more proactive approach.[17] This can be achieved through timely disease detection, complication prevention, and continuous structured monitoring of patients to identify care gaps and adverse changes in their condition, thereby ensuring a quicker response to these changes and complications. Additionally, a proactive policy should empower patients to take an active role in managing their illness and well-being.[16]

Elements of Consideration for Practicing E-health

Patients' age, education, experience in technological devices, cognitive, motor, and visual abilities or deficits, their families, and home environment play an important role in the use of technologies.[18] A key topic of debate on the

use of digital health interventions also lies around factors driving engagement; as well as the accessibility and availability of the technologies for individuals.[17] The pandemic of COVID-19 has put digital tools and the possibilities of the Internet to the test, but it has been shown that many Internet users have started using digital services more frequently than before or tested them for the first time during this particularly challenging time.[14-19]

Benefits of E-health

Implementing flexible telemonitoring systems that are tailored to patients' needs, having adaptable models for various healthcare contexts, and having the ability to- identif ideal candidates, timing, and duration is crucial for optimal use.[20] The deployment of eHealth enhances healthcare accessibility, leading to better patient understanding of their disease, increased sense of control, and improved willingness to engage in self-management. Innovative self-management solutions like eHealth can promote the independence of chronically ill patients, although the quality and effectiveness of various online platforms and resources may vary.[21] Telemedicine presents certain challenges but has numerous benefits, including sustained access to healthcare and reduced virus transmission among healthcare workers.[15] Management at a distance has proven to be a promising approach for healthcare professionals to provide support and interact with patients and their families.[22]

Current Status of E-health Use

E-health applications encompass the processes of storing data, conducting diagnoses and treatments, and evaluating outcomes of healthcare services as a whole in an electronic environment, presented in a web-based format.[23] Various monitoring systems, such as smartwatches and diabetes monitors, have been developed with the help of advances in technology. These systems can integrate with mobile applications and transfer real-time data to hospital servers, thereby improving the effectiveness of remote monitoring by efficiently managing patients' health information.[24] eHealth is an emerging field that refers to the delivery or enhancement of health services and information through the internet and related technologies, at the intersection of medical informatics, public health, and business.[25] Effective information management techniques, including real-time monitoring, data storage, transfer, retrieval, and updates, are essential for improved clinical decision-making, which can lead to timely response to chronic conditions and help prevent mortalities and provide quality care to the patients. An eHealth tool comprises the way the information is presented, delivered, and received by the program used (software). Although the eHealth tools used in clinical settings and research studies vary in features, there is no consensus on which feature has the greatest impact on the outcomes.[26]

Current COPD Patient Follow-up

The frequency of follow-up appointments for COPD patients may vary depending on the patient's clinical condition. Patients with early-stage COPD may require follow-up appointments once or twice a year, while patients with advanced-stage COPD may require more frequent follow-up appointments, such as every 3 months.[27]

During COPD follow-up appointments, healthcare providers should monitor the patient's exposure to risk factors, disease status, impact on daily life, prognosis factors, disease progression, complications, treatment effectiveness, treatment side effects, physical activity, and comorbidities. Evaluating the patients' inhaler drug use is also necessary at each follow-up. If the patient's symptoms persist despite drug therapy, referral to a rehabilitation center may be necessary.[28] Pulmonary rehabilitation can be an effective intervention for COPD patients whose symptoms do not respond to standard treatments. Studies have shown that pulmonary rehabilitation can improve shortness of breath, exercise capacity, and health status in COPD patients.[29]

Research has also indicated that pulmonary rehabilitation initiated after hospitalizations due to COPD exacerbation can reduce subsequent hospitalizations and the risk of death. Early referral to pulmonary rehabilitation may also be cost-effective.[30,31]

Aspects To Be Improved in Current Follow Up of COPD Patient

Chronic obstructive pulmonary disease (COPD) patients are a heterogeneous group with varying physiological parameters, experiencing a general decline in their health status. The decrease in physical, emotional, and social functions following the decline in lung functions in COPD patients causes a deterioration in quality of life. One of the most important issues in the follow-up of patients with COPD is the recognition of the need to improve outcomes following admission due to exacerbation. This has led to the development of discharge packages and new care pathways. Despite developing approaches to acute management, COPD patients are usually re-hospitalized within weeks of discharge.[32]

Patients with COPD fear hospitalization, and studies have shown that they prefer to treat exacerbations at home.[33] Recognizing this, a holistic approach is required for optimal clinical management of COPD, focusing not only on airway obstruction or the respiratory system but also on the overall well-being of the patient.[34] In the integrated

care workshop hosted by the American Thoracic Society in 2012, this holistic approach was defined as "ensuring that [the patient] achieves and maintains independence and functionality in society to reach the optimal daily life and health status aimed for each patient with chronic disease".[35]
Integrated care in COPD includes management support, clinical information systems, decision support guided by clinical guidelines, and the use of healthcare organization and community resources to address patients' medical, social, psychological, and cognitive needs.[35] By providing rapid medical intervention in the early stages of deterioration in the clinical condition of the patient through follow-ups and integrated care, hospitalizations can be prevented, and the cost and time spent on transportation to health centers can be reduced. Furthermore, monitoring the patient with a more holistic model using the opportunities provided by technology can improve the follow-up of patients with COPD.

Self-management on COPD
Electronic health (eHealth) has shown promise in improving self-management and health outcomes in individuals with chronic obstructive pulmonary disease (COPD).[36,37] One potential strategy is to optimize self-management by using personalized, time-dependent thresholds or predictive algorithms, as the lack of awareness and timely intervention can lead to exacerbations and hospitalizations. Moreover, the emergence of artificial intelligence and wearable devices in the healthcare industry can revolutionize COPD management.[38]

Table 1. *Studies that have used various methods of remote self-management and its potential utility in COPD.*

Methods	Studies (n)	Examples of Its Potential Utility
Telemonitoring via wireless or corded medical device	4	Smart mobile health tool for self-management of COPD exacerbations: • Mobile phone spirometer • Pulse oximeter • Forehead thermometer
Smartphone applications	1	Smartphone application-based self-management program: • Smartphone app (self-monitoring, recording exercise data, symptoms, bronchodilator use, healthcare use due to exacerbations) • Educational materials • Pedometer • Weekly group education and exercise sessions in the first month • Prescribed individualized exercise sessions • Communication via phone or messaging research team and other
Web/Internet-based platforms	9	Home-based PLB re-enforcement sessions via video conference Single exposure to educational materials viewed at the clinic • Clinical video physician-led video, providing clinical information about COPD symptoms and self-management strategies • Lay video included patients' role playing a scenario offering opinions and narratives about COPD self-management multi-component home-based COPD disease management: • Components included self-management program, home monitoring, and e-health telephone/web platform • Self-management program was based on "Living Well with COPD" program • Participants completed telephone questionnaire • Participants recorded days they experienced worsening symptoms • E-health telephone/web platform allowed timely participant follow-up for early detection of potential exacerbations and worsening symptoms

Remote monitoring technology is one such example that involves the daily use of a laptop or a tablet with monitoring equipment, with results received by the healthcare professional. The monitoring equipment can include a sphygmomanometer to measure blood pressure and heart rate, a pulse oximeter to measure oxygen levels in the blood, a spirometer to measure lung function, a thermometer, and other devices. Although most interventions involving remote monitoring were not specifically self-management interventions, regular phone calls with healthcare professionals and completion of health questionnaires were used to manage symptoms in some cases.[39]

Impact of Biomedical Engineering Innovations on COPD Practice

In addition to routine chronic disease follow-up in COPD patients, scientific organizations in the respiratory field have declared that up to 80 percent of acute exacerbations can be managed remotely or in outpatient clinics.[40] Transcutaneous CO2 and O2 measurement, remote cardiac electrical activity monitoring via wireless electrodes, respiratory rate monitoring with a single finger sensor, saturation monitoring with pulse oximeters using photodiodes as a semiconductor, determination of body composition with bioelectrical impedance analysis to evaluate the patient's weight loss and nutritional status , automatic blood pressure monitors working on the oscillometric principle, thermometers and sensors that evaluate the air quality in the work and home environment; all these devices show the impact of innovation in health technologies on human life and medical clinical practice.[41]

Although the patient's will and responsibility play a leading role in the patient's self-management in the follow-up of the chronic disease; the patient-physician relationship and the involvement of the caregiver are also important. Therefore, providing continuity of communication between stakeholders in chronic disease management is another advantage of e-health applications. Many smart devices contain measurement, evaluation, and telecommunication infrastructure. Measurement data are updated daily in line with the requirements of chronic monitoring. In addition to this routine process; If sensors detect a low saturation value on pulse oximetry, a measurement in favor of hypertensive crisis, or a possible coronary syndrome on an electrocardiogram, they can alert the patient and healthcare provider.[42]

Practical applications of all these mobile technological applications are vital; since measurement outputs can be stored and re-evaluated, it allows many procedures such as prescribing and reporting to be performed remotely. Thus, it offers a solution and financial savings opportunity, especially in difficult geographies or in cases where the patient has mobility barriers.[43]

Patient Monitoring in COPD among Developments in E-health

Using eHealth applications in caring for patients with COPD is an attractive option due to the growing number of patients which places pressure on the quality, accessibility, and affordability of COPD care.[47] Telemedicine approaches such as telemonitoring and tele-education can help initiate an increase in treatment when necessary, with feedback to healthcare providers about changes in clinical conditions such as increased cough, shortness of breath, and fatigue, especially in patients with frequently exacerbating COPD.[27]

Furthermore, COPD patients are discharged from the hospital in an average of 6 days, even though clinical exacerbation typically lasts for about 12 days.[44] This requires the extension of care for a COPD patient who has not yet stabilized in their own home. The long exacerbation recovery time and shortened hospital stays have been reported as reasons why the rate of readmission to the hospital for any reason for 30 days is 20% in COPD patients.[45] In a study conducted in Turkey, the real-time mobile adaptive monitoring system developed for the diagnosis of asthma or chronic obstructive pulmonary diseases provides improvement in COPD classification accuracy and facilitates the follow-up of chronic lung patients.[48]

A meta-analysis of ten studies on telecare for COPD demonstrated a reduction in the number of emergency room visits and hospital admissions compared to control groups receiving standard care. Telemedicine has also proven effective in increasing physical activity levels in patients with COPD. Established digital tools have already been shown to effectively support exercise programs in COPD.

Participants generally have positive perceptions and experiences using eHealth tools for exercise training, although healthcare staff tend to be more skeptical. However, a study by Rassouli et al. further demonstrated the feasibility and acceptance of a digital pulmonary rehabilitation intervention. Tele-rehabilitation for COPD patients can provide improved care, particularly for those who are geographically or socially isolated, have time conflicts, or are unable to attend regular physician visits due to comorbid conditions.[43]

Tele-monitoring enables the monitoring of variables such as respiratory rate, cough, dyspnea scores, and pulse oxygen saturation measurements. It also allows for the early diagnosis and treatment of accompanying co-morbid exacerbations such as decompensation of heart failure and daily weight monitoring.[27] A meta-analysis of ten studies on telecare for COPD demonstrated a reduction in the number of emergency room visits and hospital admissions compared to control groups receiving standard care. [46] Telemedicine has also proven effective in increasing physical activity levels in patients with COPD.[44] Established digital tools have already been shown to effectively support exercise programs in COPD.[49,50,51]

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Conclusion

With the multiple changes associated with the COVID-19 pandemic era, the development and use of technologies to promote remote monitoring, improve patients' literacy and maintain efficient communication with the patients for more effective self-management is of primary importance. Although more research in this field is needed, a return to the days without telecommunication in health is highly unlikely. Thus, we need to continue to adapt our way of doing things for this new and improving standard of care. Pre-defined tags in self-management at a distance are necessary to continue to evolve and innovate. If we want to make progress, eHealth should be embedded into regular care as an adjunct or enhancement to current self-management interventions with better study quality. Since COPD is a chronic disease, long-term involvement seems crucial.

Finally, there is a need for studies to assess the preferences of various patients and the best platform for patients that is easy to use, as well as the related costs.[39] This will help optimize the implementation of eHealth interventions and ensure they are accessible to all patients, regardless of socioeconomic status or geographic location.

In summary, the use of eHealth applications in the care of patients with COPD has shown promise in improving patient outcomes and reducing healthcare costs. Telemedicine approaches such as tele-monitoring and tele-education can help initiate treatment increases when necessary and provide early diagnosis and treatment of accompanying co-morbidities. Additionally, tele-rehabilitation can offer enhanced care for patients who are geographically or socially isolated, have time conflicts, or cannot attend regular physician visits due to comorbid conditions. However, further research is needed to assess the preferences of patients and healthcare providers, optimize the implementation of eHealth interventions, and ensure the long-term involvement of patients in self-management interventions delivered via telehealth.

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