

# Chronic Respiratory Diseases: Treatment and Prevention

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## ABSTRACT

The article investigates the therapeutic and preventive aspects of chronic respiratory diseases. The authors note that chronic respiratory diseases are among the most common non-communicable diseases worldwide, mainly due to the widespread distribution of harmful environmental, occupational and behavioral inhalation effects.

In addition to chronic obstructive pulmonary disease (COPD) and asthma, chronic respiratory diseases include interstitial lung disease, pulmonary sarcoidosis, and pneumoconioses such as silicosis and asbestos. Unfortunately, chronic respiratory diseases have received proportionally less public attention and less research funding than other diseases such as cardiovascular diseases, cancer, stroke, diabetes and Alzheimer's disease. Therefore, in order to better inform about the prevention, screening, treatment and research on chronic respiratory diseases, it is extremely important to understand their prevalence, morbidity and mortality both globally and regionally.

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## INTRODUCTION

Chronic respiratory diseases are a serious public health problem: an estimated 3.91 million people died from them in 2017, accounting for 7% of all deaths worldwide. Chronic obstructive pulmonary disease (COPD) and asthma are the most common types of chronic respiratory diseases. Pneumoconiosis, interstitial lung disease and pulmonary sarcoidosis are also global public health issues. These four types of chronic respiratory diseases are associated with demographic trends, socio-economic development and risk exposure, including smoking, environmental pollution and occupational pollution, as well as metabolic risks.<sup>1</sup>

The aging of the population has increased rapidly over the past three decades. The prevalence of smoking decreased by 28.4% among men (men and boys) and by 34.4% among women (women and girls), respectively, with significant geographical heterogeneity. Moreover, socio-demographic development, economic shifts and exposure to risks have changed significantly over the past decades. As a result, the prevalence of chronic respiratory diseases has changed significantly.

The situation described above actualizes the need to intensify the processes of treatment and prevention of chronic respiratory diseases.

## MATERIALS AND METHODS

In the process of writing the work, special literature was examined within the framework of the research topic, the material was processed using comparative research methods.

## RESULTS

Chronic respiratory diseases are widespread disorders that require significant medical and financial costs. They disrupt the lives of millions of people around the world, significantly increasing morbidity and mortality. This requires development if there is easy access to prescription drugs at a reasonable price. Thus, 82% of the population consider the high cost of medicines to be a big financial burden for themselves. In addition, the lower cost of alternative prescription drugs creates other problems.<sup>2</sup>

While some medications have been evaluated as highly effective and thus justifying their high cost, more affordable and less expensive medications may not only be extremely ineffective, but may also potentially be harmful. This motivates to find solutions that will provide patients with access to medicines that are not only affordable, but also effective in treatment.

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In North America and Europe, medicines are the main item of expenditure for the treatment of patients with respiratory diseases. Studies have shown that 68% of all treatment costs in Canada and 51% in the United States were related to drug costs. In Europe, the share of medicines in the total cost of treatment in European countries ranges from 45% in Spain to 84% in Germany between 1999 and 2002. This problem is compounded by the ever-increasing prices of medicines.<sup>3</sup>

The burden of chronic respiratory diseases is particularly high in low-income countries. The medical facilities available in these countries are not able to provide effective treatment for chronic respiratory diseases, so it is extremely important to develop accurate diagnostic tools and provide easy access to cost-effective medicines. Consequently, this has led to further increases in drug prices, which exacerbates the problem of non-infectious lung diseases when patients do not receive proper treatment.

COPD is expected to become the fifth leading cause of disability and the third leading cause of death worldwide. Old age is considered one of the key factors in the severity of respiratory diseases, especially in developing countries. It is assumed that the prevalence of COPD in the world will increase with age to about 10% among people over 40 years of age.

COPD has become the third leading cause of death in the United States and the fourth in the world. Old age is the main factor leading to the pathological development of chronic lung disease in the elderly population. In the United States, the incidence of COPD is projected to be 3.2% between the ages of 24 and 44 and 10.3% between the ages of 65 and 74.<sup>4</sup>

An increase in mortality from COPD, pneumonia with age was revealed. Aging can weaken the body's defenses in both viral and bacterial pneumonia. Elderly people are at greater risk of developing acute respiratory distress syndrome (ARDS), especially after episodes of pneumonia, sepsis or non-tuberculosis mycobacterial infections. It is known that COPD causes the development of sarcopenia, that is, the dysfunction of skeletal muscles associated with old age, which usually limits physical abilities, worsens health and even leads to death.

Taking into account the severity of sarcopenia syndrome and its high prevalence of 15%, there is a need to develop effective COPD treatment methods.

The advantage of the Internet of Things technology lies in the cost-effectiveness of sensors and unhindered monitoring of the time interval. Many types of chronic diseases that are difficult to recruit a sufficient number of cases due to limited budget and human resources can now be practically developed using the Internet of Things platform, as well as collecting a huge number of parameters that were previously considered impossible. In addition, an increasing number of doctors and scientists are planning to combine artificial intelligence technologies with the Internet of Things to help patients with chronic diseases understand and manage their lifestyle and treatment independently.<sup>5</sup>

Currently, in clinical scenarios, few studies or practices focus on disease prevention or prevention of disease risk factors. With the exception of regular physical examinations or a number of

screening programs for the population with high risk factors, such as low-dose lung cancer screening. However, experts in the field of health economics still maintain a wait-and-see attitude towards the screening program on a large scale of the population due to the burden of costs and benefits for the entire population. However, in some pilot trials, mobile phone applications, such as the Apple Research App, are used to register certain populations with various potential manifestations of diseases and to apply lifestyle interventions and efforts to prevent the disease from worsening in the future.

In addition, as part of research conducted with the support of the Bill and Melinda Gates Foundation and the United Nations Children's Fund (UNICEF), big data analysis tools to improve the vaccine delivery system in Pakistan. Instead of manually recording each person's data, experts applied immunization cards with a built-in near-field communication chip (NFC) to the local population and implemented a classification algorithm to clear incoming vaccine records and prevent potentially falsified records in real time. This system significantly reduced both the cost and workload of the immunization station and increased the efficiency of the service.<sup>6</sup>

One of the problems with a large population is aging, as more and more elderly people significantly increase the burden on the health care system. In China, the government has already built a hierarchical medical system to address the huge problem of chronic diseases due to the rapid aging of China's population. A recent national cross-sectional study found that 100 million people have been diagnosed with chronic obstructive pulmonary disease (COPD) in China, while only 12% of them have been diagnosed with COPD before, which means that most COPD patients are misdiagnosed or neglected.

In 2016, specialists developed a completely new portable spirometer in combination with a set of the Internet of Things medical system for automatic monitoring of patients with COPD, including 537 inpatient and 13,665 outpatients in Shanghai. In the system, the lung test data can be uploaded to the cloud, which the doctor can immediately receive on his mobile phone or iPad. Meanwhile, on the system platform, local doctors can easily obtain a consulting opinion from the medical staff of a higher-level hospital, including first-hand updated recommendations and instructions on quality control, as well as annotate the test result. This system simultaneously solved the problem of lack of resources and equipment, as well as gaps in specialized training and clinical experience between hospitals and doctors of different levels. It can also very effectively collect fragmentary information from patients, combine and analyze raw data atomically before they are queued for consideration by the appropriate team of clinicians.<sup>7</sup>

Unlike COPD, although asthma is also a popular chronic respiratory disease, it is more closely related to the living conditions of populations at high risk of various factors causing it, such as flower powder, dust or pet hair. However, all these factors are reported by retrospective data described by patients during a visit to the clinic or treatment of relatives. In combination with a patient's everyday handheld device, such as a cell phone or GPS device, doctors can now easily monitor some environmental parameters that can cause symptoms in patients and send an earlier warning and detection signal.

## DISCUSSION

The main problem of the quality of medical care for chronic diseases is how to monitor patients and help patients constantly cope with their diseases. Most medications for chronic respiratory diseases require lifelong treatment, as well as dose adjustment as symptoms worsen or the frequency of emergency care increases. However, the reporting system or the clinic home visit model used in the existing healthcare system is a huge obstacle to simultaneously passively reporting the progress of the disease. However, recently, more and more technologies based on the Medical Internet of Things (MIT) have been announced and tested in many preclinical or clinical trials, which constitutes a gap between the patient terminal and the healthcare terminal. On the MIT platform, patients are monitored wirelessly using low-power sensors that are either distributed across the patient's living environment or embedded in wearable clothing and furniture. While the advantage of the MIT is that at the same time there is neither a time scale nor a distance scale in any case. The signal will be simultaneously transmitted online and processed either locally or in the cloud to stratify the raw data and output the analyzed risk model stored in the system.<sup>8</sup>

When the preset value is exceeded, the MIT system will automatically report these emergencies to doctors or a medical team for timely assessment. With sufficiently complex algorithms, the system can also provide feedback to the patient's terminal, sometimes also called «biofeedback».

One example of the use of the MIT system for managing patient behavior is smoking cessation. Experts from the Netherlands have developed an optimized smoking cessation guide using text messages and summaries. In their study, they provide specific groups of medical professionals with the implementation of a smoking cessation system based on guidelines. And even in the text message system, as health care providers get access to the updated smoking cessation guidelines, this significantly increases the effectiveness of smoking cessation recommendations in their daily consultations.

Most modern pharmaceutical or hardware methods of treatment cannot completely avoid undesirable side effects, despite the use of methods such as an adverse drug reaction, the reporting system. However, due to limitations found in early prototypes, it could not account for all the side effects that could potentially occur with a large-scale production deployment, including the inability to broadcast instant notifications around the world. On the contrary, the Internet of Things platform, working around the clock and seven days a week, can provide feedback or warnings to both doctors and patients in order to quickly initiate procedures to treat side effects. Aerosol treatment of patients at home or in the community in China has prompted many doctors to publish a consensus on combining the Internet of Things platform with traditional methods of treatment.<sup>9</sup>

In addition, there is another study on the use of the Internet of Things system for the treatment of patients with stable COPD, in which a total of 600 patients in China participated. In addition to treatment with inhalers, rehabilitation of patients with COPD is also very important. Currently, there are several devices to help patients perform exercises and achieve gradual

recovery of lung functions. Also, specialists from New Zealand have developed a robotic assistance system that allows online monitoring of the rehabilitation of patients with COPD at home. In a study involving 60 patients with robot assistants, the authors of the system reported a significant increase in the frequency of their rehabilitation exercises.<sup>10</sup>

Smoking and air pollution are the two main risk factors for chronic respiratory diseases. The trend towards smoking and living in an environment with high levels of air pollution is steadily increasing, especially in developing countries. Another problem associated with chronic respiratory diseases is aging, which exacerbates the growing burden on health systems in many countries caused by an increase in the number of elderly people with diseases caused by COPD and lung cancer.<sup>11</sup>

Currently, there are opportunities for the Internet of Things to take a significant market share in the field of healthcare due to its advantages of low cost and easy accessibility. The cost of a radio frequency identification (RFID) chip is already very low, and a transmitter or sensor combined with a chip is also cheap. In addition, the non-invasive appearance and high portability make Internet of Things systems very attractive to doctors and researchers. It is estimated that more than 100 million people are diagnosed with COPD, while in the US this number is 14 million, making this market huge for chronic respiratory diseases that could potentially be captured by the Internet of Things.

Compared to the price of a drug for the treatment of chronic respiratory diseases, a device for monitoring the early symptoms of exacerbation or progression of a chronic disease is much more cost-effective. For example, when a COPD patient is diagnosed with the disease for the first time and a certain group of drugs is prescribed for treatment. According to the recommendations, he should have prescribed treatment and continue treatment until the end of his life. However, some patients would like to discontinue treatment when their symptoms improve or due to financial difficulties. This may lead to the fact that the existing treatment will be ineffective to improve the patient's condition. After all, the patient will visit the emergency department on an occasional cold day or after a flu attack, which will cost a lot of burden for healthcare.<sup>12</sup>

However, if the patients are under the supervision of the MIT system, on the first day when he stopped treatment, the system will automatically send him and his medical professional a reminder message to confirm the reason why he made the change. In addition, if the patient still retains autonomy, the system will closely monitor his condition, pathophysiology parameters such as spirometry, heart rate and oxygen saturation, etc. The objective degradation curve will be displayed on his own screen, as well as on the screen of responsible health professors. And he will instantly receive a reply message or call the nurse back. In most cases, patients return to the normal path and reverse symptoms or deterioration. This means that according to the MIT system, it looks like a hidden sensor or monitors to help patients avoid non-compliance with prescriptions. On the contrary, it could also save a lot of unnecessary costs for the deterioration of the disease caused by the loss of compliance.<sup>13</sup>

Another advantage of the Internet of Things is the real-time interaction it provides. In current situations, although there is

enough time for one visit to the clinic, the patient and the doctor talk face to face. But the conversation is mostly retrospective, focused on events that occurred in the interval between visits. In addition, the content of the subjective description is not always accurate. On the other hand, using the MIT platform ensures that all medical data or symptoms will be recorded or transmitted digitally. Patients will passively generate and provide medical data where sensors are invisible and ubiquitous, which means there are no spatial, temporal or demographic constraints to access the health system data source.<sup>14</sup>

Several studies have concluded that the use of new Internet of Things systems has allowed doctors to detect new risk factors or early symptoms associated with the onset of the disease, as well as promptly warn about the appearance of side effects, which will ultimately reduce the appropriate treatment costs and avoid mobility events.<sup>15</sup> Thanks to the versatility and high efficiency of systems using the Internet of Things, it is possible to study diseases beyond geographical and population restrictions, which benefits both doctors and patients in understanding diseases and, ultimately, improving the quality of healthcare on a global scale.

## CONCLUSION

Accurate information about the prevalence and burden of diseases is important for understanding its impact on quality of life, as well as for emergency care and public health planning. Accordingly, the use of innovative technologies in the field of prevention and treatment of chronic respiratory diseases will reduce the mortality rate from this disease and increase the number of patients going into remission.

## Author Contributions

All authors contributed in reviewing the final version of this paper.

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