The Application of online medicine in the diagnosis and treatment of pulmonary nodules in thoracic surgery

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Abstract

In recent years, with the continuous progress of medical imaging technology and the gradual popularization of low-dose computed tomography, the clinical detection rate of pulmonary nodules has significantly increased, and patients have an increasing demand for the diagnosis and treatment of pulmonary nodules. Online diagnosis and treatment services are a rapidly developing type of diagnosis and treatment model in recent years. While greatly improving clinical diagnosis and treatment efficiency, they also provide significant satisfaction to the needs of patients. At the same time, influenced by various factors, especially the increasing demand for patient diagnosis and treatment, the continuous improvement of online diagnosis and treatment functions and the continuous expansion of service scope have become research focuses. This article reviews the application and research progress of online diagnosis and treatment in patients with pulmonary nodules in thoracic surgery.

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The Application of online medicine in the diagnosis and treatment of pulmonary nodules in thoracic surgery

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Abstract

In recent years, with the continuous progress of medical imaging technology and the gradual popularization of low-dose computed tomography, the clinical detection rate of pulmonary nodules has significantly increased, and patients have an increasing demand for the diagnosis and treatment of pulmonary nodules. Online diagnosis and treatment services are a rapidly developing type of

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Key words

Internet hospitals; Online diagnosis and treatment; Pulmonary nodules; Thoracic Surgery

Introduction

At present, primary bronchogenic carcinoma is the highest incidence rate and mortality worldwide of human malignant tumor[1]. Pulmonary nodules are an important clinical manifestation of early lung cancer[2]. In recent years, with the continuous progress of medical imaging technology and the gradual popularization of low dose computed tomography (LDCT) examination, the clinical detection rate of pulmonary nodules, especially small nodules (diameter<5mm), has significantly increased[3,4]. This is obviously beneficial for early screening and diagnosis of lung cancer for people. Online diagnosis and treatment services are a rapidly developing type of treatment model in recent years[5]. While greatly improving clinical diagnosis and treatment efficiency, they also provide significant satisfaction of patients[6]. At the same time, influenced by various factors, especially the increasing demand for patient diagnosis and treatment of pulmonary nodules, the continuous improvement of online diagnosis and treatment functions and the continuous expansion of service scope have become

research focuses[7]. This article reviews the application and research progress of online diagnosis and treatment on the Internet in patients with pulmonary nodules in thoracic surgery.

Current research status of pulmonary nodules

In China, the detection rate of pulmonary nodules is increasing year by year, which is closely related to factors such as the increasing awareness of health care among the people in the past decade, the widespread use of low-dose spiral CT in health examinations, screening of high-risk groups for lung cancer, and the continuous improvement of high-resolution CT examination technology[8,9]. Due to many nodules being benign, it is difficult to diagnose a small number of early malignant nodules from all pulmonary nodules[10]. Therefore, achieving a balance between accurately screening for early lung cancer, avoiding missed diagnosis of malignant nodules, and avoiding excessive invasive biopsy and surgical rates for benign nodules has always been a challenge for clinical doctors.

Pulmonary nodules were clearly defined as focal, nearly circular, or increased density solid and subparenchymal lung shadows with a diameter of no more than 3 cm, manifested as single or multiple, usually not accompanied by atelectasis, hilar lymph node enlargement, or pleural effusion[10,11]. According to the number of nodules, they can be divided into solitary pulmonary nodules and multiple nodules. The former mostly has no obvious clinical symptoms, clear nodule boundaries in CT and increased density[11]. Multiple pulmonary nodules usually appear as a single pulmonary nodule accompanied by one or more small nodules[12]. Pulmonary nodules include benign and malignant nodules. Solitary benign pulmonary nodules are mostly granulomatous inflammation, hamartoma, etc., while malignant pulmonary nodules are more insidious in the early stages of onset and are mostly primary bronchogenic carcinoma[13,14].

At present, the clinical management and decision-making of pulmonary nodules vary from country to country around the world, but it is unanimously agreed that personalized treatment should be taken based on the patient's multifaceted risk factors and changes in CT and other imaging results[15,16]. The National Comprehensive Cancer New York (NCCN) clearly stated in its 2015 lung cancer screening guidelines that the size of lung nodules remains the primary indicator for clinical screening. For patients who do not meet the conditions for surgical treatment, long-term CT follow-up examination is recommended[17,18]. In the 2018 Chinese Expert Consensus on the Diagnosis and Treatment of Pulmonary Nodules, the clinical evaluation and management principles of solitary solid pulmonary nodules, solitary sub solid nodules, and multiple pulmonary nodules have been clearly defined[19]. Overall, the risk assessment of pulmonary nodules is mainly based on the size of the pulmonary

nodules, with dynamic imaging follow-up as the main management principle. Most clinical cases are complex and variable, and the application of imaging follow-up time based on nodule size is difficult[20]. Some scholars believe that it is necessary to conduct imaging follow-up for 12 weeks or even longer for the first diagnosed cases of pulmonary nodules[21]. In previous clinical studies, some pulmonary nodules have shrunk or even completely disappeared after several months or years of follow-up[22,23]. These nodules often belong to benign lesions and do not require surgical treatment. However, for some highly suspected malignant pulmonary nodules, surgical resection is performed directly, which reduces medical costs, radiation exposure, and psychological stress compared to those who have not undergone surgery[24].

The Current Situation of Online Diagnosis and Treatment

Definition of online diagnosis and treatment

Internet hospital is the application of the Internet in the medical field, which is the full chain and integration of the Internet in the medical field[25]. It includes various forms of health and medical services such as health education, medical information retrieval, electronic health records, disease risk assessment, online disease consultation and diagnosis, electronic prescription, remote consultation, remote treatment, and rehabilitation using the Internet as a carrier and technical means[26,27].

Policy support for online diagnosis and treatment

The development of "Internet plus medical and health" should be promoted, and it is proposed to gradually include eligible internet diagnosis and treatment services into the scope of medical insurance and carry out pilot projects for provincial-level institutions[28]. Since the outbreak of COVID-19, due to the rapid increase in the demand for Internet diagnosis and treatment in special periods, relevant policies also require medical institutions at all levels to actively organize online voluntary consultation, home medical observation and guidance and other services for COVID-19 with the help of "Internet plus", expand online medical service space, guide patients to seek medical treatment in an orderly manner, and relieve the pressure of offline outpatient services[29-31]. It encourages online follow-up and drug delivery services for some common and chronic diseases, to reduce the risk of cross infection for other patients during offline visits[32-35].

Advantages of online diagnosis and treatment

From the perspective of the medical value chain, internet diagnosis and treatment is a full chain of internet services that cover health management, disease prevention, diagnosis, treatment and

rehabilitation[36]. From the perspective of medical entities, internet diagnosis and treatment is a combination of the internet with six major entities: physicians, patients, hospitals, pharmaceutical companies, logistics companies, and insurance companies[37]. Internet diagnosis and treatment has various advantages such as full coverage of information, sharing of medical resources, personalized customization, and efficient disease management[38].

The core of the Internet is information interconnection. For patients, it can solve the problem of insufficient communication with doctors within a limited time, and it also can solve the problem of having to personally visit the hospital for medical consultation[26]. For physicians, the service delivery time can be extended, the service experience of young physicians can be increased, the legitimate income level of the physician group can be improved, and the professional value of physicians can be further reflected[26,39]. For hospitals, networked appointment, registration, and reception can improve operational efficiency and thus enhance patient satisfaction[39]. In addition, from the perspective of medical big data, internet diagnosis and treatment can accumulate and utilize massive medical data to support disease management, drug research and development, and healthcare system optimization[40]. Patients can carry out correct health management through their own health data and health interventions; Physicians can assist in diagnosis and continuous learning based on medical data; Pharmaceutical companies can use treatment data for drug development and precision marketing; Hospitals can use medical data to optimize internal performance evaluation and medical process management; Medical security departments and insurance companies can adjust payment policies, formulate reasonable premium pricing, and prevent excessive treatment based on medical insurance and treatment data[40,41].

Shortcomings of online diagnosis and treatment

There are still some details in the application process of online diagnosis and treatment on the Internet that need to be further improved and enhanced based on clinical practices. The main shortcomings include: Firstly, the quality control and regulatory system is not yet perfect. From clinical treatment to electronic medical records, internet hospitals also face quality control and regulatory challenges that this model needs to face, which requires continuous improvement and improvement of relevant laws and regulations[42]. Secondly, the degree of data integration and sharing still needs to be improved. At present, there are basically independent information systems in various medical institutions, and these "information silos" result in the inability to share patients' past medical records and information in various regions[43]. Thirdly, the overall proportion of patients seeking online medical treatment is not high enough, and it is necessary to strengthen education and

guidance, as well as strengthen training for grassroots medical personnel[44,45].

Status of traditional offline diagnosis and treatment for pulmonary nodules in thoracic surgery

It is a long-standing social phenomenon that it is difficult to register and seek medical attention when seeking offline medical treatment[26,46].

Firstly, its essence lies in the uneven distribution of high-quality medical resources, with most resources concentrated in tertiary hospitals in first tier cities and unable to sink to third or fourth tier cities, especially in relatively underdeveloped areas such as county towns and rural areas.

Secondly, when patients find pulmonary nodules with CT, most people still choose to go to tertiary hospitals in large cities for treatment. Grassroots medical institutions lack professional medical experts and cannot gain the trust of patients. They believe that only large hospitals have the best doctors, which is a stereotype in the minds of most people. This directly leads to a shortage of medical resources in large hospitals, high pressure on medical staff, and almost no one pays attention to places such as small hospitals and regular clinics.

Thirdly, even after being registered, patients who are close to the hospital still need to face the problems of waiting in line for medical treatment and traffic congestion; For patients who are far away from the hospital, additional expenses such as transportation, accommodation, and meals will be incurred due to medical treatment, which increases the time and money costs for patients to seek medical treatment.

Fourthly, with the increasing awareness of health care among the Chinese people, the widespread use of low-dose spiral CT in health examinations, screening for high-risk groups of lung cancer, and the continuous improvement of high-resolution CT examination technology, the discovery of pulmonary nodules is also increasing, and the number of patients seeking treatment for pulmonary nodules in outpatient clinics is also increasing.

As shown in Figure 1, based on the statistics of the number of lung nodule patients in our hospital's thoracic surgery department from January 2019 to December 2020, it was found that the monthly outpatient visits of lung nodule patients continued to increase from 432 at the beginning of 2019 to 851 at the end of 2020. The clinical detection rate of pulmonary nodules, especially small nodules (diameter<5mm), has significantly increased, which is obviously beneficial for early screening and diagnosis of lung cancer. However, the clinical management and treatment decision-making of difficult to diagnose pulmonary nodules have become a new challenge for patients and medical workers.

The impact of online services combined with offline outpatient services on the treatment of patients with pulmonary nodules

Our hospital obtained the "Internet Hospital" license in October 2019. In February 2020, our online business was fully launched and our system has been continuously improved. Currently, we have achieved internal and external network connectivity. The connection between the online Internet hospital platform and the offline HIS system enables online and offline patient transfer and data sharing. The two major information systems not only support hospitals to provide single online diagnosis and treatment services, but also extend hospital services to online or offline. It can provide continuous health management for patients, help them achieve the best treatment results, completely solve the drawbacks of fragmented data and processes in traditional independent systems, and ensure data exchange between different business functions online and offline from the system architecture level to achieve the full process operation of patient data.

As of May 2023, the West China Internet Hospital diagnosis and treatment platform has registered over 13 million users and more than 1800 medical staff, mainly providing diversified core medical services such as fragmented time online outpatient service, online scheduling appointment, online multidisciplinary diagnosis and treatment, online specialty, online free diagnosis, online follow-up, online chronic disease management, online rare disease consultation, online nutrition consultation, online rehabilitation consultation, online medication consultation, online nursing consultation, etc. We also provide full cycle and process services that cover pre, during, and post diagnosis, including appointment registration, intelligent guidance, disease self-examination, queuing, online payment, inspection appointment, inspection report query, image film retrieval, admission certificate issuance, drug delivery, medical record appointment mailing, electronic invoice query, in hospital navigation, intelligent customer service, and health education.

As shown in Figure 2, based on the statistics of the offline and online visits of pulmonary nodule patients in our hospital's thoracic surgery department from January 2021 to December 2022, it was found that the monthly online outpatient visits number of pulmonary nodule patients continued to increase from 2150 at the beginning of 2020 to 5289 at the end of 2022, with a very significant increase in the number of online visits.

For doctors, the internet hospital platform provides great satisfaction for the fragmented time application of doctors, while ensuring regular online consultations and medication purchases. Visiting doctors can fully utilize their fragmented time to solve relevant problems raised by patients in a timely manner without having to wait until the outpatient day to handle them.

For patients, it brings more benefits: Firstly, inspection, examination, and prescription renewal.

Online issuance of inspection, examination, and prescription renewal greatly facilitates chronic disease patients who need long-term medication and regular examinations, especially postoperative patients who have regular follow-up examinations. Secondly, post examination consultation and health assessment. Online doctors precisely meet the needs, fully leverage the characteristics of the discipline and the advantages of the specialty, and provide comprehensive post examination consultation services. Thirdly, health assessment for patients screening and referral of pulmonary nodules. Like offline consultations, online consultations also involve many patients who do not know which subject to consult, or pulmonary nodules with multiple system diseases, requiring doctors to conduct preliminary screening and evaluation before conducting specialized consultations. Meanwhile, due to the limitations of online consultation, if the patient's condition is complex and cannot be comprehensively evaluated based on the current described condition, they can be referred to an offline outpatient clinic for a more detailed understanding of the condition. Fourthly, solving the problem of seeking medical treatment in different places, without leaving home and having more comprehensive doctor-patient communication. Online diagnosis and treatment can enable patients in areas with scarce medical resources to enjoy high-quality medical services in big cities. Patients can describe their condition more clearly through text, pictures, and other forms, allowing doctors and patients to exchange more information and improving the quality of treatment of patients.

Conclusion

Strengthening the construction of internet hospitals and achieving two-way referral and integrated online and offline full process management, is one of the important means to implement China's supply side structural reform and deepen medical system reform[45,47]. It has played a positive role in promoting new urbanization and smart city construction. This change will promote the rational optimization of health industry resource allocation, improve the quality and efficiency of health industry supply, enhance people's sense of gain, and implement the Healthy China Strategy as soon as possible[48-51].

Declarations

Competing interests

The authors have no conflicts of interest to declare.

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Consent for publish

All the authors consent to publish the paper.

Authors' contributions

CS was involved in drafting the manuscript. XY, KL, CG and QS were involved in acquisition of data. QP designed and revised the manuscript. All authors have read and approved the final manuscript.

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A practical algorithmic approach to the diagnosis and management of solitary pulmonary nodules: part 2: pretest probability and algorithm

Pulmonary nodules: do we need a separate algorithm for non-solid lesions?

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Figure legends

Figure 1: Number of offline outpatient visits for patients with pulmonary nodules in thoracic surgery under traditional mode

Figure 2: Comparison of the number of visits to patients with pulmonary nodules in online and offline thoracic surgery

Supplementary Files