Commentary

Prevention and Treatment of Pneumoconiosis in the Context of Healthy China 2030

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Since the onset of reform and opening-up policies, China has risen to become the world's second-largest economy. This transformative period has witnessed considerable advancements in medical services provision, resulting in significant improvements in the overall healthcare landscape. A noteworthy accomplishment is the creation of the world's largest and most comprehensive social security system. Adhering to principles of inclusivity, multi-tiered coverage, and long-term sustainability, this system guarantees the fulfillment of basic life necessities. By the end of 2022, over 1 billion individuals were covered by basic old-age insurance, 238 million by unemployment insurance, 291 million by work-related injury insurance, and more than 1.3 billion by basic medical insurance (*1*). Despite extraordinary progress, noticeable gaps remain in healthcare and support services. This is especially true for migrant workers suffering from pneumoconiosis, a condition induced by prolonged exposure to dust in the workplace.

Advancements in the Prevention and Treatment of Pneumoconiosis in China

Current situation As of the end of 2021, China reported approximately 951,000 pneumoconiosis cases, constituting a significant portion-90%-of all occupational disease cases. There are approximately 450,000 active cases of occupational pneumoconiosis, primarily from coal workers' pneumoconiosis (CWP) and silicosis (*2*). Unfortunately, there are scarce effective pharmaceutical interventions and technologies to halt the progression of pneumoconiosis, which often coincides with other conditions such as pulmonary tuberculosis (PTB), chronic obstructive pulmonary disease (COPD), pulmonary arterial hypertension (PAH), lung cancer, and mesothelioma; these comorbidities further degrade patients' quality of life. Alarmingly, statistical data indicate that approximately 7.5% of pneumoconiosis patients in China also suffer from PTB (*3*). Pneumoconiosis remains the most prevalent and severe occupational disease nationwide.

Efforts and achievements The Chinese government has shown a consistent commitment toward the prevention and management of pneumoconiosis. In the 1960s, a robust set of dust prevention measures, known as the Eight-Figure Policy, was established. This strategy included technological innovation, wet dust removal, sealing, ventilation, personal protection, administration systems, health education, and audits, whereby it adopted a comprehensive approach that resulted in significant outcomes. Later, in the 1980s, the People's Republic of China promulgated the Regulations on Prevention and Control of Pneumoconiosis, which was further bolstered by the introduction of the Law on Prevention and Control of Occupational Diseases in 2002, coupled with relevant regulations. This series of legislative measures has formed a strong legislative framework for the prevention of pneumoconiosis.

A handful of nations worldwide, namely China, the United States, the United Kingdom, New Zealand, Germany, and Finland, have established robust data collection systems relating to occupational disease (*4*). Over the prior decade, remarkable progress has been made in legislation, standardization systems, regulatory frameworks, prevention of occupational diseases, and dust control, all of which have been realized through the collaborative efforts of relevant institutions, departments, and governments at various levels. An administrative body has been established specifically to address occupational health hazards, thereby bolstering technical service capabilities and providing support within the occupational health field. Surveillance of occupational diseases and harmful agents has been expanded, with comprehensive measures being implemented to secure occupational health conditions (*5*). The results of these endeavors are undeniable — there has been a significant decrease in newly reported occupational diseases in China, from 26,393 cases in 2013 to 11,108 in 2022, representing a 58% reduction.

The continuing challenges Pneumoconiosis is universally acknowledged as the most common

occupational disease, representing a substantial public health concern globally. Numerous industries worldwide are associated with exposure to respirable crystalline silica (RCS) dust, the chief cause of silicosis. These industries encompass quarrying, mining, mineral processing, foundry operations, brick and tile production, refractory processing, and construction actions involving materials such as stone, brick, concrete, and insulation boards (*6*). Moreover, the risks posed by dust exposure pervade an array of sectors beyond conventional industries such as construction and building, extending to evolving sectors. These include stone cutting, kitchen benchtop fabrication with artificial stone, dental prosthetic creation, and even stone-washed jeans manufacturing (*7*).

Once controlled in developed countries, pneumoconiosis among coal miners has emerged anew in the 21st century, particularly in nations such as the United States and Australia (*8*). The rapid urbanization and industrialization process in China has exposed many secondary industry workers to dust, a leading contributor to pneumoconiosis. The coal mining workforce in China numbered six million prior to 1995, which has now dwindled to approximately 2.9 million. The high levels of pneumoconiosis incidence and prevalence rates among these miners nonetheless remains troubling (*9*).

The 2020 National Occupational Hazard Survey unveiled startling results regarding the state of China's leading industries — mining, manufacturing, and electricity, gas, and water production and supply. The survey indicates that an estimated 69.3% of businesses in these sectors are exposed to dust hazards. Moreover, approximately 47.4% of the workforce exposed to work-related hazards are at risk from dust-related dangers (*10*). Given the long latency period of pneumoconiosis, which typically spans 10 to 20 years or more, it is plausible to anticipate a significant surge in new pneumoconiosis cases in upcoming years. It is of equal concern that employment injury insurance covers less than 30% of migrant workers, who primarily constitute the workforce in dust-exposed environments. The absence of sufficient insurance coverage amplifies the difficulties in diagnosing, treating, and providing medical support to those affected by pneumoconiosis. Therefore, these challenges emerge as crucial present and prospective public health concerns in China.

Present Features and Challenges

Legal, regulatory, and governance frameworks Substantial revision is needed in the existing regulations and technical standards aimed at pneumoconiosis prevention and control. Their outmoded state impedes accommodation of both individual and private organizations thriving in the present market economy. This lack of alignment extends to workers involved in labor dispatching, outsourcing, platform-based engagements, and part-time employments. Furthermore, there is a dearth of early warning systems and prompt control strategies for managing emerging hazards.

Second, the approach to occupational disease management in numerous small to medium-sized enterprises confronted with dust-related risks is deficient. These workplaces often exhibit dust concentrations that fail to align with national health standards, lack essential dust-control facilities, and display inconsistent implementation of compulsory occupational health surveillance. This raises the implication that official reports may underrepresent the true extent of occupational diseases in China.

Third, the efficacy of occupational health supervision, particularly at the county level, is impeded by a lack of dedicated professionals with expertise in occupational health. This personnel deficit hampers the capacity of such supervisory entities to appropriately execute their regulatory functions.

Diagnosis and management of diseases Current diagnostic methods for occupational pneumoconiosis lack cohesion, and the onus of managing labor relations and work-related injury compensation does not fall on the health department. This fragmented system hampers medical and health institutions from efficiently collecting employment histories and occupational disease data. Furthermore, there is anoticeable deficit of scientific criteria for diagnosing pneumoconiosis in the clinical field. Presently, the process of diagnosing occupational pneumoconiosis heavily relies on comparing patients' chest X-ray images to a standardized reference film. However, this comparison method fails to optimally assist with early diagnoses, disease assessments, and prognosis guidance. Furthermore, a common issue is that patients often find this diagnostic process difficult to comprehend, which further complicates the situation.

Technical assistance and scientific proficiency The dearth of robust, thorough research on the hazards associated with dust has hindered significant progress in fundamental theoretical explorations. This scarcity of dedicated inquiry into such critical scientific issues impairs the progression of innovative technologies.

Additionally, the unavailability of extensive and transferable pneumoconiosis reporting systems makes it difficult to ascertain reliable morbidity and mortality rates. This uncertainty prevents both researchers and the general population from acquiring a comprehensive understanding of pneumoconiosis, thereby obstructing the development of region-specific and departmental policy measures for preventing and managing this disease. A lack of cross-disciplinary expertise for preventing and treating of pneumoconiosis has led to inferior professional and technical standards for diagnosing and treating occupational health ailments compared with non-occupational respiratory diseases. The sporadic accessibility of national clinical resources and pertinent biometric information related to pneumoconiosis hampers the feasibility of conducting in-depth research in this area.

Approaches to the management of pneumoconiosis A holistic approach is deemed most effective for the management of pneumoconiosis, incorporating elements such as smoking cessation, oxygen therapy, rehabilitation, pharmaceutical interventions, and the consideration of innovative lung transplantation techniques for end-stage disease. The primary goals are to retard the degradation of lung function, deter disease progression, enhance patients' quality of life, prevent complications, and lower mortality rates. However, a substantial deficit remains in the inclusive theoretical and experiential research in this domain. An array of patients grapple with the long-term financial burden stemming from healthcare costs. Community-based medical insurance frequently falls short, leaving patients with restricted resources for self-management. This consequently results in a significant number of patients deficient in efficient management of complications, fostering rapid disease progression, and resulting in escalated disability and mortality rates.

Industrial injury insurance as a component of social security The existing industrial injury insurance system grapples with numerous challenges in its designand implementation. These encompass inadequate coverage for migrant workers, limited access for most independent workers, and problems encountered when trying to access industrial injury insurance benefits following a change of job. Given their high levels ofmobility and unclear labor relationships, migrant workers often have difficulty documenting their history of occupational dust exposure. Consequently, establishing a causal link between their illnesses and occupational factors can be problematic. Individuals with pneumoconiosis are inadequately protected, facing hurdles such as limited re-employmentopportunities, financial strains due to their health conditions, and insufficient social support.

Recommendations and Future Directions

The endorsement of the Healthy China Initiative at the 19th National Congress of the Communist Party of China reflects a commitment to public health, population wellbeing, and the establishment of a healthy nation. To realize the goals set forth in the Healthy China 2030 Planning Outline, the General Office of the State Council advanced the Opinions on Implementing the Healthy China Action. Within this framework, the Occupational Health Protection Action was conceived to enhance prevention and management of occupational diseases, including pneumoconiosis. Adhering to the objectives outlined in the Action Plan for the Prevention and Control of Pneumoconiosis, it is anticipated that by 2022 and 2030, there will be a significant and continuing decline in the ratio of new pneumoconiosis cases reported from workers with less than five years of dust exposure to the total number of annual reports.

The evidence from our analysis suggests a significant influence of several social and risk factors on the rising prevalence of pneumoconiosis among coal miners in China. Factors such as societal coal demands, industrial strategies, coal industry workforce size, employment structures, coal productivity, enterprise characteristics, scale of operations, mining technologies, dust control strategies, occupational health evaluations, pneumoconiosis diagnosis and reporting systems, occupational health management and regulation, and social security provisions all contribute to the issue. Consequently, it underscores the need for a comprehensive, multidisciplinary initiative across scientific, engineering, medical, managerial, societal, political, economic, and legal sectors to effectively address and ultimately eradicate pneumoconiosis.

In accordance with the "Healthy China" initiative, there is a pressing need for proactive strategies. These should comprise legislative and regulatory improvements, progress in the categorization and diagnosis of pneumoconiosis, fortification of management procedures, bolstering of technical support and scientific capabilities, along with the broadening of industrial injury insurance and social security provisions.

Laws, regulations, and governance systems The

mandates stipulated in the Law of the People's Republic of China on the Prevention and Control of Occupational Diseases and the Regulations on Work-Related Injury Insurance, along with its associated laws and standards, necessitate a thorough and systematic examination. With regards to both core health promotion guidelines and the distinct attributes of the primary stage of socialism, the establishment of a cost-effective occupational health service framework is recommended. Moreover, initiating supplementary liability insurance for employers at a heightened risk of pneumoconiosis could be considered beneficial. Appropriate interventions such as these could significantly improve the monitoring and control of dust-related hazards.

In the field of occupational health management, it is crucial to develop and apply novel strategies. An approach under consideration involves the fusion of on-site supervision, law enforcement, as well as hazard detection and assessment, piloted in certain industries or regions. This tactic intends to improve management of supervision information through network-based systems. Additionally, it is important to investigate the potential for developing a governance structure for registered occupational hygienists. An essential focus should be the cultivation of a collaborative linkage mechanism that includes grassroots governments, fostering cross-sectoral cooperation. This mechanism would necessitate the formulation of a tripartite coordination framework that involves workers, employers, and governmental entities. Furthermore, a paramount objective is to devise a rating and blacklisting system for occupational disease prevention and control. This system would establish and enforce accountability and deterrence, thereby facilitating rigorous actions against illegal activities.

Diagnosis and management strategies A proactive stance must be taken towards establishing a solid framework for the clinical identification and determination of pneumoconiosis. In light of the specific dynamics related to clinical identification and occupational attribution in patients suffering from pneumoconiosis, it is deemed necessary to reform the system for the diagnosis of occupational pneumoconiosis in two critical ways, drawing upon practices from developed countries dealing with occupational diseases. The revised system should fundamentally consist of two parts: the clinical identification of pneumoconiosis that is linked with the recognition of occupational exposure and causal connections; and second, the onus should fall on regulatory entities to confirm essential information required for the diagnosis of occupational diseases.

Additionally, the proposal recommends integrating pneumoconiosis into the basic social medical insurance framework. This action would facilitate parity between routine and occupational injury medical insurance. Patients diagnosed with occupational pneumoconiosis would hence have access to occupational injury medical insurance coverage. We encourage a more extensive application of existing policies — including basic medical insurance, critical illness insurance, medical aid, public welfare assistance funds, and life assistance programs — for those individuals not protected by occupational injury insurance or those whose employers have ceased operations.

Technical assistance and scientific proficiency The establishment of an integrated medical innovation system connecting scientific research, prevention, diagnosis, and management of pneumoconiosis is of critical importance. This warrants the strengthening of fundamental research facilities and platforms in medical institutions, in addition to enhancing the effective allocation of resources for public health and medical initiatives. A proposal for a nationwide, open pneumoconiosis information reporting system, bolstered by an expansive national database encompassing clinical resources and biometric information associated with pneumoconiosis cases, is tabled. It is worth underscoring the significance of enhancing the education and training structure, with the aim of integrating public health education and clinical medical perspectives. This effort calls for the reinforcement of educational and training institutions responsible for nurturing the requisite skills and competencies for pneumoconiosis prevention and management. Moreover, increasing investments in scientific research centered on dust prevention and control as well as the diagnosis and management of pneumoconiosis is advocated to widen and deepen our comprehension in these fields.

A comprehensive approach to healthcare management in patient care The inclusion of pneumoconiosis prevention and management within the foundational public health service system is advocated. Such a process necessitates an escalation in funding, reinforcement of the closed-loop dynamic management model, and a broadening of the multi-tier rehabilitation system. This expansive network incorporates representatives at the state, provincial, city, county, and town or community level, in addition

to families and individuals. The proposition also extends to the establishment of a national occupational disease medical rehabilitation guidance center to augment the proficiency of primary medical rehabilitation.

Patients with pneumoconiosis should receive targeted treatment, medical interventions, and comprehensive health management based on their individual risk assessment. With the growth of China's economy, priority should be given to initiating occupational health exams and follow-up care for dust-exposed workers who have left their positions. This initiative should first be trialed in more developed provincial-level administrative divisions before gradually being implemented nationwide. The ultimate goal is to guarantee comprehensive, lifelong health management for all workers exposed to dust.

The call for a robust medical innovation system encompassing scientific research, prevention, diagnosis, and treatment of pneumoconiosis is both immediate and paramount. To achieve this, a significant strengthening of primary research facilities and platforms in medical institutions is necessary, in tandem with an increase in the efficiency of public health and medical resource allocation. We strongly advocate the inauguration of a nationwide pneumoconiosis information reporting system, coupled with developing a comprehensive database for national pneumoconiosis clinical resources and biometric information. There is also a need to enhance our education and training framework. This will require integrating public health education and clinical medicine to ensure a holistic learning experience. Subsequently, we propose the expansion and improvement of education and training centers dedicated to fostering expertise in pneumoconiosis prevention and management. Furthermore, we suggest prioritizing increased investments in scientific research pertaining to dust prevention and control, along with research into the diagnosis and management of pneumoconiosis. We anticipate that this strategy will significantly advance our understanding and expertise in these crucial fields.

Industrial injury insurance in relation to social security

The initial stage in this process necessitates a comprehensive review and enhancement of laws and regulations pertaining to industrial injury insurance. The focus will transition from a mere compensation approach, moving toward more active prevention procedures. This methodology is designed to strengthen health advocacy and secure employment for workers endangered by dust-related hazards. The program seeks to encompass a varied workforce, which includes migrant labor(s), dispatched workers, outsourced personnel, platform-based and part-time employees, as well as participants in the gig economy. Considering the gradual and hidden progression of pneumoconiosis, it is vital to formulate a sturdy, long-term protection strategy for industrial injuries. This system should safeguard the health and welfare rights of those workers affected by pneumoconiosis, even after their departure from the workforce or retirement. Additionally, the suggestion to incorporate pneumoconiosis into the social basic medical insurance directory has been proposed, thereby allowing the parallel existence of medical insurance and industrial injury insurance.

Enhancing the medical security system is a vital progression which can be achieved through the execution of specific policies aimed at civil aid, and solidifying the creation of a linkage mechanism incorporating societal resources. This cooperative endeavor ensures a proactive role in bolstering medical security.

Advocacy is encouraged at the state level for the establishment of distinct national and local funding streams targeting pneumoconiosis. This includes the implementation of a specialized security framework with provisions for patients suffering from occupational diseases. These provisions are particularly aimed at patients whose employers have gone out of business or whose labor relations are unverifiable, ensuring they receive medical assistance and livelihood protection.

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