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Research on the Transformation Mechanism and Countermeasures of Scientific and Technological Achievements in Medical Universities

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Abstract

The transformation of medical scientific and technological achievements into actual productive forces is the key to realize the economic value of medical innovation activities and promote industrial development. Medical universities are the important subjects of the transformation of medical scientific and technological achievements, and its transformation level is of great importance to the innovation of China's medical industry. For a long time, the efficiency of technology transformation in medical universities in China is low, and there are still some problems, such as imperfect policy guarantee mechanism, low enthusiasm of achievements transformation in medical universities, and mismatching of scientific and technological achievements with market demand. To improve the transformation effect of scientific and technological achievements in medical universities, we should(1)Optimize the system design and perfect the transformation scheme of scientific and technological achievements in medical universities. (2) Do a good job in the overall deployment of the transformation of scientific and technological achievements at the university level. (3) Deepen industry-university-research collaborative innovation and boost the commercialization of pharmaceutical products.

Keywords

Medical Universities; Transformation of Scientific and Technological Achievements; Mechanism.

1. Introduction

At present, a new round of technological revolution is accelerating in the world. Countries around the world regard scientific and technological innovation as the key to enhancing overall national strength and competitiveness. Scientific and technological achievements represent the innovation ability of science and technology. In order to realize the economic value of science and technology, the industrialization scale of scientific and technological achievements must be realized, that is, the transformation process of scientific and technological achievements from the experimental research of the academic research end to the achievement entity of the industrial end. The effective industrialization of scientific and technological achievements needs to be laid out from the industrial chain and led by industrial technological innovation. Biomedical industry is an important part of high-tech industry, and a strategic emerging industry that China focuses on cultivating and developing. For the pharmaceutical industry, the transformation of medical scientific and technological achievements into realistic productive forces is also needed if the pharmaceutical innovation wants to play a real economic role. Therefore, to stimulate the vitality and improve the quality of the transformation of medical scientific and technological achievements is the key link to realize the close integration of medical science and technology with economy.

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As one of the important subjects of national innovation system, universities play an important role in scientific and technological innovation because of their social orientation and nature, large amount of information and talents gathering and multi-disciplinary development.In various researches, the scope of scientific and technological achievements mainly refers to the scientific research achievements produced by the subjects with research and development ability such as universities and research institutes. Therefore, universities are important participants and donors of the transformation of scientific and technological achievements. After a long period of economic development and social reform, higher education has spawned various types of universities. Medical universities are the main force for the cultivation of medical professionals and the development of scientific research in China, and the important subject for the transformation of medical scientific and technological achievements.However, the transformation effect of scientific and technological achievements in medical universities is not optimistic, and the transformation effect is low for a long time.Therefore, it is urgent to improve its transformation level.

2. Analysis on the Transformation Mechanism of Scientific and Technological Achievements in Medical Universities

2.1. Policy Analysis on the Transformation of Scientific and Technological Achievements in Medical Universities in China

The development of the pharmaceutical industry is closely related to various policies, and the innovation activities of universities cannot be separated from the guidance of the overall national policies. Therefore, sorting out the policies related to the transformation of scientific and technological achievements of medical universities can grasp the external resources and conditions of the current innovation and transformation of medical achievements from the perspective of innovation environment. At present, there is no Top-level design specifically for the transformation of scientific and technological achievements in medical universities in China. Macro policies related to the transformation of scientific and technological achievements in medical universities mainly come from three aspects:

First, innovation policies for the pharmaceutical industry. In 2006, *the Outline of the National Medium and Long Term Program for Scientific and Technological Development(2006-2020)* identified 16 science and technology projects, including *the National New Drug Innovation Program*, which supported the transformation of new drug products in China's research and development stage and effectively promoted the industrialization and economy of new drugs [1]. In 2019, the newly revised *Drug Administration Law* formulated a number of policies to encourage pharmaceutical innovation, explicitly encouraging and supporting the innovation of drugs that are clinically value-oriented and have clear therapeutic effects on human diseases. At the same time, it innovated the review mechanism, gave priority to review and approval, and optimized the management of clinical trials. Establish the drug marketing licensor system to stimulate the market vitality [2].

Second, policies to promote the commercialization of scientific and technological achievements. Mainly represented by the three deployment, *Promote the Conversion of Scientific and Technological Achievements of the People's Republic of China*, *the Implementation of the Law of the People's Republic of China to Promote Scientific and Technological Achievements Conversion Several Provisions* and *Action Plan for Promoting Transformation of Scientific and Technological Achievements Transfer* [3], they provides the policy basis and the key task for achievements for the transformation of scientific and technological achievements and in-depth implementation .

Third, policies for promoting scientific and technological innovation in universities. The "University Innovation Capability Enhancement Plan" (referred to as the "2011 Plan") launched in 2011 with collaborative innovation as the theme points out that the connotation

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development of higher education in China requires all universities to face the needs of science frontier and regional development, strengthen collaborative innovation, encourage universities to carry out in-depth combination of science and education and industry-university cooperation, and establish strategic alliances. Improving the yield of scientific research results [4]. *On Strengthening Institutions of Higher Learning Transfer of Scientific and Technological Achievements Transformation Work Several Opinions of the Technical Transformation* is of great significance in universities, guidance is clear, pointed out that universities should actively for economic and social development to provide a steady stream of scientific research achievements, from and to delegate encouraging achievements transformation and improve the results of transfer mechanism, strengthen the construction of the transforming ability of transfer [5].

2.2. Transformation Path of Scientific and Technological Achievements in Medical Universities

For universities, universities of science and technology achievement transformation can be understood as referring to occur in the technological innovation activity, the theoretical research, research and development, production process. For they do not have the ability to scale production and sales, thus to realize the industrialization of scientific and technological achievements of universities of science and technology must be output in the form of transfer, sell and transfer to the enterprise. Therefore, in the construction of the transformation path of scientific and technological achievements in universities, the end of transformation does not involve the final profit of products. Specifically, the transformation path of scientific and technological achievements in universities is mainly divided into two stages, as shown in Figure 1.

The transformation path consists of knowledge creation, technology research and development and technology transformation. The human resources invested by university researchers, the financial support obtained from various channels, research and development platforms and laboratories are the original inputs of the transformation of scientific and technological achievements, which are used to carry out university subject research and project experimental development. The first phase, the process of knowledge creation and technology research and development is the production of knowledge and innovation link, produce the knowledge such as papers, monographs, patent output, this part of the output and can be regarded as again for the second phase, the technical transformation of inputs, eventually to transfer technology to transfer or license to the industry end, in preparation for the subsequent production and sales of new products.

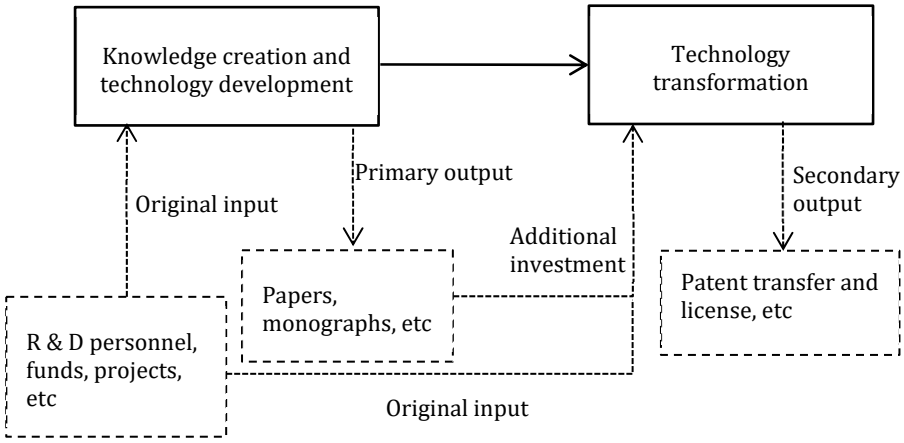

Figure 1. Transformation process of scientific and technological achievements in Medical Universities

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2.3. Characteristics of Transformation of Medical Scientific and Technological Achievements

Combined with the characteristics of medical innovation and the analysis of the transformation path of medical scientific and technological achievements, the transformation of medical scientific and technological achievements has its special features.

(1) There are many transformation links, which are interlinked

The output of medical scientific and technological achievements serves people, and the effectiveness and quality safety of drugs cannot be ignored, which requires that medical scientific and technological achievements are foolproof in each stage of research and development, experiment and production, so the time is usually long. The transformation of scientific and technological achievements of long path structure is complex, from the laboratory research and development to the whole process of marketing is actually made for technology development, technology achievements transformation and multiple interlocking links such as commercial products, including clinical trials also contains multiple period, such as the several stages, in turn, not across and indispensable. For the original research drug, it takes 10-15 years for a new drug to undergo molecular structure design, experimental design, experimental and clinical research, production, marketing and monitoring, etc. Even for generic drugs, it takes 3-5 years on average [6].

(2) The transformation is difficult and uncertain

Due to the high technology and high risk of medical science and technology innovation, the transformation of medical science and technology achievements is more difficult, and whether the transformation can be successful depends on the smooth development of every link in the transformation path. In the stage of pharmaceutical development, pharmaceutical products have to go through the selection, design, screening and treatment of chemical substances for many times, which is of great technical difficulty and high failure rate. In the transformation of medical achievements, preclinical and clinical trials take a long time and have high technical requirements, and there is a risk of trial failure and product elimination at each node. In pharmaceutical manufacturing, the unreasonable dosage form or improper product packaging will affect the stability and use effect of the product.In the stage of pharmaceutical commercialization, the market environment is complex and there are certain barriers to entry. In addition, when pharmaceutical products compete with the same type of products in the market, the promotion ability and marketing efficiency determine the market share to a large extent. Therefore, it can be seen that in the long process of pharmaceutical innovation, risks from all aspects and links are full of uncertainties as to whether pharmaceutical achievements can be successfully transformed into industrial and economic achievements.

(3) Influenced by multiple parties, each subject has a high degree of correlation

Medicine a long chain of transformation of scientific and technological achievements, stage, universities, research institutes, many businesses and organizations as part of the medical innovation ecosystem are involved in its innovation, some involvement in the pharmaceutical production each link of the value creation, some only in some parts of them in the phases of the activity play a different role. For example, universities and research institutes mainly provide knowledge creation in the technological development stage.Enterprises, especially multinational corporations and large enterprises, are fully involved in the development, manufacturing and commercialization of medicine. Small enterprises participate in the outsourcing or joint construction of a certain link in the transformation of technological achievements. As a regulator, the government needs to supervise and coordinate all aspects of pharmaceutical innovation in the whole process.

(4) The input-output structure of transformation is complex

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An in-depth analysis of the transformation process of medical scientific and technological achievements shows that the transformation process of medical achievements is complex, multi-link and staged. The creation of medical value is not a simple one-time input-output process. The resources invested by scientific research institutions to promote the transformation of achievements are continuously added along with the deepening of scientific research activities. The average development cost of a genetic engineering new drug is between 100 and 300 million US dollars, while the investment cost of a class I new drug is higher, generally between 300 and 500 million US dollars [7]. Similarly, the outputs of medical achievements are not only terminal products such as new drug products. Academic papers, new invention patents and utility model patents that reflect intellectual achievements are also important intermediate outputs of the transformation of medical scientific and technological achievements.

2.4. Transformation Mode of Medical Scientific and Technological Achievements

Based on the analysis of existing literature [8-10], according to the differences in the dominant position of universities, the transformation of scientific and technological achievements in universities currently mainly takes the following forms.

2.4.1. Technology Transfer Mode

Technology transfer is the universities or research institutions through transfer institutions, intermediaries, such as technical brokers will be the school a mature scientific research value assessment and sold to companies such as organization, transfer contract, signed for both schools get paid compensation, and to the enterprise to provide technical training, technical services and technology to improve services. In this mode, schools and other technology developers provide original innovation and mature technology, but due to lack of production conditions, the follow-up incubation and marketing promotion of products are implemented by enterprises.

For medical universities, in practice, mainly through the form of patent licensing, patent transfer and commissioned production technology transfer, achievements mainly include the approval document for the new drug certificate, approval documents, clinical, etc., it is also a important form of domestic pharmaceutical science and technology achievements transformation of universities, according to statistics, in 2018, domestic all kinds of medical colleges and universities signed a technology transfer contract 477,The actual income in that year exceeded 140 million yuan [11].

2.4.2. Production-university Cooperation Mode

Production-university cooperation is a mode in which universities and enterprises begin to cooperate at the immature stage of scientific and technological achievements and jointly complete the industrialization of achievements in order to achieve synergistic development and benefit maximization under the premise of mutual development. In this mode, the two sides mainly carry out two kinds of cooperation. One is cooperative research and development, that is, in the subject project, the two sides take technology development and scientific research as the joint point, carry out experimental projects, new technology and product development, project planning and other research and development activities. Second, cooperative construction, that is, the university and enterprises jointly build enterprises and other economic entities, research and development centers and laboratories, talent training bases, so that projects, funds, technology, talent, scientific research results and other innovative elements to transfer, share and combination.

This is a relatively mature a achievements transformation pattern in universities, it is not limited by the scale and macro policy environment, the cooperation between both sides can be

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according to their own needs, simple and flexible, but there is also a short-term, in-depth cooperation, resource sharing limited problem, not form a stable cooperation mechanism from the strategy. It is of little value to enhance the scientific and technological innovation ability of universities and enterprises.

2.4.3. The Self-run Industrial Model of the Academic Research Party

Self-run industry refers to a mode in which institutions of higher learning or scientific research institutes raise funds through multiple channels to establish modern enterprises, participate in market economic activities and carry out operation by themselves within the scope of national laws and regulations. In this mode, the scientific research results directly flow from the academic research party to the internal Self-run enterprises for production and listing, without the intermediary role of other institutions, eliminating the need for market trading activities.

Its main advantage is that it integrates the advantages of both sides in industrial development, and universities can quickly transform disciplinary and technological advantages into industrial core competitiveness. At the same time, school-run enterprises are closely connected with schools, and market operation and operation conditions can be quickly fed back to universities. However, this mode has high requirements on the scientific research strength, supporting resources, human cost and fund raising ability of universities, so only a small number of universities in China carry out achievements transformation in this way.

3. Problems Existing in the Transformation of Scientific and Technological Achievements in Medical Universities in China

3.1. The Policy Guarantee Mechanism of Medical Universities Needs to be Further Improved

At present, China has provided favorable conditions for the healthy development of the pharmaceutical industry from the aspects of promoting high-tech industry innovation and strengthening the cultivation of strategic emerging industries, gradually improved the relevant legal provisions on the transformation of scientific and technological achievements, and provided a direction for the transformation of scientific and technological achievements in universities. Framework defined, but more than the current policy design for the transformation of scientific and technological achievements made specification as a whole, mainly in the stressed the government's guidance and motivation of transformation of scientific and technological achievements, arouse the enthusiasm of scientific research personnel, but the real sticking point to some achievements, such as the distribution on the management of intellectual property disposition, proceeds, the support of the huge funding gap problem. In terms of information asymmetry and communication obstacles, the existing policy guarantees are not perfect enough.

3.2. The Enthusiasm of Universities in the Transformation of Scientific and Technological Achievements is not High

At present, medical universities focus on basic research and theoretical research, and generally have poor initiative and enthusiasm in carrying out transformation activities of scientific and technological achievements, which are mainly manifested in the following aspects. One is the lack of incentive measures for medical research and development personnel in the assessment and evaluation, especially in the link of professional title evaluation, the number of papers published and awards are still the key items of universities, and the lack of attention to the transformation of scientific and technological achievements. Second, the research projects of universities and colleges are mostly from the longitudinal projects entrusted by the government, which are not well-targeted and disconnected from the market demand. As a result, there are few projects that can be used for transformation, and the research and

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development personnel lack the awareness of the transformation of the projects they undertake, and the organizational management and follow-up industrialization of the results are not enough.

3.3. The Scientific and Technological Achievements of Universities do not Match the Market Demand

At present, many universities of science and technology achievements is rich, but a lot of market is far distance, and the causes mainly medical university and technology market, and the lack of effective information two-way communication between businesses, this kind of information asymmetry on the led to the college scientific research activities by the independent production and management of universities, guiding significance of the market is limited. Although some research and development teams consciously develop research activities close to the market needs, due to the limitations of understanding of market needs, the output results are still misplaced with industrialization, and the transformation input is wasted.

4. Suggestions for Promoting the Transformation of Scientific and Technological Achievements in Medical Universities

4.1. Optimize the System Design and Improve the Achievement Transformation Plan of Medical Universities

4.1.1. Strengthen the Design of Key and Controversial Links of Achievement Transformation in the Top-level System

In the current transformation of scientific and technological achievements under the protection of relevant guiding policy documents, the competent department of the government to fully understand the key content and link of transformation of scientific and technological achievements, concerned about the achievements of the disputes in real pain points and implementation process, especially the understanding of the concerns and obstacles is to carry out the transformation of scientific and technological achievements of universities, combined with these key problems, targeted policy. For example, improve the benefit distribution system of achievement transformation to protect the immediate honor and interests of the subjects involved in technology transformation. Perfecting the incentive system, encouraging the introduction of talents and technological innovation, and promoting universities to attach importance to the training of scientific research talents.

4.1.2. Formulate Transformation Plans for Scientific and Technological Achievements of the Pharmaceutical Industry According to the Development of the Industry

Competent departments of the pharmaceutical industry at all levels should take the overall development needs of the pharmaceutical industry as the guide, design phased transformation and development plans for the industry's scientific and technological achievements, increase fiscal and tax policy support for R&D and innovation, and clarify preferential policies for the transfer of pharmaceutical innovation technology. To guide medical universities to carry out specific technological innovation and achievements transformation, to reform the management system of scientific research projects as a breakthrough, and to promote the transformation of scientific and technological innovation in universities from free exploration-oriented supply to market-oriented demand. Develop specialized service institutions for the transformation of medical scientific and technological achievements, and support the cultivation of service institutions for the transformation of medical scientific and technological achievements that provide specialized services such as evaluation, intellectual property rights, scientific and technological consultation and technology trading. Organize pharmaceutical university alliances at the same level or within the same region to jointly establish scientific and

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technological achievements transformation management alliances or technology transfer offices.

4.2. Make Overall Arrangements for the Transformation of Scientific and Technological Achievements at the University Level

4.2.1. Improve the Institutional Norms and Operational Mechanisms for the Transformation of Scientific and Technological Achievements in Universities

Medical universities should perfect the incentive mechanism of scientific research personnel engaged in the transformation of scientific and technological achievements, perfect the incentive policy of income distribution oriented by increasing the value of knowledge, and formulate a series of policies from the aspects of evaluation system, assessment system, employment mechanism and scientific research management. For example, we will improve policies on the distribution of benefits from commercialization of scientific and technological achievements and the use of relevant funds to encourage researchers to make innovations and start businesses. Standardize the management of the transformation of scientific and technological achievements of researchers in leading positions, and protect the rights and interests of those who make scientific and technological achievements.

4.2.2. Strengthen the Consciousness of the Subject of Scientific Research in Universities and Increase the Investment in Scientific Innovation

Universities are the important subject of the transformation of scientific and technological achievements and the intellectual source of industrial innovation. The innovation ability of industrial colleges and universities plays an important role in promoting the development and upgrading of industries. At present, the overall scientific research subject consciousness of medical universities still needs to be strengthened, and the investment intensity of medical research and development still has room to be improved. Therefore, medical universities should clearly position themselves in the pharmaceutical industry innovation system, and constantly improve the enthusiasm of scientific research activities while paying attention to personnel training in medical universities.

4.3. Deepen Industry-University-Research Collaborative Innovation and Boost the Commercialization of Pharmaceutical Products

4.3.1. Enhance the Practicality of Knowledge Creation in Universities through Communication with Government and Enterprises

Medical universities should be closely around the pharmaceutical industry development needs, extensive production, cooperation and docking, with government departments and institutions to strengthen learning communication, society, industry association, the institute of science and technology groups such as advantage, in active communication with the parties' master the cutting-edge medicine industry development, all-round grasp the enterprise, and industry demands for new technology and new products. Achieving theoretical research close to the actual needs of the industry.

4.3.2. Promote the Transformation of Achievements in the Joint University-enterprise R&D Platform

Medical universities should combine their own and enterprises' respective advantages in R&D technology, build a joint R&D platform, and devote themselves to scientific research, experimental development and promotion and application in the field of biomedicine. Provided by the enterprise for R&D platform market direction, technical requirements, funding, and the necessary hardware security, schools provide platform with scientific research personnel, equipment, and scientific research advantages of science and technology resources, through the depth of University-enterprise cooperation, improve the pertinence and applied research

projects, ensure that the source of enterprise technology innovation and product development supply. At the same time, the transformation of scientific and technological achievements will be organically linked with the talent training and discipline construction of the school, and a pharmaceutical research and talent training base with continuous innovation ability will be built to help the industrialization process of pharmaceutical innovation.

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