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Innovative Exploration of Health Management and Nursing Models: A Pharmacological Perspective on Comprehensive Strategies

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Abstract: With the acceleration of global aging and the increasing burden of chronic diseases, innovative health management and nursing models have become increasingly important as they are key to improving the quality of medical services and patients' quality of life. Currently, traditional nursing models face many challenges in meeting the diverse and complex needs of patients, making it urgent to introduce pharmacologically-based individualized medication management and individualized treatment techniques to achieve precise health management. Pharmacology, as an important bridge between drug development and clinical application, plays a core role not only in individualized medication management but also provides important support in drug efficacy assessment and safety management. This article reviews the current status of pharmacology in the innovation of health management and nursing models, exploring comprehensive nursing strategies based on pharmacology, including individualized medication management, drug efficacy assessment, and safety monitoring, to optimize treatment plans and thus enhance patient adherence and medication safety. Through a comprehensive discussion, this paper aims to provide theoretical support and practical guidance for the reform of future health management models, promote the scientific and refined development of nursing services, and subsequently drive overall improvements in the quality of medical care.

Keywords: Health management; Nursing models; Pharmacology; Individualized medication; Drug safety; Innovative strategies

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1. Introduction

With the rapid development of socio-economic factors and continuous advancements in medical technology, health management and nursing models have undergone significant reforms, and their importance in modern medical systems has become increasingly evident. Traditional nursing models mainly focus on the treatment of diseases, emphasizing direct interventions by healthcare professionals with patients. However, with the rise in

chronic diseases and the exacerbation of population aging, a single disease treatment approach can no longer meet the increasingly diverse and personalized health needs of patients. The emergence of health management concepts has driven nursing models to transform towards a comprehensive, preventive, and personalized direction. This shift emphasizes not only the disease itself but also the comprehensive improvement of patients' lifestyles, psychological states, and social support systems, aiming to achieve an organic combination of disease prevention, health promotion, and long-term management [1]. Furthermore, pharmacology, as a crucial link between drug treatment and nursing practice, is closely related to this transformation in nursing models, and its innovative applications in health management are particularly critical. Pharmacology involves not only the mechanisms of drug action, drug interactions, and monitoring of adverse reactions but also guidance on rational medication use and enhancing patient medication adherence. The application of pharmacology is irreplaceable for optimizing treatment outcomes and ensuring patient safety [2].

In current health management practices, drug-related issues remain prominent, especially the high incidence of adverse drug reactions and inadequate patient medication adherence, which severely affect treatment outcomes and quality of life. Research shows that patients often interrupt their medication due to a lack of understanding of drug knowledge or fear of adverse reactions, leading to disease deterioration and waste of medical resources. To address this issue, there is an urgent need for interventions through innovative nursing models. Nurses, as members of the medical team who have the most frequent contact with patients, play a crucial role in drug management and health education. Specifically, the implementation of continuous nursing models, such as health education through digital platforms like WeChat, can not only enhance patients' self-management capabilities and improve their understanding and adherence to medication but also effectively reduce the incidence of complications and readmissions, thus significantly improving the quality of nursing services and patient satisfaction. Additionally, nurse-led nursing management models have shown good results in managing patients with multiple chronic diseases, emphasizing teamwork, personalized care, and a patient-centered approach, which helps integrate pharmacological knowledge with nursing practice and promotes multidisciplinary collaboration and innovation [1,6].

Against this backdrop, this paper aims to systematically review the innovation of health management and nursing management models from a pharmacological perspective. It specifically explores interdisciplinary integration methods to construct comprehensive nursing strategies based on pharmacological knowledge to enhance the quality of nursing services and address current drug-related issues. By analyzing the strengths and weaknesses of existing nursing management models in conjunction with the latest advancements in pharmacology, practical and feasible innovative pathways are proposed to provide theoretical support and practical guidance for nursing practice, promoting continuous innovation and development in the fields of health management in science, technology, and service models [7,8]. This comprehensive strategy not only helps improve treatment outcomes and quality of life for patients but also promotes the transformation and upgrading of the nursing profession to better meet the demands of medical services in the new era.

2. The core role of pharmacology in health management

2.1. The application and development of individualized medication strategies

Pharmacology plays a crucial role in health management, one of which is promoting the formation of individualized medication strategies. This advancement is largely attributable to the in-depth exploration of the role of genetic polymorphisms in drug metabolism in pharmacogenomics. The existence of genetic polymorphisms

leads to hereditary differences among individuals in pharmacological genes such as drug-metabolizing enzymes, transport proteins, and receptors, resulting in significant variations in the absorption, distribution, metabolism, and excretion (ADME) processes of drugs among different patients, which directly affects drug efficacy and safety. With the continuous accumulation of large-scale genomic and multi-omics data, pharmacogenomics research has expanded from traditional single-gene correlations with drugs to comprehensive studies covering proteomics, transcriptomics, metabolomics, and other levels, providing a solid scientific basis for individualized medication strategies [1,2].

Advancements in precision drug dosage adjustment technologies enable more accurate individualized medication dosage designs in clinical practice by combining patients' physiological characteristics (such as age, weight, liver and kidney functions) with pharmacokinetic models, effectively avoiding insufficient drug effects or toxic reactions. For example, in anticoagulant therapy, adjusting warfarin dosage based on information from genotypes such as CYP2C9 and VKORC1 has become a paradigm in this field [3,4]. Furthermore, computer-assisted clinical decision support systems (CDSS) have played a significant supportive role in drug selection and dosage adjustments. This system integrates patients' genetic information, clinical data, and drug information, providing personalized medication recommendations through real-time analysis, thereby enhancing medication safety and effectiveness. Such systems have gradually been applied in various fields, including chronic disease management and anticancer treatments, significantly improving the quality of clinical decision-making [5,6].

Despite the challenges faced in implementing individualized medication strategies, such as differences in pharmacogenetic polymorphisms among different ethnic groups, the prevalence and cost of genetic testing, as well as ethical and privacy concerns, the future of individualized medication is expected to become more precise and efficient with continuous advancements in artificial intelligence and the integration of multi-omics data with clinical big data [7,8]. Overall, pharmacology, by revealing the impact of genetic polymorphisms on drug metabolism and supported by advanced dosage adjustment technologies and clinical decision support systems, has promoted the widespread application of individualized medication strategies in health management, significantly enhancing treatment safety and effectiveness.

Drug monitoring and efficacy assessment occupy an important position in pharmacological health management. Traditional therapeutic drug monitoring (TDM) ensures that drug concentrations in patients' blood are maintained within therapeutic ranges by analyzing those concentrations, thereby reducing the risk of toxic reactions and treatment failures. This method has been widely applied in various fields, including immunosuppressants, anti-epileptic drugs, and antibiotics [6,9]. TDM not only aids in individualized dosage adjustments but also monitors patient adherence and drug interactions. In recent years, with the continuous advancement of detection technologies, new biomarkers and monitoring technologies have significantly improved the accuracy of efficacy assessments. For example, liquid biopsy technology, by analyzing circulating tumor DNA and exosomes, can provide dynamic efficacy monitoring and resistance mechanism analysis for cancer patients [10,11]. Advances in real-time drug concentration detection technologies, such as high-performance liquid chromatography coupled with mass spectrometry, have achieved rapid and sensitive measurement of drug blood concentrations, thereby supporting clinical treatment plans [12].

In addition, the importance of multidisciplinary collaboration models in drug efficacy evaluation has become increasingly prominent. Close cooperation between nursing staff, pharmacists, and clinical physicians allows for rapid understanding and application of drug monitoring data, thereby optimizing personalized treatment plans for patients. For example, nurses play a crucial role in medication education, monitoring adverse drug reactions,

and managing treatment compliance. Multidisciplinary teams integrate drug monitoring data with clinical symptoms to timely adjust treatment strategies, significantly improving patient prognosis [9,13]. In summary, the development of drug monitoring and efficacy evaluation technologies, especially the application of biomarkers and multidisciplinary collaboration, greatly enhances the precision and safety of drug therapy, providing solid support for health management.

Medication safety management is an important component in ensuring patient health and improving healthcare quality. Adverse drug reactions (ADRs) can be classified based on their mechanisms into type A (dose-related) and type B (non-dose-related), with differences in severity and prevention strategies. ADRs not only increase patient mortality and hospital stay but also impose a significant economic burden on the healthcare system [14,15]. Therefore, exploring the classification, occurrence mechanisms, and impacts of ADRs on patient health is fundamental to building a safe medication system.

Pharmacology-based risk assessment tools, such as the Naranjo scale and WHO-UMC system, have been widely applied in clinical nursing practice with the aim of early identification of ADRs and interventions to enhance early warning capabilities [15,16]. Furthermore, drug interaction management strategies emphasize the crucial role of nursing staff in medication safety education. Through patient education, medication monitoring, and multidisciplinary communication, nurses can effectively reduce risks associated with drug interactions. For example, when managing high-risk medications like warfarin and anticancer drugs, the medication guidance and monitoring provided by nurses have significantly reduced the incidence of adverse events [17,18].

With the rapid advancement of big data and artificial intelligence technologies, medication safety management is gradually transforming towards intelligence and precision. By integrating electronic health records (EHR), medication alert systems, and machine learning models, automatic monitoring and risk prediction of ADRs can be achieved [14,19]. At the same time, establishing a comprehensive ADR reporting and evaluation system promotes information sharing and rapid response, further strengthening medication safety management. Overall, from a pharmacological perspective, medication safety management relies on risk assessment tools and the significant role of nursing staff, combined with digital technology, to construct a comprehensive prevention and intervention system for ADRs, providing solid guarantees for clinical medication safety.

In the innovative nursing model guided by pharmacology, multidisciplinary team collaboration has become a key factor in optimizing drug therapy and improving patient care quality. The collaborative work of pharmacists, nursing staff, and physicians forms an organic team that can comprehensively assess patients' disease status and medication usage, thus achieving overall optimization of drug therapy. Taking elderly emergency care as an example, the multidisciplinary team established at Mount Sinai Hospital specifically for elderly patients includes emergency physicians, geriatric specialists, nursing staff, and pharmacists, relying on daily comprehensive assessments and team discussions to effectively develop individualized care and medication management plans, significantly improving patients' hospitalization decisions and medication safety [20]. Moreover, multidisciplinary team collaboration not only promotes knowledge sharing among professionals but also improves the efficiency and safety of medication management through information-sharing platforms and coordination mechanisms. For instance, during the COVID-19 pandemic, a mobile multidisciplinary team consisting of geriatric specialists, infectious disease experts, and palliative care specialists was formed in a nursing home in France, effectively controlling the spread of the pandemic and ensuring the rational allocation of medication and care resources through collective decision-making and information sharing [21]. Successful cases indicate that multidisciplinary teams can achieve collaborative optimization of drug therapy, reduce medical

risks, and enhance care quality through clearly defined responsibilities, effective communication mechanisms, and shared information platforms [22,23]. Therefore, constructing a patient-centered, multidisciplinary collaborative nursing model is an important approach to achieving innovation in nursing guided by pharmacology.

Intelligent technologies, such as artificial intelligence (AI) and big data analysis, are gradually penetrating the fields of medication management and health monitoring, driving the innovative development of pharmacological nursing models. A study on the management of multiple chronic diseases indicates that AI-assisted tools can effectively enhance the safety and quality of clinical decision-making, particularly when dealing with complex patients with multiple comorbidities; AI technology helps healthcare providers formulate more precise treatment plans by integrating patients' medication information and socio-psychological factors [24]. In terms of medication reminders and remote monitoring, the application of intelligent medication reminder systems has significantly improved patients' medication adherence, reducing instances of missed and incorrect dosages. This system has also enhanced patients' knowledge levels, promoting self-management. Although patients' trust in this system is slightly lower compared to traditional nursing staff, its potential as an auxiliary tool should not be overlooked [25]. Combined with remote monitoring technology from mobile health applications, it can not only monitor patients' health status in real time but also support the formulation of personalized care plans, especially suitable for managing chronic diseases and medication guidance [26,27]. However, intelligent technology still faces many challenges in formulating personalized care plans, such as data privacy protection, evaluation of clinical applicability, and maintenance of doctor-patient relationships. Therefore, future efforts should focus more on the deep integration of technology and clinical practice to enhance patients' and healthcare providers' acceptance and trust in intelligent nursing tools [24].

2.2. Patient education and self-management support

The popularization of pharmacological knowledge is of great significance for enhancing patients' self-management abilities. Systematic patient education can not only help patients better understand the efficacy and potential side effects of medications but also strengthen their awareness and compliance regarding medication safety. Digital platforms, as key tools for patient education, have been widely applied in the management of various chronic diseases. For example, a digital self-management education program aimed at diabetes patients, through multimedia content and interactive tests, significantly enhances patients' understanding of their condition and their self-efficacy, thus promoting changes in health behaviors [28,29]. Furthermore, chronic disease management models based on new media have significantly improved treatment outcomes for patients with conditions like rosacea through continuous educational support [30]. Nursing staff have employed innovative methods in medication guidance and psychological support, such as interactive psychological education series for veterans with severe mental illnesses, which not only enhance patients' understanding of medication treatment but also strengthen the collaborative relationship between healthcare providers and patients [31]. At the same time, nursing staff help patients establish good self-management habits and positive psychological states through personalized health education and psychological interventions, thereby optimizing overall treatment outcomes [32,33]. In summary, integrating pharmacological knowledge into patient education and self-management support is an important component in enhancing medication safety and care quality and should rely on digital tools and the professional guidance of nursing staff to build a continuously effective patient support system.

2.3. Latest research progress and future development trends

2.3.1. New pharmacological technologies driving innovation in nursing models

Frontier pharmacological approaches, such as nanoparticle drug delivery systems and gene editing technologies, are profoundly affecting nursing practice and driving changes in nursing models. Nanotechnology enhances the targeting and bioavailability of drugs while reducing side effects, thereby providing patients with more precise drug treatment options. Gene editing technology offers new possibilities for personalized medicine by precisely regulating patients' gene expression to achieve fundamental control over diseases. The advancements in these technologies push nursing models towards personalization and precision, requiring nursing staff to not only master traditional nursing skills but also possess knowledge of pharmacology and molecular biology to assist in formulating and implementing individualized nursing plans. Additionally, in the context of precision medicine, the demand for transformation in nursing models is increasingly evident, as nursing work shifts from traditional disease management to comprehensive health management based on patients' genomic information, lifestyle, and environmental factors, emphasizing collaboration among interdisciplinary teams and data-based decision support. For example, in the nursing practice of cardiovascular diseases, monitoring and regulating drug delivery systems using nanotechnology can achieve refined management of patients' hemodynamics, enhancing the safety and effectiveness of nursing care [34]. At the same time, with the gradual application of gene editing technology in clinical practice, the nursing team must also participate in the entire management process of gene therapy, providing preoperative assessment, postoperative monitoring, and psychological support to ensure the safety and effectiveness of the treatment.

2.3.2. Data-driven health management strategies

The application of big data and machine learning technologies in the fields of drug efficacy prediction and risk management is becoming increasingly widespread. This trend is driving health management strategies towards intelligence and dynamism. By deeply integrating EHR and pharmacological information, nursing decision support systems have been established to improve the quality and efficiency of nursing care. For example, models developed using machine learning based on nursing assessments, discharge plans, and clinical documentation data can accurately predict the risk of unplanned readmission for elderly patients within 30 days, thereby supporting personalized discharge care plans [35]. Such data-driven tools not only enhance the nursing staff's awareness of patient risks but also promote the implementation of early interventions, effectively reducing hospitalization rates and medical costs. Looking ahead, dynamic health management systems based on data analysis will be able to monitor and alert to changes in patients' health status in real time, by integrating physiological data from smart wearable devices to create multidimensional health profiles, achieving precise health status assessments and the formulation of personalized intervention plans. Meanwhile, artificial intelligence technologies such as deep learning have demonstrated outstanding performance in the analysis of nursing records, helping to identify the risk of post-discharge patient mortality, thus allowing for adjustments in follow-up and treatment plans [36]. The continuous optimization of electronic health record platforms and the improvement of data sharing mechanisms will further promote the application of nursing decision support systems, driving the intelligent transformation of nursing models.

2.3.3. Policy and ethical considerations

The innovation in the field of pharmacology is continually supported by policies and regulatory environments in

health management, aimed at ensuring the safe application and equitable promotion of innovative technologies. National policies actively promote the development of precision medicine and intelligent nursing models; however, this also brings ethical challenges regarding patient privacy protection and data security. In intelligent nursing models, the collection, storage, and analysis of vast amounts of sensitive health data may pose potential risks of privacy breaches, thus strict adherence to privacy regulations such as HIPAA is required to protect patients' rights [37]. Additionally, patients' awareness and attitudes towards data security directly impact their acceptance of new technologies, so relevant policies should enhance public education and transparency to foster patients' trust in innovative nursing models [38]. In terms of data sharing and inter-agency cooperation, policymakers should balance data security with the efficiency of information flow, encouraging the application of technologies such as blockchain in medical information management to achieve data immutability and controlled access [39]. To promote innovation in pharmacology and nursing models, policy recommendations include: improving the regulatory framework and clarifying responsible entities; supporting the training of interdisciplinary talents to enhance nursing staff's understanding and application of new technologies; promoting collaboration between medical institutions and technology companies to facilitate technology transfer; and strengthening ethical review and risk assessment to ensure the safety and compliance of technology applications. These measures will provide a solid guarantee for the implementation of new pharmacological technologies in nursing practice and promote continuous innovation in health management and nursing models.

3. Conclusion

Pharmacology plays an important supporting role in the innovation of health management and nursing models, especially in areas such as personalized medication, drug monitoring, and safety management, which have received widespread recognition. From an expert perspective, advancements in pharmacology not only enhance the precision and effectiveness of drug treatments but also bring new transformational opportunities to nursing practice. Personalized medication strategies, through precise assessments of patients' genetic backgrounds, physiological conditions, and pathological features, facilitate the individualized adjustment of medication plans. This measure significantly reduces the risk of adverse reactions and drug interactions, while improving patient compliance and treatment efficacy. This progress enables nursing staff to pay more attention to individual differences and dynamic changes in patients' conditions during the implementation of medication management, thereby promoting an overall improvement in nursing quality in terms of safety and effectiveness.

However, breakthroughs in a single discipline are insufficient to meet the complex health demands of modern society; thus, the construction of innovative nursing models must rely on multidisciplinary collaboration. The deep integration of pharmacology with nursing, information technology, nutrition, psychology, and other fields has formed a patient-centered comprehensive nursing system. Specifically, the introduction of intelligent technologies such as big data analysis, artificial intelligence-assisted decision-making, and remote monitoring has greatly expanded the methods of drug monitoring and nursing intervention plans, allowing nursing staff to grasp patients' medication status in real time and adjust nursing strategies promptly. Furthermore, patient education, as an important component of the nursing model, enhances patients' understanding of drug knowledge and self-management abilities, promoting the continuity of treatment and improving overall health levels.

In the process of promoting the transformation of nursing models, the latest technologies in pharmacology and data-driven strategies provide powerful momentum but also present challenges in terms of policies,

regulations, and ethics. Issues such as data privacy protection, transparency, and fairness of intelligent algorithms, and compliance in drug information sharing must be fully addressed and regulated alongside the application of technologies. Therefore, medical institutions, regulatory agencies, and academia should collaboratively develop scientific and reasonable standards and guidelines to ensure that innovative outcomes can safely and compliantly benefit patients.

Disclosure statement

The author declares no conflict of interest.

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