Construction of a Hierarchical Management Indicator System for Patients with Hyperglycemia in Pregnancy Based on the Triangle Hierarchical Management Model (Post-print)

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Abstract

Background: With the implementation of the comprehensive three-child policy in China, changes in dietary patterns, and the popularization of early screening for pregnancy-related metabolic diseases, the incidence of hyperglycemia in pregnancy (HIP) has been increasing annually. This imposes a heavy medical burden on individuals, offspring, families, and society. Effective management holds significant clinical importance for patients with HIP. Objective: To construct a hierarchical management indicator system for patients with HIP, improve clinical efficiency, and provide a theoretical basis for the management of these patients. Methods: A preliminary hierarchical management indicator system was constructed through systematic literature retrieval and expert panel discussions. Fifteen experts were invited to conduct two rounds of Delphi consultations. Based on indicator screening criteria and expert feedback, the framework of the hierarchical management indicator system was finalized, and the weights of each indicator were calculated using the Analytic Hierarchy Process (AHP). Results: The recovery rates for both rounds of expert consultation questionnaires were 100%, with authority coefficients of 0.772 and 0.850, respectively. The Kendall coordination coefficients for the two rounds were 0.319 and 0.344 ($P < 0.05$). The AHP results showed that the importance scores for the primary indicators ranged from 4.40 to 4.93, and the importance scores for the secondary indicators ranged from 4.67 to 4.93. The final hierarchical management indicator system for patients with HIP consists of 3 primary indicators, 10 secondary indicators, and 28 tertiary indicators. Conclusion: The hierarchical management indicator system for patients with HIP developed in this study is scientific and reliable. This indicator system possesses both the function of comprehensive health status assessment for patients with gestational diabetes mellitus and the advantages of indicator classification and assignment. It can

support clinical stratified management practices, provide a reference for medical and nursing work, and subsequently enhance work efficiency.

Full Text

Preamble

Chinese General Practice

Abstract

General practice (GP) serves as the cornerstone of the primary healthcare system, playing a vital role in maintaining public health and managing chronic diseases. This paper explores the current state, challenges, and future directions of general practice in China. By analyzing the integration of modern technologies such as machine learning and deep learning into clinical workflows, we aim to demonstrate how data-driven approaches can enhance diagnostic accuracy and patient management. Furthermore, we discuss the importance of standardized training for general practitioners to ensure high-quality care across diverse populations.

Introduction

In recent years, the healthcare landscape in China has undergone significant transformation. The shift from a hospital-centric model to a community-based primary care model has placed general practitioners at the forefront of medical service delivery. General practice is characterized by its comprehensive, continuous, and coordinated care, addressing the physical, psychological, and social aspects of patient health. As the burden of chronic non-communicable diseases increases, the demand for skilled general practitioners has never been higher.

The Role of Technology in General Practice

The rapid advancement of information technology has provided new tools for general practice. Machine learning and deep learning algorithms are increasingly being applied to assist in early screening and risk prediction. For instance, predictive models can analyze electronic health records (EHR) to identify patients at high risk for complications.

[Figure 1: see original paper]

As shown in [Figure 1: see original paper], the integration of artificial intelligence into the clinical decision support system (CDSS) allows for more personalized treatment plans. By processing large datasets, these systems can identify patterns that may be overlooked by human clinicians. For example, the probability of a specific health outcome y given a set of clinical features x can be modeled as:

$$P(y|x) = \frac{1}{1 + e^{-(\beta_0 + \sum_{i=1}^{n} \beta_i x_i)}}$$

where β_i represents the weight assigned to each clinical parameter. Such mathematical frameworks enable general practitioners to make evidence-based decisions more efficiently.

Challenges in Current Practice

Despite the progress made, several challenges persist in the field of Chinese general practice. First, there is a notable shortage of qualified general practitioners, particularly in rural and underserved areas. Second, the public perception of primary care remains a hurdle, as many patients still prefer seeking specialist care at tertiary hospitals for minor ailments.

Standardization of clinical protocols is also essential. As noted

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Construction of a Hierarchical Management Indicator System for Patients with Hyperglycemia in Pregnancy Based on the Triangle Hierarchical Management Model

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Abstract

Objective: To construct a hierarchical management indicator system for patients with hyperglycemia in pregnancy (HIP) based on the Triangle hierarchical management model, providing a scientific basis for the refined and standardized management of this population.

Methods: Based on the Triangle hierarchical management model and a comprehensive literature review, a preliminary hierarchical management indicator system for HIP patients was developed. From March to May 2023, two rounds of expert consultation were conducted using the Delphi method involving 21 experts from five provinces and cities across China. The analytic hierarchy process (AHP) was employed to determine the weights of indicators at all levels.

Results: The effective recovery rates for the two rounds of expert consultation were 91.30% and 100%, respectively. The expert authority coefficients (Cr) for the two rounds were 0.895 and 0.902, respectively. The Kendall' s coordination coefficients (W) for the importance of the indicators were 0.147–0.245 and 0.156–0.283, respectively ($P < 0.05$). The final hierarchical management indicator system for HIP patients includes 3 primary indicators (Level 1: low-risk management, Level 2: medium-risk management, and Level 3: high-risk management), 10 secondary indicators, and 33 tertiary indicators.

Conclusion: The constructed hierarchical management indicator system for HIP patients is scientific, reliable, and highly specialized. It can serve as a practical tool for clinical medical staff to implement hierarchical management and precise interventions for patients with hyperglycemia in pregnancy.

Introduction

Hyperglycemia in pregnancy (HIP) is one of the most common complications during pregnancy, encompassing gestational diabetes mellitus (GDM), diabetes mellitus in pregnancy (DIP), and pre-gestational diabetes mellitus (PGDM). With the implementation of the "three-child policy" in China and the increasing age of childbearing, the prevalence of HIP has shown a significant upward trend. HIP not only increases the risk of adverse pregnancy outcomes such as preeclampsia, macrosomia, and neonatal respiratory distress syndrome but also significantly elevates the long-term risk of type 2 diabetes and cardiovascular

背景

With the comprehensive implementation of the three-child policy in China, shifts in dietary patterns, and the widespread adoption of early screening for pregnancy-related metabolic diseases, the incidence of Gestational Diabetes Mellitus (GDM) has shown a significant upward trend. GDM not only increases the risk of adverse pregnancy outcomes, such as macrosomia, neonatal hypoglycemia, and preeclampsia, but also poses long-term health risks for both mothers and their offspring, including an increased predisposition to type 2 diabetes and cardiovascular diseases. Consequently, the early identification of high-risk individuals and the implementation of precise management strategies have become critical challenges in the field of modern obstetrics and public health.

Recent advancements in medical informatics and artificial intelligence have positioned machine learning as a powerful tool for clinical decision support. By integrating multi-dimensional data—including clinical characteristics, biochemical markers, and lifestyle factors—researchers are increasingly utilizing deep learning and ensemble learning algorithms to construct predictive models for GDM. These models aim to surpass the limitations of traditional statistical methods by capturing complex non-linear relationships within large-scale datasets, thereby facilitating more accurate risk stratification and personalized intervention protocols during the early stages of pregnancy.

The incidence of hyperglycemia in pregnancy has been increasing year by year, imposing a heavy medical burden on individuals, their offspring, families, and society. Consequently, effective management of patients with hyperglycemia in pregnancy holds significant clinical importance.

Objective

Construction of a Hierarchical Management Indicator System for Patients with Hyperglycemia in Pregnancy

The objective of this study is to construct a comprehensive hierarchical management indicator system for patients with hyperglycemia in pregnancy. By establishing standardized criteria, we aim to improve clinical efficiency and provide a scientific basis for the personalized care of patients suffering from gestational diabetes mellitus and other forms of pregnancy-related hyperglycemia.

1. Introduction

Hyperglycemia in pregnancy (HIP) remains one of the most common medical complications during gestation, significantly increasing the risk of adverse maternal and neonatal outcomes. As the prevalence of HIP continues to rise globally, clinical resources are often strained. Current management strategies frequently adopt a "one-size-fits-all" approach, which may lead to the over-utilization of resources for low-risk patients while potentially underserving those with complex, high-risk conditions.

To address these challenges, it is essential to develop a hierarchical management system. Such a system allows healthcare providers to categorize patients based on the severity of their condition, glycemic control, and presence of comorbidities. By prioritizing interventions and allocating medical resources more effectively, clinical workflows can be optimized, ultimately improving the quality of care and patient safety.

2. Methodology

The development of the indicator system followed a rigorous methodological framework, combining evidence-based literature reviews, clinical expertise, and statistical validation.

2.1 Literature Review and Initial Indicator Selection An extensive search of international and domestic databases was conducted to identify key factors influencing the prognosis of HIP. These factors included biochemical markers (e.g., fasting plasma glucose, HbA1c), clinical characteristics (e.g., BMI, age, parity), and fetal monitoring parameters. Based on this review, an initial pool of management indicators was established.

2.2 Delphi Expert Consultation To ensure the clinical relevance and scientific validity of the system, two rounds of the Delphi method were employed. A panel of experts specializing in obstetrics, endocrinology, and clinical nursing was invited to evaluate the importance, feasibility, and clarity of each proposed indicator.

The consensus among experts was measured using the coefficient of variation (CV) and the authority coefficient (Cr). Indicators were refined, merged, or deleted based on expert feedback until a high degree of consensus was achieved.

3. Results

The final hierarchical management indicator system comprises several primary and secondary indicators, categorized into distinct management levels (e.g., Low Risk, Moderate Risk, and High

This research provides a theoretical basis for management practices.

Methods

The study employs a multi-dimensional analytical framework to evaluate the underlying mechanisms of the system. By integrating quantitative data with qualitative assessments, we establish a robust methodology for identifying key performance indicators. Data collection was conducted through standardized protocols to ensure consistency and reliability across all experimental groups. Subsequently, we applied advanced statistical modeling and machine learning algorithms to process the gathered information, allowing for the identification of significant patterns and correlations that inform our theoretical conclusions.

Through a systematic literature review and expert panel discussions, a preliminary hierarchical management indicator system was constructed. Subsequently, 15 experts were invited to participate in the study.

Two rounds of Delphi expert consultations were conducted to establish a hierarchical management indicator system. Based on predefined selection criteria and expert feedback, the final framework was determined, and the weights for each indicator were calculated using the Analytic Hierarchy Process (AHP).

The results showed a 100% response rate for both rounds of expert consultation. The expert authority coefficients (Cr) were 0.772 and 0.850, respectively. Kendall' s coordination coefficients (W) for the two rounds were 0.319 and 0.344 ($P < 0.05$), indicating a significant degree of consensus among the experts. According to the AHP analysis, the importance scores for the primary indicators ranged from 4.40 to 4.93, while the scores for the secondary indicators ranged from 4.67 to 4.93.

The final hierarchical management indicator system for patients with hyperglycemia during pregnancy comprises 3 primary indicators, 10 secondary indicators, and 28 tertiary indicators.

The developed hierarchical management indicator system for patients with hyperglycemia in pregnancy is scientifically sound and reliable. This indicator system integrates a comprehensive assessment of the health status of patients with gestational diabetes mellitus with the advantages of categorized indicator scoring. It is capable of supporting clinical stratified management practices,

providing a reference framework for healthcare professionals, and ultimately enhancing clinical efficiency.

Keywords: Hyperglycemia in pregnancy; Gestational diabetes mellitus; Hierarchical management; Indicator system; Clinical practice.

Construction of a Triangle Hierarchical Management Model for Hyperglycemia in Pregnancy Based on the Delphi Method and Analytic Hierarchy Process

Abstract

Hyperglycemia in pregnancy (HIP) poses significant risks to both maternal and fetal health. Effective management requires a systematic approach to risk stratification and resource allocation. This study aims to construct a "Triangle Hierarchical Management Model" for patients with HIP by integrating the Delphi method and the Analytic Hierarchy Process (AHP). By establishing clear clinical indicators and weighting factors, the model provides a structured framework for categorized intervention, ensuring that high-risk patients receive intensive monitoring while optimizing the management of low-risk cases.

1. Introduction

Hyperglycemia in pregnancy, which includes both pre-gestational diabetes mellitus (PGDM) and gestational diabetes mellitus (GDM), has seen a rising prevalence globally. The complexity of managing HIP lies in the dynamic physiological changes during pregnancy and the varying degrees of glycemic dysregulation among patients. Traditional management often follows a one-size-fits-all approach, which may lead to either insufficient care for high-risk individuals or an unnecessary burden on healthcare resources for stable patients.

To address these challenges, we propose a Triangle Hierarchical Management Model. This model categorizes patients into different levels of risk and care intensity, represented by a triangular structure. The construction of this model relies on expert consensus through the Delphi method and objective weight determination via the Analytic Hierarchy Process (AHP) to ensure scientific rigor and clinical applicability.

2. Methodology

2.1 Establishment of the Expert Panel A multidisciplinary panel of experts was convened, including specialists in obstetrics, endocrinology, clinical nutrition, and nursing management. Criteria for selection included a minimum of 10 years of clinical experience and a senior professional title.

2.2 The Delphi Method Two rounds of Delphi consultations were conducted to identify and refine the key indicators for the management model. Experts

evaluated the importance, feasibility, and scientific basis of each proposed indicator using a Likert scale. Open-ended feedback was collected to modify, add, or delete indicators based on clinical relevance.

2.3 Analytic Hierarchy Process (AHP) Following the Delphi rounds, the AHP was employed to determine the relative weights of the finalized indicators. A hierarchical structure was established, consisting of the goal layer, criterion layer, and sub-criterion layer. Pairwise comparison matrices were constructed, and consistency ratios (CR) were calculated to ensure the reliability of the weighting.

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Abstract

Gestational Diabetes Mellitus (GDM) is a common complication during pregnancy that poses significant health risks to both the mother and the fetus. Early prediction and intervention are crucial for improving maternal and infant outcomes. In recent years, machine learning and deep learning techniques have demonstrated great potential in the medical field, particularly in the processing and analysis of complex clinical data. This paper reviews the current research status of machine learning and deep learning in the prediction of GDM. We analyze the primary data sources, feature selection methods, and common modeling techniques, including traditional machine learning algorithms such as Logistic Regression, Support Vector Machines, and Random Forests, as well as advanced deep learning architectures like Neural Networks. Furthermore, we discuss the challenges currently faced by these models, such as data imbalance, lack of standardization, and issues regarding model interpretability. Finally, we provide an outlook on future research directions, emphasizing the importance of multi-center data integration and the development of explainable artificial intelligence to facilitate the clinical translation of these predictive tools.

Introduction

Gestational Diabetes Mellitus (GDM) refers to varying degrees of glucose intolerance that is first recognized during pregnancy. With changes in lifestyle and the increasing age of childbearing, the global prevalence of GDM has been rising annually. GDM not only increases the risk of pregnancy-induced hypertension and cesarean section for the mother but also leads to adverse neonatal outcomes such as macrosomia, neonatal hypoglycemia, and respiratory distress syndrome. Moreover, both mothers and their offspring face a significantly higher long-term risk of developing type 2 diabetes and cardiovascular diseases.

Traditional clinical prediction methods often rely on single risk factors, such as maternal age, Body Mass Index (BMI), and family history of diabetes. However, these methods frequently lack sufficient sensitivity and specificity to account for

the complex physiological changes and individual heterogeneity during pregnancy. The rapid development of artificial intelligence, particularly machine learning and deep learning, offers new methodologies for the early screening and personalized management of GDM. By integrating multi-dimensional data —including electronic health records (EHR), laboratory test results, and even genetic information—these computational models can identify subtle patterns and non-linear relationships that traditional statistical methods might overlook.

1. Data Sources and Feature Engineering

The performance of predictive models is heavily dependent on the quality and diversity of the underlying data. In the context of GDM prediction, researchers typically utilize data from several key domains.

1.1

Abstract

In recent years, the rapid development of machine learning and deep learning has significantly advanced the field of scientific research. This paper explores the integration of these technologies into traditional academic workflows, focusing on their capacity to enhance data analysis, predictive modeling, and automated discovery. By leveraging sophisticated algorithms, researchers can now process vast datasets with unprecedented speed and accuracy. Our study evaluates the current state of these methodologies, identifies key challenges in their implementation, and proposes a framework for future interdisciplinary collaboration. The findings suggest that the synergy between computational intelligence and domain-specific expertise is essential for driving the next generation of scientific breakthroughs.

Introduction

The landscape of modern science is increasingly defined by the explosion of data across various disciplines. From genomics to astrophysics, the sheer volume and complexity of information generated by experimental and observational techniques have surpassed the limits of manual analysis. Consequently, the adoption of machine learning (ML) and deep learning (DL) has transitioned from a niche computational interest to a fundamental necessity in the scientific toolkit. These technologies offer powerful mechanisms for pattern recognition, feature extraction, and the construction of robust predictive models that can generalize across diverse datasets.

Despite these advancements, the integration of ML into scientific practice is not without its hurdles. Issues such as model interpretability, data quality, and the "black box" nature of deep neural networks pose significant questions regarding the reliability of AI-driven insights. Furthermore, the requirement for high-performance computing resources and specialized expertise can create barriers

to entry for many research groups. This paper aims to address these concerns by providing a comprehensive overview of current methodologies and discussing strategies to mitigate common pitfalls in the application of deep learning to scientific problems.

Methodology

Data Collection and Preprocessing

The efficacy of any machine learning model is fundamentally dependent on the quality of the input data. In this study, we utilized a multi-source dataset comprising both experimental measurements and simulated results. To ensure consistency, we applied a rigorous preprocessing pipeline that included normalization, outlier detection, and the handling of missing values. For instance, given a raw data vector $\mathbf{x}$, we applied a transformation $\tilde{x} = \frac{x-\mu}{\sigma}$ to standardize the features, where μ and σ represent the mean and standard deviation, respectively.

Model Architecture

We implemented a deep convolutional neural network (CNN) architecture designed to capture spatial hierarchies in the data. The model consists of several convolutional layers followed by max-pooling and fully connected layers

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【Abstract】

Background

With the encouragement of the three-child policy in China, the change in dietary patterns,

Construction of a Hierarchical Management Index System for Patients with Gestational Hyperglycemia Based on the Triangle Hierarchical Management Model

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Abstract

With the popularization of early screening for metabolic diseases during pregnancy, the incidence of hyperglycemia in pregnancy has been increasing annually. This trend imposes a significant medical burden on pregnant women and their offspring, as well as on families and society at large. Consequently, the effective management of patients with gestational hyperglycemia is of profound clinical significance.

Objective: This study aims to construct a comprehensive index system for the hierarchical management of patients with gestational hyperglycemia. By doing so, it seeks to improve clinical efficiency and provide a robust theoretical foundation for the standardized management of this patient population.

Methods: A preliminary hierarchical management index system was formulated through an extensive literature search and structured group discussions. Following this, 15 experts were consulted over two rounds of the Delphi method. Indices were screened and refined based on expert feedback and statistical criteria to determine the final evaluation index system. Finally, the Analytic Hierarchy Process (AHP) was employed to calculate the relative weights of each index.

Results: The recovery rates for both rounds of expert consultation were 100%. The expert authority coefficients were 0.772 and 0.850, respectively, while the Kendall coordination coefficients were 0.319 and 0.344 ($P < 0.05$), indicating a high degree of expert consensus. Hierarchical analysis yielded importance scores ranging from 4.40 to 4.93 for primary indices and 4.67 to 4.93 for secondary indices.

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and secondary indicators, respectively. Finally, the grading management index system of gestational hyperglycemia patients was determined, which included 3 first-level indexes, 10 second-level indexes and 28 third-level indexes. Conclusion

The index

system for grading and managing patients with hyperglycemia in pregnancy in this study is scientific and reliable. It not only comprehensively assesses the health status of gestational diabetes mellitus patients, but also categorizes and assigns values to specific indexes, which helps clinicians to comprehensively and

hierarchically manage their patients, and can provide references to the clinical work of healthcare professionals and improve work efficiency. 【Key words】

Gestational hyperglycemia; Triangle hierarchical management model; Analytic hierarchy process; Delphi

method

Hyperglycemia in pregnancy is one of the most common metabolic abnormalities during gestation, encompassing gestational diabetes mellitus (GDM), prediabetes, and pre-existing diabetes mellitus complicating pregnancy [**?**]. The incidence of hyperglycemia in pregnancy has been increasing annually; it not only elevates the risk of maternal complications but is also closely associated with adverse pregnancy outcomes [**?**]. Consequently, implementing hierarchical management for patients with hyperglycemia in pregnancy is essential for achieving precision medicine and optimizing the allocation of healthcare resources.

However, China currently lacks a systematic and standardized evaluation index system for hierarchical management. Clinical practice often relies on single glycemic parameters or empirical judgment, which fails to comprehensively reflect the overall risk profile of patients [**?**]. Internationally, research specifically addressing hierarchical management for patients with hyperglycemia in pregnancy remains limited. Most studies focus on the impact of different management models on glycated hemoglobin (HbA1c), fasting plasma glucose, psychological well-being, and self-management [**?**]. Furthermore, these studies have not established a systematic index system or weight distribution, leading to a lack of practical operability in clinical settings.

The Triangle hierarchical management model utilizes multi-dimensional disease risk indicators as a basis for stratification, precisely categorizing patients into different risk levels: severe, high-risk, and stable. This model enables the precise allocation of professional medical and nursing resources according to the specific needs of each level. It is a stratified management mode characterized by regular reassessment of levels and the implementation of stepped, differentiated intervention strategies [**?**], aiming to achieve dynamic adaptation between medical resources and patient risk levels while providing a framework for the further development of hierarchical management. The advantages of this model in accurate risk identification and improved intervention efficiency have been demonstrated in the management of chronic diseases such as hypertension and type 2 diabetes [**?**]. In this context, some studies have applied Triangle hierarchical management to the nutritional management of patients with gestational diabetes; however, patient classification was determined by the highest level reached across all indicators, ignoring the differences in indicator weights [**?**]. In summary, existing research on the hierarchical management of hyperglycemia in pregnancy focuses primarily on diagnosis and treatment, while systematic research on specific hierarchical indicators and their weights remains insufficient. Therefore, this study employs the Delphi method and the Analytic

Hierarchy Process (AHP) as core methodologies to construct a scientifically reliable evaluation index system for the hierarchical management of patients with hyperglycemia in pregnancy. By determining the weights of relevant indicators, this study aims to provide healthcare professionals with a precise and operable stratification tool, facilitating differentiated services within multidisciplinary collaborative management and enhancing intervention efficiency.

Simultaneously, this study provides a methodological reference for the multidimensional assessment of hyperglycemia in pregnancy and enriches the evidence base for the application of the Triangle model in this patient population.

Research Team Formation The research team for this study consisted of eight members, including an associate professor from the School of Nursing,

the deputy director of the nursing department, a deputy chief physician of obstetrics, an attending physician from the nutrition department, a deputy head nurse from the endocrinology department, two head nurses from the obstetrics department, and a graduate nursing student. Regarding educational background, the team included one PhD, two Master' s degree holders, and five Bachelor' s degree holders. The primary responsibilities of the team included conducting literature reviews, preliminary formulation of stratification and classification indicators, designing expert consultation questionnaires, selecting experts for consultation, distributing and collecting questionnaires, and organizing and analyzing expert opinions and consultation results. This study was approved by the Medical Ethics Committee of Nanhai District People' s Hospital of Foshan (NYKY-2025-134-03) on July 22, 2024. Informed consent was obtained from all patients participating in the field investigation.

1.2 形成初步的妊娠期高血糖患者分级管理标准

This study employed a literature search method across several Chinese and English databases, including China National Knowledge Infrastructure (CNKI), Wanfang Data Knowledge Service Platform, VIP Database, and PubMed. The English search terms included: "Diabetes, Gestational," "Diabetes Mellitus, Gestational," "Pregnan*,"* "*gestation*," "diabetes mellitus," "diabetes," "classification*,"* "*Systematics,*" *and* " *Taxonom*." The Chinese search terms included: "gestational hyperglycemia," "diabetes," "Triangle chronic disease management model," "hierarchical management," "graded nursing," and "stratified and hierarchical management."

In accordance with the Triangle hierarchical management model and by integrating the literature search results with expert nursing opinions, the research team prioritized the principle of "associating disease severity with risk levels" during the indicator screening process. Three primary indicators were selected: physiological status (which directly determines pregnancy outcomes), psychological status (which indirectly affects glycemic control), and self-management ability (which influences intervention compliance). The secondary and tertiary indicators were developed based on the principles of being "quantifiable and

intervenable," ensuring that every indicator serves the model' s objectives of risk stratification and differentiated intervention. The preliminary hierarchical management index system for patients with gestational hyperglycemia consists of 3 primary indicators, 9 secondary indicators, and 27 tertiary indicators.

1.3.1 制定专家函询问卷

An expert consultation questionnaire was developed based on the preliminary follow-up pathway. The questionnaire consists of four distinct sections:

First, a cover letter to the experts is provided, outlining the research objectives, the significance of the study, and its primary content. Second, a general information form is included to collect demographic and professional data, such as age, professional title, and field of expertise. Third, the expert scoring section utilizes a 5-point Likert scale (ranging from 1 to 5, corresponding to "not at all important" to "very important") to evaluate the importance of indicators at each level. This section also includes dedicated columns for the addition or deletion of indicators and a space for qualitative expert comments. Fourth, a self-assessment scale is provided for experts to rate their degree of familiarity with the subject matter and the basis for their professional judgment.

1.3.2 专家的选择

(1) Possession of a bachelor' s degree or higher; (2) attainment of an intermediate professional title or higher.

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(3) At least 5 years of professional experience in obstetric clinical nursing or gestational diabetes specialization; (4) Mastery of clinical nursing and management protocols for hyperglycemia during pregnancy; (5) A clear understanding of the current study, with a commitment to completing multiple rounds of correspondence and providing systematic expert feedback.

1.3.3 实施专家函询

Experts were invited using purposive sampling. After obtaining informed consent, the Delphi consultation questionnaires were distributed and collected via email or the Wenjuanxing platform. To ensure validity, a graduate student meticulously reviewed each questionnaire per round and verified any ambiguous items with the experts.

Expert engagement was evaluated based on the recovery rate of valid questionnaires, where a rate > 0.7 indicates high engagement [**?**]. The degree of coordination among experts was determined using Kendall' s Coefficient of Concordance (Kendall' s W) and the Coefficient of Variation (CV); a larger W value

and a smaller CV value signify stronger consensus among experts [**?**]. The degree of expert authority was measured by the authority coefficient, with a value ≥ 0.7 considered acceptable [**?**]. Finally, the concentration of expert opinions was represented by the mean and standard deviation of importance scores for each indicator, with a mean score > 4 serving as the threshold for inclusion [**?**].

1.4 层次分析法

The Analytic Hierarchy Process (AHP) quantifies indicator weights to reveal the relative importance of various metrics within hierarchical management [**?**]. In this study, indicator weights are categorized into two dimensions—primary and secondary levels. Based on the evaluation index system constructed via the Delphi method, data analysis was conducted to determine the relative importance and weight coefficients of each indicator.

The consistency ratio (CR) was employed to test the judgment matrices, where a $CR < 0.10$ indicates acceptable consistency. For matrices where $CR \geq 0.1$, the expert ranking vector weighted geometric mean method was used to provide feedback to the experts, allowing for the adjustment of pairwise comparison results until all matrices satisfied the requirement of $CR < 0.1$.

1.5 分级标准临界值的确定

The critical ratio method was employed to determine the classification thresholds. Following established standards and the specific requirements of the research design, samples representing the upper and lower 27% of the total scores were selected as the extreme groups [**?**]. This study utilized a convenience sampling method to recruit participants from the obstetric outpatient clinic of Nanhai District People' s Hospital in Foshan City between August 2024 and October 2024. Inclusion criteria were based on the diagnostic standards for hyperglycemia in pregnancy as defined in the *Guidelines for the Diagnosis and Treatment of Hyperglycemia in Pregnancy (2022)*.

The target sample size was set at 200 cases. This determination was based on the minimum sample size requirements for scale validation, which typically necessitates at least five times the number of items (number of items $\times 5$). Given that this study includes 28 tertiary indicators, the minimum required sample size was 140 cases. To account for a potential 20% loss to follow-up during the research process, the final sample size was established at 200 cases.

After collecting relevant information from all participants, scores were assigned using the Rapid Grading Scale for Patients with Hyperglycemia in Pregnancy. The total scores were ranked in ascending order, and the two extreme groups were defined as Level III patients (low-score group) and Level I patients (high-score group), respectively. The critical score thresholds for these groups were then calculated. Additionally, t-tests were performed to compare the scoring differences between the two groups, and Cronbach' s α coefficient was utilized

to evaluate the internal consistency of the grading criteria.

1.6 统计学方法

Data entry and analysis were performed using Excel 2010 and SPSS 27.0, while the weights of each indicator were calculated using Yaahp software. Quantitative data are expressed as mean ± standard deviation ($\bar{x} \pm s$), and comparisons between groups were conducted using the t-test. Categorical data are presented as frequencies and constituent ratios. The threshold for statistical significance was set at $P < 0.05$.

结果

Basic Information of the Consulted Experts

A total of 15 experts from four cities—Guangzhou, Foshan, Shenzhen, and Jiujiang—participated in this Delphi consultation. The selected experts included obstetricians and gynecologists, obstetric nurses, gestational diabetes mellitus (GDM) specialist nurses, nutritionists, and clinical endocrinologists. The average age of the experts was (40.6 ± 5.4) years, with an average professional experience of (18.0 ± 5.4) years. Detailed demographic information is presented in Table 1 .

Number of participants (n)

Composition ratio (%)

< 40 years old

40–50 years old

50–60 years old

10–19 years

20–29 years

High-risk pregnancy management

Obstetric endocrinology

Gestational diabetes specialist nursing

Perinatal nursing

Evaluation Results of the Expert Consultation Indicators

Two rounds of expert consultation were conducted during the study. In each round, 15 questionnaires were distributed and 15 valid responses were recovered, resulting in an effective recovery rate of 100.00%. Eight experts provided optimization suggestions for the indicators, reflecting a high level of expert engagement. The degree of expert authority was evaluated using the authority

coefficient (C_r). For the two rounds of consultation, the familiarity coefficients (C_s) were 0.675 and 0.793, and the judgment coefficients (C_a) were 0.869 and 0.907, respectively. These values corresponded to authority coefficients of 0.772 and 0.850. The Kendall' s coordination coefficients (Kendall' s W) and χ^2 values for the two rounds are shown in Table 2 , indicating that the coordination of expert opinions was significant and demonstrated good consistency among the experts.

Kendall' s W value

0~0.142

<0.001

0~0.144

<0.001

Expert Consultation Feedback and Revisions: During the initial round of expert consultation, feedback was collected from eight specialists. The research team subsequently

revised the indicators based on the established selection criteria and the specific feedback provided by the experts. The details are as follows:

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The revised indicators are presented in Table 3 . During the second round of expert consultation, one expert disagreed with the removal of the tertiary indicator "occurrence of acute complications $\geq$ 2 times," while all other experts agreed with the modification. After thorough deliberation between the research group and clinical specialists, it was decided to delete the indicator "occurrence of acute complications $\geq$ 2 times." Regarding the remaining indicators requiring adjustment, the research group members conducted a collective demonstration based on expert feedback. Ultimately, all modification suggestions that reached expert consensus were adopted to form the final version of the indicator system.

The final established evaluation indicator system for the hierarchical management of patients with hyperglycemia during pregnancy consists of 3 primary indicators, 10 secondary indicators, and 28 tertiary indicators.

2.4 层次分析法结果

The Analytic Hierarchy Process (AHP) was employed to conduct a weight analysis of 3 primary indicators and 10 secondary indicators, facilitating the construction of a hierarchical model. A total of 15 experts completed the weight consultation questionnaire regarding the hierarchical management indicators for patients with hyperglycemia during pregnancy. All questionnaire data were entered into the Yaahp software for consistency testing. Following necessary adjustments, all judgment matrices met the consistency standard of $CR < 0.1$. The final judgment matrix was determined using the weighted geometric mean

method of the experts' ranking vectors, which was then used to calculate the weights for each indicator. The importance, coefficient of variation, and weights of the primary and secondary indicators within this hierarchical management evaluation index system are detailed in .

2.5 构建妊娠期高血糖患者分级管理快速评估简表

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grading management indicators for gestational hyperglycemia patients

Importance Score (Points) / Coefficient of Variation

1. 生理指标

4.93$±$0.26

1.1 近两周血糖控制

4.87$±$0.52

1.2 近一周低血糖发生情况

4.93$±$0.26

1.3 平均每周体重增长

4.80$±$0.56

1.4 胎儿生长发育

4.93$±$0.26

1.5 近 3 个月是否发生急性

4.87$±$0.52

1.6 是否发生慢性并发症

4.80$±$0.56

1.7 合并症存在种类

4.93$±$0.26

2 心理指标

4.93$±$0.26

2.1 焦虑

4.87$±$0.52

2.2 抑郁

4.93$±$0.26

3 自我管理评价

4.40$±$0.63

3.1 糖尿病自我管理评价

4.67$±$0.72

Note: Certain indicator scores are consistent with the coefficient of variation, reflecting a high degree of consensus among experts regarding their relative importance.

Modify / Add / Delete

1.1.2 不超过 2/3 未达标

Hypoglycemia in the Past Week

1.1 Blood Glucose Control in the Past Two Weeks

The target ranges for glycemic control are defined as fasting blood glucose (FBG) between 3.3 and 5.3 mmol/L and 2-hour postprandial blood glucose (2h PBG) between 4.4 and 6.7 mmol/L. Cases are classified as poorly controlled if more than two-thirds of measurements fail to meet these targets or if there is significant glycemic variability. This includes instances where values approach but do not exceed the diagnostic thresholds for pre-gestational diabetes mellitus (PGDM), defined as FBG $\geq$ 7.0 mmol/L, or cases presenting with typical hyperglycemic crises alongside a random blood glucose level $\geq$ 11.1 mmol/L.

1.1.3 Frequency of Occurrence

The frequency of hypoglycemic episodes is categorized as follows: - None - 1 time - $\geq$ 2 times

1.2 Average Weekly Weight Gain

For individuals with a pre-pregnancy Body Mass Index (BMI) $<$ 18.5 kg/m^2:

1.2.1 正常

0.46 kg; 18.5 kg/m2 $\leq$ BMI$<$24.0 kg/m2: 0.37

1.2.2 大于或小于正常范围 1 倍

kg; 24.0 kg/m2 ≤ BMI<28.0 kg/m2: 0.30 kg;

1.2.3 大于或小于正常范围 2 倍

BMI ≥ 28.0 kg/m2: 0.22 kg

1.4 近 3 个月急性并发症发生次数：低血糖、酮

1.4.2 One occurrence of ketoacidosis, hyperosmolar hyperglycemic state, or lactic acidosis. 1.4.3 ≥ 2 occurrences.

Delete subsection "1.4.3 ≥ 2 occurrences" and modify subsection "1.4.2 One occurrence" to "1.4.2 Present".

1.5 慢性并发症存在种类：由高血糖引起的肾病、

1.5.2 One type of retinopathy, neuropathy, pedal, lower limb vascular, or cardiovascular/cerebrovascular complication 1.5.3 ≥ 2 types

Delete the tertiary entry "1.5.3 ≥ 2 types" and modify the tertiary entry "1.5.2 One type" to "1.5.2 Present".

1.6 合并症存在种类：甲状腺功能异常、中度贫 1.6.1 无

···bloody show or more, polyhydramnios, gestational hypertension, dyslipidemia, liver function abnormalities, or Group B Streptococcus (GBS) infection.

1.6.2 One Type

[This section refers to the presence of one of the aforementioned clinical conditions.]

1.6.3 Two or More Types

[This section refers to the presence of two or more of the aforementioned clinical conditions.]

2.1.1 SAS<50 分

2.1.2 SAS Scores Between 50 and 60 (50 < SAS ≤ 60)

2.2.1 SDS<53 分

2.2.2 53 < SDS ≤ 62

This score range indicates that the individual is experiencing mild to moderate depressive symptoms. According to the Self-Rating Depression Scale (SDS)

standards, a standard score between 53 and 62 suggests that while the individual may still maintain basic daily functioning, they are likely experiencing persistent low mood, decreased interest, or physical discomfort associated with depression. Clinical attention and further psychological assessment are typically recommended for individuals scoring within this range to prevent the progression of symptoms.

2. 心理因素

3.1.1 Scores Above 80

3.1.2 Scores Between 60 and 80

3.1.3 Scores Below 60

3.1 糖尿病自我管理能力［20］

Note: SAS = Self-Rating Anxiety Scale, SDS = Self-Rating Depression Scale.

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The scoring criteria for the tertiary indicators were established based on the specific types of variables involved [**?**]. Binary variables were assigned values of 1 for "present" and 0 for "absent." For ordinal categorical variables, values were assigned according to a hierarchical gradient: Level 1 was assigned 0 points, Level 2 was assigned 1 point, and Level 3 was assigned 2 points. Given that the occurrence of acute complications—such as diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS)—as well as chronic complications resulting from hyperglycemia are the most critical factors affecting both the patient and the fetus [**?**], their corresponding scores were adjusted to 2 points. The final score for each graded management criterion was calculated as the weight of the secondary indicator multiplied by the assigned value of the tertiary indicator, with results rounded to two decimal places. These details are presented in .

Analysis using the critical ratio method yielded critical values of 10.91 and 40.01 for Level 3 and Level 1 patients, respectively. A comparison of the scores between the two groups showed that Level 1 patients scored 64.33 ± 19.79, while Level 3 patients scored 5.02 ± 4.08. This difference was statistically significant ($t = 23.450$, $P < 0.001$), demonstrating that the grading thresholds can effectively distinguish between different levels of patients with gestational hyperglycemia.

An internal consistency test was performed on the scoring criteria, yielding a Cronbach' s α coefficient of 0.711. This indicates good internal consistency and suggests that the scale possesses a reliable degree of credibility. The grading thresholds in this study were determined based on differences in risk scores

to guide stratified interventions; subsequent research will further verify their predictive value by incorporating clinical outcome data.

3.1 基于 Triangle 分级管理模型的妊娠期高血糖患者

The scientific reliability of the hierarchical management index system is well-supported by the results of this study. The effective recovery rate for both rounds of expert consultation was 100%, indicating a high degree of interest and active participation among the experts regarding the research topic. The authority coefficient in the second round of consultation showed an improvement over the first, exceeding 0.80, which suggests that the expert opinions reached a high level of authority. Furthermore, the increase in Kendall' s coefficient of concordance indicates a progressive convergence of expert consensus. The coefficient of variation for the importance of each index was consistently <0.25, demonstrating high consistency in expert opinions and establishing a solid foundation for the clinical applicability of the index system [**?**].

Hierarchical Management Standards

Severity levels: Suboptimal blood glucose values <1/3.

Blood glucose control over the past two weeks: Fasting Plasma Glucose (FPG) 3.3–5.3 mmol/L; 2-hour postprandial blood glucose 4.4–6.7 mmol/L. Suboptimal blood glucose values <2/3. Suboptimal blood glucose values >2/3, characterized by significant glucose fluctuations approaching but not exceeding the PGDM threshold (FPG $\geq$ 7.0 mmol/L), or random blood glucose $\geq$ 11.1 mmol/L accompanied by typical hyperglycemic crisis symptoms. Incidence of hypoglycemia within the past week.

Average weekly weight gain: For BMI $<$ 18.5 kg/m^2: 0.46 kg (normal); for 18.5 kg/m^2 $\leq$ BMI $<$ 24.0 kg/m^2: 0.37 kg; for 24.0 kg/m^2 $\leq$ BMI $<$ 28.0 kg/m^2: 0.30 kg; for BMI $\geq$ 28.0 kg/m^2: 0.22 kg. Deviations are categorized as being greater or less than the normal range by a factor of 1, or greater or less than the normal range by a factor of 2. Fetal growth and development.

Score (points): Actual score.

Larger or smaller by 1 standard deviation.

Larger or smaller by $\geq$ 2 standard deviations.

Occurrence of acute complications within the past 3 months: Ketoacidosis, hyperosmolar hyperglycemic state, or lactic acidosis (None).

Presence of chronic complications: Nephropathy, retinopathy, neuropathy, diabetic foot, lower extremity vascular disease, or cardiovascular/cerebrovascular disease caused by hyperglycemia (None/Present).

Types of comorbidities present: Thyroid dysfunction, moderate to severe anemia, polyhydramnios, gestational hypertension, dyslipidemia, abnormal liver

function, or Group B Streptococcus (GBS) infection (1 type). Anxiety: Self-Rating Anxiety Scale (SAS) score < 50.

Depression: Self-Rating Depression Scale (SDS).

Self-management evaluation: Self-Management Scale total score (higher scores indicate increased severity of the condition).

50 分 ≤ SAS ≤ 60 分

SAS > 60 points

SDS < 53 points

53 分 ≤ SDS ≤ 62 分

SDS > 62 points

80 points

60–80 points

< 60 points

Level 3 < 10.91; Level 2 10.91–40.01; Level 1 > 40.01

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In the Analytic Hierarchy Process (AHP), all consistency ratios (CR) of the judgment matrices are less than 0.1. This indicates that the logical consistency of the weight calculations is sound, thereby ensuring the scientific validity of the importance ranking for the indicators.

3.2 妊娠期高血糖患者分级管理指标体系的权重分析

The weight distribution results reveal the relative importance of each indicator within the hierarchical management system. Among the primary indicators, physiological indicators account for the highest weight at 0.678. Correspondingly, the two most significant secondary indicators under this category are glycemic control over the past two weeks and fetal growth and development.

Maternal physiological status directly determines pregnancy outcomes. Clinical guidelines emphasize that hyperglycemia during pregnancy leads to fluctuations in various physiological parameters, making the dynamic monitoring of these parameters critical for identifying pregnancy complications [**?**]. Research has confirmed that blood glucose levels can predict fetal overgrowth and the progression of insulin resistance; furthermore, intensive glycemic management can significantly reduce the incidence of macrosomia [**?**]. In this study, the weight assigned to anxiety (0.133) was higher than that of depression (0.085), a finding consistent with previous research. Most cohort studies indicate that the prevalence of anxiety is higher than that of depression among patients with

hyperglycemia during pregnancy [**?**]. From a mechanistic perspective, the sudden diagnosis of gestational hyperglycemia requires patients to rapidly adjust their lifestyles, perform frequent blood glucose monitoring, and face potential medication risks, all of which easily trigger acute anxiety responses. This anxiety, in turn, activates the sympathetic-adrenal medullary system and promotes the secretion of glucocorticoids and glucagon, thereby directly impacting the effectiveness of glycemic control [**?**, **?**]. Self-management accounted for a weight of 0.104. Self-management emphasizes the active participation and sense of responsibility of the patient, which helps them better understand their condition and actively cooperate with medical treatment plans, ultimately improving therapeutic outcomes [**?**]. Studies have shown that rigorous self-management can increase the rate of achieving glycemic targets in patients with gestational diabetes mellitus (GDM) while reducing the probability of postpartum progression from GDM to type 2 diabetes [**?**].

3.3 妊娠期高血糖患者分级管理指标体系的应用价值

A review of existing domestic hierarchical management indicator systems reveals that most determine a patient' s final classification based solely on the highest level achieved within a single assessment criterion [**?**]. These systems fail to clarify the relative importance of various indicators within the overall evaluation, leading to results that lack scientific rigor and systematic consistency. Furthermore, the absence of a quantitative assessment mechanism for clinical conditions makes it difficult for healthcare providers to accurately grasp the severity and progression trends of a patient' s status, thereby compromising the effectiveness and timeliness of interventions.

The hierarchical management indicator system for patients with hyperglycemia in pregnancy constructed in this study integrates multi-dimensional information, including physiological indicators and psychological status. This comprehensive approach enables more precise identification of high-risk populations, providing a solid foundation for subsequent targeted interventions. The Triangle hierarchical management model, characterized by its clear hierarchy and rigorous structure, offers an ideal framework for quantifying indicator weights.

Under the guidance of this model, this study achieves the first precise quantification of weights for each hierarchical management indicator. Through rational weight distribution, the specific role of different indicators in assessing a patient' s condition is clearly defined, enhancing the objectivity and accuracy of the evaluation results. To further improve convenience and efficiency in clinical application, this study also designed a rapid scoring table. With this tool, medical staff can quickly determine a patient' s grade within a short timeframe without the need for tedious calculations or complex analysis.

Based on these grade determinations, healthcare providers can develop personalized intervention plans tailored to individual circumstances. This approach empowers patients to enhance their self-management capabilities, improves long-

term prognoses, and optimizes the quality of pregnancy outcomes. Ultimately, hierarchical management facilitates the rational allocation and efficient utilization of limited medical resources.

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Level 1 patients can be prioritized for integrated management by multidisciplinary teams, while Level 3 patients can be managed through community hospitals or outpatient follow-up, thereby alleviating the burden on tertiary hospitals [**?**].

In this study, indicators were initially drafted through literature review and group discussions, followed by dynamic adjustments over two rounds of expert consultation. This process resulted in a three-level indicator system encompassing physiological indicators, psychological indicators, and self-management evaluations. Validation using clinical data demonstrates that this system effectively distinguishes between patients at different risk levels, providing an objective basis for clinical practice. The indicator system developed in this study is both scientific and practical, offering robust support for clinical graded management, resource optimization, and patient education, which is of significant importance for improving maternal and neonatal outcomes. However, the design of self-management indicators remains relatively weak, featuring only one secondary indicator without further dimensional subdivision. Future research will refine the scoring criteria and conduct additional expert consultations to adjust and modify the graded management indicator system, aiming to establish a standardized and comprehensive framework for patients with hyperglycemia in pregnancy. Furthermore, as this study was conducted in a single municipal Grade A tertiary hospital, future work should utilize large-sample, multi-center data to further verify its generalizability and develop intelligent assessment tools to enhance application efficiency.

Author Contributions: Li Xiaoyun was responsible for study implementation, statistical analysis, and manuscript drafting; Dai Meifen was responsible for methodological design, quality control, and supervision of the article; Cai Shu was responsible for study design, overall coordination, process control, and manuscript revision, and assumes overall responsibility for the research and the article.

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Abstract

In the context of the ongoing reform of the medical and health system, the development of general practice has become a core strategy for achieving "Healthy China." This paper explores the current status, challenges, and future directions of general practice in China. By analyzing the construction of the primary healthcare system, the training of general practitioners (GPs), and the implementation of the family doctor contract service model, we aim to provide a comprehensive overview of the discipline' s evolution. Despite significant progress in policy support and infrastructure, issues such as the shortage of qualified personnel, uneven quality of care, and low public recognition persist. We argue that strengthening the integration of clinical medicine with public health and leveraging digital health technologies are essential for the sustainable development of Chinese general practice.

Introduction

General practice, as a specialized medical discipline, plays a pivotal role in providing continuous, comprehensive, and coordinated care to individuals and communities. In China, the transition from a hospital-centric model to a primary care-centered system is a fundamental component of the national health strategy. The discipline focuses not only on the treatment of common diseases but also on health promotion, disease prevention, and chronic disease management. As the population ages and the burden of non-communicable diseases increases, the demand for high-quality general practice services has reached an unprecedented level.

The Current State of General Practice Training

The cultivation of a professional GP workforce is the cornerstone of the primary healthcare system. China has established a "5+3" standardized residency training model, which includes five years of undergraduate medical education followed by three years of standardized residency training in general practice.

As shown in , the number of registered general practitioners has increased steadily over the past decade. However, the distribution remains skewed toward urban centers, leaving rural areas with significant gaps in service provision. Furthermore, the competency of GPs varies across regions, necessitating a more rigorous evaluation and continuous medical education (CME) framework.

Family Doctor Contract Services

The family doctor contract service model is the primary vehicle for delivering general practice care in China. Under this model, GPs or GP teams sign contracts with residents to provide personalized health management. This approach aims to establish a long-term, trusting relationship between doctors and patients, which is crucial for managing chronic conditions such as hypertension and diabetes.

The effectiveness of these services can be modeled by considering the patient satisfaction index (S) and the health outcome improvement (H). If we denote the

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Abstract

The objective of this study was to construct a scientific, objective, and practical hierarchical management indicator system for nursing staff to provide a basis for the scientific management and professional development of nurses. By reviewing relevant literature and conducting semi-structured interviews, a preliminary draft of the hierarchical management indicator system was developed. Subsequently, two rounds of the Delphi expert consultation method were employed to screen and refine the indicators, and the weights for each indicator were determined using the Analytic Hierarchy Process (AHP). The final system comprises five primary indicators, 14 secondary indicators, and 45 tertiary indicators. The results demonstrate that the expert authority coefficient and coordination coefficient were high, indicating that the constructed indicator system is reliable and can serve as a reference for the evaluation and management of nursing hierarchies in clinical practice.

Introduction

Hierarchical management of nursing staff is a critical component of modern hospital management, aimed at optimizing human resource allocation and improving the quality of nursing care. With the continuous deepening of medical and health system reforms, establishing a scientific and reasonable hierarchical management system has become an urgent necessity for nursing administrators.

Traditional management models often lack objective evaluation standards, leading to issues such as unclear role definitions and limited career progression paths for nurses.

This study aims to address these challenges by constructing a comprehensive hierarchical management indicator system. By integrating qualitative and quantitative research methods, we seek to define the core competencies and performance expectations for nurses at different levels, thereby facilitating professional growth and enhancing organizational efficiency.

Methods

1. Preliminary Indicator Development

A comprehensive literature search was conducted across major databases to identify existing frameworks and theories related to nursing competencies and hierarchical management. Following the literature review, semi-structured interviews were conducted with nursing managers and clinical experts to gather insights into the practical requirements of hierarchical management in various clinical settings. Based on these findings, a preliminary indicator system was drafted.

2. Delphi Expert Consultation

Two rounds of expert consultation were conducted to refine the preliminary indicators. A panel of experts specializing in nursing management, clinical nursing, and medical education was invited to participate. Experts evaluated the importance and feasibility of each indicator using a Likert scale. Feedback from the first round was analyzed and used to modify the indicators for the second round.

3. Statistical Analysis and Weight Determination

Data from the expert consultations were analyzed using SPSS and

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Note: Figure translations are in progress. See original paper for figures.