Pediatric Nursing Risk Management Methods Based on Big Data Analysis

Zhongmei Chen[1,a],Xinru Chen[2,b]*,Guanlin Zheng[3,c],Yanyan Ren[4,d]

672671296@qq.com[a], tawxmei@163.com[b], dpkouzi@163.com[c], renyanyan7@163.com[d]

Department of Midwifery, Taishan Vocational College of Nursing, Tai'an, China[1]
School of Nursing, Philippine Women's University, Manila, Philippines[2]
Department of Midwifery, Taishan Vocational College of Nursing, Tai'an, China[3]
Department of Midwifery, Taishan Vocational College of Nursing, Tai'an, China[4]

Abstract. In recent years, the competitive pressure in China's medical industry has become increasingly intense. Nursing quality is directly related to the overall image and safety of the medical industry, while nursing quality is related to the allocation of nursing personnel. The characteristics of pediatric nursing work determine the need for more nursing human resources than adult departments. This article summarizes big data analysis, analyzes data preprocessing and pediatric nursing processes, discusses the composition of data warehouses, and analyzes the current situation of pediatric nursing human resource allocation in Hospital A. The most common reason for interdepartmental rotation accounts for 62%.

Keywords. Big data, pediatric care, risk management, LOF testing

1 Introduction

In the era of emerging internet technology and big data, the number of internet websites and users is rapidly increasing. The information, knowledge, and data generated are also enormous. It is becoming increasingly difficult for users to obtain the data they want. In the era of big data, search and recommendation are two main means of accurately obtaining information.

With the continuous progress of technology, many experts have conducted research on pediatric nursing risk management. For example, Kim Y S, Mahmood M, Kwon S assess doctors' understanding of CT scans in children, including the patient's radiation protection, radiation dose, and potential health risks of radiation exposure to CT scans. A questionnaire was distributed to all clinicians of medical staff who prescribed pediatric CT examinations in five pediatric hospitals [1]. Grossoehme D H, Brown M, Richner G recorded the risks and complications of non bronchoscopic bronchoalveolar lavage (NB-BAL) in 35 mechanically ventilated patients with diffuse severe pneumonia in the pediatric intensive care unit. Prospective data collection of patient ventilation settings and oxygen requirements before NB-BAL was conducted for each patient, as well as oxygenated hemoglobin saturation and heart rate readings before, during, and after surgery [2]. Joseph A, Joshi R, and Mihandoust S validated the effectiveness of the Pediatric Mortality Index (PIM) and Pediatric Mortality Risk (PRISM) models in the entire population and specific subgroups of pediatric intensive care units (PICUs). Compare PIM and PRISM prediction models for differences in calibration

PMBDA 2023, December 15-17, Nanjing, People's Republic of China
Copyright © 2024 EAI
DOI 10.4108/eai.15-12-2023.2345303

(consistency between predicted risk and observed mortality) and differences (area under the subject work characteristic curve, AUC) [3]. Despite the fruitful research results on pediatric nursing risk management in China, there are still shortcomings in the research on pediatric nursing risk control methods that integrate big data analysis.

This article studied big data analysis and pediatric nursing risk management methods, and discovered the BERT model. The results show that big data analysis methods play an important role in pediatric nursing risk management.

2 Methods

2.1 Big Data Analysis

(1) Big Data Analysis Concept

Big data analysis refers to the transformation of data from simple digital visual representations to graphs, patterns, and other visual representations, enabling users to more clearly see the differences between data and quickly find hidden information [4]. During the exploration process of data mining analysis, valuable analysis results and standardized analysis processes can be fixed based on the actual situation of the enterprise, and various visual tools can be used to display data in the form of easily perceivable icons, effectively providing the effect and utilization rate of data analysis [5]. The hidden value in interrelated data is generated during the process of data analysis, and its value is also the most important goal that so-called data processing wants to achieve. [6] The biggest difference between so-called “big data analysis” and traditional data analysis generated by computer software systems in the past is the exponential growth of data items and data volumes. Due to significant changes in the amount of data, the conditions required to store, query, and analyze data have rapidly improved compared to the past [7]. From the perspective of actual process operations, “big data analysis” requires exploring models by analyzing raw data to find the root causes of reality. This is the need to establish relevant models and forecasts to optimize processes to achieve continuous improvement and innovation in various fields and platforms.

(2) Data preprocessing

Before conducting data analysis and mining, it is necessary to first check the integrity and quality of data, and clean up missing and abnormal data. Common data that need to be cleaned up include missing values, abnormal values, duplicate values, and other data that need to be standardized [8]. Because data comes from different system databases, it is necessary to place all data sources in a unified pattern into a specified database for analysis and mining. This process is typically used to describe the process of extracting, transforming, and loading data from the source to the target [9]. Transfer data from different systems to the target database in a unified standard format ETL [10]. With the continuous development of Internet information technology and the emergence of personalized recommendation and big data analysis engines, it is possible to search and analyze large amounts of data more effectively and obtain more valuable information for the platform and users; For log data, it is possible to analyze the historical data browsed and clicked by users, as well as the historical data of system operation status. The system will make judgments based on the analysis of historical data to produce more intelligent processing results. The analysis and processing methods and purposes of log

data and website crawler data are similar [11]. They are all based on careful analysis of this information to explore its potential value. This data analysis process is called “offline (or offline) batch processing mode”; For communication industry data in the communication field, after processing and analyzing the data, through statistical induction and query, the most meaningful analysis results can be obtained, helping communication enterprises develop and improve communication quality [12].

(3) Composition of data warehouse

As a collection of multidimensional data analysis tools, data warehouses are the main analysis tools of data warehouse systems [13]. Its characteristics are fast and efficient, multi-angle analysis, and diverse analysis methods, which can meet the query, reporting, and decision support requirements of multidimensional environments. A data warehouse can handle any logical and statistical analysis related to an application, and can also be connected to other external analysis tools, such as data mining tools. To ensure data security, data warehouses can allow users to view only the information they should view based on their security level [14]. Data warehouse is actually a data management technology with data analysis functions. Data warehouse refers to extracting, cleaning, and summarizing existing scattered data to obtain new data. The original data may have redundancy, conflicts, or errors that cannot be directly used for analysis. After data warehouse collation, it can have consistent conventions, metrics, coding structures, and physical attributes, ensuring data quality and global consistency [15].

2.2 Pediatric Care Process

Communication between caregivers and children is only one-way. This does not meet the requirements of modern nursing management and personalized services. The ward is the same as the adult ward. Winfrey proposed that patients should simplify various examination procedures as much as possible and shorten the reporting time; It is required that the treatment and nursing process must be reasonably designed to fully reflect the concerns of patients, rather than merely promote the development of medical staff work processes. For example, the management of pediatric wards in traditional conventional pediatric care is often divided into two categories: newborns and ordinary children, while ordinary children have a large age span, a wide range, and are not specific. Due to the particularity of pediatric nursing work in recent years, doctor-patient disputes are on the rise. At the same time, nursing models and modern nursing needs are also constantly changing. It is necessary to take necessary improvement measures based on understanding and analyzing various aspects of traditional pediatric nursing routine and their corresponding shortcomings. The community undertakes health care services for sick children after discharge, but the allocation of community personnel and medical facilities cannot meet the implementation needs of continuous care; In addition, there is a phenomenon of disconnection and disconnection between hospitals and communities. Some hospitals and community health service centers are not well connected and continuous care is not in place, limiting their effective development. In recent years, with the development of health service reform and the continuous improvement of medical technology, more and more sick children can return to school for further education or participate in various social activities after receiving treatment for a period of time. From hospital to school to social reintegration, it is a necessary stage for this group of children and an important link in the recovery of social functions.

2.3 LOF Detection

LOF detection algorithm is a classical density based outlier detection algorithm. It can perform unsupervised and semi supervised learning on data. The idea is to calculate a numerical score to reflect the degree of abnormality in the sample. The reachable distance is calculated based on the k proximity distance. The reachable distance from detection point p to sampling point o, reach-dist (p, o), is the maximum value of the k-proximity distance between sampling point o and the direct distance between sampling point p and point o, as shown in Equation (1):

$$reach_{dist_k}(p,o) = \max\{k - dis\tan ce(o), d(p,o)\} \tag{1}$$

Local accessibility density should be calculated based on accessibility distance. For sampling point p, those data sampling points whose distance from point p is less than or equal to the k-distance (p) are referred to as their k-nearest neighbors, denoted as Nk (p). The local reachability density of a data point p is the reciprocal of its average reachability distance from adjacent data points, as shown in Equation (2):

$$lrd_k(p) = \frac{1}{\frac{\sum_{o \in K_k(p)} reach_{dist_k}(p,o)}{|N_k(p)|}} \tag{2}$$

The anomaly score of each sample is called a local anomaly factor, which measures the local deviation of the density of a given sample relative to its neighbors. The anomaly score depends on the degree of isolation of the object relative to its surrounding neighborhood. More specifically, locality is given by the k nearest neighbors whose distance is used to estimate local density [16].

The definition of influenza outbreak week is: if the number of influenza emergency cases in a certain week exceeds the 10th percentile of the annual average weekly influenza emergency cases, the week is defined as an influenza outbreak week, otherwise it is a non influenza outbreak week. Therefore, dummy variables such as the day and week of the influenza outbreak were introduced to control their impact on pediatric outpatient services. After incorporating confounding factors, the GAM basic model is shown in Equation (3) below:

$$Lag[E(Y_t)] = \alpha + \beta Z_t + S(temp, df2) + S(humi, df3) + dow + \inf luenza \tag{3}$$

Y_t is the outpatient volume of the child care system on day t (person time); E (Y_t) is the mathematical expectation of Y_t; α is the intercept.

3 Experience

3.1 Object Extraction

In this system, two ETL mechanisms are set up, one for one-time import of historical data, and the other for incremental data import. Incremental data import refers to the import of newly generated data from the previous day. The existing HIS products have little or no involvement in the comprehensive management, optimal use, improvement of hospital medical quality, socio-economic benefits, and competitiveness of hospitals. In order to overcome the shortcomings of the above design model, this study focuses on the quality of children's

services and aims at resource optimization. This model is conducive to improving the quality of medical services, taking into account hospital infrastructure and personnel construction, and is the most suitable model for modern hospitals. On the basis of integrating the database, convert the data into an analysis format, that is, build a data cube, describe each item of data in a multidimensional manner, and convert the data stored in ODS into a structure suitable for multidimensional analysis, which can be used by external applications such as data access interfaces. Through the display of main operational data, it is possible to immediately understand the operational status of the hospital; By monitoring and predicting the number of outpatient visits, the allocation of medical resources can be adjusted in a timely manner; Work efficiency can be judged by statistical diagnosis and treatment behavior time; Through difference indicator analysis and abnormal data monitoring, vulnerabilities in department management can be identified and detailed to specific personnel. The implementation of these functions also confirms that data warehouse technology is an effective means of analyzing medical big data.

3.2 Experimental Analysis

First, considering the long-term impact of time and season, the outpatient volume of the child care system itself is a sequence that changes over time. In addition, research has shown that both temperature and humidity can have an impact on outpatient visits, and the correlation is non-linear, that is, high and low temperatures can have harmful effects on health. Therefore, it is necessary to control the mixed effects of temperature and relative humidity on the outpatient volume of children's respiratory system. Use natural cubic spline smoothing functions to control time, temperature, and relative humidity. Firstly, analyze the data source according to requirements, establish data specifications, and extract conversion rules based on the master data format. During the ETL process, it is necessary to clean up and verify data, such as character legality, date data format, and numeric validity, and perform correct conversion. Data that cannot be successfully converted will be saved to the error dataset for manual troubleshooting. The successfully converted data is collated and stored as detailed data in a comprehensive database.

4 Discussion

4.1 Determining Test Objectives and Selecting Workloads

For the three main work scenarios of the big data analysis application platform, namely BI analysis, data integration, and machine learning, the performance load varies under different scenarios. This article needs to generate multitasking concurrent scenarios through benchmark testing to obtain performance data under various scenarios, providing support for subsequent performance anomaly identification research. In terms of workload selection, this article starts from platform application scenarios, selects the workload of machine learning scenarios, BI analysis scenarios, and data integration scenarios from Micro Big Bench, covering the performance characteristics of different industries and scenarios for big data analysis applications, and develops a test plan, as shown in Table 1.

Table 1. Test plan.

Scene number	Workload	Number of concurrent users
BI Analysis Scenario	1	34
Data integration scenario	5	23
Machine Learning Scenarios	8	32
Mixed Scenarios	3	28

As can be seen from the above, the BI analysis scenario has 1 workload and 34 concurrent users; The data integration scenario has 5 workloads and 23 concurrent users; The machine learning scenario has 8 workloads and 32 concurrent users; The mixed scenario has 3 workloads and 28 concurrent users. The specific rendering results are shown in Figure 1.

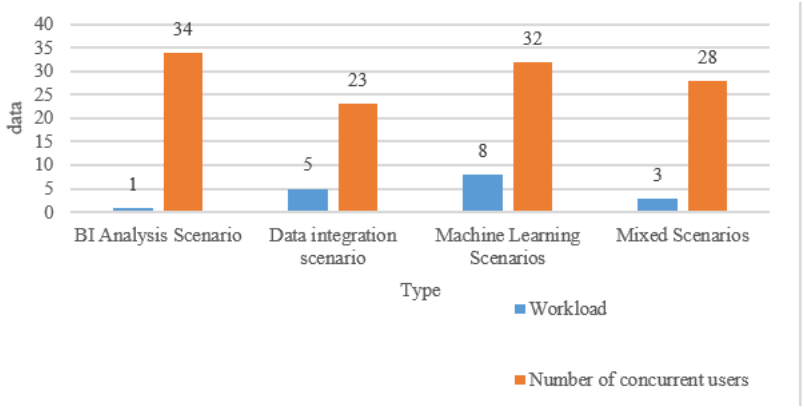

Figure 1. Test plan.

In BI analysis scenarios, data visualization analysis is mainly performed, characterized by covering multiple SQL queries, including single table queries and multi table join queries. From the BI workload of MicroBigBench, select 34 task combinations that cover multiple SQL query characteristics. To effectively perform dashboard analysis for users, please use more loaded SQL.

4.2 Current Situation and Analysis of Pediatric Nursing Human Resource Allocation in A Hospital

The pediatric department of the hospital has 105 nursing staff, 5 nursing staff in management positions, 90 nursing staff in clinical positions, and 10 nursing staff in other positions. A retrospective analysis was conducted on the human resource allocation data of the pediatric department of the hospital from January to March 2023. From January to March 2023, the Department of Pediatrics conducted a total of 25 human resource allocations. The reasons for allocation within the department are shown in Table 2.

It can be seen from the above that the reason for allocation within the department is COVID-19 prevention and control accounting for 32%, the reason for allocation within the department is going out to study accounting for 6%, and the reason for allocation within the department is inter department rotation accounting for 62%. The specific results are shown in Figure 2.

Table 2. Proportion of personnel deployment reasons.

Cause	Data
COVID-19 Prevention and Control	32%
Study outside	6%
Interdepartmental rotation	62%

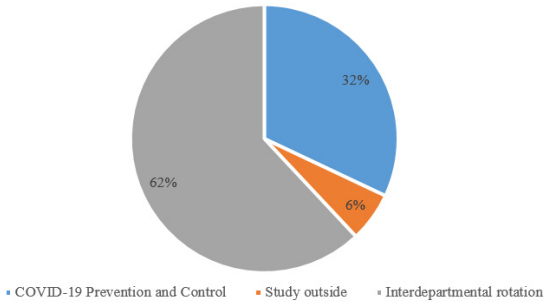

Figure 2. Proportion of personnel deployment reasons.

The reasons for deployment within the department include: prevention and control of COVID-19, going out to study, and rotation between departments; In emergency situations, the time required for personnel deployment is mainly concentrated outside the 8-hour work period. The reason for deployment is that interdepartmental rotation is the most common, accounting for 62%.

5 Conclusion

Pediatric nursing management has always been a hot topic in the international nursing community, and is also a relatively weak link in China's nursing management. Pediatric nursing risk management is more serious. This article analyzed the child care process, explored the composition of the database, discovered LOF detection algorithms, and tested the performance characteristics of different industries and scenarios covering big data analysis applications. The results show that selecting 34 task combinations from MicroBigBench's BI workload that cover multiple SQL query characteristics can effectively conduct dashboard analysis for users.

Acknowledgments. This paper was supported by the following projects: Key Project of Research and Practice on the Construction of Midwifery Specialty in Higher Vocational Education Based on the Background of Digital Transformation, Zheng Guanlin (No.: 202305); Social Science Project of Tai'an City in 2021: Exploration of Loose-leaf Teaching Material Design of "Maternal and Infant Nursing Vocational Skill Grade Certificate" under "1+X" Certificate System (No.: 21-ZD-032); "14th Five-Year Plan" of Education Science of Shandong Province in 2021: Design and application of loose-leaf teaching material of "mother and infant nursing" under "1+X" certificate system (No.: 2021ZC136).

References

[1] Kim Y S, Mahmood M, Kwon S, et al. Wireless, skin-like membrane electronics with multifunctional ergonomic sensors for enhanced pediatric care. IEEE Transactions on Biomedical Engineering. 2020;67 (8):2159-2165.

[2] Grossoehme D H, Brown M, Richner G, et al. A retrospective examination of home pca use and parental satisfaction with pediatric palliative care patients. American Journal of Hospice and Palliative Medicine®. 2022;39(3):295-307.

[3] Joseph A, Joshi R, Mihandoust S, et al. Pediatric intensive care unit (PICU) patient room design: identifying safety risks in mirrored rooms through a graphical systems analysis. HERD: Health Environments Research & Design Journal. 2022;15(1):189-206.

[4] Chung H U, Rwei A Y, Hourlier-Fargette A, et al. Skin-interfaced biosensors for advanced wireless physiological monitoring in neonatal and pediatric intensive-care units. Nature Medicine. 2020;26(3):418-429.

[5] Tahiri Z, Talbi M, Mansouri M E. Evaluation of Moroccan physician's knowledge about radiation doses and risks from pediatric computed tomography. Radioprotection. 2022;57(2):123-126.

[6] Delgado-Corcoran C, Wawrzynsk S, Mansfield K, et al. 1096: Perceptions of ECMO providers about pediatric palliative care. Critical Care Medicine. 2021;49(1):549-549.

[7] Walker D M, Tolentino V R. COVID-19: The impact on pediatric emergency care. Pediatric Emergency Medicine Practice. 2020;17(Suppl 6-1):1-27.

[8] Ray K N, Shi Z, Ishani G, et al. Trends in pediatric primary care visits among commercially insured US children, 2008-2016. JAMA Pediatrics. 2020;174(4):350-357.

[9] Zuckerman B, Ng C Y, Daglilar J O, et al. Connected pediatric primary care for at-risk children. Pediatric Clinics of North America. 2020;67(4):665-673.

[10] Schulzke S M, Stoecklin B. Update on ventilatory management of extremely preterm infants—A neonatal intensive care unit perspective. Pediatric Anesthesia. 2022;32(2):363-371.

[11] Ross C, Kools S, Sieving R. "I'm not gonna die because of an STD": Female African American adolescents' perspectives on how they protected themselves from sexual risks while in foster care. Journal of Pediatric Nursing. 2021;56(6):47-53.

[12] Blount J P, Bowman R, Dias M S, et al. Neurosurgery guidelines for the care of people with spina bifida. Journal of Pediatric Rehabilitation Medicine. 2020;13(2):1-11.

[13] Abu-Shamsieh A, Maw S. Pediatric care for immigrant, refugee, and internationally adopted children. Pediatric Clinics of North America. 2022;69(1):153-170.

[14] Evans B, Dore S, Couser D. Review of pediatric hypercarbia and intraoperative management. Current Opinion in Anaesthesiology. 2022;35(2):248-254.

[15] Lazarev V V, Linkova T V, Negoda P M, et al. Aplasia of the superior vena cava and persistent superior left vena cava in a 3-year-old child: Case report. Russian Journal of Pediatric Surgery Anesthesia and Intensive Care. 2021;11(1):85-90.

[16] Wolf M D, Jagannathan N, Enk D. Ventilation through small-bore airways in children by implementing active expiration. Pediatric Anesthesia. 2022;32(2):312-320.