Construction of a Risk Prediction Model for Postpartum Stress Urinary Incontinence Based on Machine Learning

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Abstract: Pregnancy pregnancy and childbirth is one of the main causes of Stress Urinary Incontinence (SUI). SUI not only affects women's physical health, but also affects women's mental health. 48 puerperae with SUI 6-8 weeks postpartum and 118 puerperae without urinary incontinence during the same period were selected in a hospital in eastern China. Patient information was retrieved from medical records, and postpartum women were asked to complete the International Urinary Incontinence Counseling Questionnaire Short Form (ICI-Q-SF). The early prediction model of SUI was constructed based on the random forest ensemble learning method. Compared with the results of the traditional logistic regression model, the random forest model has better prediction performance and can be used as a screening tool for high-risk groups of SUI during pregnancy to guide clinical work.

1. Introduction

Stress urinary incontinence (SUI) is complaint of involuntary loss of urine on effort or physical exertion,or on sneezing or coughing[1]. The pathophysiological causes of stress urinary incontinence are complex, factors known to be associated with a greater risk of postpartum urinary incontinence are pregnancy and childbirth[2]. The prevalence of SUI in female urinary incontinence patients ranges from 25%-45%.The reported prevalence of urinary incontinence in the postpartum period ranges from 30 to 40%[3-4]. SUI not only affects women's physical health seriously, but in severe cases can lead to women's psychological health, including anxiety, depression，loss of self-confidence and other emotions[5].

Studies have shown that pelvic floor muscle training can reduce the incidence of postpartum urinary incontinence in women [6], and greatly improve women's quality of life. Therefore, early identification, diagnosis and intervention of postpartum urinary incontinence can reduce the incidence of postpartum urinary incontinence in women. Fu Wenying et al[7-8] used ROC curve combined with multivariate Logistic regression analysis to construct a postpartum SUI risk prediction model. However, this model needs to be highly dependent on the correct data, and the accuracy of the model is not high. The purpose of this study was to find a new method to accurately identify high-risk groups of postpartum urinary incontinence.

2. Materials and Methods

2.1 Study subject

A total of 48 patients with SUI were collected from January 2021 to May 2021 in Hangzhou maternity hospital for prenatal examination, pregnancy, and delivery, and returned to the hospital for follow-up 6-8 weeks after delivery. The same method was used to select 118 patients without SUI during the same period. as a control group. Inclusion criteria for women with SUI: ① Meet the diagnostic criteria for SUI by the International Continence Society; ② Full-term singleton delivery;

③ Willing to participate in this study; ④ No previous urinary tract infection and kidney disease; ⑤ No history of pelvic surgery; ⑥ Clear consciousness, no complaints of cognitive impairment, and normal overall cognitive function. ⑦ 6 to 8 weeks postpartum re-examination and fill in the International Urinary Incontinence Advisory Committee Urinary Incontinence Questionnaire (ICQI-SF). In the control group, women without SUI should meet the above inclusion criteria except ①. Exclusion criteria: ① patients with irregular obstetric examination; ② patients with visual or hearing impairment; ③ patients with other factors that may lead to voiding disorders (neurogenic bladder, myelopathy, traumatic stenosis of lower urinary tract, diabetes insipidus, etc.) excluded; ④ patients with Obvious physiological defects and major diseases, such as severe cardiovascular and cerebrovascular diseases, nervous system diseases, and motor organ diseases. All maternal age, gravidity, parity, pre-pregnancy BMI, increased BMI during pregnancy, mode of delivery, painless delivery, fetal weight and other data were collected from medical records, and the risk factors of postpartum SUI were analyzed after sorting and summary.

2.2 Definition

SUI is defined as the involuntary leakage of urine that occurs due to increased abdominal pressure associated with pregnancy and childbirth.Postpartum period is defined as 6-8 weeks after delivery in this article.

2.3 Ethics

In this study, all procedures involving human participants were in compliance with the Declaration of Helsinki (revised 2013). This study was approved by the Ethics Committee of Hangzhou maternity hospital.

2.4 Model building and analysis

In this study, an early prediction model of SUI was constructed based on the random forest method. Random forest is an ensemble learning method based on the idea of bagging. It has the characteristics of high precision and strong generalization ability, and is widely used in the field of auxiliary diagnosis of obstetric diseases [9].

The grid search method (GridsearchCV) was used to adjust the optimal parameters of the random forest model. In this study, SPSS22.0 statistical software was used for data analysis, and the random forest and logistic algorithms were established and verified based on python.

The performance of the prediction model was evaluated by the area under the curve (AUC) of the ROC curve, sensitivity, specificity and F1 score under 5-fold cross-validation.

3. Result and Discussion

3.1 Data Baseline Description

Age, gravidity, parity, pre-pregnancy BMI, increased BMI during pregnancy, mode of delivery, painless delivery, birth weight and other data were collected. The basic characteristics of puerperae are shown in Table 1.Receiver operating characteristic curves are shown in Figure 1.

Table 1.General characteristic of the study population(n=166)

Characteristics	Mean±SD
Age,years	30.57±3.85
Gravidity,number of times	2.02±1.18
Parity,number of times	1.37±0.51
Pre-pregnancy BMI,kg/m2	20.78±3.24
Increased BMI,kg/m2	5.22±2.05
Birth weight,g	3347.53±411.53
Delivery mode	

Vaginal delivery[n %]	130(78.3)
Cesarean section[n %]	36(21.7)
Epidural anesthesia[n %]	68(51.5)

3.2 Results

The experimental results of cross-validation are shown in Table 2. The random forest model has the best predictive ability, and the AUC, F1 and sensitivity are significantly better than the traditional logistic regression model. The specificity is 0.44, the sensitivity is 0.92, and the F1 value is 0.60, which is significantly better than the other four methods.The results are shown in Table 2.

Table 2. Prediction average results of different methods after 5-fold CV

Modle	Specificity	Sensitivity	F1	ROC
Logistics	0.45	0.75	0.55	0.65
Machine learning	0.44	0.92	0.60	0.78

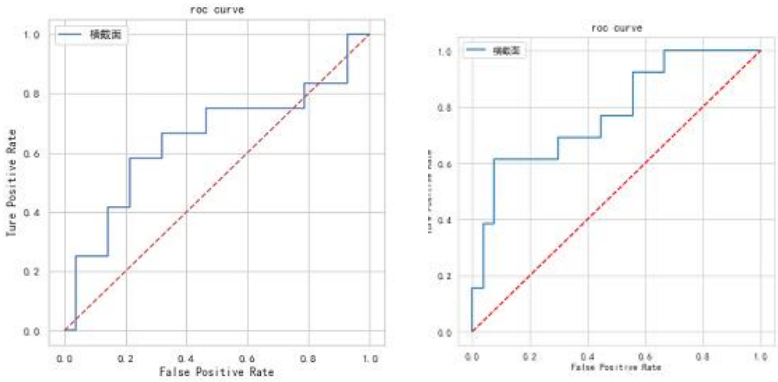
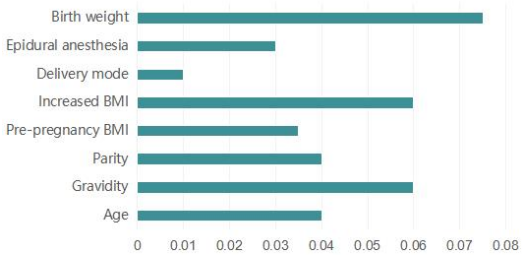


Figure 1.Receiver operating characteristic curves

3.3 Feature Importance Analysis

Predictive models are clinically significant and can be used for postpartum as well as prenatal assessments. This study included maternal age, parity, pre-pregnancy BMI, mode of delivery, epidural anesthesia et to establish a predictive model. The unit logistic regression analysis showed that vaginal delivery (P<0.01), epidural anesthesia (P=0.03), pre-pregnancy BMI (P=0.035), age (P=0.04) and parity (P=0.04) were the predictors of postpartum SUI. The results are shown in Figure 2. The model has better recognition performance. According to this article, vaginal birth has the strongest correlation with SUI. Although it is impossible to determine the mode of delivery before delivery, in some cases, if the mother is identified as a high-risk group of SUI according to this model, we can guide her to perform pelvic floor muscle exercises during pregnancy and strengthen the management of pregnant women. Cesarean delivery is a protective factor in the short term, but the protective effect of cesarean delivery on SUI is limited in the long term[11]. Epidural anesthesia may prolong the second stage of labor. Models can be used to screen out high-risk groups and other pain relief methods can be selected to avoid the occurrence of SUI. Maternal age, parity, and pre-pregnancy BMI can be determined before delivery. BMI is associated with the occurrence of SUI, which may be due to increased intra-abdominal pressure due to weight gain during pregnancy, which is likely to cause damage to the pelvic floor tissue of the parturient, resulting in decreased urinary continence [12]. Medical staff can advise patients to manage their pre-pregnancy weight to reduce the incidence of urinary SUI. During pregnancy, medical staff can inform relevant risks, guide obstetrics scientific diet and exercise, control weight, and reduce the incidence of postpartum SUI.. Take necessary obstetric measures to avoid pelvic floor injury as much as possible to reduce the possibility of postpartum SUI.

Figure 2 .Factors Affecting Postpartum SUI



4. Conclusion

In this study, a risk prediction model for postpartum SUI was constructed based on the risk factors of SUI using machine learning methods. The model has high sensitivity, specificity and accuracy, and has strong clinical operability. It can be used as a screening tool for high-risk groups of SUI during pregnancy to guide clinical practice. Work. Although the model adopts internal cross-validation, multi-center, prospective large-sample external validation is still required to evaluate the generalization of the predictive model.

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