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Predictive Score of Maternal and Foetal Prognosis during Labour in Primiparous Woman in a Congolese Hospital

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Authors' contributions

This work was carried out in collaboration between all authors. Author SVJJJ collected data and wrote the first draft of the manuscript. Author MAAM performed the statistical analysis. Author ELK managed the literature searches. Author JPOM designed the study and wrote the protocol All authors read and approved the final manuscript.

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ABSTRACT

Background: In Africa, primiparity is associated with high maternal and neonatal morbidity and mortality during pregnancy and childbirth. This study aims to establish a clinical score to identify the primiparous parturients at risk of pejorative evolution.
Methodology: This was a case-control study nested in ROC analysis, aiming diagnosis. During the period from April 1st, 2012 to June 30th 2013, the 1230 primiparous who gave birth at the Oïcha General Reference Hospital in the Democratic Republic of Congo were selected for this study. The primiparous were divided into an evaluation group (n = 686) and a validation group (n = 544). The evaluation group was subjected to a multi-variate analysis with conditional logistic regression to search for risk factors for the pejorative evolution of labour, which allowed the construction of the "Juakali score" for alerting about a bad prognosis of labour. The ROC analysis had revealed the threshold value and the area below the ROC curve, the discriminatory power.

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Results: The overall prevalence of pejorative evolution was 14.8%. Risk factors: age = 26 years, Height <150cm, Weight <50Kg, BMI (Body Mass Index) ≥ 30Kg / m^2, cervical dilatation rate <1cm / h at the latent phase. The score varied from 0 to 9 with a threshold value of 6, from which the positive predictive value was 75.3% in the assessment group (AUC = 0.924) and 63% (AUC = 0.922) for the validation.
Conclusion: The Juakali Score is a reliable tool for predicting the pejorative evolution of labour, which can be used to adjust driving behaviour early in labour monitoring.

Keywords: Predictive score; prognosis; labour; primiparous; congolese.

1. INTRODUCTION

In Africa, primiparity is associated with high maternal and neonatal morbidity and mortality during pregnancy and childbirth, which may require the recourse to a caesarean section during labour. The main indications of caesarean section during labour in primiparous patients are mechanical and dynamic dystocia, serious abnormalities of the foetal heart rhythm, and a non-commitment of the presentation with advanced or complete dilatation [1-3].

The results of the WHO Global Surveillance of Maternal and Perinatal Health Surveys show that the increase in caesarean section rates is associated with a higher risk of post-delivery antibiotic therapy as well as severe maternal morbidity, high maternal mortality, an increase in the foetal mortality rate and in the number of new-borns admitted in intensive care units compared to infants who were not born by caesarean section [4, 5].

The precarious conditions of caesarean delivery in Africa, therefore, make it a high-risk operation [6] and, nevertheless, the data on the assessment of the maternal and neonatal prognosis resulting from it are not sufficiently documented [7].

At the General Hospital of Reference of Oïcha (HGRO), the rates of Caesarean sections (26.1%) and low APGAR scores (13.6%) remain high despite the correct application of the partogram of the WHO following the training of providers [8].

Our question is whether it is possible, through a clinical score, to identify the primiparous parturients eligible for caesarean section at HGRO from recognized independent variables [9].

Establishing a clinical score to identify the primiparous parturients at risk of pejorative evolution to HGRO is the objective pursued by this study.

2. MATERIALS AND METHODS

It is a "two-part case-control study" carried out from April 1st, 2012 to June 30th, 2013 on a population of 5,369 parturients, of whom 2,136 had given birth between April 1st and September 30th, 2012 and 3,233 between the January 1st and June 30th, 2013.

The first component looked for and retained the risk factors for caesarean section, low APGAR scores, and those for a prolonged labour following multivariate analysis of significant predictive factors ($p < 0.05$) with conditional logistic regression [9]. It included 686 primiparous who met the following inclusion criteria: admitted at the start of labour with mono-foetal pregnancy at term, cephalic vertex presentation, foetal heart beats in norms, intact membranes, without cervical abnormalities, and followed on the partogram.

The second component was diagnosis based on the evaluation and then the validation of a score constructed from the risk factors of pejorative labour evolution [9]. It took place in 2 stages: the first stage consisted in constructing and evaluating a score, the "Juakali score" for the alert based on the risk factors selected in the first section [9]. To do this, the same sample of 686 primiparous of the first strand had been retained; the second stage consisted of validating the score on a different sample as recommended by the literature [10,11]. 544 primiparous from the population of 3,233 parturients who gave birth during the period from January 1st, 2013 to June 30th, 2013 and fulfilling the inclusion criteria of the study were concerned.

For score quotation, whenever the predictive factor met the conditions of the conditional logistic regression for only one parameter, it received a definitive score of 1; for two

parameters: dimension 2, and for three parameters: dimension 3. Once the definitive dimension of each predictive factor was calculated, the score of each subject was calculated by summing the final scores of each predictive factor found in it.

For the evaluation and the validation of the score, we split our sample of the 2nd part into 2 groups, namely:

- Group of "cases" consisting of subjects with pejorative evolution of labour, i.e. subjects who had concomitantly had: a prolonged labour, undergoing Caesarean section and for whom the new-born had a low APGAR score in the 5th minute, that is a total of 98 cases for the evaluation part and 84 cases for the part validation of the score ;
- "Non-case" group, consisting of subjects in whom one or two of the three poor obstetric and materno-foetal prognoses had been selected (caesarean section, prolonged labour and low APGAR score) or in which none had been observed poor prognosis, i.e. 588 subjects for the evaluation part of the score and 460 subjects for its validation.

To measure the relationship between the sensitivity and the specificity of our score, we plotted the ROC curve or characteristic curve of the performance of a test using the XLSTAT 2014 software as recommended by many authors [12,13]. We evaluated the precision of our score by calculating the area below the ROC (AUC = area under a receiver-operating characteristics curve) curve, using the same XLSTAT 2014 software. (AUC = 0.5), uninformative (0.5 ≤ AUC <0.7), moderately informative (0.7 ≤ AUC <0.9), very informative (0.9 ≤ AUC <1) and perfect (AUC = 1) [11,13].

The threshold value of the score was directly determined from the calculation of the specificity, sensitivity, positive predictive value and accuracy of each score. Other analyses, including description of variables (quantitative and qualitative), averages and their standard deviations, were completed using Epi Info™ software 7.1.1.14.

3. RESULTS

3.1 Risk Factors and Rating of the "Juakali Score" for Alerting

The overall rating of the score was 10 and the angle adjacent to the hypotenuse <45 ° had the highest score of 3.

3.2 ROC Analysis in the Global Prediction of Poor Obstetric and Materno-foetal Prognosis by the Juakali Score

The aim was to analyse the sensitivity, specificity, positive predictive value and accuracy of the score to diagnose the associated maternal and foetal poor prognosis. The threshold value of the score was also highlighted.

3.2.1 ROC analysis in evaluation group

The prognosis was poor if the score was ≥ the threshold value which was 6. From this value, there was a risk of simultaneous prolonged labour, caesarean section and low new-born APGAR score at the fifth minute.

3.2.2 ROC analysis in the validation group

The materno-fetal prognosis was poor if the score ≥ the threshold value of 6.

3.3 Study of the Accuracy of the score in the Diagnosis of Poor Obstetric and Materno-foetal Prognosis

3.3.1 ROC curve in the evaluation group

The ROC curve in the evaluation group show the sensibility and specificity of the Juakali score in this group.

Table 1. Risk Factors and Rating of the « Juakali Score » for Alerting

Risk factors	Prolonged labor	Caesarean section	APGAR<7	Total
Angle <45°	1	1	1	**3**
Age ≥ 26 years	1	1	0	**2**
Height < 150cm	1	1	0	**2**
Weight < 50Kg	1	0	0	**1**
BMI ≥30Kg/m^2	0	1	1	**2**
Total	**4**	**4**	**2**	**10**

Table 2. Synthetic ROC analysis for overall poor prognosis score in the assessment group

Juakali score	Sensitivity	Specificity	VPP	Accuracy
0.000	1.000	0.000	0.125	0.125
1.000	1.000	0.105	0.138	0.217
2.000	1.000	0.125	0.141	0.235
3.000	0.953	0.527	0.224	0.580
4.000	0.907	0.617	0.253	0.653
5.000	0.860	0.845	0.443	0.847
6.000	0.814	0.962	0.753	0.943
7.000	0.523	0.997	0.957	0.937
8.000	0.233	0.997	0.909	0.901
9.000	0.047	1.000	1.000	0.880

Table 3. Synthetic ROC analysis for the prediction of overall poor prognosis by the score in the validation group

Juakali Score	Sensitivity	Specificity	VPP	Accuracy
0.000	1.000	0.000	0.076	0.076
1.000	1.000	0.105	0.084	0.173
2.000	1.000	0.125	0.086	0.191
3.000	0.952	0.527	0.142	0.560
4.000	0.905	0.617	0.162	0.639
5.000	0.857	0.844	0.310	0.845
6.000	**0.810**	**0.961**	**0.630**	**0.949**
7.000	0.524	0.996	0.917	0.960
8.000	0.238	0.996	0.833	0.939
9.000	0.048	1.000	1.000	0.928

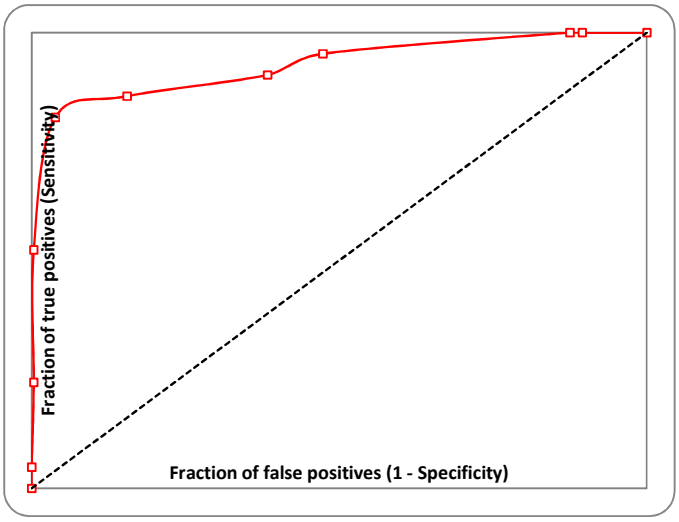

Fig. 1. ROC curve for the poor overall prognosis in the assessment group (p-value <0.0001, AUC = 0.924 (95% CI = 0.891-0.958), standard error = 0.017)

3.3.2 ROC curve in the validation group

The ROC curve in the validation group shows the validation of the Juakali score with the an AUC value approaching 1.

4. DISCUSSION

It is recognized, on the basis of several studies [2,14,15], that primiparity is exposed to many risks, both maternal, foetal and neonatal. In order

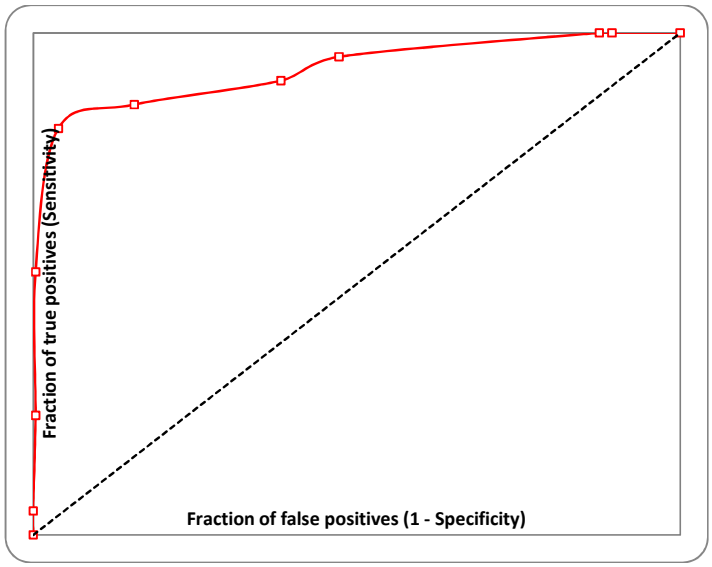

Fig. 2. ROC curve for the poor overall prognosis in the validation group (p-value = <0.0001, AUC = 0.922 (95% CI = 0.866-0.979), standard error = 0.02)

to reduce maternal and foetal morbidity and mortality during childbirth in primiparous women, it is important to look for different risk factors related to maternal anthropometric characteristics, those related to pregnancy and labour. However, in the studies cited above [2, 14,15], none of the authors analysed these risk factors as a whole in order to highlight the importance of their interaction.

In their study of the risk factors for caesarean section and low scores of APGAR, Juakali *et al.* [9] evaluated the relationship between many potential factors, taken separately, and the occurrence of caesarean sections, with low scores of APGAR as well as of the prolonged labour. They found that few of these factors were independent of one or all of them. The only risk factors were age ≥ 26 years, angle <45°, height <150 cm, weight <50 kg and BMI ≥ 30 kg / m^2.

It was the relative impact of these risk factors that was quantified in this study to develop a risk score, "Juakali score" for alert, allowing the exact calculation of a probability of pejorative evolution of labour in the primiparous in labour from the end of the latent phase of the labour.

The reliability of this score resides in the statistical analyses which led to its construction and to its testing on two different groups, namely; the evaluation group and the validation group as recommended by other authors [10]. Indeed, the parameters chosen for the construction of the score had been after analysis by multi-varied conditional logistic regression. The main advantage of this technique is to quantify the strength of the association between each independent variable and the dependent variable, taking into account the effect of the other variables integrated in the model [16,17].

The score thus constructed was tested in two distinct groups to bypass the problem of overestimating the discriminatory power of the score. This is important because a regression analysis is designed to calculate the best fit for the same sample analysed. Therefore, the discriminatory power of the different scores may be lower if a prediction is made for another sample from the same population [10].

The discriminatory power was used to evaluate the performance of the prognostic models of the score. Discrimination which is the ability of a prognostic score to rank patients correctly as having a pejorative evolution of labour or not, had been measured by the AUC (area below the ROC curve). It thus determines the precision of the score [18,19]. The ROC analysis, in turn, allowed us to show the threshold value of the score, sensitivity, specificity, positive predictive value and score accuracy.

Whether it was in the evaluation or validation group, we found a discriminatory power of our excellent score. Our score is therefore of great diagnostic interest, because the AUC is between

0.9 and 1. It is these values between 0.9 and 1 which were indicated by other authors as reference values to speak of a very informative test [11,12]. These results suggest that a parturient at risk of pejorative evolution for his work can be identified on the basis of our score.

The ROC analysis also determined a threshold value in the two groups, a value from which pejorative labour evolution had occurred. At this threshold value, we also found that the specificity of the score, its sensitivity, positive predictive value and accuracy were good. Our test is therefore as specific as sensitive. A specific test produces few false positives and a high sensitivity test produces few false negatives. As a result, sensitivity and specificity are inherent characteristics of a test and are useful for describing its expected performance [20]. Fletcher et al. [12] stated that a specific test had few false-positive results and found that it was required when false-positive results could harm the patient.

Positive predictive value is the proportion of people with a positive outcome who are truly affected by the disease [20]. The positive predictive value of our score and its accuracy were high in both groups. This reinforces the reliability of our score.

5. CONCLUSION

Consideration of different risk factors for poor materno-foetal prognosis led to the construction of the "Juakali score" for alerting the pejorative evolution of labour at the end of the latent period of cervical dilatation. This score, of great discriminatory power and high predictivity, is an important tool to consider when monitoring labour with the partograph (partogram). Taking into account the score may make it possible to modify the outcome of the work by interfering with the determining factor which is the angle adjacent to the hypotenuse lower than 45°, corollary to the cervical dilatation.

CONSENT

All authors declare that “written informed consent was obtained from the patient (or her guardian) for participating in this study”.

ETHICAL APPROVAL

The ethical approval was gotten from the local ethic committee of the Faculty of Medicine and Pharmacy at the University of Kisangani.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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