A new algorithm based on Artificial Intelligence on screening of preterm birth: a retrospective study in high-risk population

Marcelo Santucci FRANCA, MD, Obstetric Dept. Federal University of Sao Paulo, Brazil
Valter Lacerda de ANDRADE JR., MD, Postgraduate Department, Sector of Business Intelligence & Analytics of Impacta School of Technology, Brazil
Dr Alan HATANAKA, PhD, Obstetric Dept., Federal University of Sao Paulo, Brazil
Jader CRUZ, MD, Centro Hospitalar Universitário de Lisboa Central, Lisboa, Portugal.
David Baptista da Silva PARES, MD, PhD, Obstetric Dept. Federal University of Sao Paulo, Brazil
Rosiane MATTAR, MD, PhD, Obstetric Dept. Federal University of Sao Paulo, Brazil
Antonio Fernandes MORON, MD, PhD, Obstetric Dept. Federal University of Sao Paulo, Brazil

Abstract

Objective: The objective of this study is to create a new screening for spontaneous preterm birth (sPTB) based on artificial intelligence (AI) more efficiently than current models.

Methods: We included singleton pregnancies evaluated between March 2011 to August 2018, 755 pregnant were eligible women from 18th to 24th-week gestation. We analyzed by transvaginal ultrasound cervical length. All non-spontaneous preterm births delivered by induction, c-section were excluded because of IUGR, diabetes, elective or iatrogenic indication (n=99), and we excluded all mechanic preterm birth treatments as cervical pessary or cerclage (n=22) to reduce the risk of bias, and we exclude all patients without perinatal results (n = 110). The final number of the study population was 524 singleton pregnancies. The ultrasound examination was preceded by a detailed appointment to collect all relevant clinical data for screening preterm birth < 35 weeks. All these data were analyzed, after performed Odds Ratio (CI95%), by stepwise forward logistic regression (sFLR). The first analysis considered 33 variables and discriminated the most statistically significant. We performed multiple classical algorithms of AI to discriminate the best model for screen sPTB<35 weeks. After the AI results, another AI model was created based on the stacking-based ensemble learning method (SBELM) by the neural network, to improve the performance. This method is sort of a gathering the best AI algorithms to perform with the best part of each one. The ROC curve analysis to predict sPTB at < 35 weeks was performed to evaluate CL< 25 mm, sFLR, the best algorithms of IA, and SBELM and area under curve (AUC) were calculated for all. After fixing 10% of false-positive rate, sensitivity, specificity, accuracy, predictive positive and predictive negative values were performed to compare all techniques.

Results: Demographic characteristics of the 524 patients were analyzed after inclusion. Thirty-three variables were subdivided into 129 dummies, to discriminate higher risk for preterm birth. The most relevant variables to explain sPTB < 35 weeks were expressed in table 1.

After fixing 10% of false-positive rate for all techniques, cervical length <25mm, sFLR, XGradBoost (the best algorithm of AI) and SBELM presents, respectively: Sensitivity of 33.3, 41.7, 44.4 and 58.3%; Specificity of 91.8, 92.4, 92.6 and 93.6%; Accuracy of 87.8, 88.9, 89.3 and 91.2%; Predictive positive value 23.1, 28.8, 30.8 and 40.4%; Predictive negative value 94.9, 95.6, 95.8 and 96.8%; Area Under ROC curve (AUC) of 0.318, 0.770, 0.788 and 0.801. All methods presented high statistical significance when compared to short cervix AUC and P-value obtained < 0.00001(Wilcoxon test).

Conclusion: Artificial intelligence applied to clinical and ultrasonographic variables could be auspicious for screening of preterm birth < 35 weeks, improving the performance of short cervix, with low false-positive rate.

Image

Selected Variables	Coef Beta	SD	Wald	Sig.	Odds Ratio	C.I.95%	
						Inferior	Superior
History of cervical incompetence	4.321	1.325	10.625	0.001	75.238	5.600	1010.890
Ethnics black	-1.335	0.671	3.964	0.046	0.263	0.071	0.979
Previous Preterm Delivery ≤ 28 w	0.914	0.704	1.685	0.194	2.495	0.628	9.916
Previous Curettagge	-0.867	0.797	1.184	0.277	0.420	0.088	2.004
No bacterial infection during preg	0.477	0.518	0.846	0.358	1.611	0.583	4.447
Weight (≤ 58 kg)	0.360	0.427	0.713	0.398	1.434	0.621	3.308
No Smoking	-0.864	0.598	2.084	0.149	0.422	0.130	1.362
Cervical length < 30.9 mm	1.504	0.400	14.141	0.0001	4.498	2.054	9.849
Constant	-3.001	0.757	15.717	0.0001	0.050		

Table 1 - Principal variables were selected according to sFLR, the value of P was expressed, and the value of Coef. beta is the number applied on the Logit function to discriminate the cases with a higher risk for preterm birth in this population.

Recent Publications

1. Franca MS, Hatanaka AR, et al (2021) Cervical pessary plus vaginal progesterone in a singleton pregnancy with a short cervix: an experience-based analysis of cervical pessary' s efficacy. MFNJM Doi: 10.1080/14767058.2021.1919076.
2. Hatanaka AR, Franca MS et al. (2019) Antibiotic treatment for patients with amniotic fluid "sludge" to prevent spontaneous preterm birth: A historically controlled observational study. AOGS DOI: 10.1111/aogs.13603
3. Witkin, SS, Franca MS et al. (2019) Vaginal biomarkers that predict cervical length and dominant bacteria in the vaginal microbiomes of pregnant women. MBIO. DOI: 10.1128/mBio.02242-19
4. Pacagnella RC, Franca MS et al (2019) A randomized controlled trial on the use of pessary plus progesterone to prevent preterm birth in women with short cervical length (P5 trial). BMC. DOI: 10.1186/s12884-019-2513-2
5. Franca MS, Hatanaka AR et al (2020) Cervical pessary plus progesterone for twin pregnancy with short cervix compared to unselected and non-treated twin pregnancy: A historical equivalence cohort study (EPM Twin Pessary Study)". RBGO. DOI: 10.1055/s-0040-1713806

Photograph



Biography

Dr Marcelo Franca has his expertise in screening of preterm birth and cervical pessary treatment and passion in improving the health and wellbeing of maternal care and childcare, reducing preterm birth. His open and contextual evaluation model based on Artificial Intelligence to screening preterm birth can create new pathways for improving healthcare. He has built this model of screening after years of experience in research, evaluation, teaching and administration both in hospital and education institutions. He is also an enthusiast of cervical pessary treatment. He published articles in singleton and twin pregnancies demonstrating that pessary can reduce preterm birth if is associated to experience and learning. In the Hospital from his research, cervical pessary is offered without cost for preterm birth high risk population because the costs involved in neonatal ICU to be overtaken in more than ten times the costs involved in cervical pessary management for all screened population.

Email: marcelosantucci.franca@gmail.com