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Cost-Consequences Analysis (CCA) of Artificially Intelligent (AI) Clinician-Friendly Interpretable Computer-Aided Diagnosis (ICADX) Tool for the Detection of Preterm Births (OB-GYN) Developed at HosmartAI (HORIZON 2020 FUNDED)

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Background

- Preterm delivery contributes to an increased risk of fetal and maternal death and several health deficiencies. Diagnosis of preterm delivery in advance is important to avoid or minimize its undesirable consequences to the baby and the mother.
- Data-driven decision-making using AI algorithms has been increasingly common in the obstetrics field by providing improved diagnostic accuracy and automated, standardized interpretation and inference processes.
- CADXpert OB-GYN uses clinically validated models that can efficiently predict Pre-term birth using data from standard clinical practice.

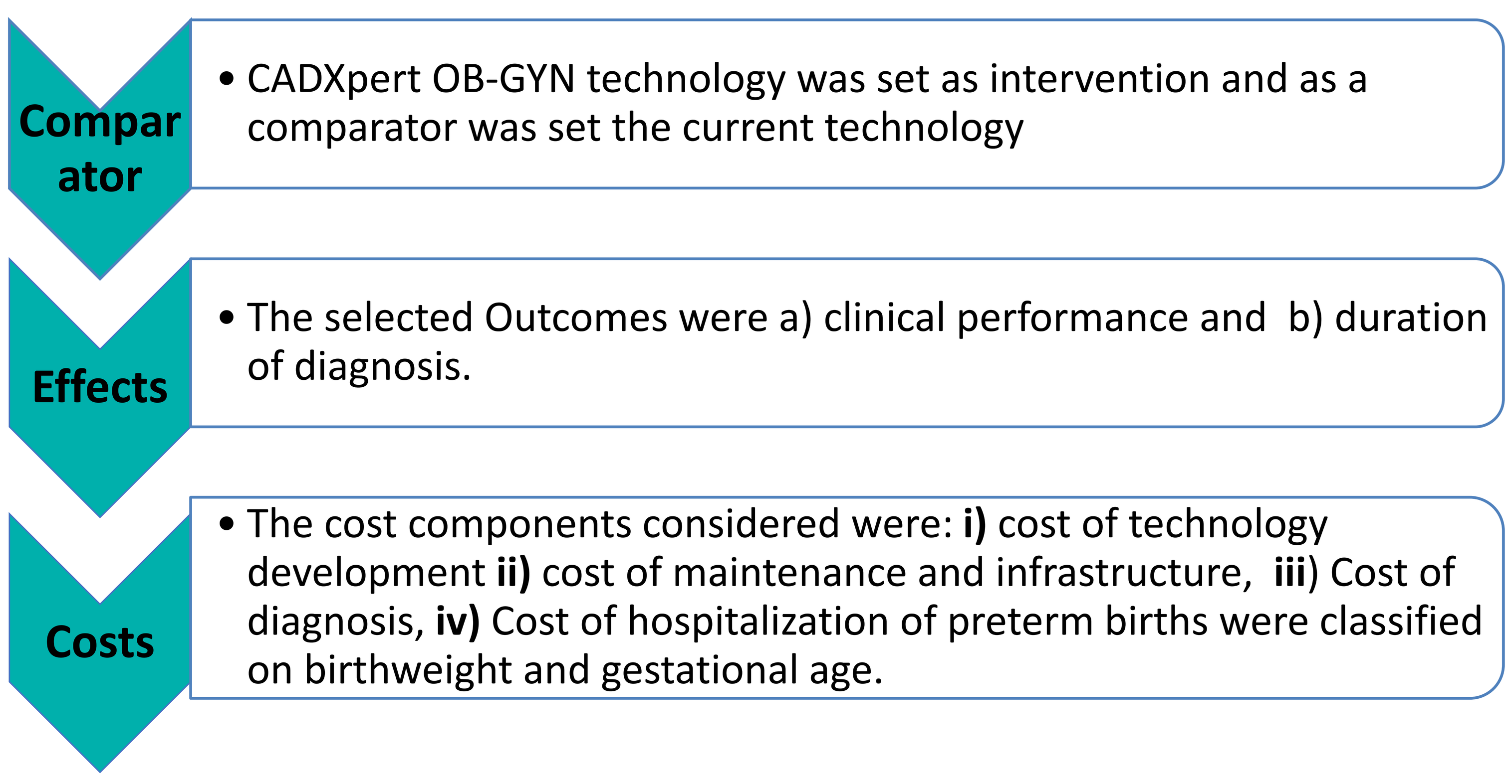
Objective

The study aims to analyze the economic and clinical performance of the AI-web based predictive model on the accurate detection of preterm births.

Methods

- 207 pregnant women participated in the study at Hippokration General Hospital of Thessaloniki with the following inclusion criteria:
  - Symptoms of preterm birth
  - Symptoms of FGR
  - Age >18 years old
  - Singleton pregnancies
- A micro-costing analysis was performed, based on the perspective of the Greek healthcare system, to identify the following cost elements:
  - costs of development of the new AI technology,
  - cost of maintenance of the technology
  - cost of diagnosis and hospitalization of preterm births classified per birth weight and gestational age.
- The selected Key Performance Indicators (KPIs) to capture the effectiveness of the new technology were a) clinical performance and b) user satisfaction.
- The comparison with the current technology was performed incrementally (both costs and effects) to enable the cost-consequence analysis of the CADXpert OB-GYN technology.
- The chosen methodology was cost-consequence analysis (CCA) since it enables the presentation of various impacts of an intervention individually, rather than combining them into a single metric, This approach enables a more holistic understanding of the effects, while leaving it to the decision maker to determine the relative significance of each aspect (Figure 1).

Figure 1. Components of costs and consequences in cost consequence analysis



- The model prediction variables were collected based on medical team recommendations. The variables used consisted of epidemiological and clinical parameters e.g., Maternal age, smoking, BMI, mode of delivery, etc. The characteristics of the sample which were also used as model prediction variables are presented in Table 1.
- To prevent over-fitting, we assessed the prediction accuracy of all models under consideration using 10-fold stratified cross-validation and area under the receiver operating characteristic curve (ROC-AUC).
- In each cross-validation fold, a training sample (consisting of 70% of participants) was used to create all machine learning (ML) models, followed by a held-out sample (consisting of 30% of participants) for performance evaluation. The final model that was chosen for this clinical decision support task, is a Voting ensemble of the Logistic Regression and Xgboost. This model is embedded in the CADxpert application to provide the prediction for PTB outcome.
- The application provided the prediction along with the explanation for each prediction. Then, the participants' continued care was provided according to standard clinical practice, independent of CADxperts results. The medical team was then provided with the final results from each case and collected them with the results from the CADxpert.

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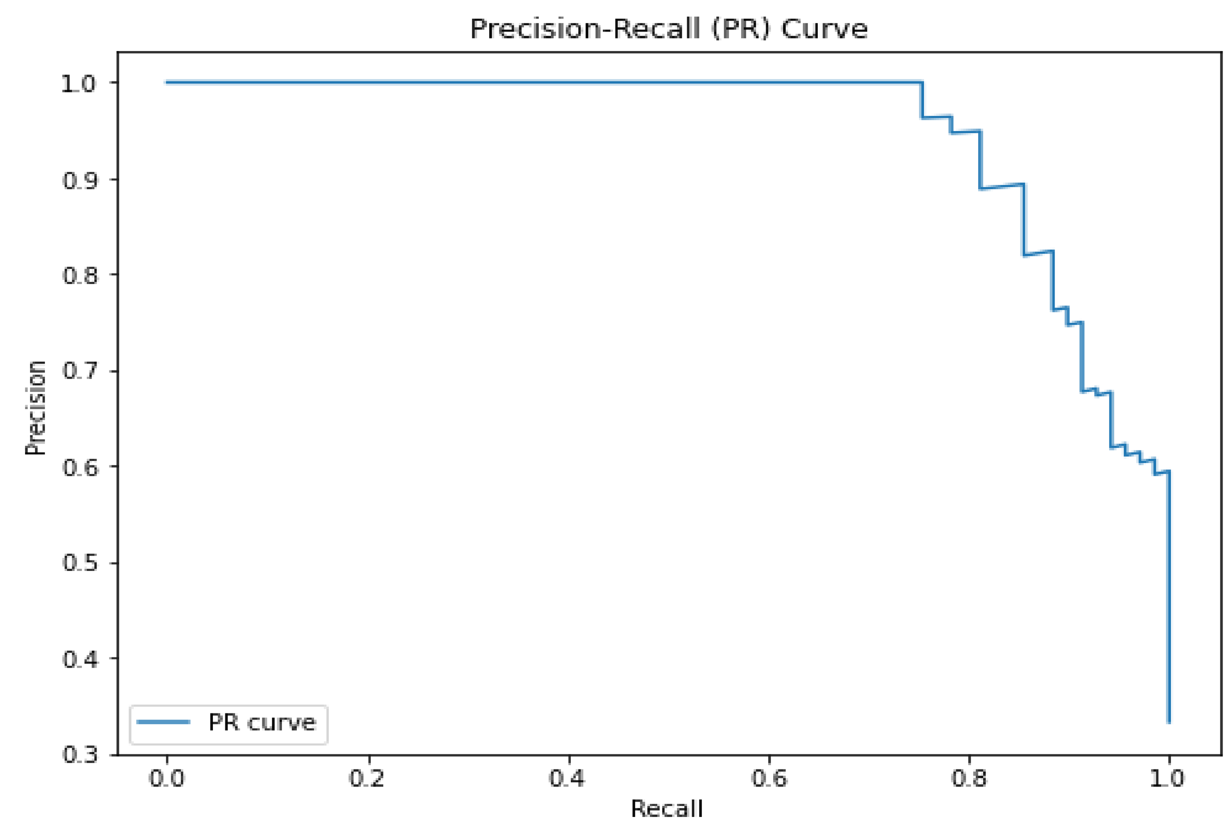
Table 1. Characteristics of the sample & Variables used at the Prediction Accuracy Model

Variable	Mean (Std. Dev)	Variable	Count (Percentage) or Mean (Std.Dev)
Maternal age	31.61 (5.37)	Accelerations	(0: 1) , (1: 3), (2: 4), (3: 3)
BMI	27.69 (9.18)	Decelerations	(0: 8), (1: 2) , (2: 2)
UtA doppler	1.096 (0.519)	Parity	(0:7) , (1:2), (2:1)
UA doppler	1.153 (0.251)	Smoking	No: 11
MCA doppler	1.872 (0.386)	ART conception	Yes: 3, No: 9
CPR	1.706 (0.532)	Mode of delivery	Vaginal: 10, CS: 3
DVP	4.364 (0.59)	CTG stv	5.509 (1.522)
DV doppler	0.482 (0.143)	Papp-a	0.995 (0.206)
b-hcg	1.074 (0.199)	CTG stv	5.36 (1.22)
Composite outcome	Yes: 3 No: 8		

Results

- The Model's performance was rigorously evaluated reflecting its predictive capabilities in a real-world clinical setting. The Receiver Operating Characteristic (ROC) curve demonstrates the model's discrimination capacity. With an AUC of 0.83, the model has a good ability to differentiate between the positive and negative classes Figure 2.

Figure 2. Model Precision Recall (PR) Curve



- In table 2 the results of the cost consequences analysis are presented. Regarding the cost analysis, the new technology seems to be a cost saving option versus the current practice. CADXpert OB-GYN has an extra cost of personnel, maintenance and AI infrastructure but due to its predictive capacity, the closer monitoring of the pregnant mother is able to delay the premature delivery by at least 3-4 weeks. This delay changes the status/category of the delivery from the cost of prematurity with co-morbidity, (age category 1500-1999gr) (DRG cost of €3.158) to cost of prematurity without comorbidities €2.646, leading to savings of €512 per neonate. If we take into consideration the 328 preterm births annually, the savings of this category shift has been estimated at €155.794. This cost is underestimate, since the savings can be much greater due to avert of comorbidities and even death due to prematurity.

Table 2. Cost-Consequences Analysis of CADxpert OB-GYN technology

COST-CONSEQUENCES ANALYSIS PILOT 1 - OBSTRECTICS SCENARIO			
Cost/Outcomes Categories	HOSMARTAI Intervention (Annual Cost)	Current Practice (annual cost)	Difference
Cost of AI Technology (personnel)	5.000 €	0 €	5.000 €
Cost of Maintenance	6.972 €	0 €	6.972 €
Cost of AI Infrastructure	170 €	0 €	300 €
Cost of Prematurity (age category 1500-19999gram) with co-morbidity (T25Mγ)	0 €	3.158 €	-3.158 €
Cost of Prematurity (age category 1500-1999gr) without comorbidity (DRGT25X)	2.646 €	0 €	2.646 €
Cost of averted severity prematurity (n=328 preterm births annually) Annual Cost	880.030 €	1.035.824 €	-155.794 €
Consequences Categories	HOSMARTAI Intervention	Current Practice	Difference
Clinical Performance	0.83	0.75	0.08
Duration of diagnosis PTB>75% (Duration for Experienced Physician>2years) in weeks	34 weeks	28 weeks	6 weeks

Conclusions

CADXpert OB-GYN is a very promising technology with a clinical performance indicator equal to 0,83 vs. 0,75 of the current technology leading to savings of at least €155.794 annually.

References

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