Personalized pregnancy odds estimation can be obtained using AI embryo evaluation and individual patient characteristics.

Oral Presentation by **Prof. Daniel Seidman** at the 2023 European Society of Human Reproduction and Embryology (ESHRE) Annual Meeting

Introduction

There is strong interest in the application of artificial intelligence (AI) in IVF. In fact, over 52 AI approaches were reported at ESHRE's 38th annual meeting in 2022, with strong emphasis placed on examining the relationships between AI embryo evaluations and an embryo(s) likelihood of achieving a pregnancy.

The problem

Reported AI embryo scoring tools are designed for objective embryo ranking based on the likelihood of achieving clinical pregnancy. While useful for embryologists, these scores are not meant to be interpreted as personalized probabilities of pregnancy prediction, thereby limiting their clinical utility.

Furthermore, while clinic and patient-specific characteristics do not influence AI score ranking within the cohort examined, they strongly confound the pregnancy predictions based on these AI scores, and thus, must be taken into account for personalized patient consulting in the IVF clinic.

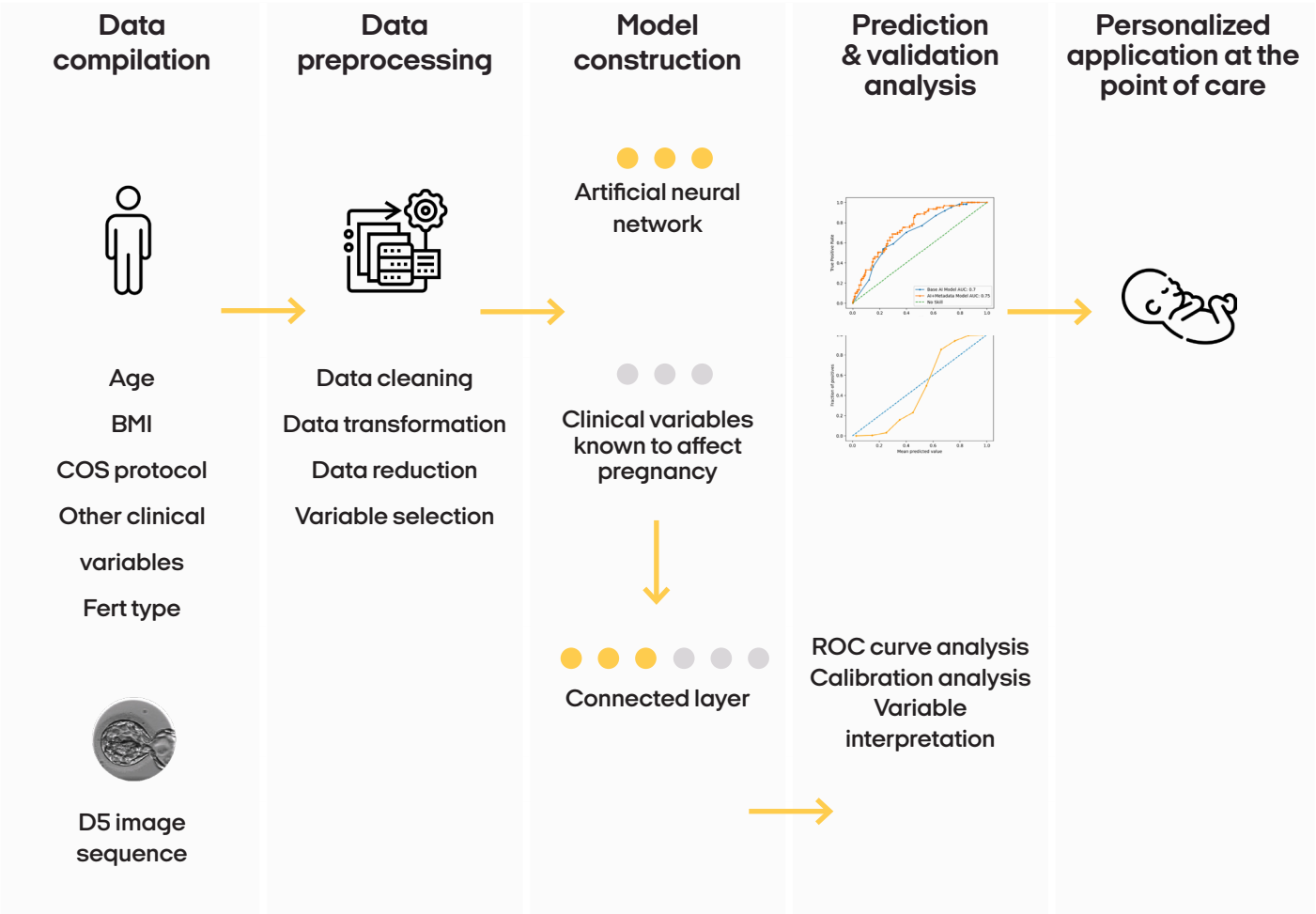
The AIVF Hypothesis

We hypothesized that personalized pregnancy odds estimations can be attained by creating an AI-based framework that provides clinic-calibrated pregnancy probabilities based on individual patient/clinic characteristics.

Study Design

We constructed a proof-of-concept AI prediction model that concatenates general AI score outputs with clinical characteristics extracted from the electronic medical record as input parameters (N= 9,812 embryos with known clinical outcomes).

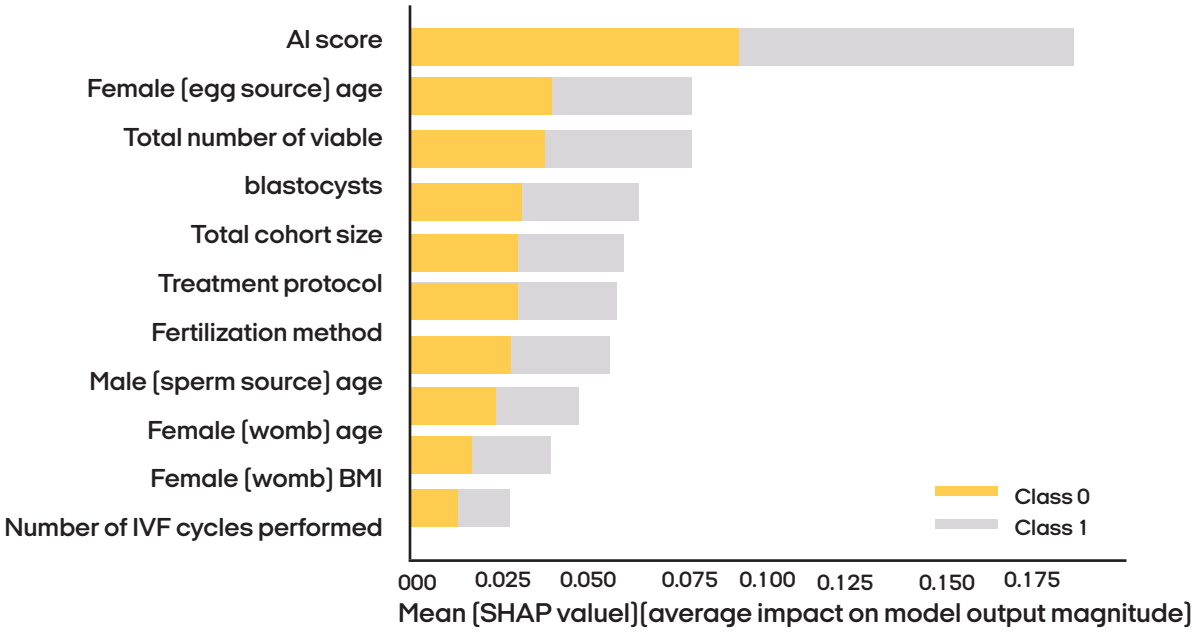
We then conducted variable importance ranking analysis using Shapley Additive Explanations (SHAP) to compute the contribution of each clinical variable to the model's prediction. Results were used as input data for further processing and model calibration on a per-clinic basis.
Three representative clinics from Spain, USA, and Israel were included in this analysis.



Results

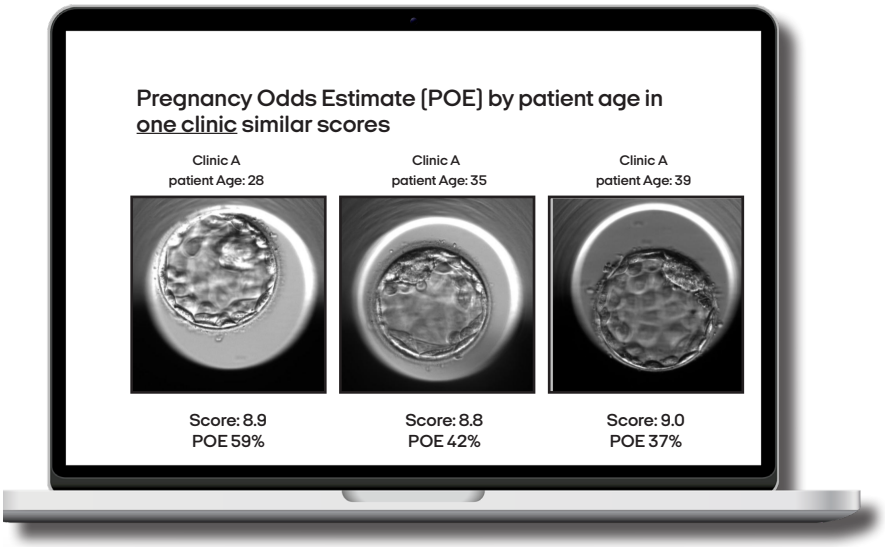
SHAP analysis demonstrated how AI embryo quality score, maternal age, and number of viable blastocysts were found to be the major parameters that contribute to the accuracy of the AI prediction model. Reliability curve analysis was performed to evaluate the behavior of the final AI model relative to each individual clinic dataset (Spain, Israel, USA). The model's predicted probabilities closely matched the expected distribution of probabilities for each clinic (brier score <0.25). A comparison analysis showed that pregnancy odds estimates (POE) for each embryo differed significantly, as expected, even when parameters are fixed for patient age, AI embryo quality score, and clinic source.

Clinical Variables Importance Ranking

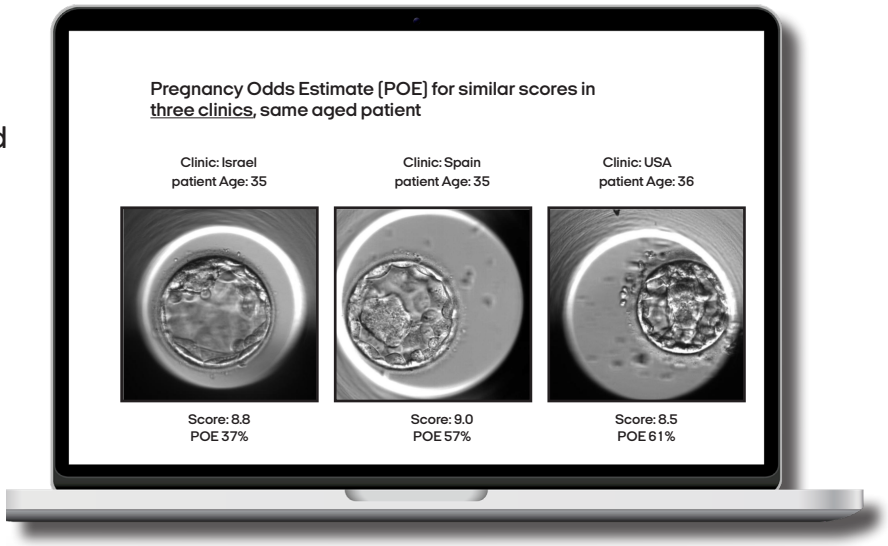


Shapley Additive Explanation (SHAP) is used to compute the contribution of each cariable to the model's prediction

This image shows three representative blastocysts from three patients treated at the same clinic with similar high AI scores. Results show very different pregnancy odds estimates according to the patients' age.



This image shows three representative blastocysts with similar high AI scores from three patients of similar age, treated at three different clinics in Israel, Spain, and the USA. Results show very different pregnancy odds estimates according to the specific clinic.



Conclusions

Model calibration is an important, overlooked aspect of AI model training. Our calibration framework enables a more reliable, personalized approach to embryo evaluation and accurately considers patient/clinic variables that may influence its AI predictions. Our calibrated AI model generates pregnancy odd estimations that allow more accurate, personalized patient counseling in the IVF clinic.

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