

Predicting Viability in Early IVF Pregnancy: A Machine Learning Algorithm

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Background

There is **currently no specific provision within miscarriage diagnosis guidelines for IVF pregnancies** where the precise expected gestational age can be calculated based on the embryo transfer (ET) date.¹

Given **reliable known timing of embryo transfer**, it might be expected that the presence of a visible embryo heartbeat as well as gestation sac and embryo size will be predictable for each day of gestation.

This might enable a prediction of miscarriage based on one scan, which may support the patient journey.

Waiting periods in medical care can induce anxiety, with the degree of **psychological distress** related to both the length of the waiting time and the consequences of the awaited outcome.²⁻³

Objective

To determine whether **early pregnancy ultrasound measurements, alongside known embryo transfer (ET) date** can be used to develop an **algorithm to predict viability in early IVF pregnancies**.

Methods

IVF pregnancies with embryo transfer at day 3-6 of development, with a confirmed intrauterine pregnancy at first scan (5-8weeks gestation), over three years 2019-2021, at a single IVF unit, Hammersmith Hospital, London UK, were included.

Methods

The **main outcome** measurement was **viability at the end of the first trimester scan (11-14 week dating scan)**.

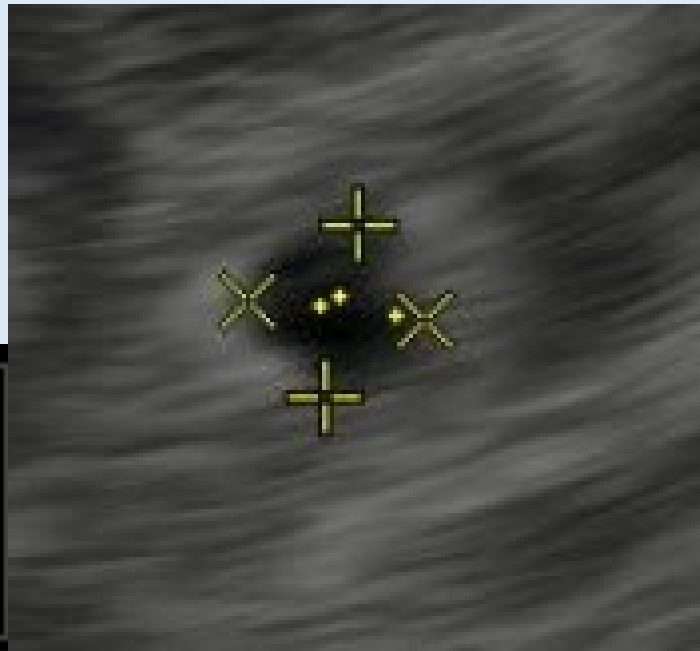
We undertook **machine learning logistic regression analysis** of the data to build an algorithm to predict viability in this cohort of patients: IVF pregnancies at first early pregnancy scan 5-8weeks expected gestational age by ET. The data was split 80:20 into training and test data sets.

The **variables** included were:

- Expected gestational age by ET date (days)**
- Crown rump length (mm)**
- Mean gestation sac diameter (mm)**
- Fetal heartbeat (yes/no).**

Mean Gestation
Sac Diameter
Measurements
Example

GS1 4.51 mm
GS2 4.58 mm
MGS 4.54 mm



Fetal Pole Crown
Rump Length
Measurement
Example

CRL 19.63 mm
GA 8w3d±6d
EDD 16-04-2024



Results

1161 IVF embryo transfers were included in the study, of which:

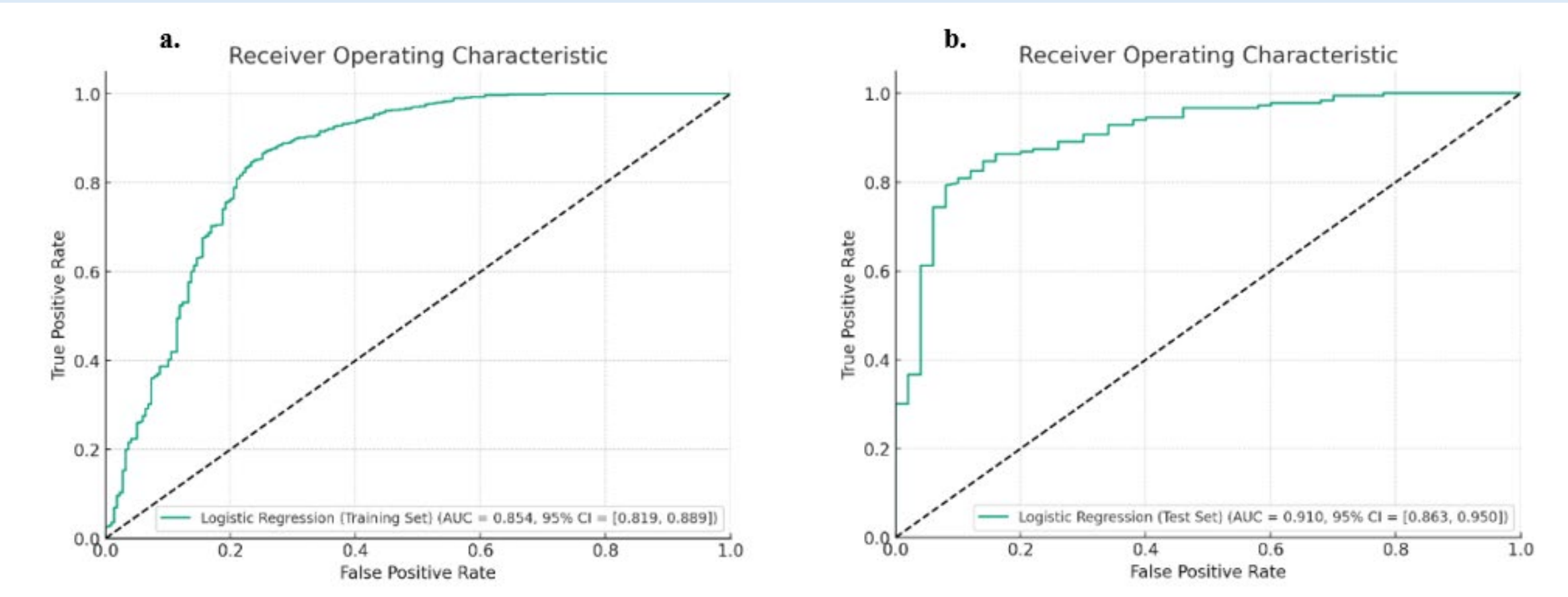
- 677 (58.3%) were frozen cycles and 484 (41.7%) fresh cycles
- 892 (76.8%) remained viable at 11-14 weeks
- 269 (23.2%) were non-viable.

Classifier	ROC AUC	ROC AUC Lower (95% CI)	ROC AUC Upper (95% CI)	F1-score	Precision	Sensitivity (Recall)	Specificity
Logistic Regression (Training Set)	0.854393	0.888807	0.819301	0.916051	0.874359	0.961918	0.961918
Logistic Regression (Test Set)	0.910437	0.950170	0.863063	0.919481	0.876238	0.967213	0.967213

Table: Logistic Regression Model Results to Predict Viability of IVF pregnancies at first early pregnancy scan 5-8 weeks expected gestational age by embryo transfer

Results

Figure: The Receiver Operating Characteristic Curves of the Training (AUC 0.85)(a) and Test (AUC 0.91)(b) Data Sets for the Logistic Regression Model to Predict Viability of IVF



Discussion

The results demonstrate that a **machine-learning algorithm** can be trained, with large data sets to **predict viability in IVF pregnancy** from early pregnancy features.

This model is **unique** in giving women a prediction of viability in cases even where the heartbeat is seen but the rate of growth may not align with a healthy pregnancy.

Only **four variables** are included which are **routinely collected** in an early pregnancy ultrasound and makes the model usable in a clinical context.

Evidence shows that giving women information about the likely outcome can **manage expectations and reduce anxiety**.⁴

The **next** step is **external, multi-centre validation**.

Conclusion

This model provides an **opportunity** for IVF early pregnancy patients to **understand their risk of miscarriage**.