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Retrospective comparison of deep learning versus logistic regression for selecting the best embryo for transfer

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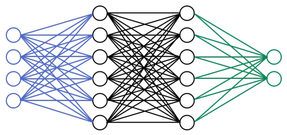
OBJECTIVE

To understand how the performance of a deep learning model compares to a logistic regression model for embryo ranking using prospectively collected embryo images.

BACKGROUND

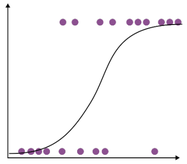
- Artificial intelligence (AI) algorithms have begun to be utilized for embryo selection in IVF
- There remains a debate about whether interpretable machine learning models are more suitable versus deep learning models
- Two previously developed models were compared retrospectively in this study for their ability to rank embryos:

Deep learning (1)



Ranks embryos using deep convolutional neural network which analyzes static blastocyst images

Logistic Regression (2)



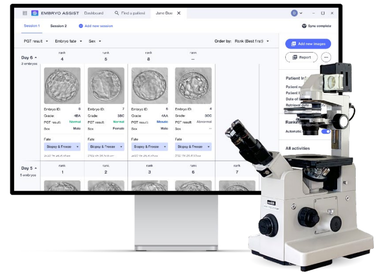
Ranks embryos using:
- Morphology grade (i.e. 5AB)
- Embryo day (5, 6, or 7)
- Patient age at retrieval

METHODS

Data Collection
- Images and morphology grades of individual embryos were collected prospectively using an embryo image capture software (Alife Embryo Assist) between January – December 2024 at two clinics in the U.S.
- A total of 4543 embryo images and morphology grades were collected from 870 patients
- Of these, 406 embryos were transferred
- 90% of transferred embryos were genetically tested

Statistical Analysis
- After removing aneuploid embryos, embryos were retrospectively ranked within each patient's cohort using both the deep learning and logistic regression models
- Pregnancy rates of embryos that were top-ranked in their cohort versus those that were lower-ranked were compared
- Patients were only included if they had multiple viable embryos to choose from
- Only the first transfer from each cohort was considered

Embryo Assist Imaging System Used for Data Collection



RESULTS

- The top-ranked deep learning embryo was transferred in 45% of cohorts
- The top-ranked logistic regression embryo was transferred in 76% of cohorts
- Transferring the top-ranked embryo by deep learning was associated with an **8.9% higher pregnancy rate**
- Transferring the top-ranked embryo by logistic regression was associated with a **4.1% higher pregnancy rate**
- There were no differences in the average age of the patients between the two groups, nor were there differences in the average AI score of the top-ranked embryo in the cohort, suggesting that these comparisons did not introduce significant biases.

Model 1: Deep Learning

Outcome	Top-Ranked Embryos	Lower-ranked embryos	Difference	P-value
Pregnancy Rate	76.1%	67.2%	8.9%	0.08
Fetal Heartbeat	60.0%	53.8%	6.2%	0.38

Model 2: Logistic Regression

Outcome	Top-Ranked Embryos	Lower-ranked embryos	Difference	P-value
Pregnancy Rate	71.3%	67.2%	4.1%	0.51
Fetal Heartbeat	56.8%	52.7%	4.1%	0.45

CONCLUSION

- Both deep learning and logistic regression models show promise for selecting the top ranked embryo in a patient's cohort
- The simplicity and interpretability of the logistic regression may allow for faster adoption and clinical trust, while deep learning may further enhance success rates

REFERENCES

1. Loewke, Kevin, et al. "Characterization of an artificial intelligence model for ranking static images of blastocyst stage embryos." Fertility and sterility 117.3 (2022): 528-535.
2. Barash, Oleksii O., et al. "CLINICAL EVALUATION OF A MACHINE LEARNING MODEL FOR EMBRYO SELECTION: A DOUBLE-BLINDED RANDOMIZED COMPARATIVE READER STUDY." Fertility and Sterility 120.4 (2023): e1.