accuracy of 94.0% (95% CI: 92.4-95.7%). A one sample t-test revealed that the system performed significantly ($P<0.05$) better than the embryologists in selecting two embryos for transfer among which at least one will eventually form a blastocyst. The accuracy of the CNN in selecting an embryo at 70 hpi, which developed into a high-quality blastocyst (HQB) for a single embryo transfer (SET), was 63.9% that is significantly higher ($P<0.05$) than the average accuracy of the embryologists (52.8%, 95% CI: 48.6-57.0%). The accuracy of the CNN in selecting an embryo at 70 hpi, which developed into HQB for a double embryo transfer (DET), was significantly higher (79.4%, $P<0.05$) compared to the embryologists with an average accuracy of 72.4% (95% CI: 70.7-74.0%).

CONCLUSIONS: Here, we reported an artificial intelligence-based approach for predicting the developmental fate of cleavage stage embryos. Our study shows that the developed CNN outperforms an embryologist's morphologic assessment at 70 hpi in predicting blastocyst formation. Additionally, we demonstrated that this technology might be used to select embryos with the highest in-vitro developmental potential. Utilization of artificial intelligence (AI) technologies in human IVF practices may allow for more objective/standardized methods for improving embryo selection.

Reference: None.

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THE APPLICATION OF MACHINE LEARNING METHODS TO EVALUATE PREDICTORS OF LIVE BIRTH IN PROGRAMMED THAW CYCLES.

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OBJECTIVE: The utilization of frozen embryo transfers is increasing annually. The objective of this study was to investigate the utility of machine learning (ML) methods to weight predictors for positive pregnancy and live birth rate (LBR) in programmed thaw cycles.

DESIGN: Retrospective cohort study.

MATERIALS AND METHODS: All first, autologous programmed thaw cycles (January 2014 to October 2017) were reviewed. Data was collected from both stimulated and subsequent frozen cycles. Each patient received estrogen replacement until endometrial thickness was deemed adequate (usually $\geq$8mm). Progesterone was prescribed with embryo transfer after 5 doses of progesterone supplementation.

For data analysis, we normalized the numerical variable and one-hot-encoded the categorical variables. For each outcome, a logistic regression model was fitted with LASSO regularization. The model test ROC was evaluated and averaged across 10 random training/test data splits. For each outcome, the top variables, most predictive across the 10 random splits are presented using regression coefficients (RC).

RESULTS: A total of 1726 cycles were available for analysis with 129 variables evaluated. The median age of the cohort was 34.3. The positive pregnancy rate among our cohort was 70% and the LBR was 47%. Top predictors for both models are shown in Table 1. The ROC for model fit for positive pregnancy and LBR was 0.65 and 0.73 respectively. Interestingly, both increasing age at oocyte retrieval and anti-mullerian hormone (AMH) level were weaker predictors for live birth (RC -0.5, 0.6 respectively) than those listed. Transfer of a euploid embryo was a weaker predictor for LBR in our cohort (RC =0.2), as were blastocyst alphanumeric grades.

CONCLUSIONS: The abundance of measurements related to infertility treatment is well suited for the application of ML. A clinician makes decisions based on knowledge and past experience which may bias the process and impact clinical outcomes. In our work, we already find that factors considered by clinicians to predict the outcome are not identical to those considered by our model. Validation and further development of ML models is ongoing.

SUPPORT: None.

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DEEP LEARNING FOR AUTOMATIC DETERMINATION OF BLASTOCYST EMBRYO DEVELOPMENT STAGE.

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OBJECTIVE: To build and to validate a computational tool aimed at reducing the subjectivity inherent to current embryo classification methods.

DESIGN: Data augmentation for building and initial validation of a neural network architecture using an embryo pictures' bank.

MATERIALS AND METHODS: An Inception V3 deep convolutional neural network architecture was built and trained using a dataset containing 1,204 pictures of blastocyst obtained from 2 IVF centers and classified by an expert embryologist into three categories according to its development stage: (i) expanding, (ii) hatching and (iii) hatched. The dataset was increased to a total of 15,000 images using data augmentation techniques to assure that the network model is robust to translations and rotations. 12,000 images where employed training and the remaining 3,000 for validation through the computation of the weights of the neural network.

RESULTS: Once the network was trained, we used it to classify 56 images never seen before by the network. All 54 images were correctly classified by the network.

CONCLUSIONS: Results indicate the feasibility of employing deep learning techniques for the automatic and objective classification of blastocyst development stage which will pave the way for building computational tools that will aid the expert embryologist to define a ranking based on quantitative information.

SUPPORT: Darwin Technologies LTD.

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ARTIFICIAL NEURAL-NETWORK ANALYSIS COMBINED WITH TIME-LAPSE IMAGING PREDICTS EMBRYO ABILITY TO DEVELOP TO THE BLASTOCYST STAGE.

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OBJECTIVE: To assess the potential of machine learning algorithms, implemented for image analysis at early developmental stages, to predict embryo development to the blastocyst stage.

DESIGN: The ANN approach was undertaken to assess retrospectively the ability of human embryos to develop to the blastocyst stage. The analysis focused on 113 embryos generated in 32 IVF cycles, carried out between October 2015 and May 2018. Female age was 36.3±4.9 years. To minimise possible patient-based bias, cycles were recruited ensuring to have in the same cohort both embryos able to develop to the blastocyst stage and arresting at earlier stages.

TABLE 1. Top predictors, with regression coefficients, for positive pregnancy and LBR

Top predictors for Clinical Pregnancy	Regression Coefficient	Top predictors for live birth	Regression Coefficient
# Stimulation cycles	-1.8	# Stimulation cycles	-3.1
Embryo age at transfer (blastocyst transfer)	1.6	Embryo age at transfer (blastocyst transfer)	1.1
# of blastocysts in correlating fresh cycle	0.8	# of blastocysts in correlating fresh cycle	1.1
Endometrial thickness at transfer	0.6	Endometrial thickness at transfer	0.8
# Miscarriages < 20 weeks	-0.8	# Miscarriages < 20 weeks	-0.8