AI in Embryology: Expanding Beyond Embryo Selection

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AI HAS become synonymous with embryo selection in assisted reproduction, but the 'AI in Embryology' session at the European Society of Human Reproduction and Embryology (ESHRE) Congress 2026 demonstrated that its role is rapidly expanding. Presentations explored how AI could support decision-making across the IVF laboratory, from real-time quality control and objective oocyte assessment to donor programme optimisation and the identification of novel biomarkers of embryo competence. Alongside these innovations, speakers also highlighted the importance of clinical validation, emphasising that AI is most effective when designed to complement, rather than replace, embryologist expertise.

REAL-TIME QUALITY CONTROL FOR THE IVF LABORATORY

Although AI has become increasingly established in embryo selection, one presentation shifted the focus to monitoring the performance of the IVF laboratory itself, highlighting an emerging application of the technology. Research from Bori et al.,[1] presented by Sandra Marqueño, IVIRMA Global Research Alliance, Spain, designed a stage-aware AI system to forecast IVF key performance indicators in real time using morphokinetic data from more than 70,000 embryos.[1] Rather than predicting the fate of individual embryos, the model aggregated developmental information across incubator embryos to estimate blastocyst utilisation and implantation rates throughout culture. Predictive performance improved as embryo development progressed; the model scored an area under the curve of 0.787 for usable blastocyst prediction after incorporating developmental features. The study introduced a novel way of using AI systems beyond embryo ranking through application at the incubator-population level. This positions AI as a potential quality assurance system, enabling laboratories to identify performance issues while cycles are still in progress rather than retrospectively.

FROM INDIVIDUAL OOCYTES TO DONOR COHORTS

The session also highlighted how AI is extending upstream in the IVF workflow, providing objective tools to inform decisions long before embryos reach the selection stage. Kenji Ezoe, Kato Ladies Clinic, Shinjuku, Japan, presented research on assessing developmental competence of immature oocytes following rescue *in vitro* maturation using the deep learning platform Magenta™, developed by Future Fertility (Toronto, Canada).[2] As expected, rescue-matured oocytes showed lower developmental potential than *in vivo*-matured oocytes. However, Magenta scores successfully identified rescue-matured oocytes with greater developmental potential, showing significant associations with maturation, fertilisation, and blastocyst development. The study demonstrates AI's potential to be an objective tool supporting decision-making when considering whether rescue-matured oocytes should be used clinically.

Once oocyte quality can be objectively quantified, those assessments can also be applied at cohort level. Lais Vanzella, Future Fertility, Canada, shared their research on whether the AI-supported ROSE

workflow, developed by Future Fertility, could improve donor oocyte allocation by reducing the proportion of donor lots unlikely to achieve clinically meaningful blastocyst yields.[3] Across more than 18,000 donor-age oocytes from 11 fertility centres, ROSE consistently outperformed simulated random allocation, producing significantly fewer donor lots that failed to meet predefined blastocyst formation targets (all $p<0.01$). The greatest benefit was observed under the most stringent allocation criteria, where ROSE reduced the relative risk of complete lot failure by 66.1%. Rather than selecting a single 'best' egg, the algorithm balanced the quality of donor eggs across treatment batches, reducing the chance that patients would receive a group of eggs unlikely to produce blastocysts.

Together, these studies suggest that AI is evolving from a tool for embryo selection into one that can support decision-making throughout the IVF workflow, enabling more objective assessment of oocyte quality while optimising the allocation of valuable clinical resources.

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SEPARATING VALIDATED AI FROM GENERAL-PURPOSE MODELS

Several presentations also explored how AI compares with conventional embryologist evaluation and where its limitations begin to emerge. Ella Krasnitsky, Assuta Medical Center, Tel Aviv, Israel, examined concordance between the Gardner and Schoolcraft morphological grading system for blastocyst quality and iDAScore, an AI-powered embryo assessment platform developed by Vitrolife (Gothenburg, Sweden), across more than 10,500 blastocysts.[4] Overall agreement between embryologist assessment and AI scoring was high, with 70.7% of embryos classified as both good-quality Gardner and high AI score, while discordant classifications were

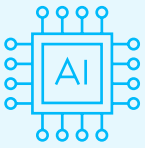
uncommon. Notably, embryos graded as good quality by morphology but assigned low AI scores still achieved a pregnancy rate of 42.8%, comparable with the unit's overall pregnancy rate of 46% (p=0.9). These findings suggest that although AI largely reinforces conventional morphological assessment, embryos with discordant classifications may still retain clinically meaningful reproductive potential. Rather than replacing embryologist expertise, AI is more valuable when used to complement clinical judgement and support more nuanced embryo selection.

In contrast, Arth Ladva, Oasis Fertility, India, examined what happens when embryo assessment is attempted using general-purpose AI systems rather than models developed specifically for reproductive medicine. The study looked at whether publicly available large language models (ChatGPT [OpenAI, San Francisco, California, USA], Gemini [Google, Mountain View, California, USA], Claude [Anthropic, San Francisco, California, USA], and Grok [xAI, Palo Alto, California, USA]) could accurately predict live birth using blastocyst morphology images alone across 151 single embryo transfer cycles.[5] Overall, all four platforms demonstrated limited discriminatory ability, with area under the receiver operating characteristic curve values ranging from 0.52–0.64, and high rates of prognostic discordance; Grok showed the greatest discordance (60.9%), while Gemini achieved the highest concordance (64.9%), but still misclassified more than one-third of outcomes. Misclassification was predominantly driven by false-negative predictions, suggesting a consistent pessimistic bias when clinical information was unavailable. Agreement between AI-generated assessments and embryologist Gardner grading was also poor, indicating that general-purpose AI does not replicate expert morphological reasoning.

When considered together, these studies highlight that the value of AI in embryology lies not simply in the technology itself, but in rigorous clinical validation and context-specific application. While specialist AI models can provide meaningful decision support alongside embryologists, general-purpose AI lacks the domain-specific knowledge required for reliable embryo assessment.

NOVEL BIOMARKERS FOR EMBRYO SELECTION

Looking ahead, researchers explored how AI could move beyond assisting embryo selection to identifying entirely new markers of developmental competence. Juanjo Fraire-Zamora, Eugin Clinic, Spain, investigated whether dynamic blastocyst behaviour could provide independent information about embryo ploidy beyond conventional morphokinetic milestones.[6] Using AI-generated annotations from approximately 1,800 blastocysts, the study showed that euploid embryos achieved significantly larger maximum blastocyst diameters than aneuploid embryos (161.2 µm versus 154.2 µm; p<0.001). Each 10 µm increase in maximum diameter was associated with a 14% increase in the odds of euploidy, independent of developmental timing. In contrast, contraction frequency, amplitude, and timing were not independently associated with chromosomal status. Larger blastocytes at their point of maximum expansion were more likely to be chromosomally normal, regardless of how quickly they had developed. Importantly, this association was independent of developmental timing, indicating that maximum blastocyst expansion may provide biological information beyond conventional morphokinetic markers.



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KEY TAKEAWAYS

Taken together, the studies presented during the 'AI in Embryology' session reflected a clear evolution in how AI is being applied within reproductive medicine. Rather than focusing solely on embryo ranking, researchers demonstrated how AI could support quality assurance, optimise laboratory workflows, improve objective assessment of oocytes and embryos, and uncover novel biological markers of developmental competence. Equally, the session reinforced that successful clinical implementation depends on robust validation and thoughtful integration into existing practice. As AI technologies continue to mature, future research will determine how these complementary tools can be incorporated into routine IVF care while maintaining the central role of embryologist expertise.

References

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