Past embryo viability is not always a good predictor of future pregnancy: Dynamic viability suggests video has limited benefit over static images for AI assessment

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Introduction and Background

Artificial Intelligence (AI) has been applied to the problem of embryo quality (viability) assessment using either video (time-lapse) or single static images. Whether historical data within time-lapse provide additional advantages over single static images of embryos for assessing embryo viability at the time of transfer is not known. This applies to both manual and AI-based embryo assessment. If embryo viability changes over time prior to transfer, then the implication is that the assessment of future pregnancy using historical embryo data from videos would provide limited additional value over single static images taken immediately prior to transfer.

Study Design and Methods

A retrospective dataset was used of single embryo images taken at (up-to) three time-points prior to transfer: Early Day 5, Late Day 5 (8 hours later), and Early Day 6 (16 hours later), with corresponding fetal heartbeat (clinical pregnancy) outcomes. The AI assessed the viability of each embryo at its available time-points. Viability prediction was compared with pregnancy outcome to assess viability predictiveness at each time-point prior to embryo transfer. Single static images of 173 embryos were taken using time-lapse incubator from a single IVF clinic. 116 embryos were viable (led to a pregnancy) and 57 were non-viable (did not lead to a pregnancy). The AI was trained and validated on 3,651 Day 5 static embryo images taken from multiple IVF laboratories and countries but was not trained on data from this clinic.
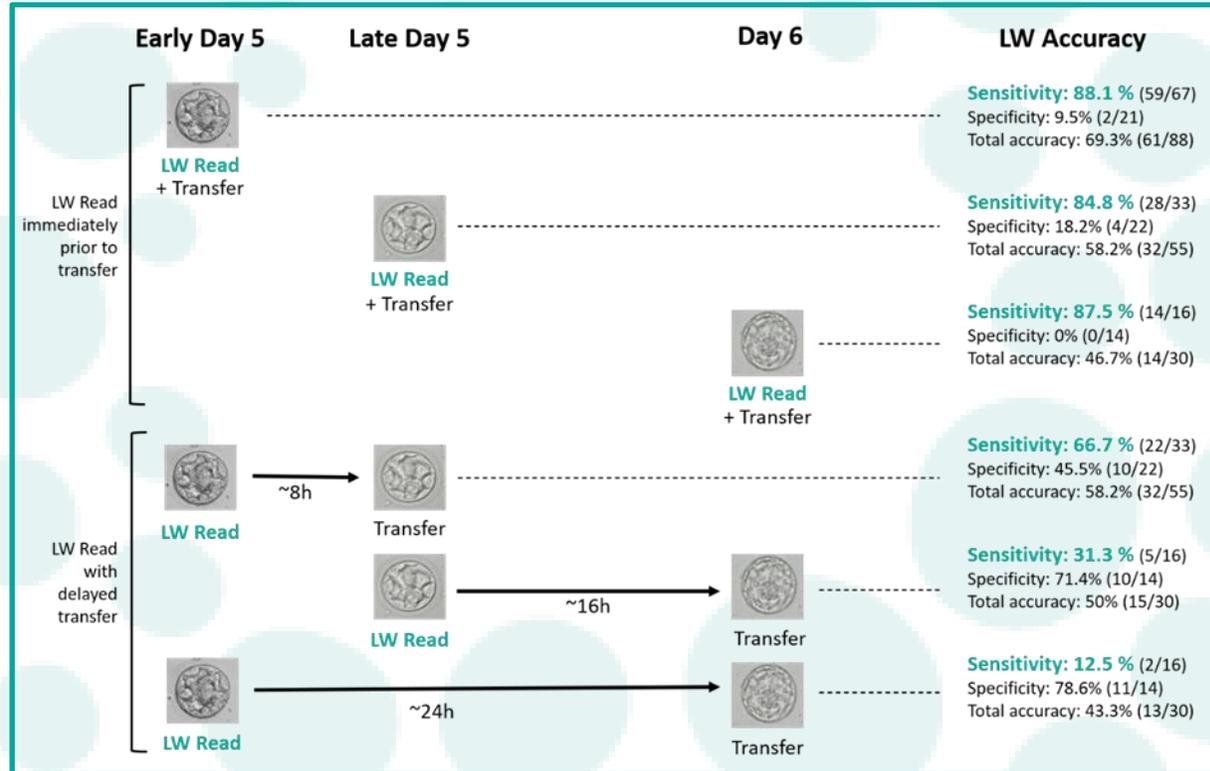
Main Results

When embryos were assessed as viable by the AI immediately prior to transfer (no delay), the sensitivity in predicting successful pregnancy was 88.1% (59/67) for Early Day 5, 84.8% (28/33) for Late Day 5 and 87.5% (14/16) for Early Day 6. When the delay between AI assessment and transfer is 8 hours, 16 hours and 24 hours, the sensitivity dropped to 66.7% (22/33), 31.3% (5/16) and 12.5% (2/16), respectively.

These results indicate that the viability of the embryo is dynamic, and therefore, time-series analysis, i.e., using historical time-lapse/video, may not be well suited for embryo viability assessment. This indicates that past viability is not necessarily a good predictor of future viability or pregnancy outcome. The viability of the embryo assessed immediately prior to transfer, from a static point-in-time image, is a more reliable predictor of pregnancy outcome at the point of transfer.

This result is consistent with current clinical practice of using Gardner score end-point assessment for embryo quality. Results also suggest there may be benefit from using time-lapse in combination with AI, where AI continually assesses embryo viability over time using static image assessment. The time-point at which the embryo should be transferred to maximise pregnancy outcome is when the embryo has the greatest AI viability score.

Summary

AI assessment of single static embryo images at multiple time-points indicates embryo viability is dynamic, and past viability is a limited predictor of future pregnancy.

Limitations

Although evidence suggests past embryo viability is a limited predictor of future pregnancy, a side-by-side comparison of video versus single static image AI assessment would further verify that the historical or change in embryo development or viability has minimal impact on embryo viability assessment at the time prior to transfer.

Wider implications

The findings suggest that static end-point AI assessment is sufficient for predicting embryo implantation potential. Continual AI monitoring of embryos can potentially allow optimisation of which embryo to transfer and when, to ultimately improve pregnancy outcomes for patients.