Artificial intelligence in fertility treatment

Strategic delivery:	☒ Safe, ethical, effective treatment	☐ Consistent outcomes and support	☐ Improving standards through intelligence
Details:			
Meeting	SCAAC		
Agenda item	7		
Paper number	HFEA (10/06/2019) 007		
Meeting date	10 June 2019		
Author(s)	Rasheda Begum, Scientific Policy Officer Stevan Cirkovic, Policy Officer		
Output:			
For information or decision?	For information		
Recommendation	Members are asked to: • advise the Executive if they are aware of any other recent developments in AI relevant to fertility treatments or research; • discuss their views on the impact AI will have on fertility treatment as technology advances, including practical and ethical challenges to their application; • discuss their views on the Authority's regulatory interest around AI systems – scope and limits		
Resource implications	None		
Implementation date	N/A		
Communication(s)	None		
Organisational risk	☒ Low	☐ Medium	☐ High

1. Introduction

1.1. Artificial intelligence (AI) is an area of computer science that involves the use of intelligent machines designed to perform a task. AI research within medicine is growing rapidly.

1.2. AI is driven largely by data. In healthcare, this could be related to data pertaining to patient characteristics or data from medical images. With a large enough dataset, machine learning can be applied to create algorithms independently and form systems such as artificial neural networks (ANNs) that are advanced enough to generate clinical judgements or predictions.

1.3. Training an AI depends on data, so availability and quality of data consistency are crucial to realising any potential benefits as well as the levels of accuracy achieved in study settings. In so far, controlled study environments may differ greatly from the real-life scenarios found in the UK fertility sector.

1.4. Practical challenges could include limited and inconsistent data sharing between clinics, difficulties in obtaining informed consent for data sharing from patients (e.g. to technology provider servers for continuous optimisation of algorithms), and the large computational power for running AI systems.

1.5. AI has been addressed by other government bodies including the NHS who addressed AI in the January 2019 NHS Long Term Plan[1], where AI is acknowledged as an element of digital transformation to consider in the next 10 years that should be both embraced by the NHS as well as subjected to scrutiny. The Department of Health and Social Care also developed a Code of Conduct for data driven health and care technology[2], setting out 10 principles around behaviours expected from those developing, deploying and using data-driven technologies. Expected behaviours include transparency and adhering to standards.

1.6. The Nuffield Council on Bioethics has published a briefing note[3] examining the current and potential landscape of healthcare applications of AI. The note weighs up the potential to help address important challenges against ethical issues relevant to applications in embryology, including:

- the potential for AI to make erroneous decisions;
- the question of who is responsible when AI is used to support decision-making;
- difficulties in validating and questioning the outputs of AI systems;
- inherent biases in the data used to train AI systems;
- ensuring the protection of potentially sensitive data;
- securing public trust in the development and use of AI;
- and effects on the roles and skill-requirements of healthcare professionals.

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[1] https://www.longtermplan.nhs.uk/wp-content/uploads/2019/01/nhs-long-term-plan.pdf
[2] https://www.gov.uk/government/publications/code-of-conduct-for-data-driven-health-and-care-technology/initial-code-of-conduct-for-data-driven-health-and-care-technology
[3] http://nuffieldbioethics.org/wp-content/uploads/Artificial-Intelligence-AI-in-healthcare-and-research.pdf

1.7. This paper provides a general overview of examples of AI that have been explored in fertility scenarios.

2. Current developments in AI relevant to fertility treatment

2.1. AI is being used in time-lapse technology, which is a technique where embryos are placed in an incubator with a built-in camera that takes images of the embryo in real-time and the images are used by an embryologist to select which embryo is most suitable for transfer.

2.2. In a study by Malmsten et al., 2018, a convolutional neural network (CNN) was built using time-lapse images and deep learning was applied to predict cell division times. Accurate predictions of cell division times within five frames of an embryologist's annotation were made in 91% of cell-stage transitions.

2.3. A study by Zaninovic et al., 2018 applied an AI system using time-lapse images for predicting embryo quality. An algorithm was designed using 18,000 images and was tested to observe if embryo quality grades (good, fair and poor) could be predicted correctly. There was an average of 74.95% accuracy in predicting for the three embryo grades. Correlation between the AI output and known implantation data showed 90.6% accuracy for a true positive (implanted and good quality) and 89.6% accuracy for a true negative (non-implanted and poor quality).

2.4. AI based prediction of live birth according to age from blastocyst images was compared with predictions made by conventional embryo selection (by means of morphological features and clinical information) in a study by Miyagi et al., 2019. AI was found to produce better results than conventional embryo selection.

2.5. A paper by Siristatidis et al., 2016 provides an overview of a proposed web-based system that uses AI for the purpose of predicting IVF outcome. This system employs an Artificial Neural Network (ANN) that receives data regarding a patient seeking fertility treatment and the ANN generates several treatment scenarios based on the pre-requisite set of data.

2.6. A paper by Mirsky et al., 2017 describes an automated system for sperm selection based on quality. Using images developed from Interferomatic Phase Microscopy (IPM), an algorithm was designed based on quantitative phase map images together with consideration to the morphology aspects of sperm. This information was used to train a support vector machine to be able to classify good and bad sperm.

3. Conclusions

3.1. There are applications for AI in fertility treatment, particularly around embryo and sperm selection, practices that are usually done using morphology assessment and with a view to support and complement decisions made by an embryologist.

3.2. To affirm whether AI will have benefit, further studies are needed to investigate the technology and potential unintended consequences and ethical ramifications.

3.3. There are wider issues around the use of AI that have been addressed by other organisations and public bodies. Ethical concerns include determining accountability or liability for errors made as a result of AI-generated outputs (e.g. wrongly discarding viable embryos), ensuring autonomy and an ability to question these outputs on part of the human decision-makers interacting with AI (both

patients and clinicians), as well as the validity of input data and algorithms across diverse patient groups, medical histories, and an evolving body of scientific evidence.

3.4. The use of AI in the fertility treatment would raise questions about how the Authority would inspect their suitability and appropriate use in centres as well as that of quality assurance systems in place. Even in applications where the AI only acts as a decision aid, centres must still ensure tasks are performed by competent practitioners with the necessary competence and training. In the future, this requirement could be expanded to AI-specific training (e.g. on working with biases and challenging AI-generated recommendations) and to cover the 'competence' of the AI systems themselves.

3.5. The potential introduction and provision of any such applications in the future using AI technology should be developed and introduced responsibly.

4. Recommendations

4.1. Members are asked to:

- advise the Executive if they are aware of any other recent developments in AI relevant to fertility treatments or research;
- discuss their views on the impact AI will have on fertility treatment as technology advances, including practical and ethical challenges to their application.
- discuss their views on the Authority's regulatory interest around AI systems – scope and limits

5. References

- Malmsten J, Zaninovic N, Zhan Q, Toschi M, Rosenwaks Z, Shan J. Automatic prediction of embryo cell stages using artificial intelligence convolutional neural network. Fertility and Sterility. 2018 Sep 1;110(4):e360.
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