



Medicine and Machines: Will AI take over ART?

Dr Cristina Hickman
Chief Scientific Officer - Apricity
Advisor – TMRW
Founder - IVF Professionals
Scientific Representative - British Fertility Society
Lecturer and Supervisor – Imperial College London

Celine Jacques
Data Analyst- Apricity

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AI is ideally suited to solve.....

1. Creating a Universal Language of BL Classification

Gardner & Schoolcraft

Istanbul Consensus scoring
system for Blastocysts

Veeck and Zaninovic

ASEBIR

Sjoblom classification system

ACE / NEQAS

Graduated embryo scoring

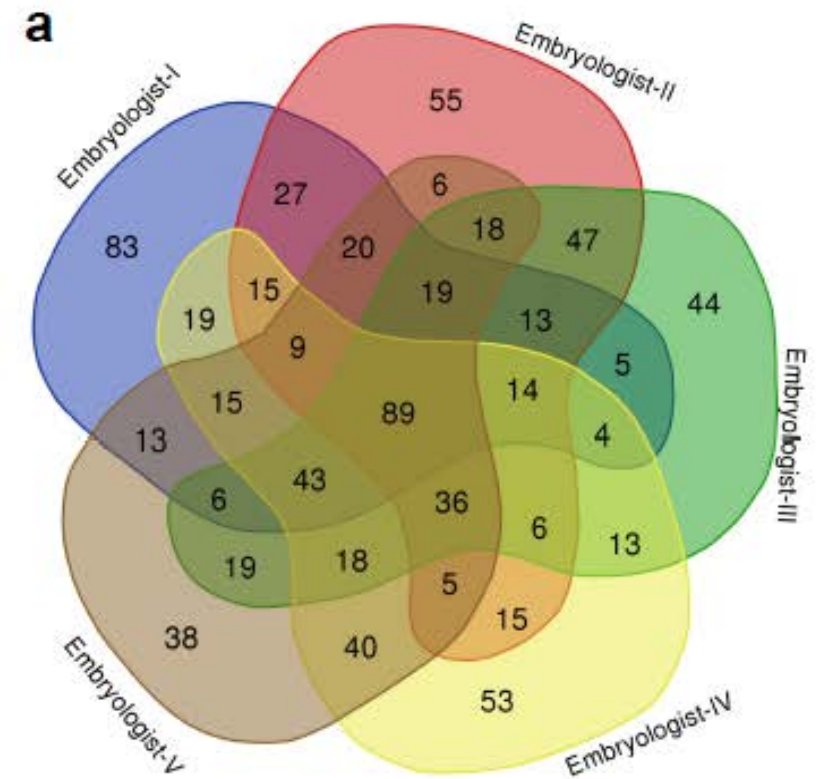




AI is ideally suited to solve.....

2. Improving Intra-and Inter-operator consistency

Out of **395** blastocysts,
5 embryologists from different countries
could only agree classification in **89** embryos (23%)





AI is ideally suited to solve.....

3. Improving efficacy of diagnosis by harnessing the full power of big data

Demographics

Treatment type,
drugs, dose

Folliculogram

Clinical +
laboratory practice

Standards of care

We are drowning in data
&
thirsty for knowledge

PGT

Morphokinetics

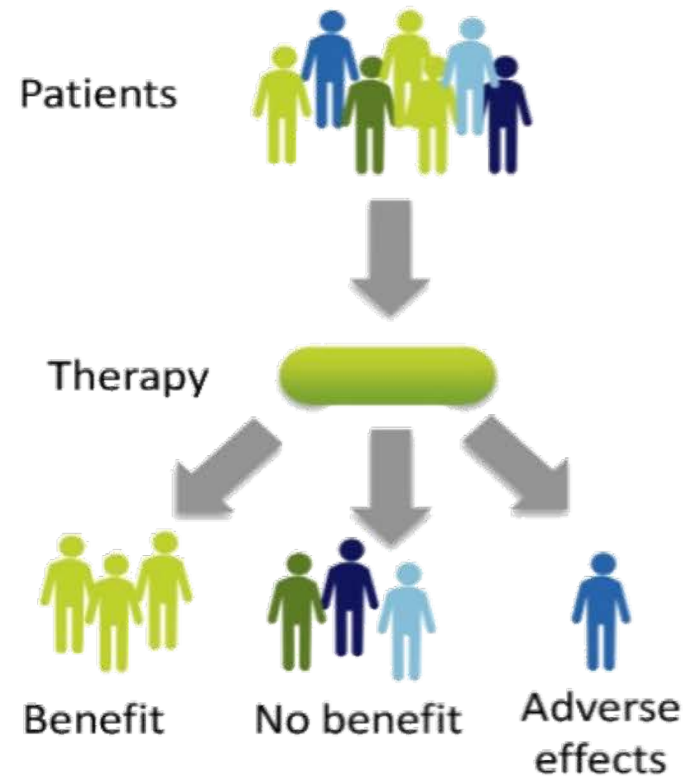
**403.2 million data
points per embryo**

Proteomics

Embryo image

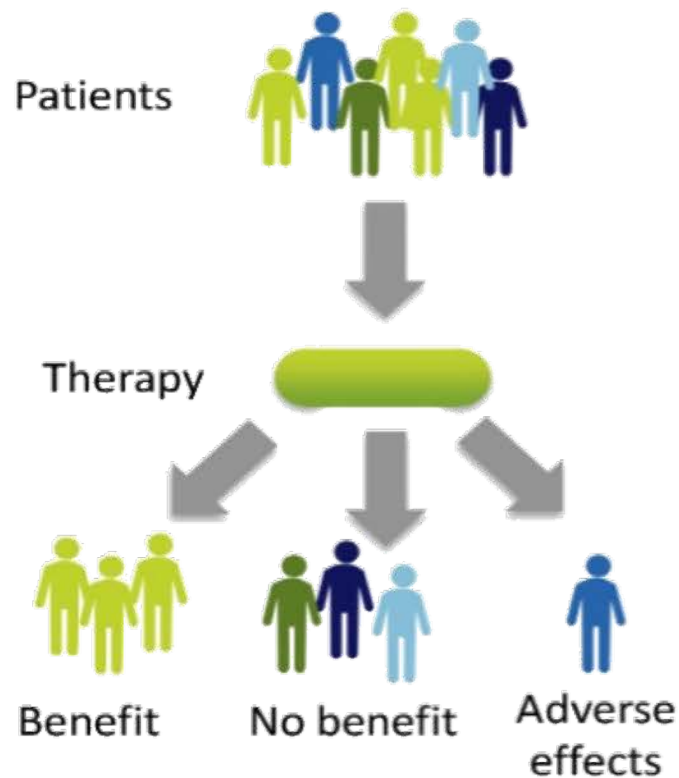
Precision Medicine

Without Personalized Medicine:
Some Benefit, Some Do Not



Precision Medicine

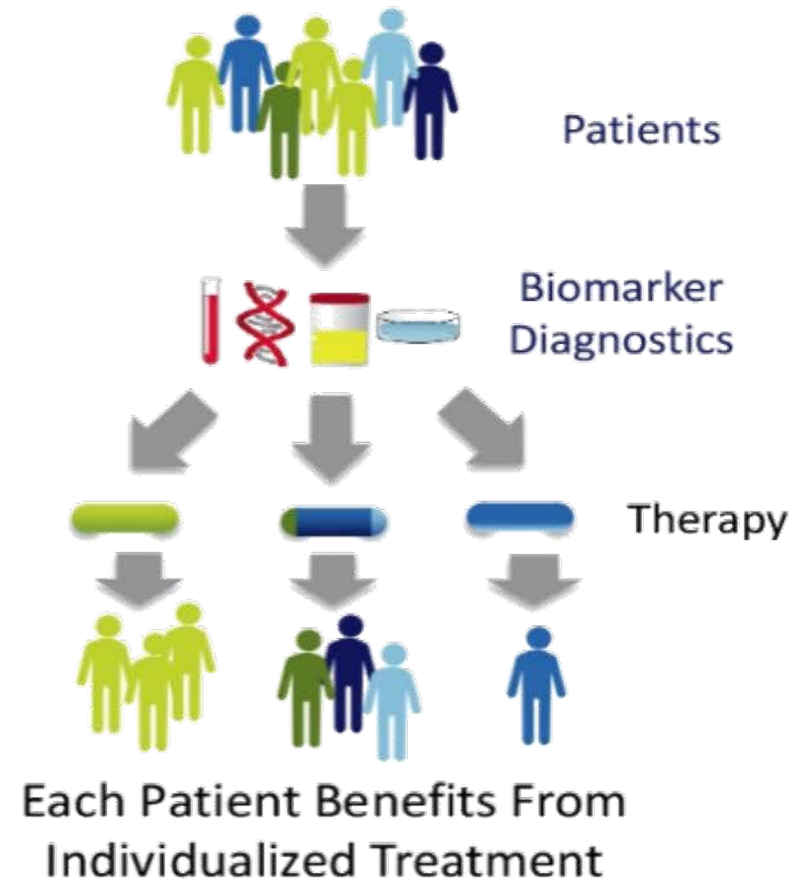
Without Personalized Medicine:
Some Benefit, Some Do Not



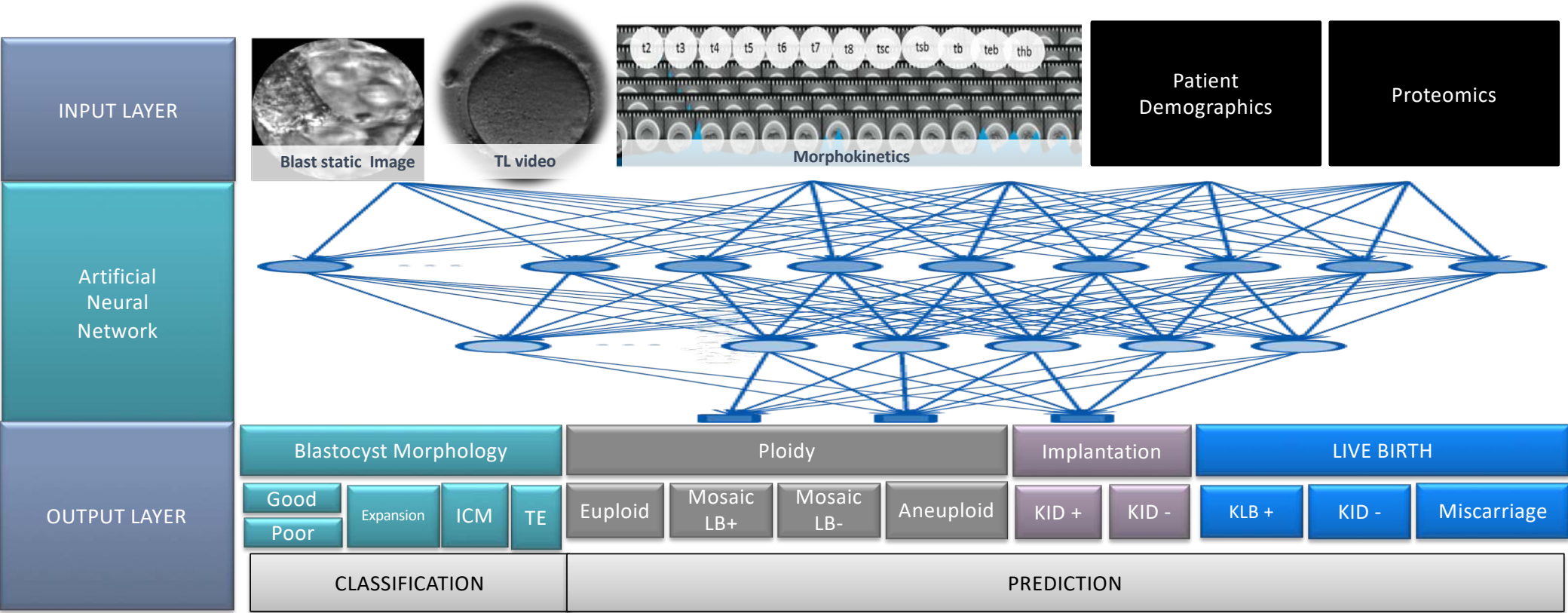
Personalised Medicine

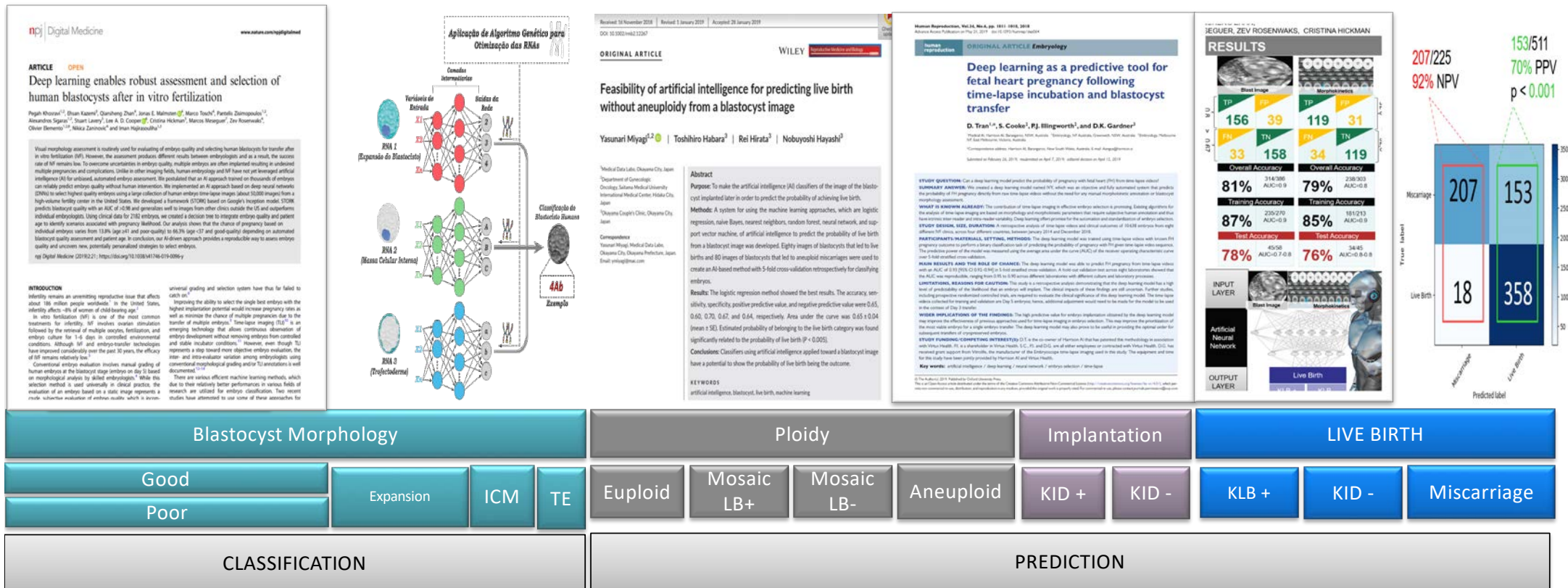


With Personalized Medicine:
Each Patient Receives the Right Medicine For Them

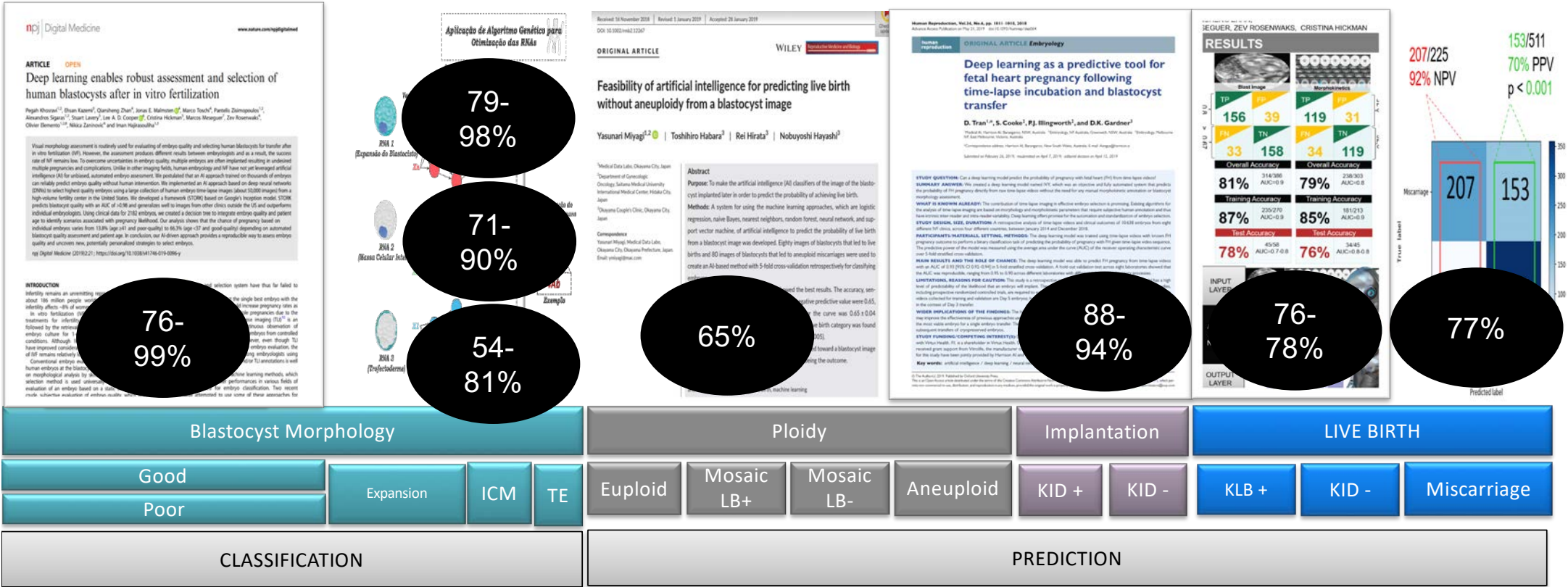


Current application of AI in ART: Embryo Selection





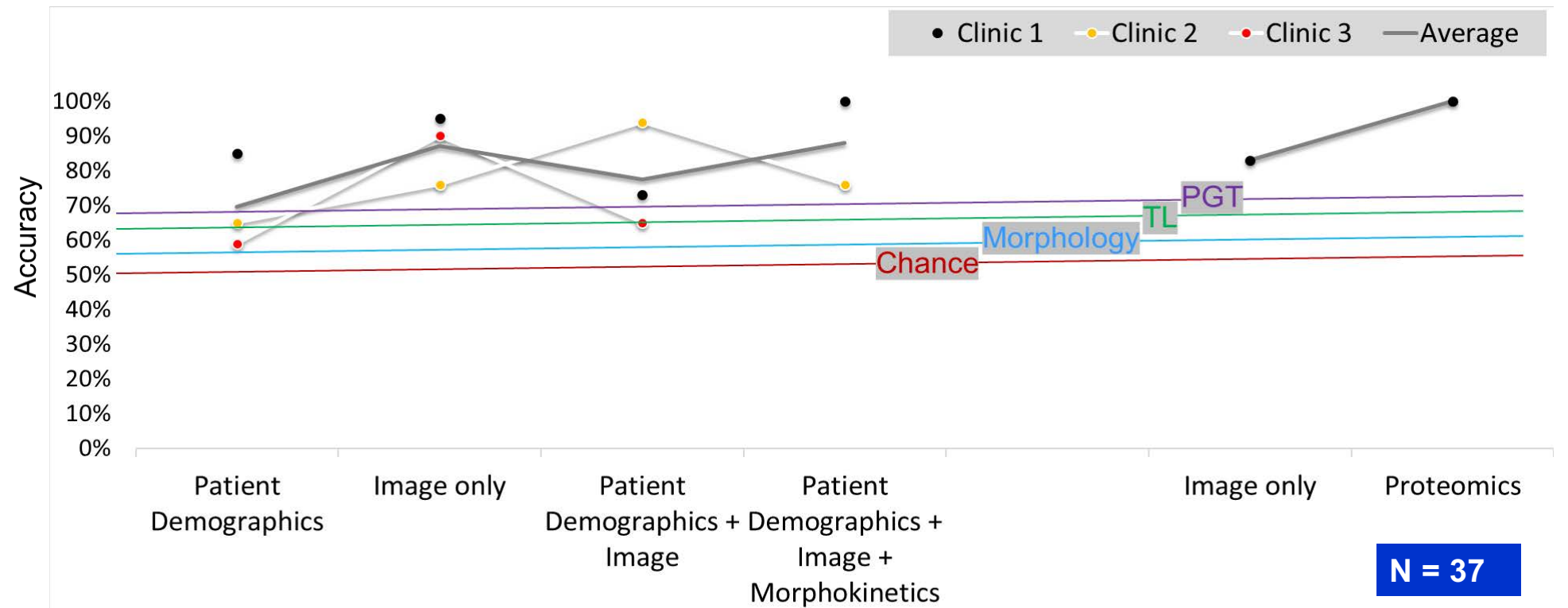
Current application of AI in ART: Embryo Selection - Accuracy





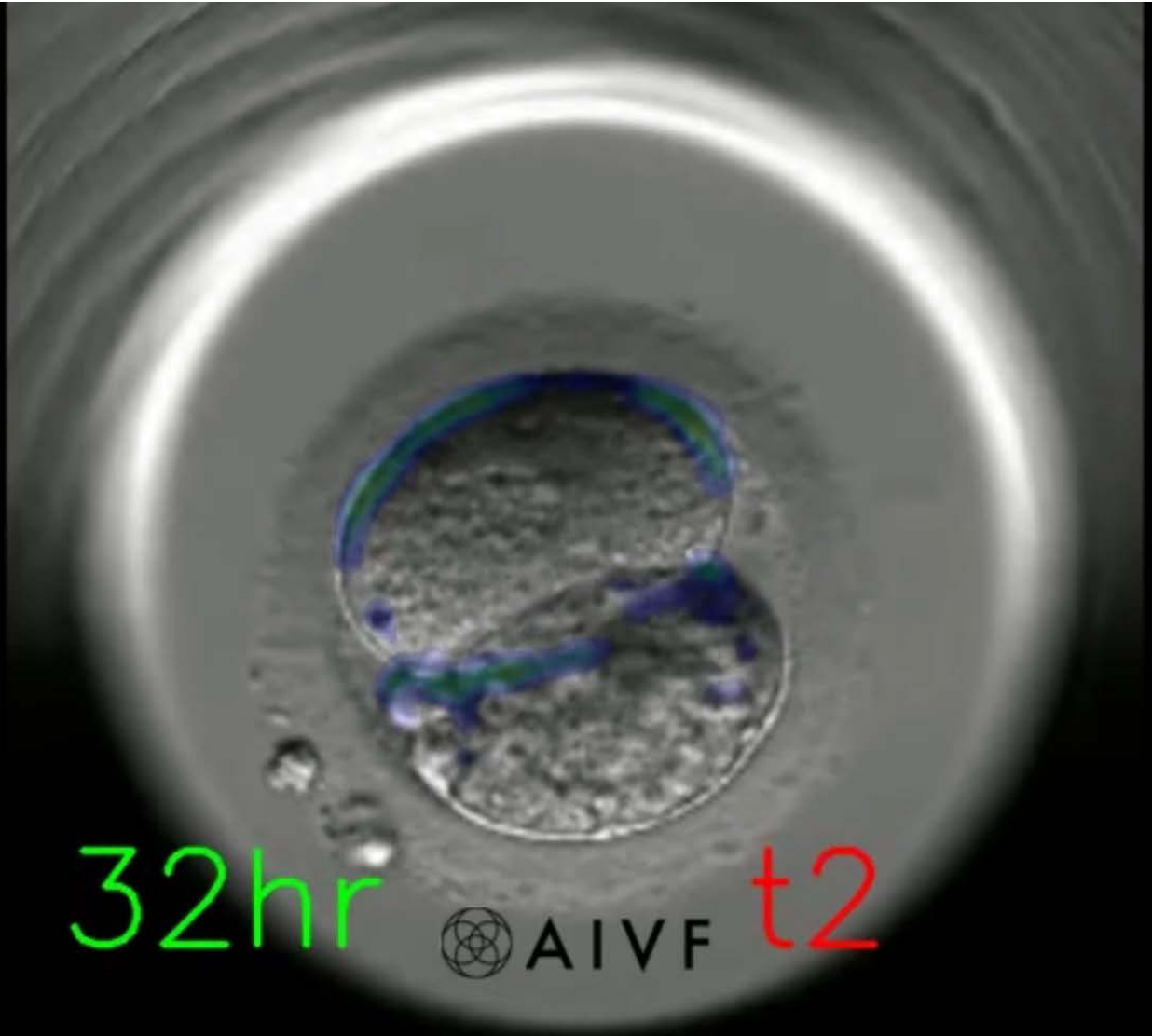
Efficacy of AI predicting outcome surpasses current technologies

• Rocha et al. (Unpublished)



N = 37

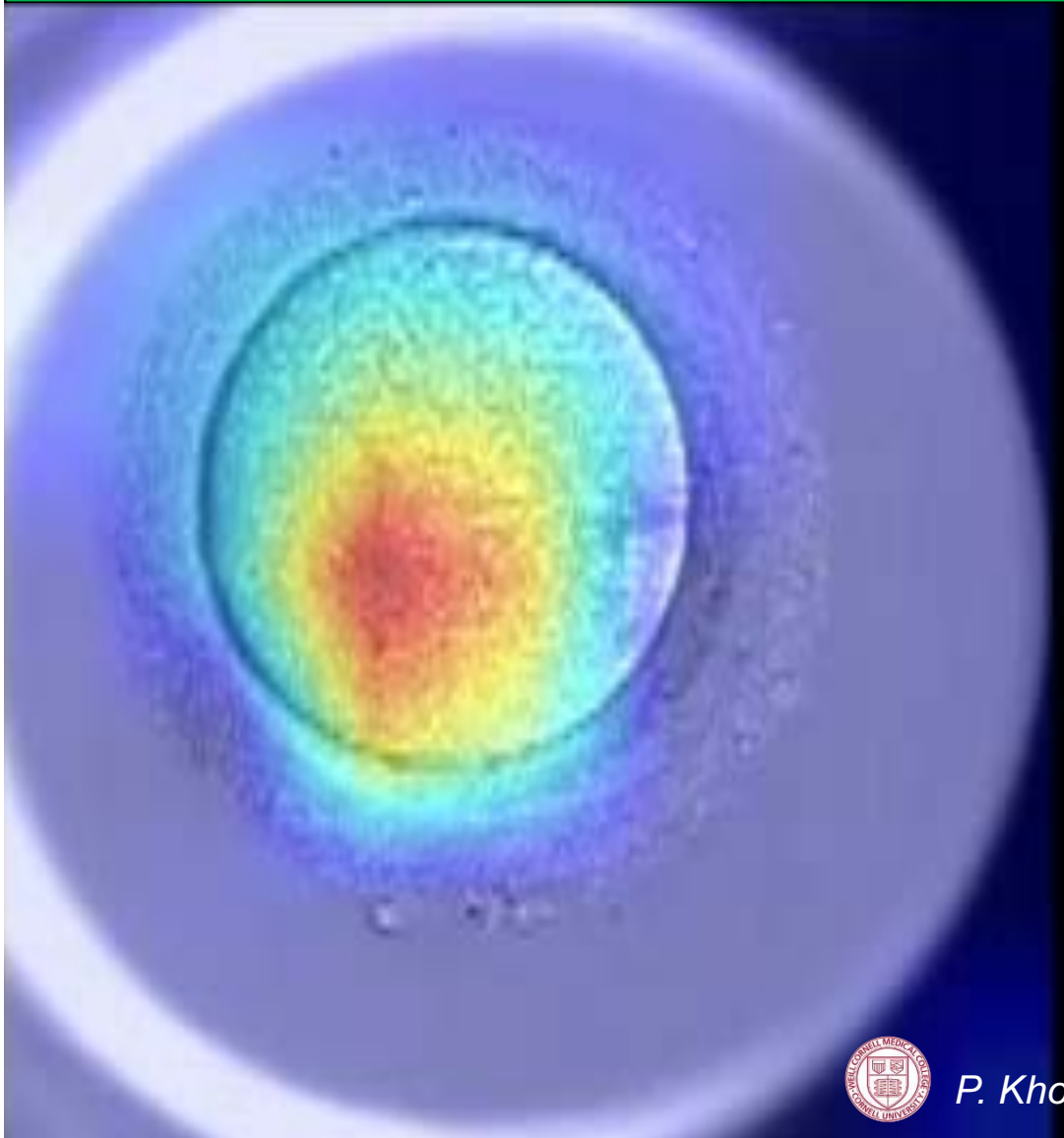
17 pos, 23 -ve



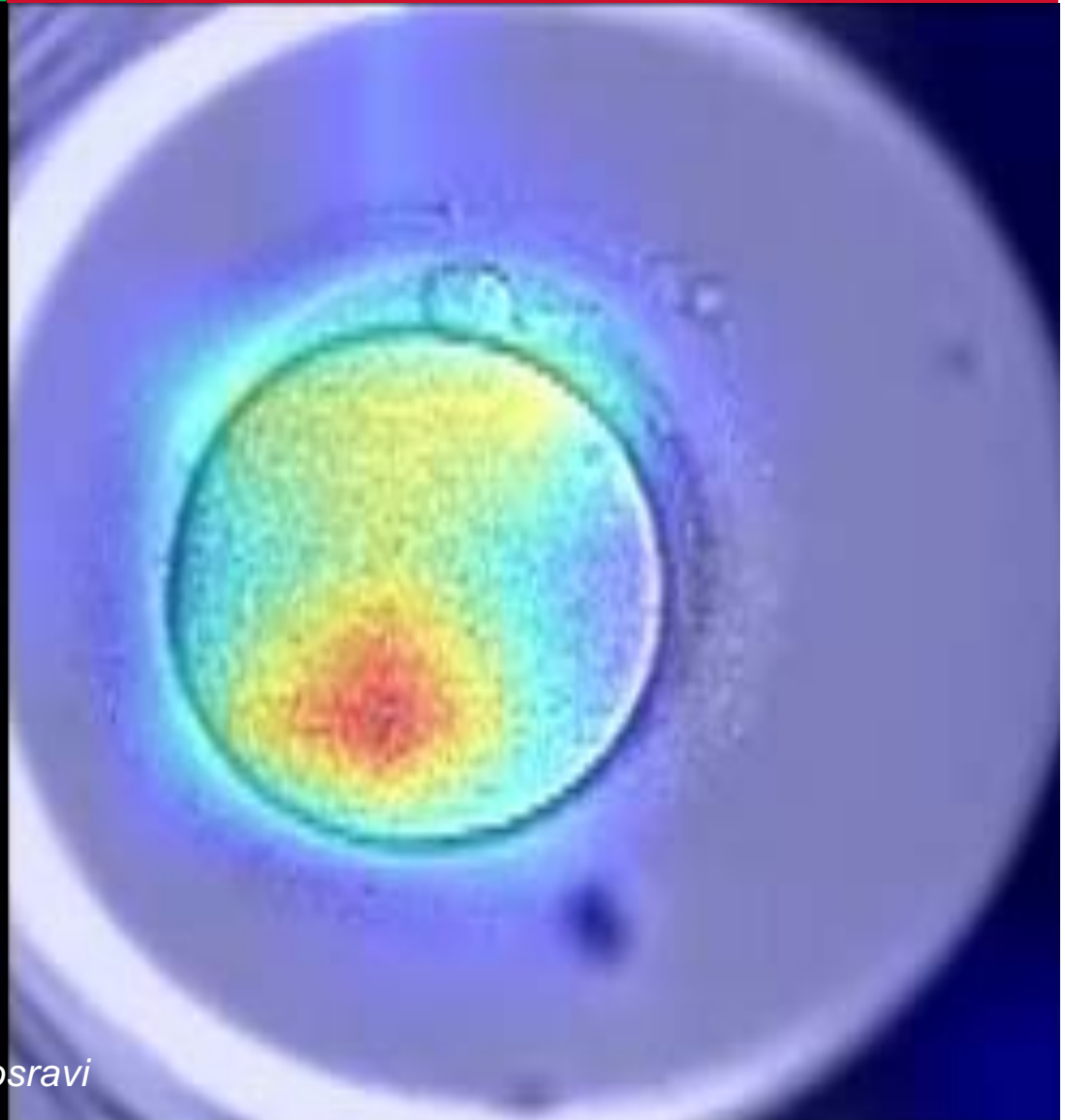
32hr t2



STORK positive



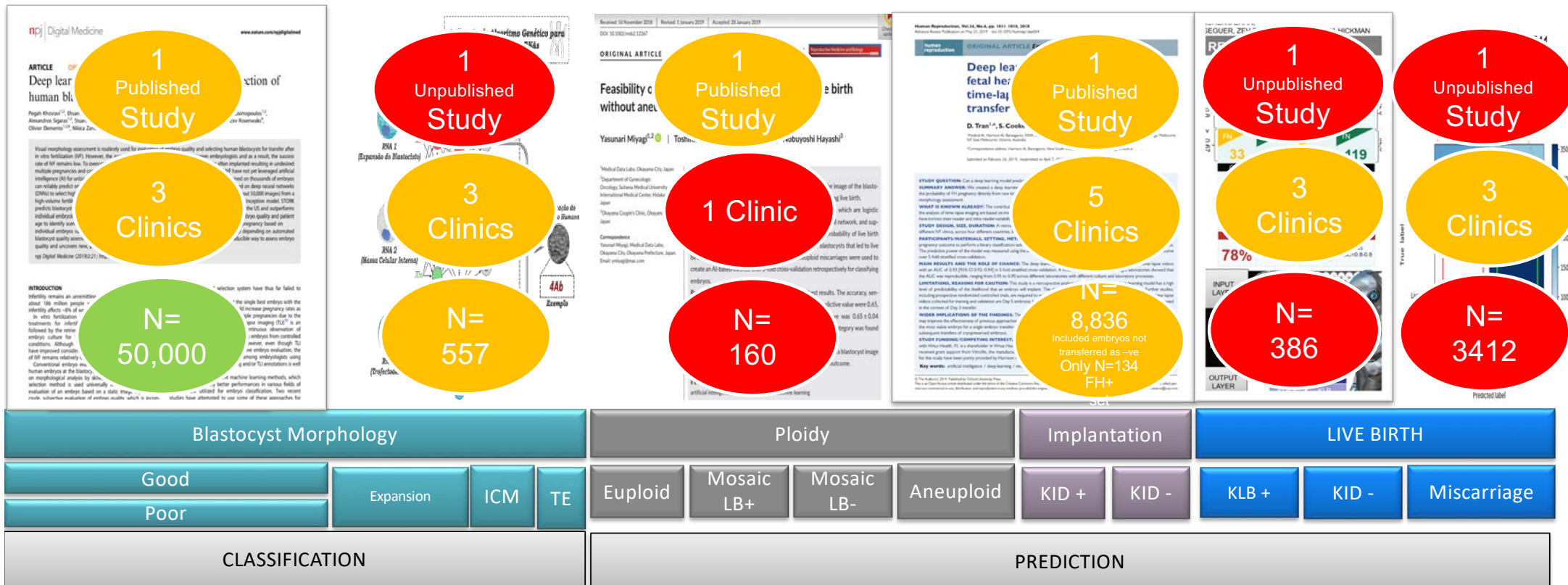
STORK negative



P. Khosravi



Current application of AI in ART: Embryo Selection - study limitations



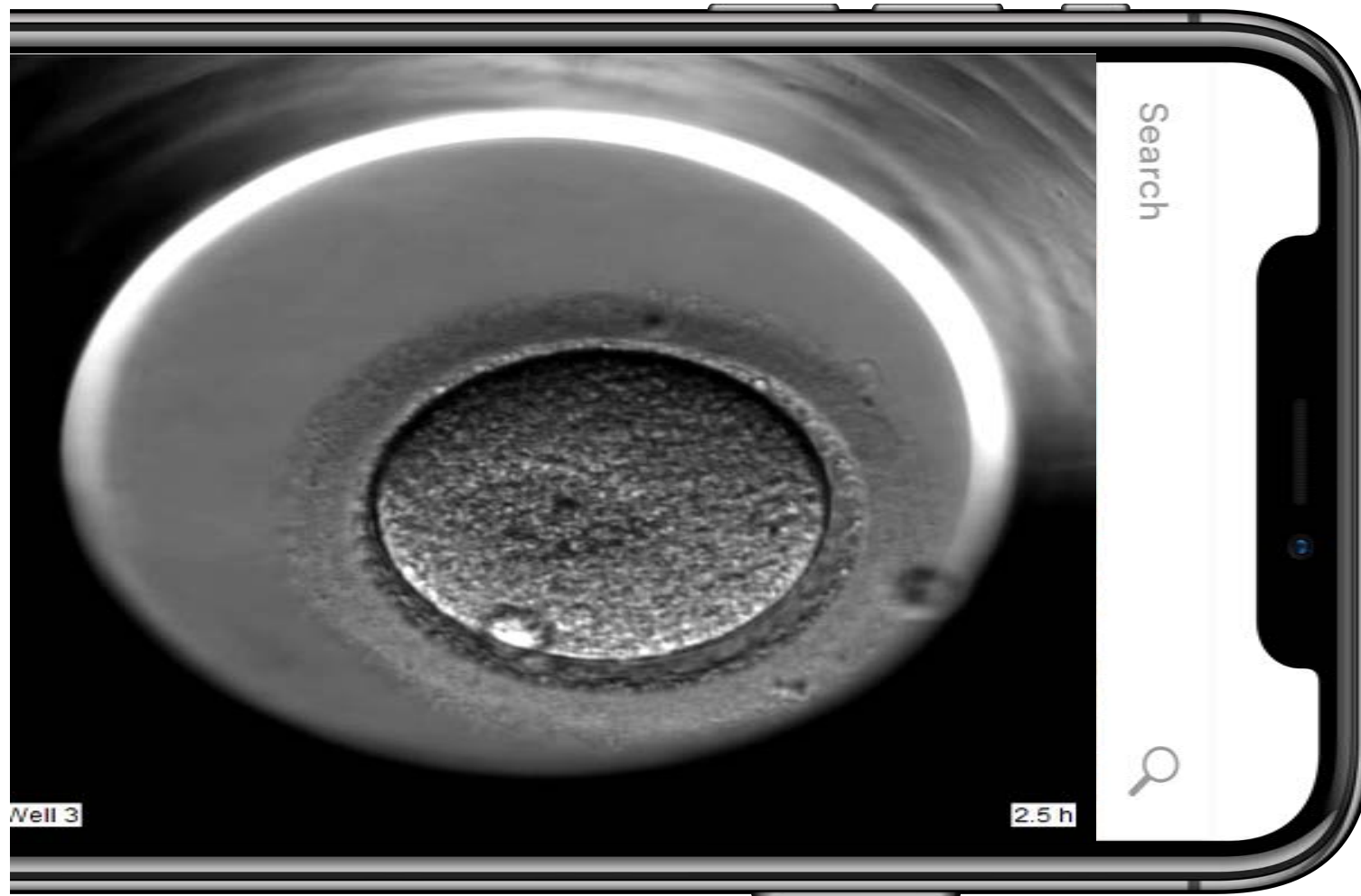


Current application of AI in ART: Embryo Selection

study limitations



Would patients welcome live access to videos?

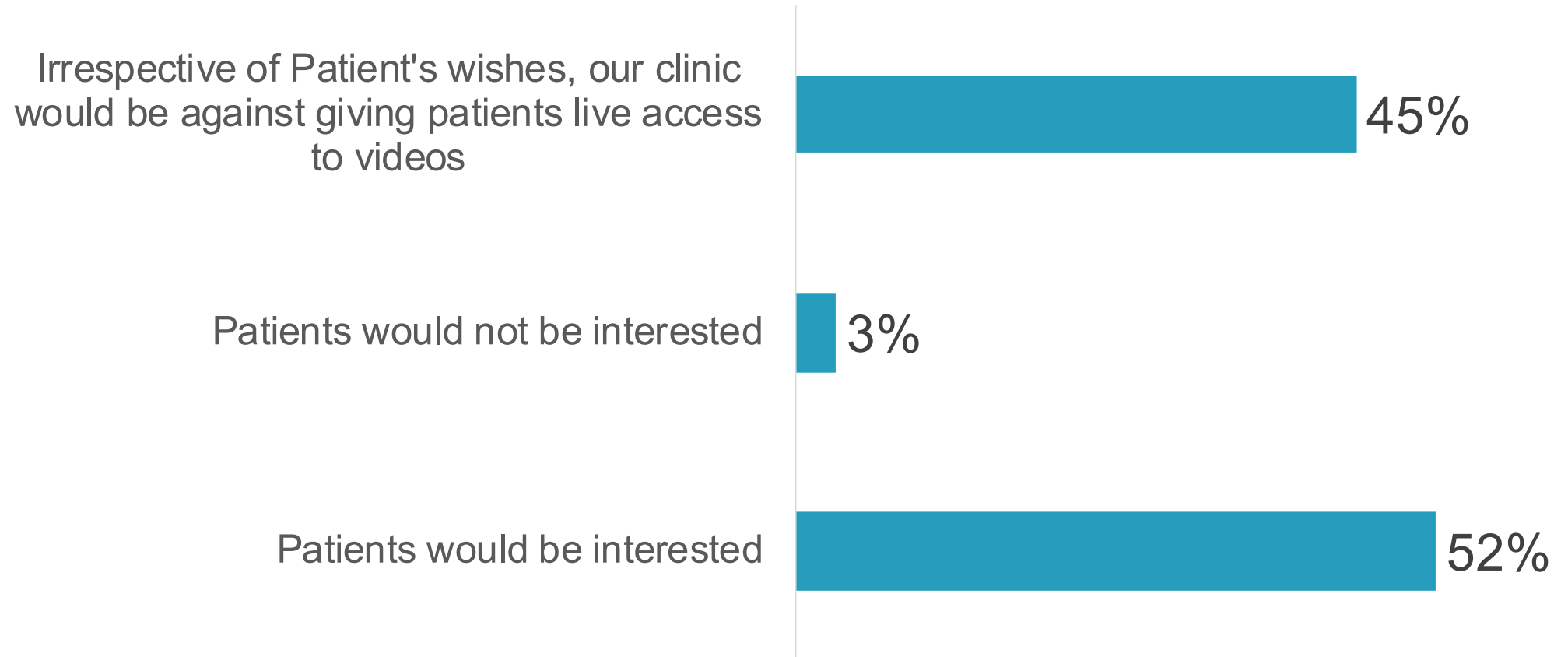


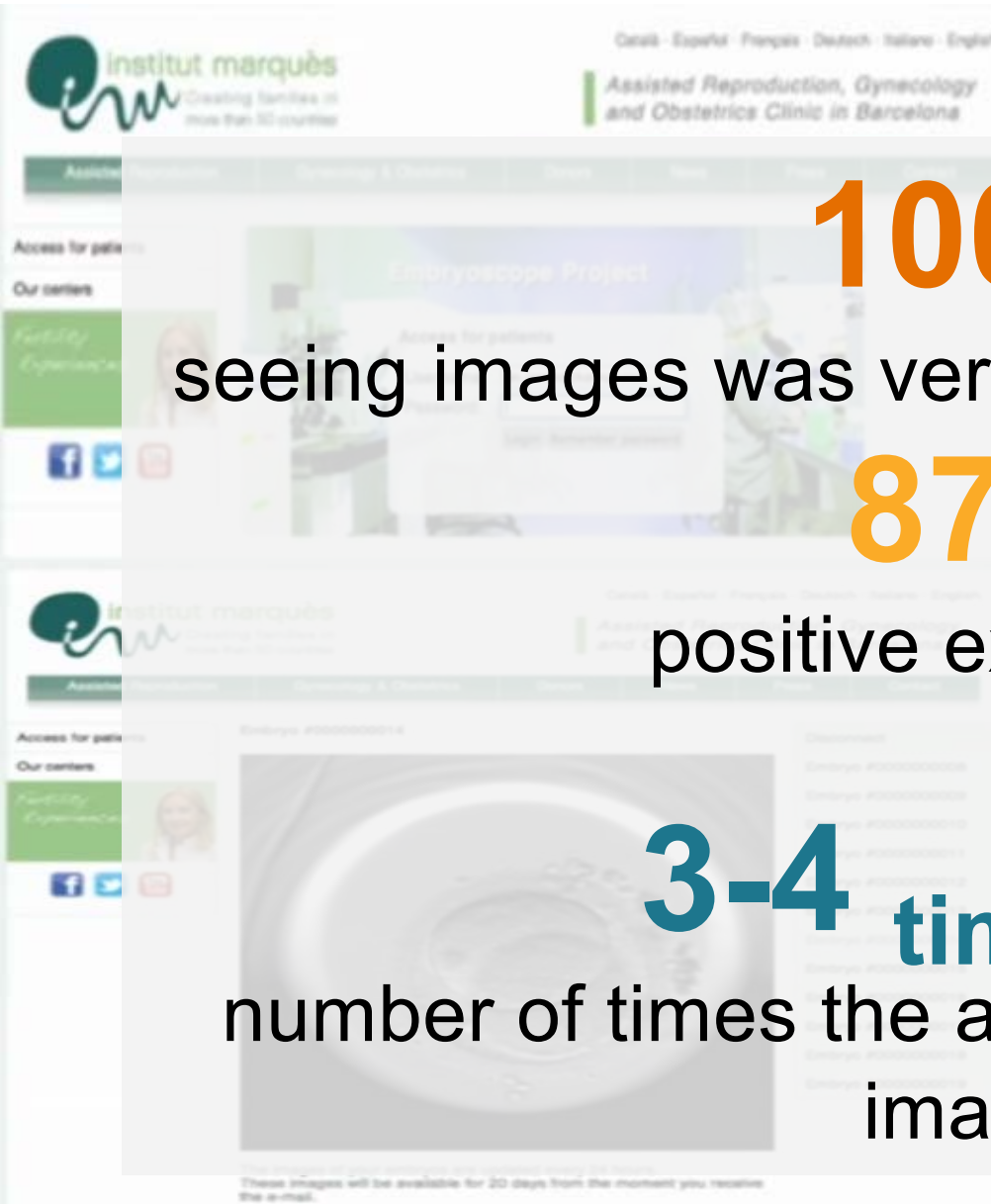
Do You think patients would welcome live access to videos?

Patients would not be interested

Patients would be interested

Do You think patients would welcome live access to videos?





100%

seeing images was very powerful and calming

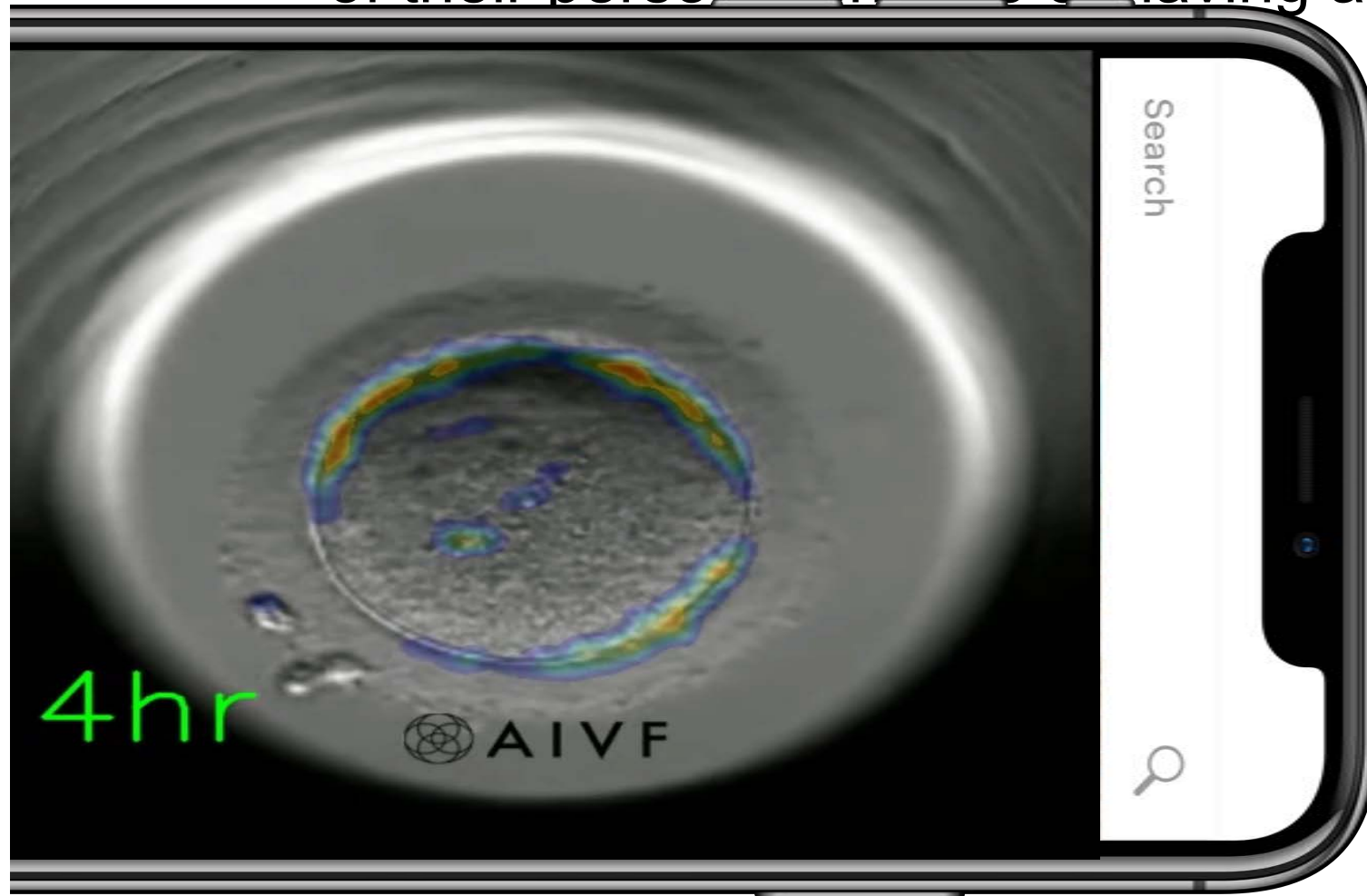
87%

positive experience

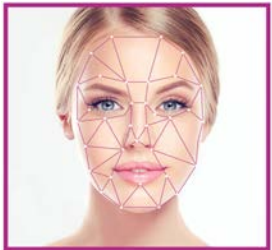
3-4 times/day

number of times the average couple look at
images

Using AI to educate patients and manage their expectations
of their personal chance of having a baby



AI uses before embryo created...



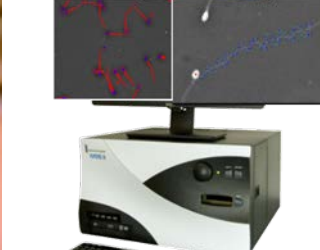
Gamete donation programmes



Stimulation Management



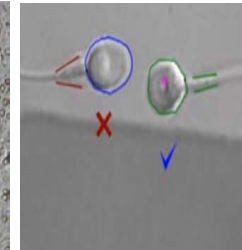
Oocyte collection



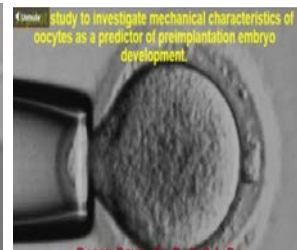
Semen Analysis



Sperm Searching

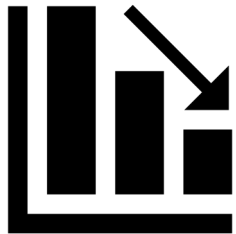


ICSI

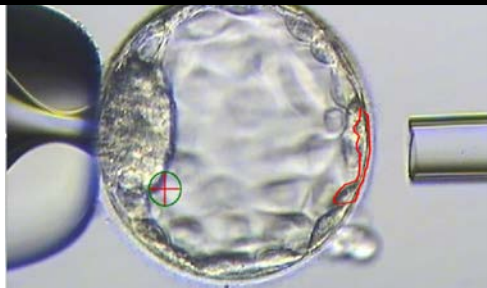


Oocyte diagnosis

AI uses after embryo created...



Live + alarmed KPI assessments



Assisted Biopsy



Live + alarmed QC assessment

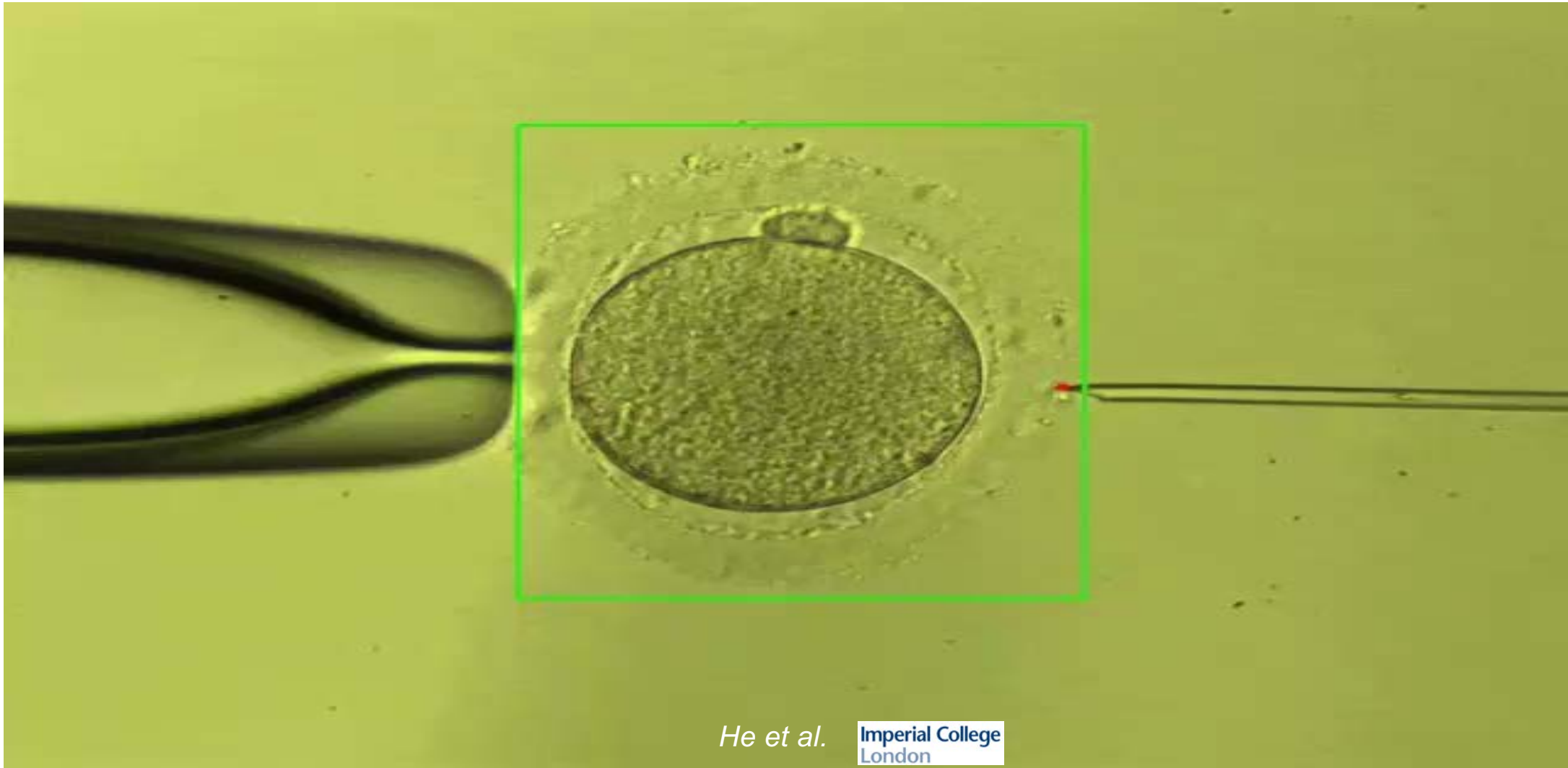


Assisted ET



Equipment monitoring

AI uses other than embryo selection



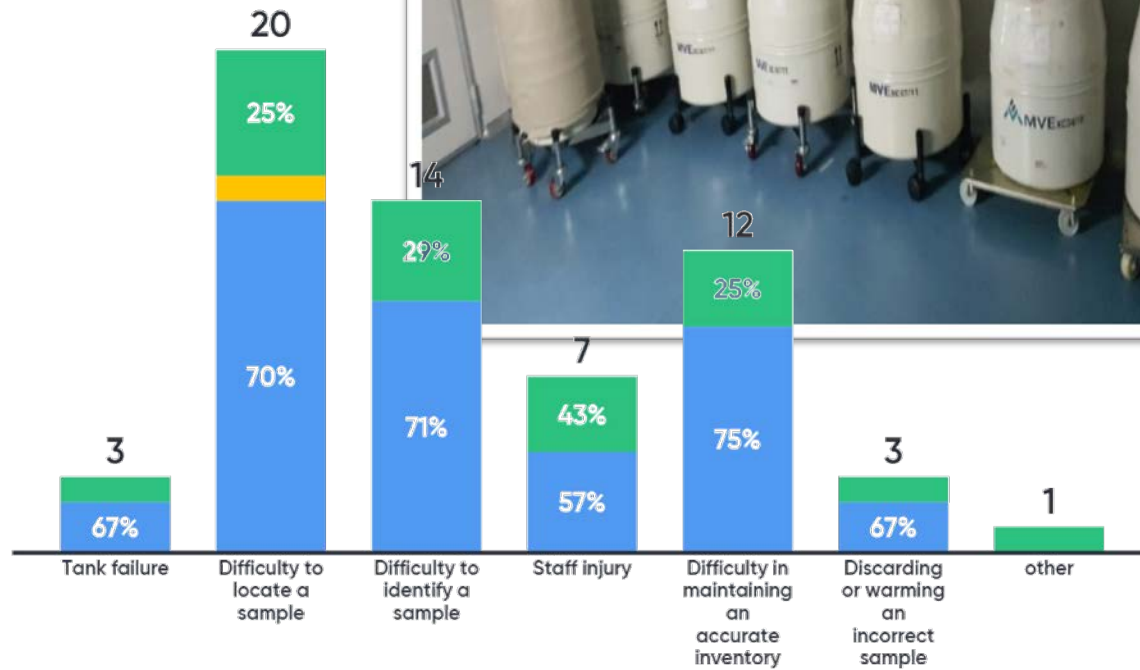
He et al.

Imperial College
London



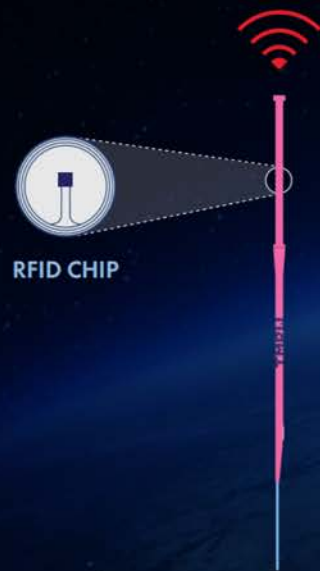
What type of storage does your clinic use?

- Liquid Nitrogen storage
- Vapour Nitrogen storage
- Mixture of Liquid and Vapour phase storage



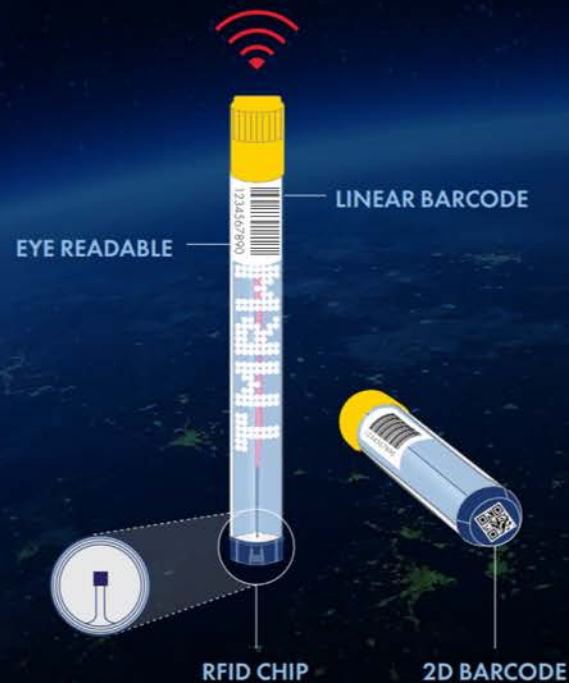


THE TMRW LABWARE RFID ON EVERY EMBRYO



RFID CHIP

THE TMRW CRYO-DEVICE



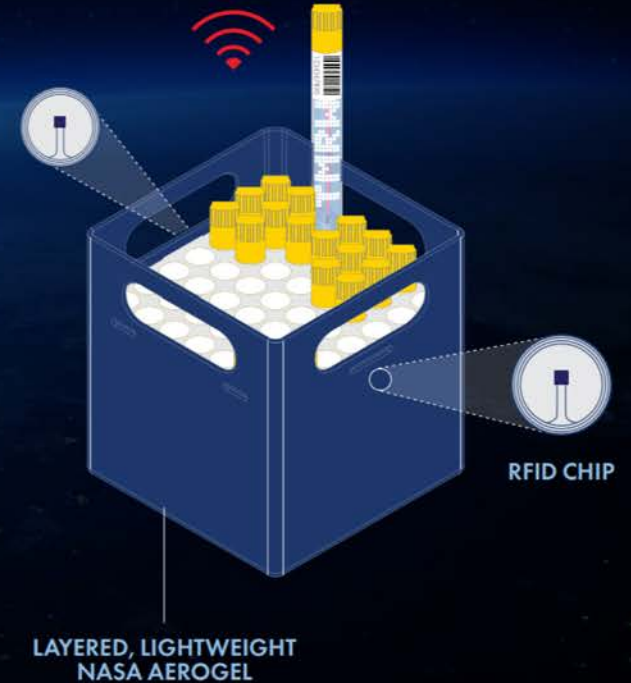
EYE READABLE

LINEAR BARCODE

RFID CHIP

2D BARCODE

THE TMRW BEACON, AN RFID-ENABLED VIAL



RFID CHIP

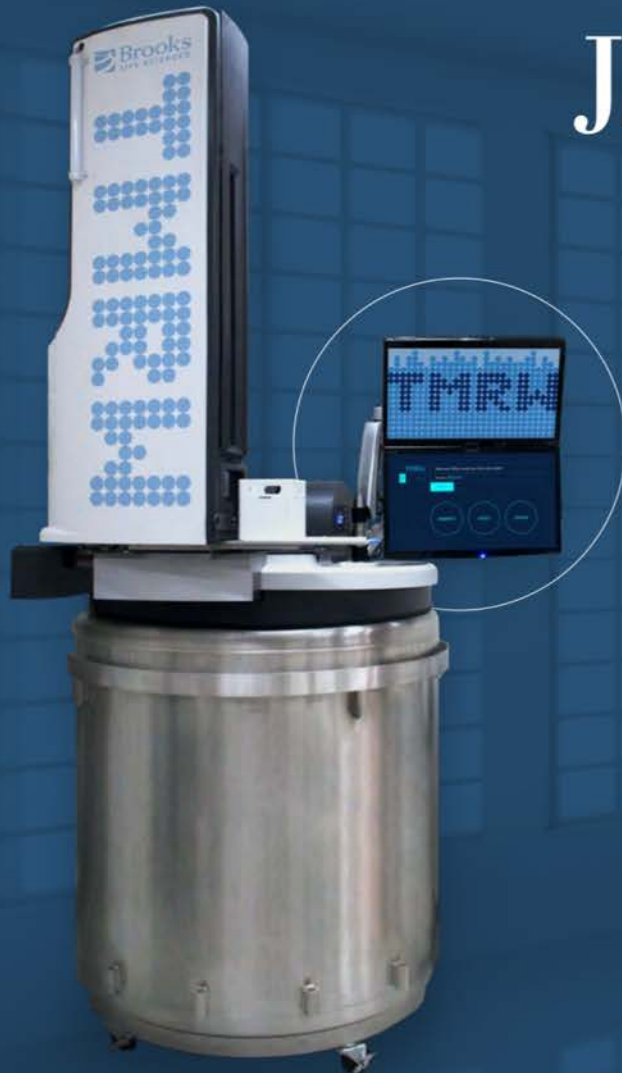
LAYERED, LIGHTWEIGHT
NASA AEROGEL

THE TMRW CRYO-CASSETTE

THE TMRW CRYO ROBOT



THE TMRW SOFTWARE JETBLUE SIMPLE



TANK #1

Procedure
FET

Date & Time
06 MAY 2019 12:30

Patient Name
Danielle Pesina

Date of Birth
05 SEP 1986

EMR ID
54015

Beacon ID
123-456-789-0
6 Cryodevices

Cryodevices
2 Selected

80-82	Embryo	1-AB	12 MAR 2018	<input type="radio"/> Unchanged <input type="radio"/> Consumed <input type="radio"/> Discarded
80-83	Embryo	1-AC	12 MAR 2018	<input type="radio"/> Unchanged <input type="radio"/> Consumed <input type="radio"/> Discarded

4 Remain

80-84	Embryo	1-AD	12 MAR 2018	<input type="radio"/> Unchanged <input type="radio"/> Consumed <input type="radio"/> Discarded
80-85	Embryo	1-BA	14 MAR 2018	<input type="radio"/> Unchanged <input type="radio"/> Consumed <input type="radio"/> Discarded
80-86	Eggs		15 MAR 2018	<input type="radio"/> Unchanged <input type="radio"/> Consumed <input type="radio"/> Discarded
80-87	Eggs		15 MAR 2018	<input type="radio"/> Unchanged <input type="radio"/> Consumed <input type="radio"/> Discarded

TMRW

Create a New Tub

Welcome! What would you like to work on today?

Freeze **Thaw**

You're adding the Specimens on the Tub

All Cryodevices are accounted for

Beacon ID 123-456-789-0
2 Selected

4 Cryodevices

Cryodivice ID	Type	Model	Release	Expiry	Status	Project	Unchanged	Consumed	Discarded
001-001-789-0	Embryo	1-AB	12 MAR 2018	Yes	Normal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
001-001-789-0	Embryo	1-AC	12 MAR 2018	Yes	Normal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2 Remain

001-001-789-0	Embryo	1-AD	12 MAR 2018	Yes	Normal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
001-001-789-0	Embryo	1-BA	14 MAR 2018	Yes	Normal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Well done, we're all done!

Please do a safety check before signing out

☒ All Cryodevices have been returned

☐ The Cryobath is clear of Specimens

☐ All Robot Cassettes have been returned to the Robot

Stanley - TMRW

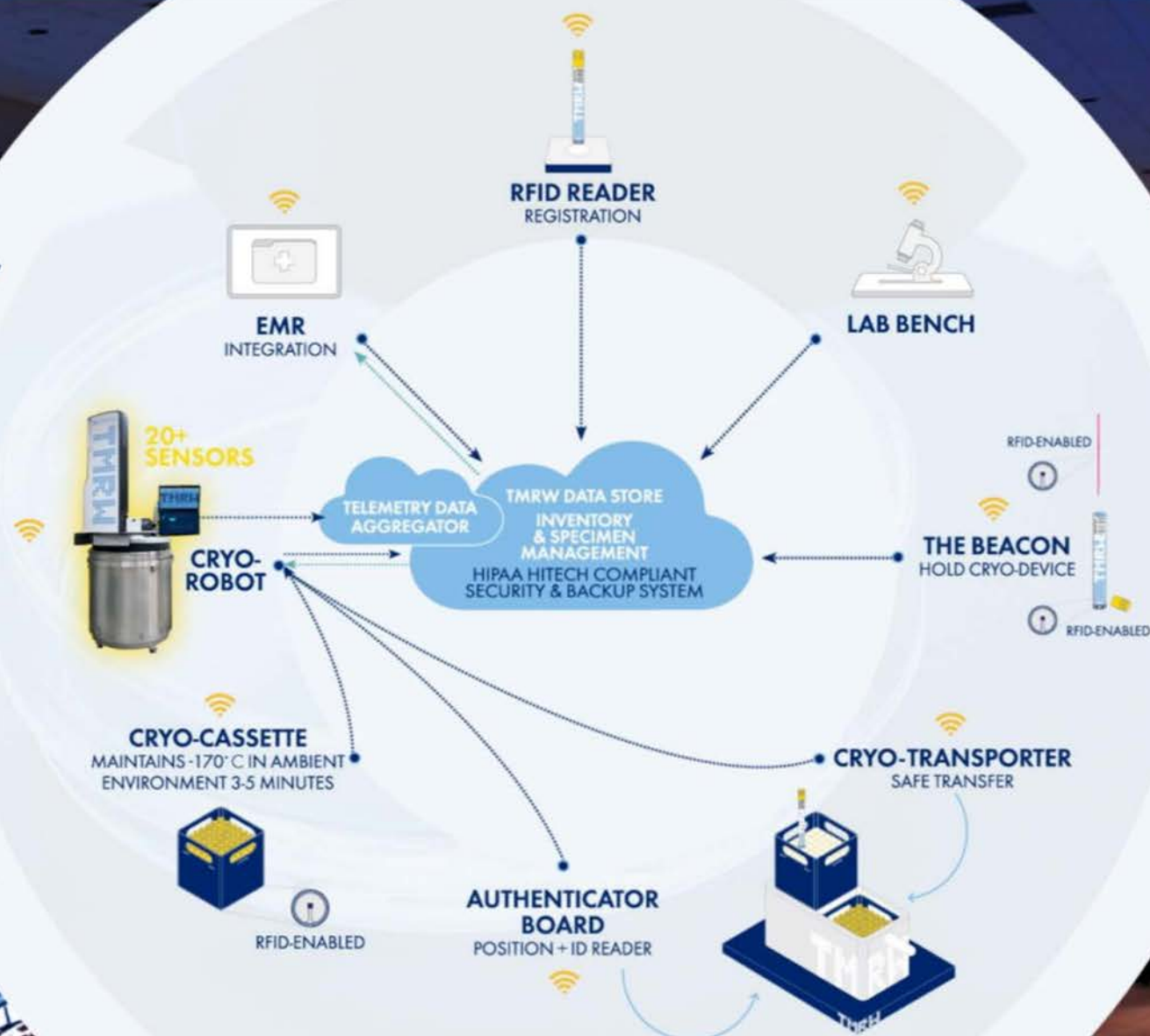
Sign Out



TMRW TEAM

TMRW OVERWATCH

TMRW SPECIMEN MANAGEMENT SYSTEM





Future application of AI in ART:

Equipment Monitoring → predicting non-conformities



Increasing opportunities of DATA capture:
i.e. RFID traceability, increased sensor number and type



LEARNING from data capture
i.e. prediction of equipment malfunction



PREDICTION of equipment malfunction

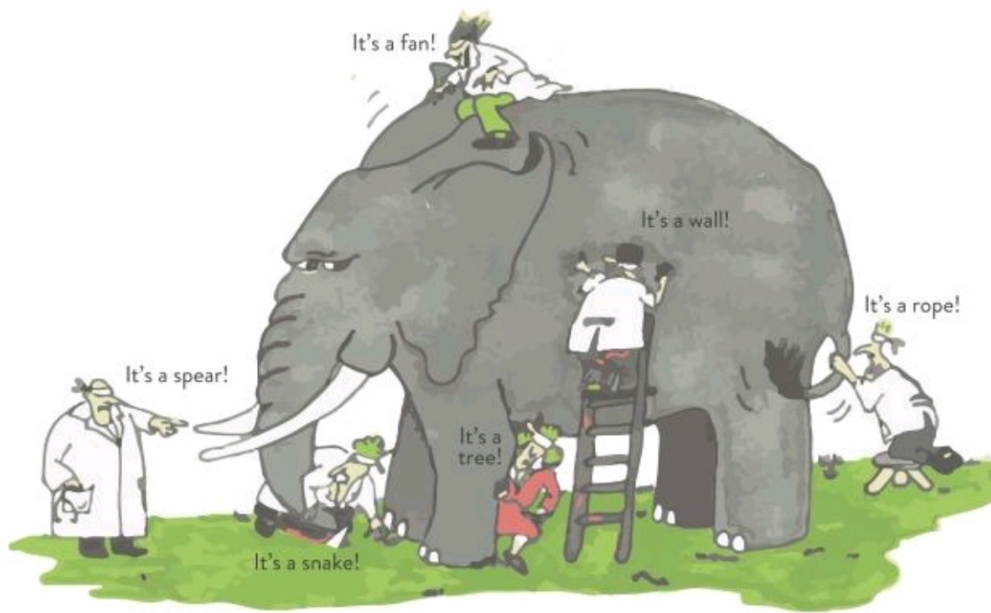


PREVENTION of equipment malfunction

How do we evolve evidence based learning as a field?



RCT

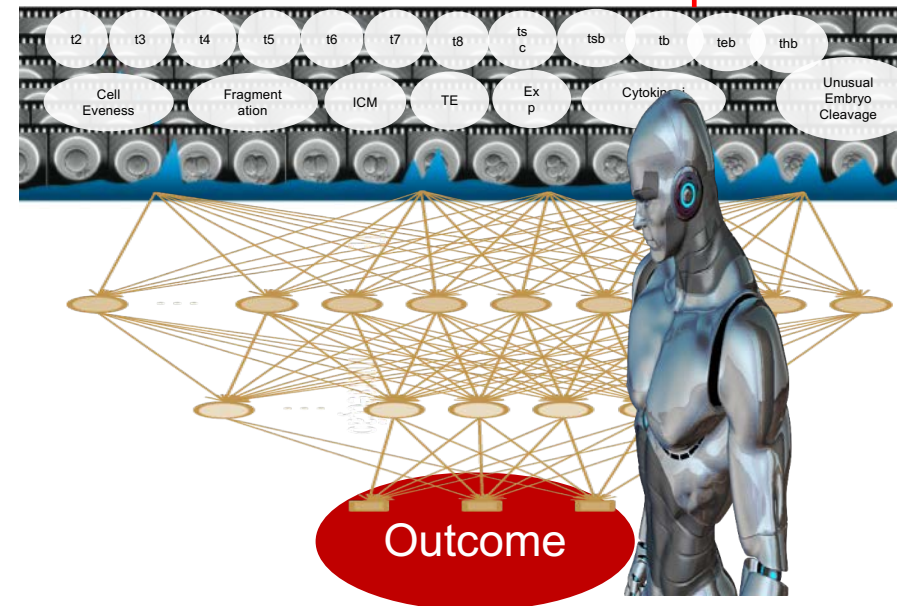


“Insufficient evidence”

Does RCT controlled cohort reflect clinical reality?

Prospective cohort study with Huge Diverse data using AI

403.2 Million data points



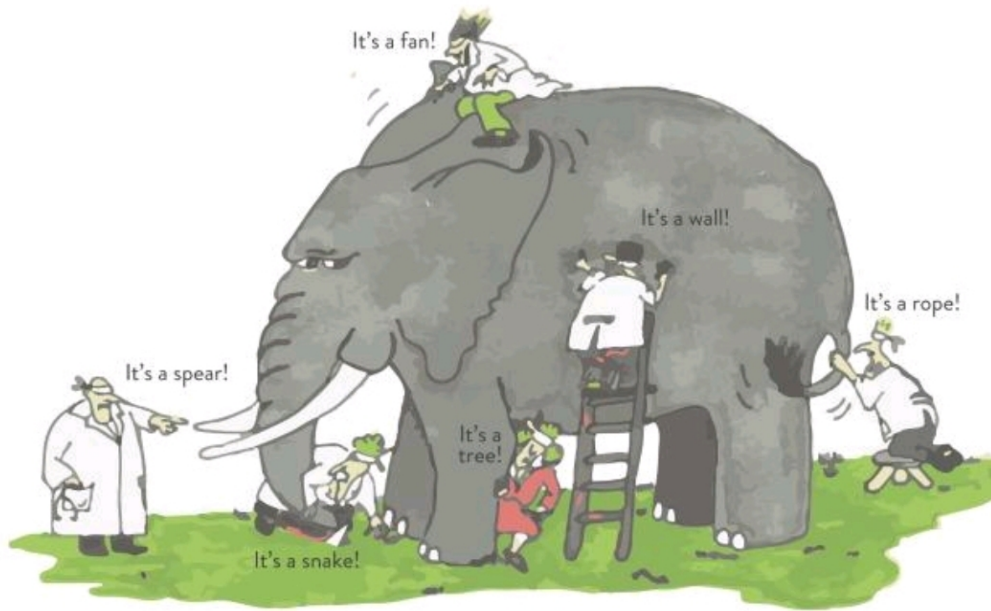
Need LARGE diverse data at global scale to mitigate BIAS

Secure infrastructure for global knowledge sharing



How do we evolve evidence based learning as a field?

RCT



"Insufficient evidence"

Does RCT controlled cohort reflect clinical reality?

Prospective cohort study with Huge Diverse data using AI



Need LARGE diverse data at global scale to mitigate BIAS

Secure infrastructure for global knowledge sharing



A woman with long dark hair, wearing a white lab coat, is shown in profile, looking out towards a bright sunset or sunrise. The background is a soft, hazy landscape with mountains or hills under a warm, golden light. A semi-transparent grey box is overlaid on the left side of the image, containing white text.

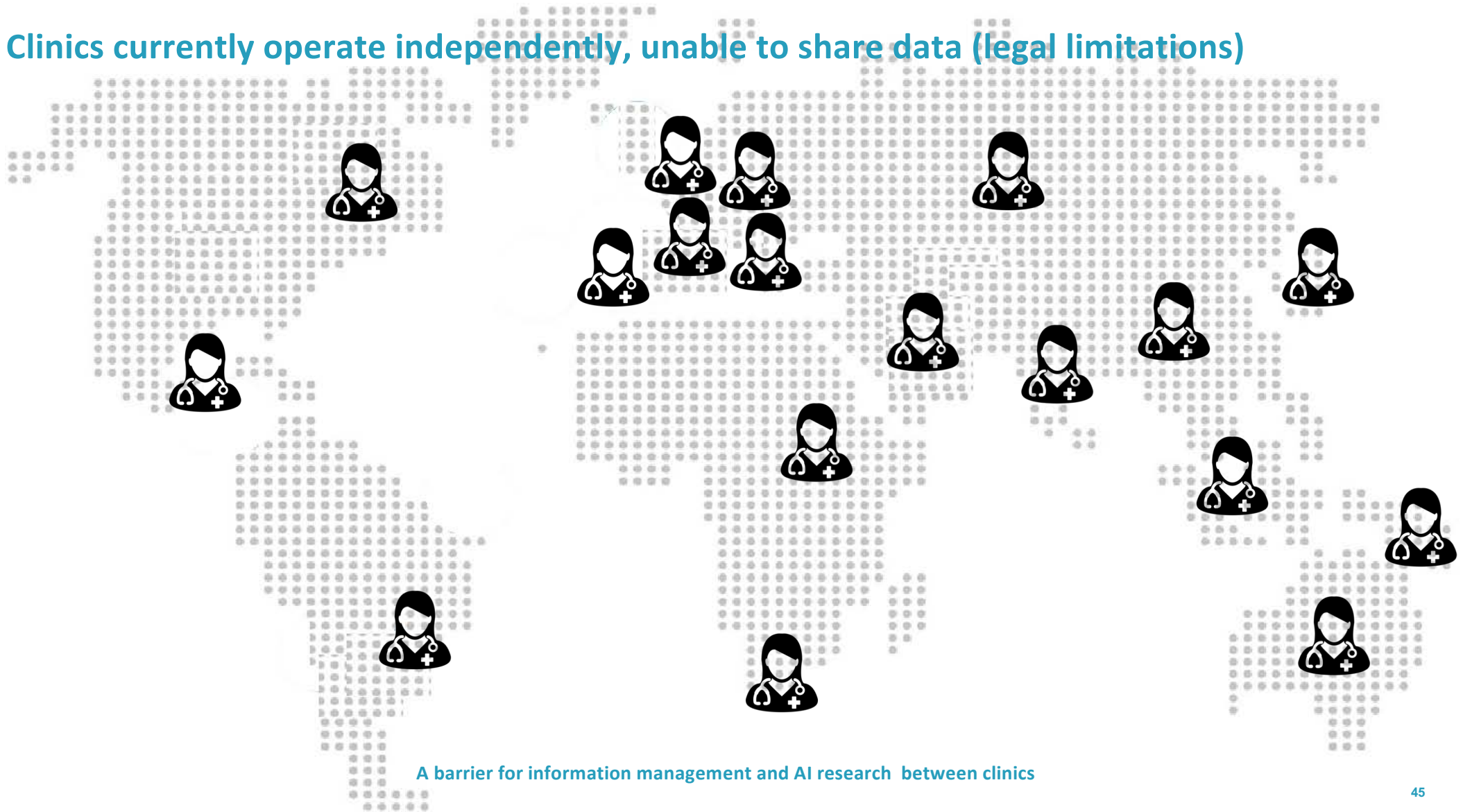
**TO CREATE A GLOBAL DATA-HUB INFRASTRUCTURE
ACROSS IVF CLINICS**

THAT IS LEGAL, ETHICAL, INFO GOV COMPLIANT

TO EVOLVE EVIDENCE-BASED MEDICAL PRACTICE IN ART

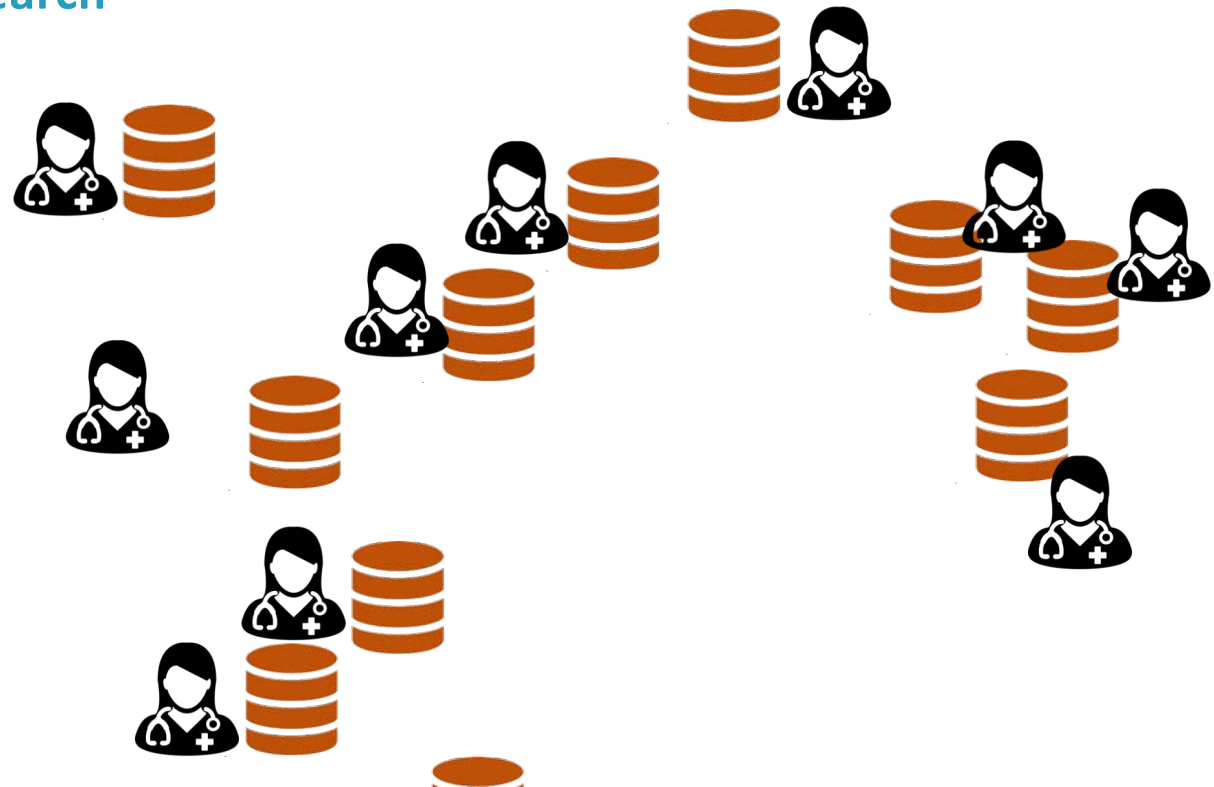
TO BETTER **SERVE PATIENT INTERESTS**

Clinics currently operate independently, unable to share data (legal limitations)



A barrier for information management and AI research between clinics

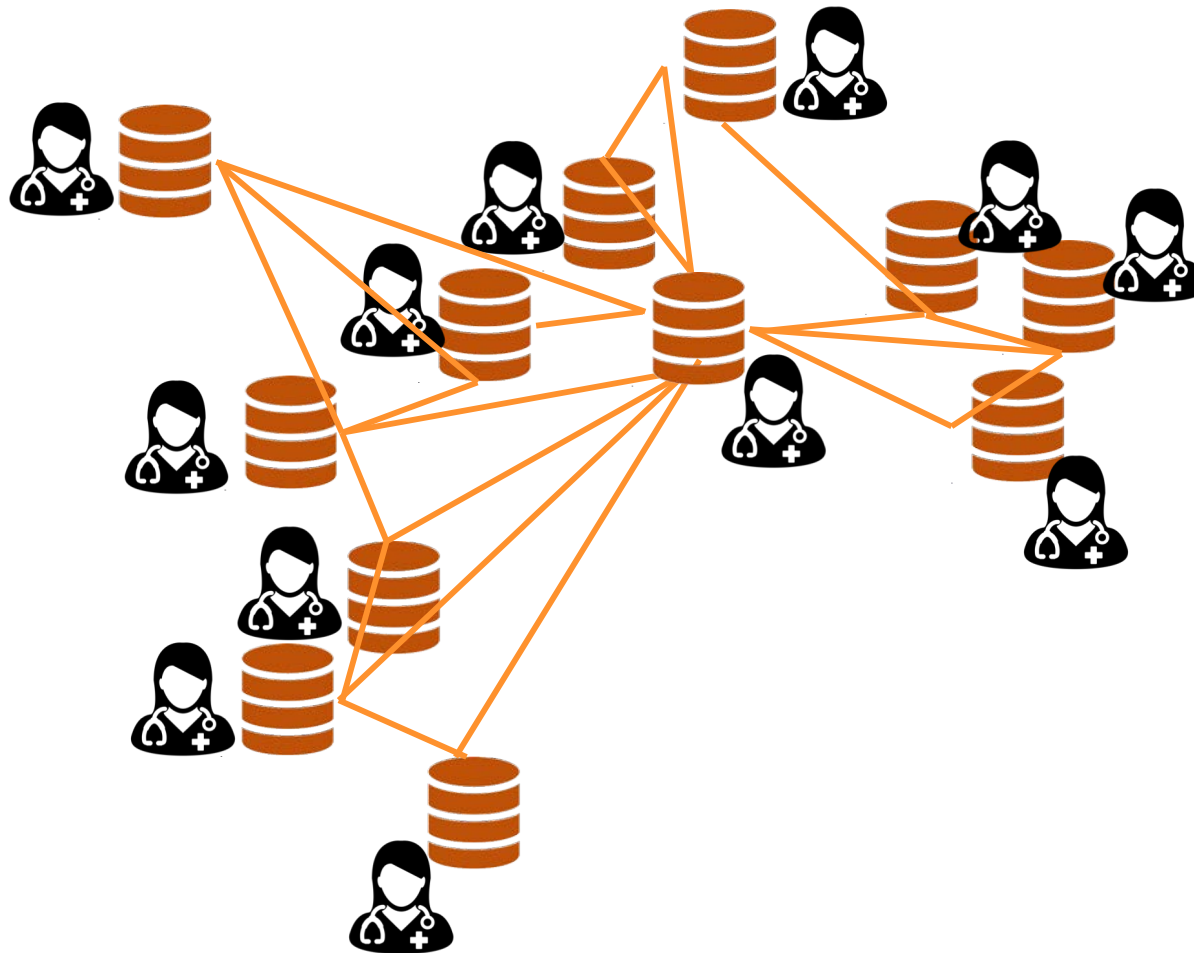
Apricity provides the legal and practical solution for clinics to become ready for AI research



DATA PREPARATION			AI TRAINING + VALIDATION		BRINGING AI BENEFITS TO PATIENTS			
Collect	Visualize	Clean	AI Algorithm developed	AI algorithm tested in data hub	Software	Regulatory compliance	AI accessible worldwide	Ongoing algorithm maintenance

APRICITY HELPS CLINICS EVOLVE THEIR AI PROGRAM

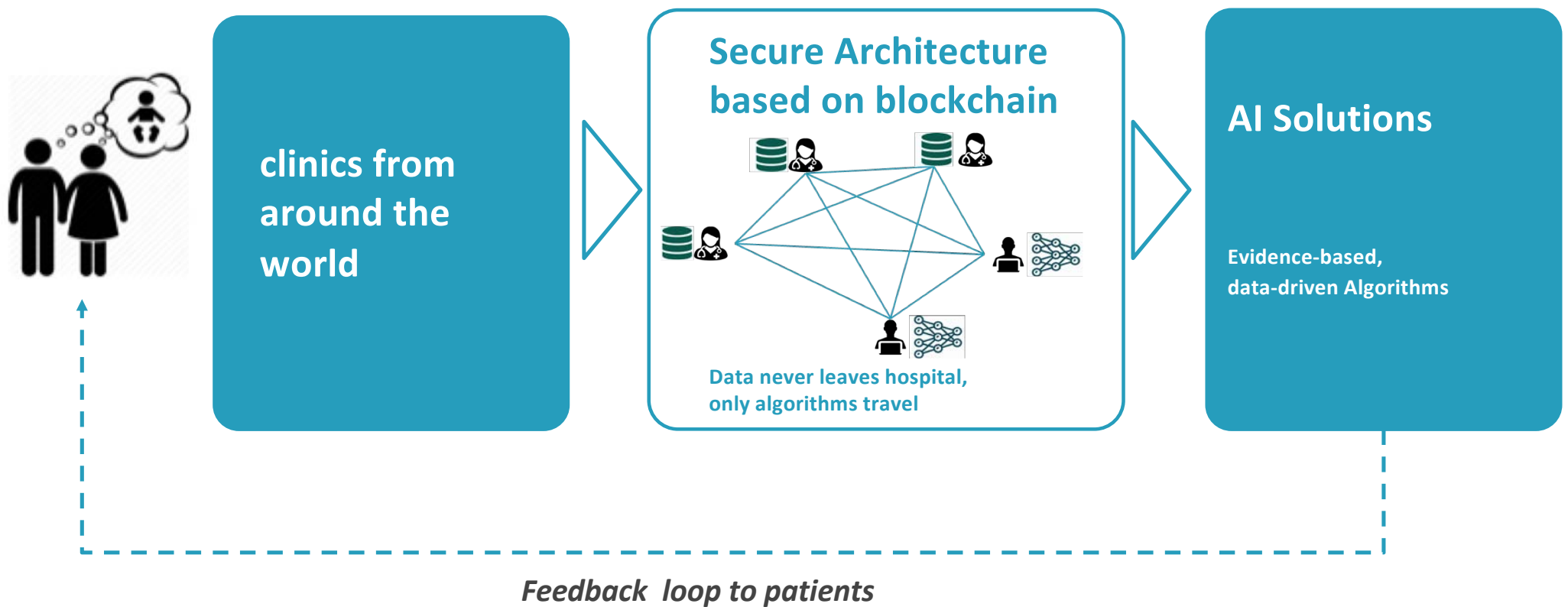
Secure Blockchain Architecture custom made for IVF



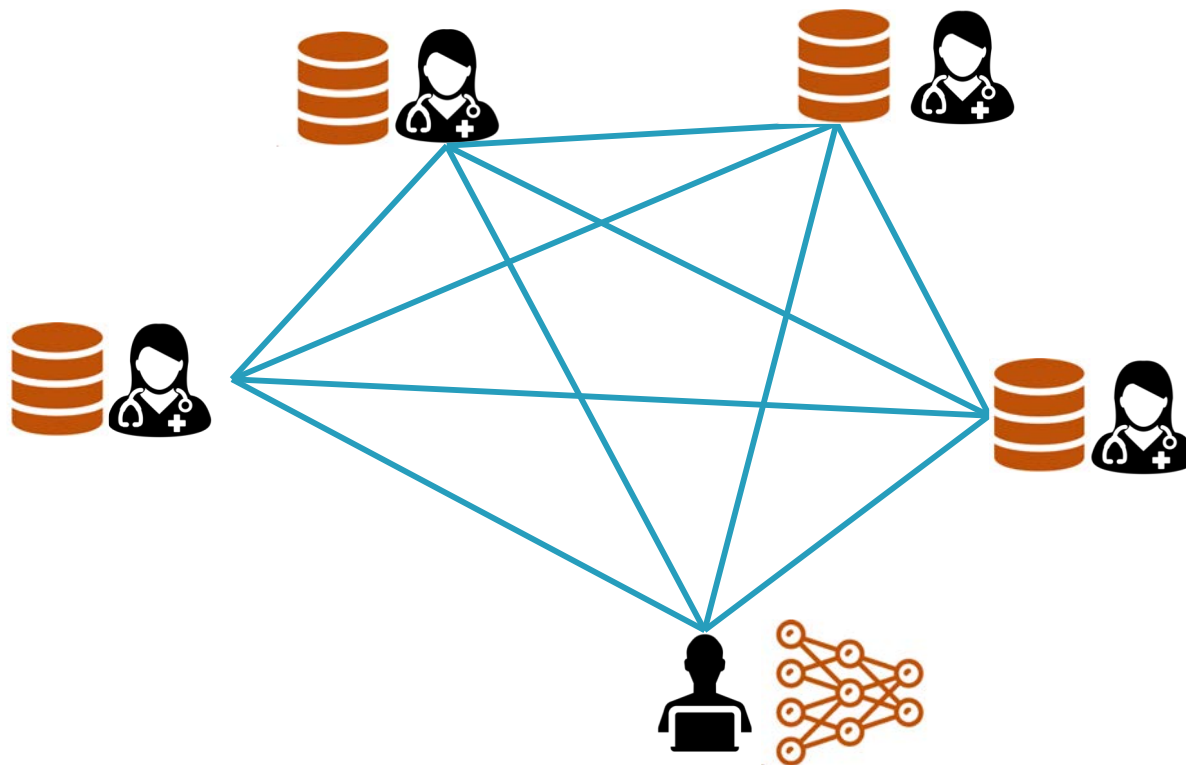
Data never leaves hospitals, only algorithms travel. Network is only accessible by authorised clinics.



a technological framework making it possible for Benefits of AI to reach patients faster



Framework designed for collaborative data science projects on sensitive data



Privacy

In line with regulation, identifiable information is not accessible

Traceability & Transparency

all interactions with local data are tracked: what data was accessed, when, by whom, for what purpose

Accountability

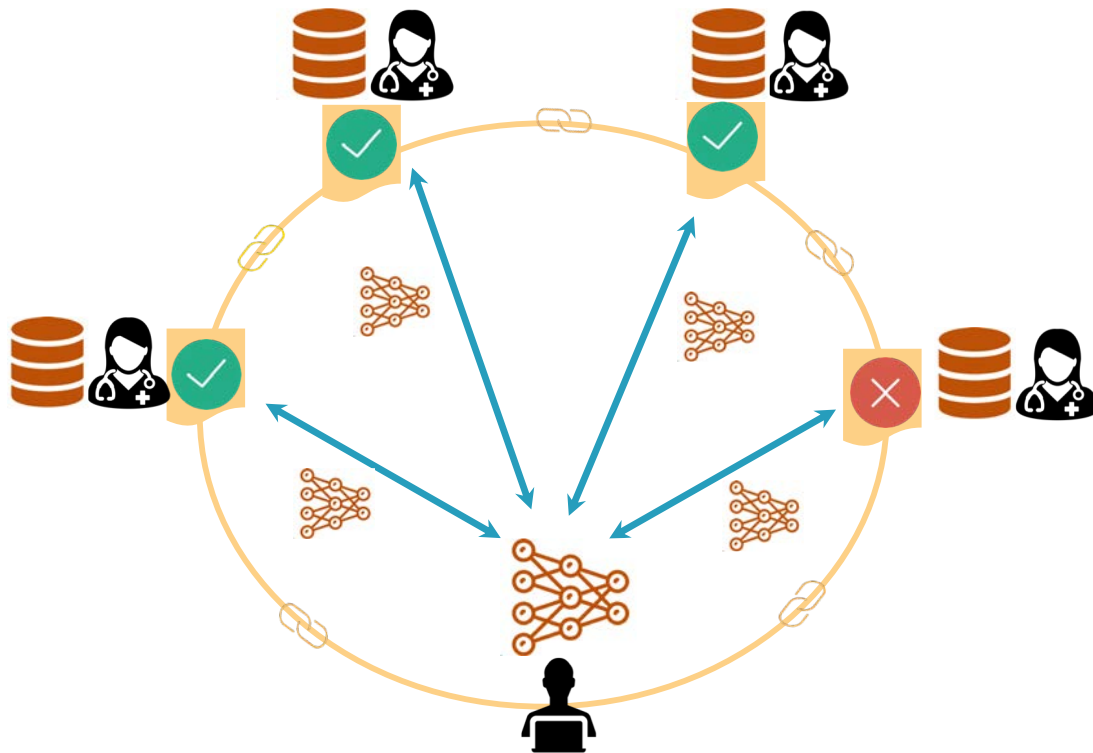
Server owner fully controls who accesses what data

Security

unauthorised access is not possible



Clinics control external access to the dedicated server

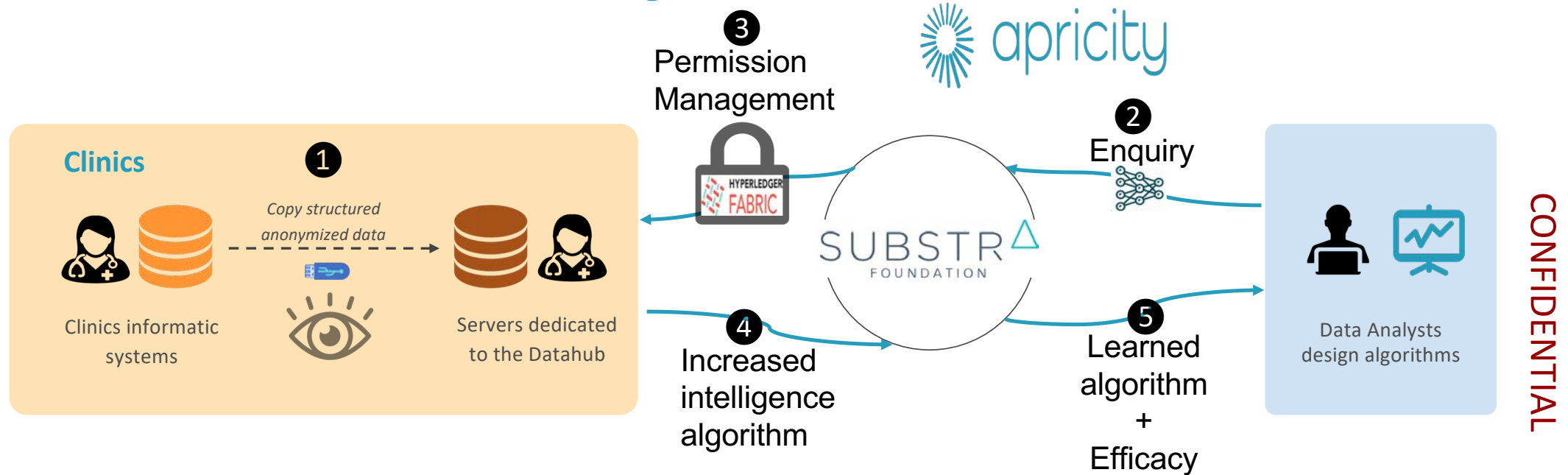


Clinics choose who can send the algorithms to be trained in their dedicated server data

Clinics can modify access permission rules at will



How does information flow through the Datahub



- 1** Clinic staff anonymise the data and, following witnessing to ensure compliance, move data to servers dedicated to the Datahub
- 2** Data Analysts (From Apricity, from other clinics, from other member AI organisations) design algorithm based enquiries
- 3** All the data remain the property of the clinic. Only models and algorithms travel on the network, not data. Using Hyperledger Fabric, a permissioned blockchain implementation that adheres to Fabric pre-defined protocols which define how the Fabric components interact (write only, smart contracts....). The ledger is immutable.
- 4** AI algorithms travel from dataset to dataset, learning locally on data, but return without the data, with increased intelligence having learnt from data. Training is done by federated learning. Training and validation phases are distributed and coordinated
- 5** Learned algorithm and efficacy data is accessible to external data analysts



Mutually Beneficial Relationship

APRICITY

- ❖ Advise clinics on data capture + automation to ensure high quality data
- ❖ Provide expert assistance to install and maintain the network and all the documents needed
- ❖ Obtain the competent authorities' approval to conduct studies
- ❖ Ensuring system compliant with legal, ethics, information governance, data security standards
- ❖ Consistency and agreement between alliance members in data capture / organization
- ❖ Develop API for data capture

CLINIC

- ❖ Provide local resources (1 staff member + 1 server per clinic)
- ❖ Collect the data, format appropriately, transfer to server
- ❖ Gain patient consent
- ❖ Local ethical approval
- ❖ Use Apricity data hub for evidence based learning

Where are we now?



PRE-CONTRACT SIGNED	PRE-AI			AI		Present + Publish	GO TO MARKET			
Apricity Data Hub explained Agreement in Principle	Install Server	Train Clinic	Clean Data	AI Algorithm developed	AI algorithm tested in data hub		Software	Regulatory compliance	AI accessible worldwide	Ongoing algorithm maintenance
Current agreement from 200k cycles/annum including Asia, Europe, Middle East, North and South America	First clinic installation in Q1 2020									
Team of Trained Data engineers & Data analysts										

A stylized sunburst graphic composed of numerous light blue rays emanating from a central point, located in the upper right quadrant of the slide.

Making AI Accessible to all IVF clinics.....

To evolve evidence based medicine and
invigorate the best type of intelligence:
the one that is not artificial

Cristina Hickman
Celine Jacques

cristina@apricity.life
celine@apricity.life



C. Rocha

S. Lavery



M. Nogueira



C.Hickman
Cristina@Apricity.life



I. Hajirasouliha



J. Barnes



N. Zaninovic

O. Elemento

Q. Zhan

Alexandros Sigaras



C. Hickman

P. Khosravi



P.He

P.He



J. E. Malmstein

Z. Rosenwaks



Imperial College
London



M. Meseguer



R Hariharan

L. Benham-Whyte