Artificial Intelligence in Reproductive Medicine

Koen Wouters

Universitair Ziekenhuis Brussel

Brussels IVF

VUB VRIJE UNIVERSITEIT BRUSSEL

I have no conflict of interest

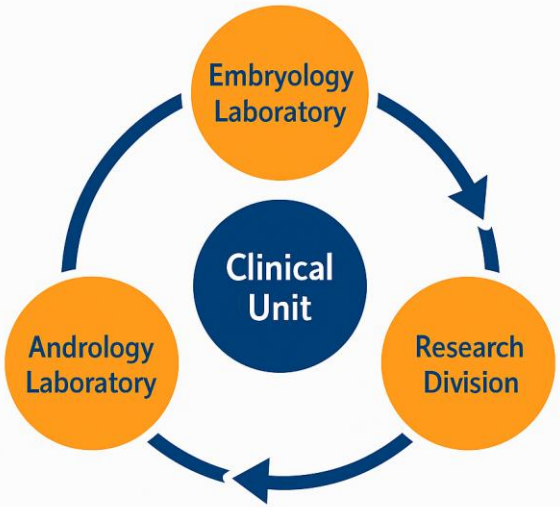
Brussels IVF

https://www.brusselsivf.be/

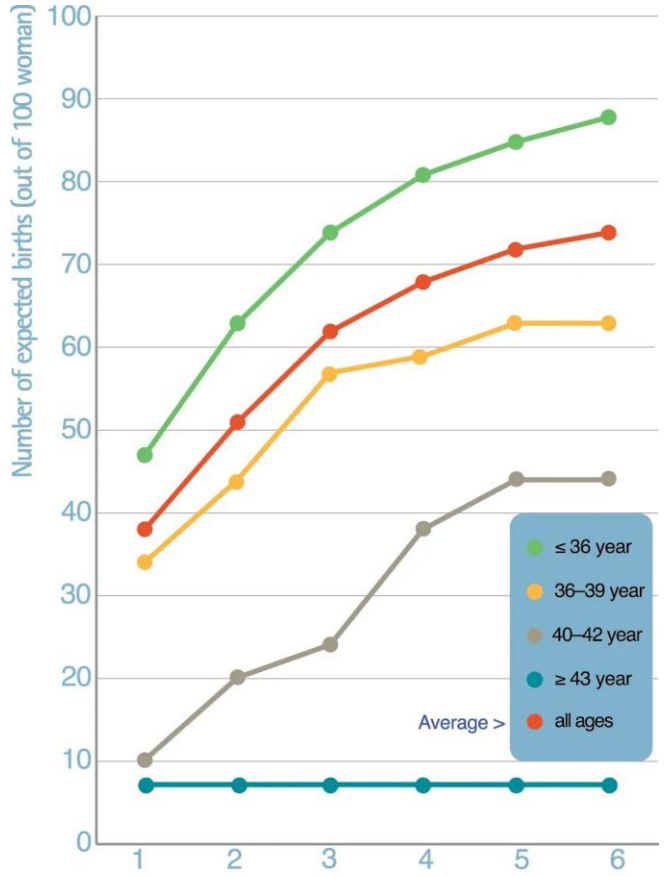
Brussels IVF

- Since 1983, over 50000 babies.
- Over 200 employees.
- ICSI birth place
- 33% of all ART cycles in Belgium.

Patients from over 70 countries

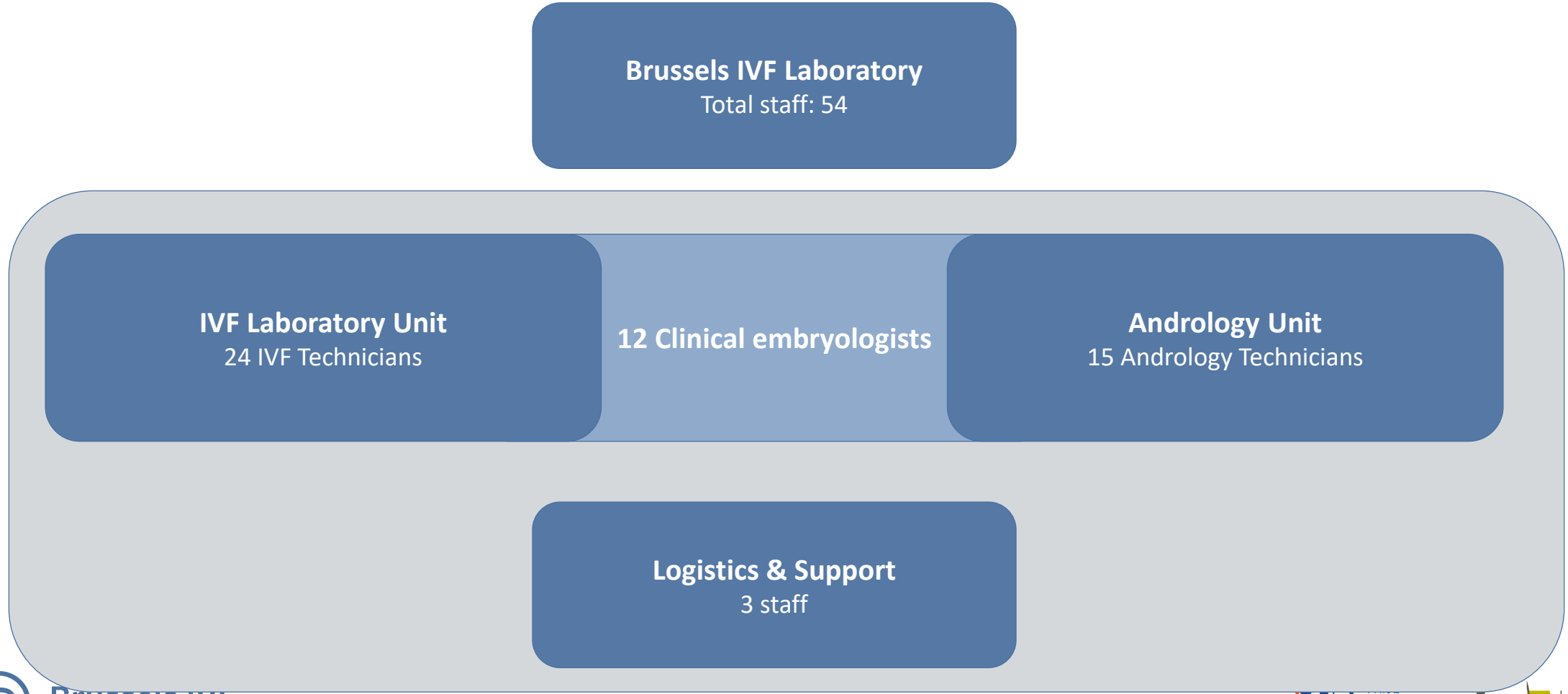


Organizational Structure

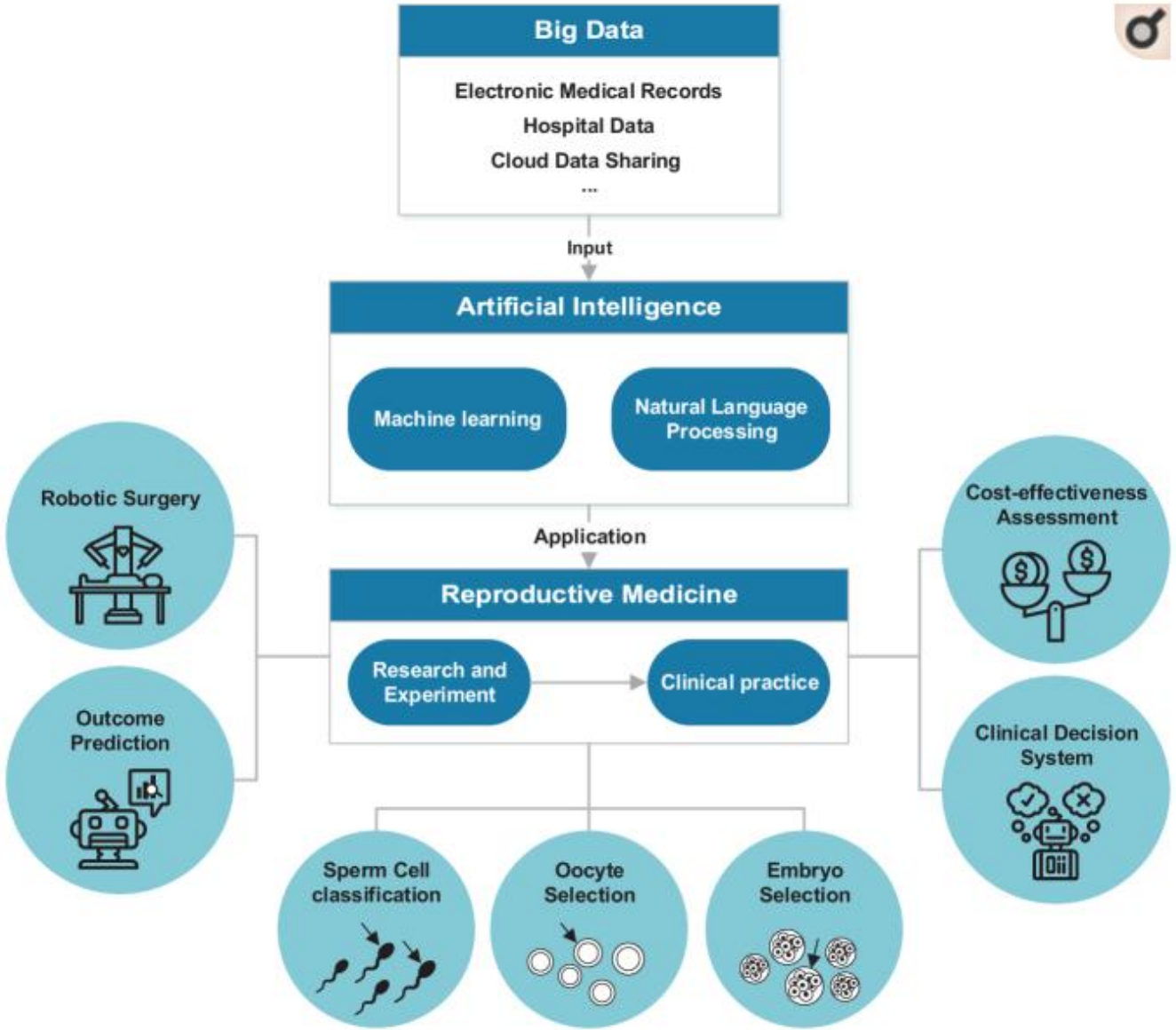


The lab

Andrology - Embryology



Artificial Intelligence IN IVF



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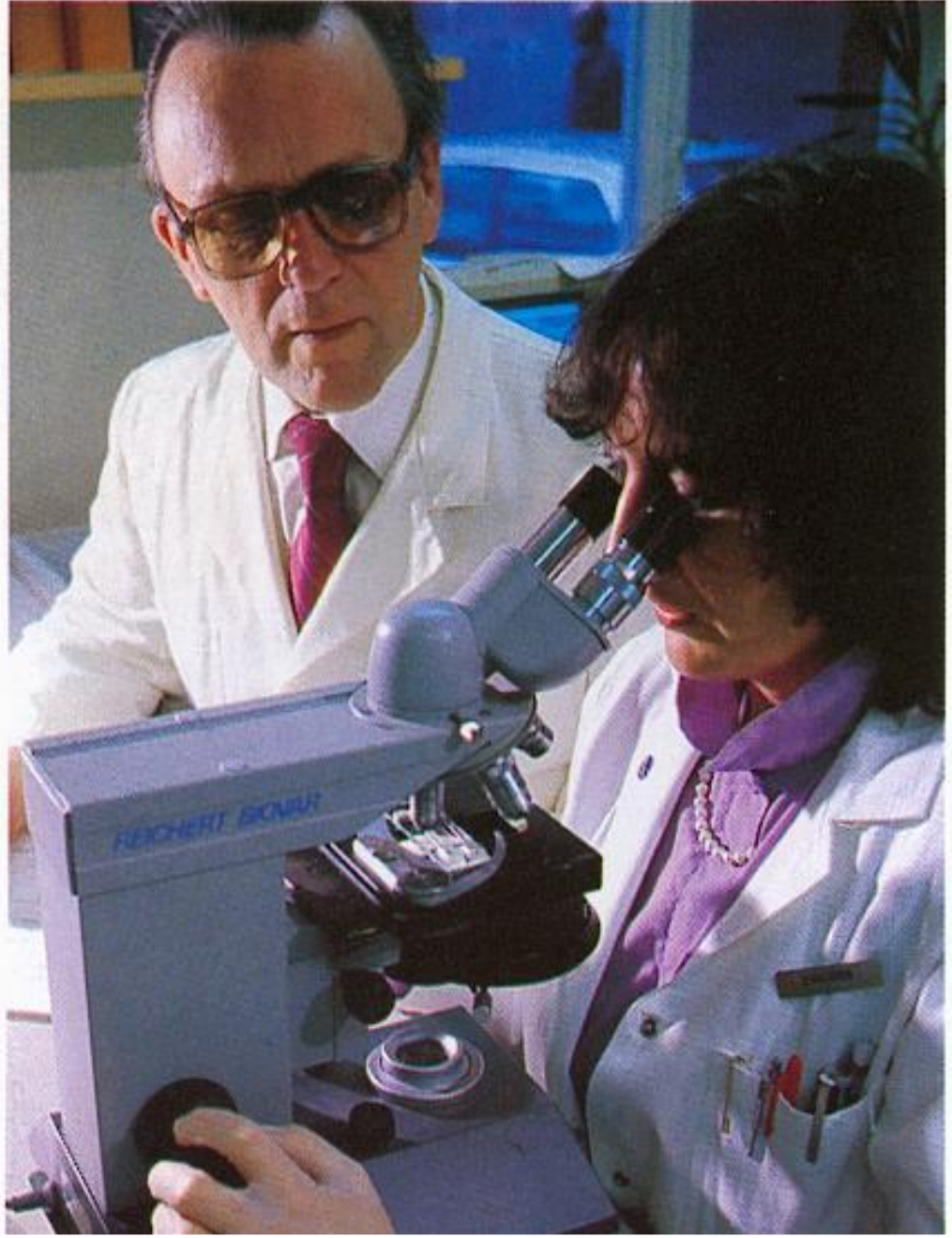
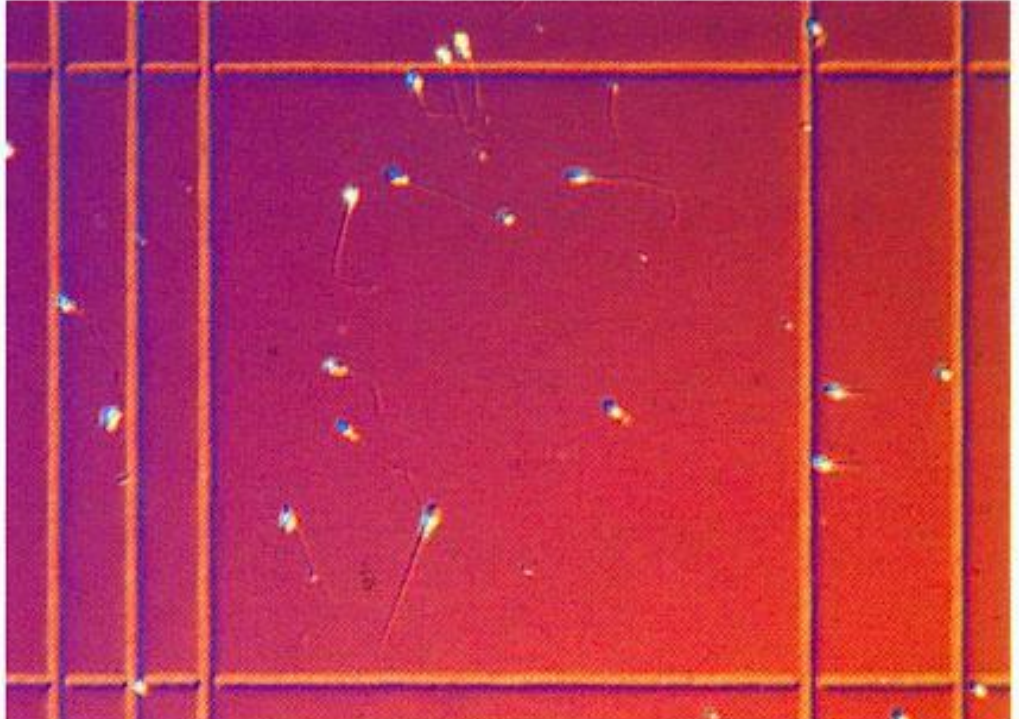
AI in IVF

Sperm





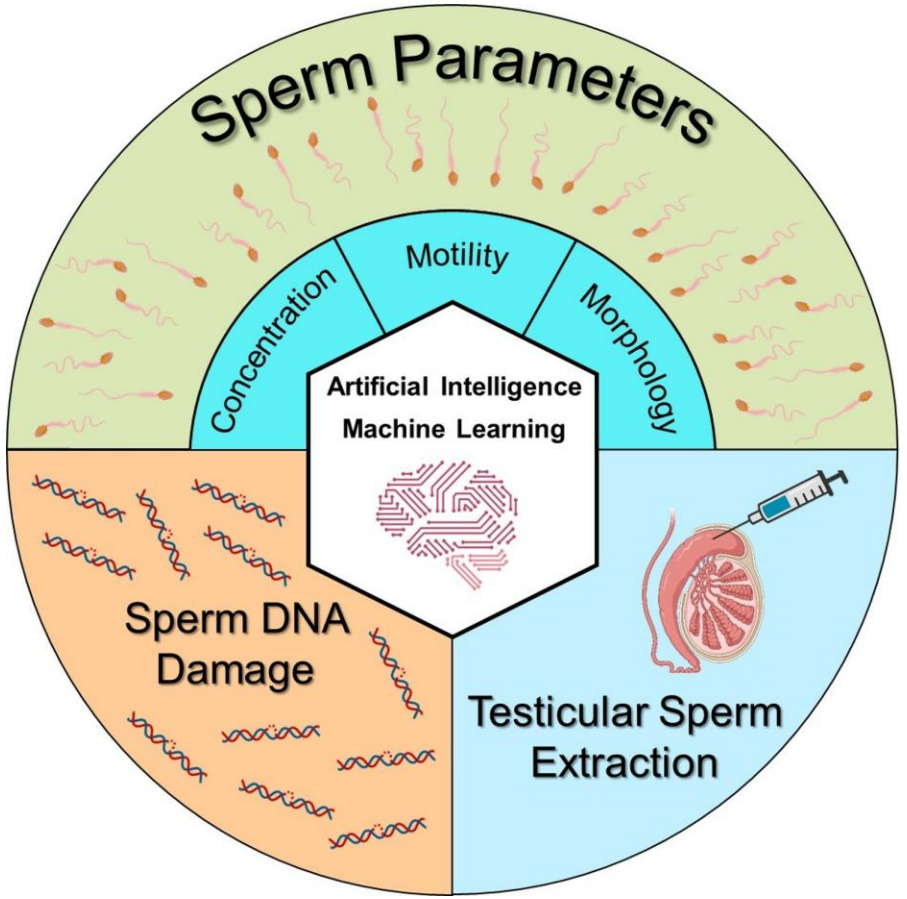
WHO laboratory manual for the **examination and processing of human semen**

Sixth Edition

AI in Sperm Selection

- Computer vision for morphological analysis

  Pattern recognition, predictive analytics
- Deep learning algorithms for motility prediction
- Automation of sperm grading and sorting



Panner Selvam et al, 2024

Mobile AI Applications for Sperm Analysis

Do it yourself

- **Rapid and Cost-Effective**
  - Modern kits are accurate and user-friendly.
  - Do not assess all semen parameters.
    sperm **concentration** and **motility.**
    Range from red (not ok) – orange – green (ok)

- **Privacy and Convenience**
  - Lowers the first step for men to go to a fertility clinic.

Review Article
Male reproductive health and infertility
pISSN: 2287-4208 / eISSN: 2287-4690
World J Mens Health 2021 Oct 39(4): 615-625
https://doi.org/10.5534/wjmh.200130
The World Journal of MEN's HEALTH

Clinical Update on Home Testing for Male Fertility

Daniel Gonzalez, Manish Narasimman, Jordan C. Best, Jesse Ory, Ranjith Ramasamy
Department of Urology, Miller School of Medicine, University of Miami, Miami, FL, USA

Fig. 4. Men's Loupe (Tenga Health Care) device and smartphone-based SEEM kit. (A) Men's Loupe 0.8 mm diameter ball lens microscope attached to smartphone. (B) Technique for loading semen sample into plastic jacket of ball lens microscope. (C) Magnifying lens semen analysis device with QR code sheet to download the application for operating. (D) Instructions of kit for use. (E) Screenshot of sample test results with concentration and motility.

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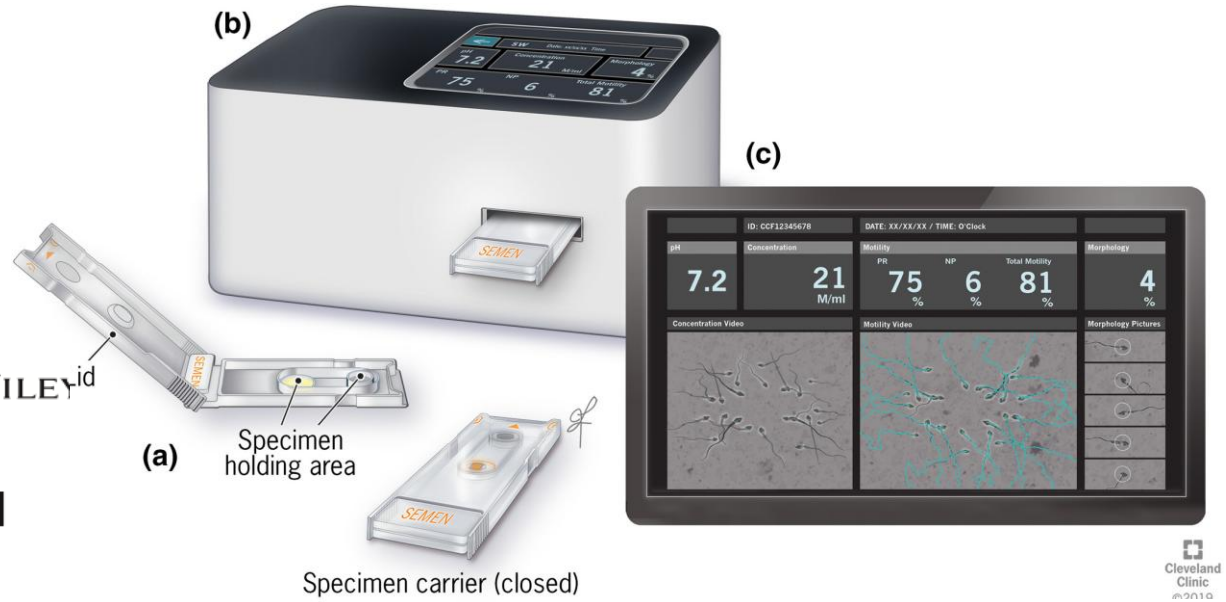

ORIGINAL ARTICLE

First International Journal of Andrology
ANDROLOGIA
WILEY

Automation of human semen analysis using a novel artificial intelligence optical microscopic technology

Ashok Agarwal[1] | Ralf Henkel[1,2] | Chun-Chia Huang[3] | Maw-Sheng Lee[3,4]

Andrologia. 2019;00:e13440.
https://doi.org/10.1111/and.13440

MES

SQA-Vision – Automated Semen Analyzer

FEATURES

Low Cost and Fast Turn Around
- Reduce sample testing time by 90%
- Deliver patient results immediately
- Cut your cost per test in half

Accuracy and Precision
- Accurate results regardless of expertise
- Exceptional repeatability
- Inter / Intra laboratory standardization

Stay Current with New Standards
- WHO 5th Edition testing criteria
- SQA specific CAP proficiency challenge
- FDA approved / CLIA moderately complex

Fast – Objective – Standardized

Day to Day Simplicity
- Disposable testing capillary
- Easy to learn and use
- From power ON to testing in minutes
- Solutions in place for the whole testing process
- Live phone support and e-mail/online assistance

Peace of Mind
- Objective Testing
- Video and picture confirmation
- Proven technology

75 seconds to analyse a sample

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SiD
SPERM SELECTION ASSISTANT
BY IVF 2.0 LIMITED

SiD can judge human spermatozoa in suspension effortlessly and more accurately than the human eye

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Advanced selection techniques

Sperm identification device SiD

Automatic SpermSearch

This AI tool can find sperm in infertile men 1,000 times faster than a human

RBMO

ELSEVIER

ARTICLE

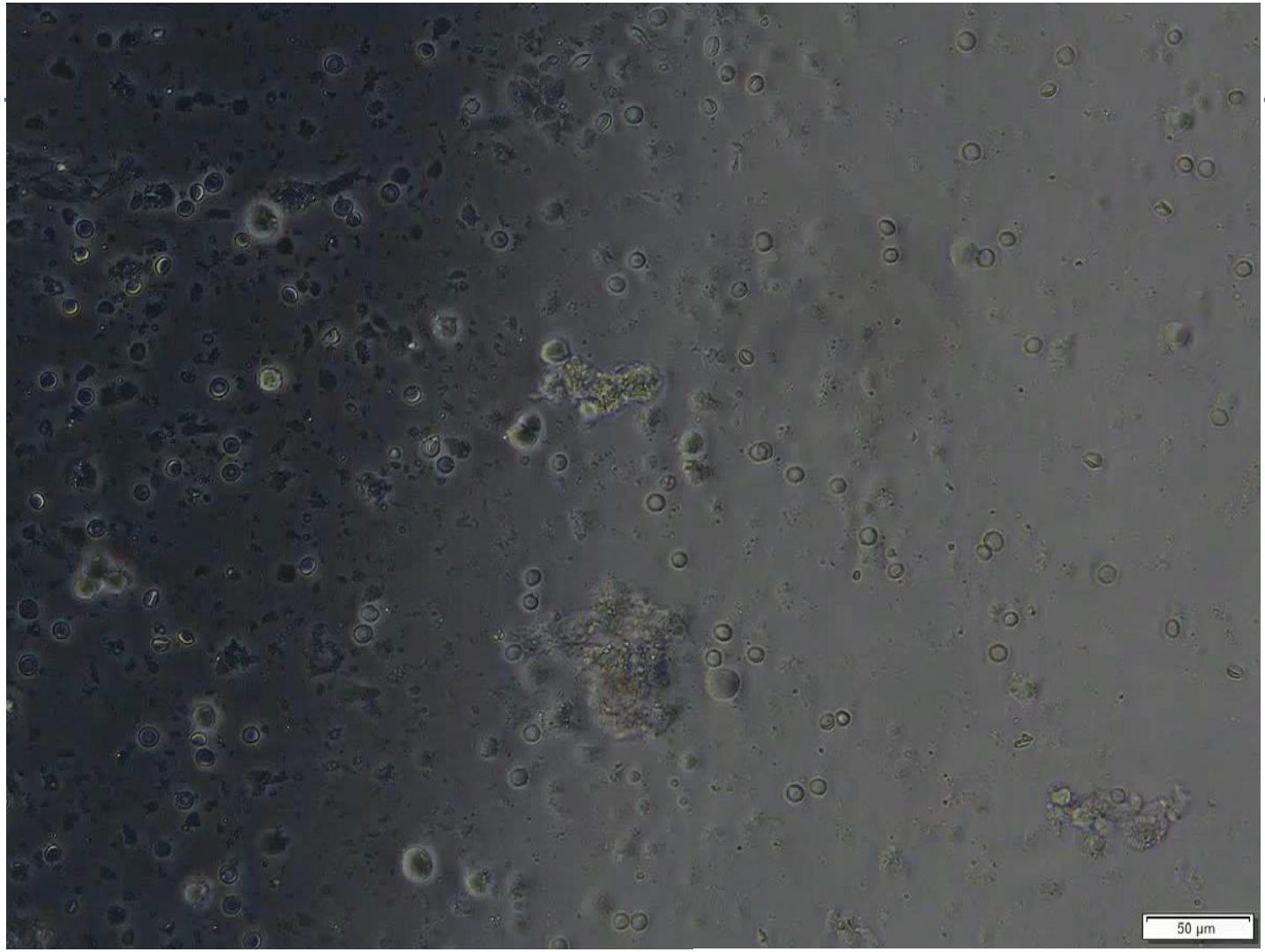
Evaluation of an artificial intelligence-facilitated sperm detection tool in azoospermic samples for use in ICSI

BIOGRAPHY

Dale Goss is a PhD student at the University of Technology Sydney and a graduate of Stellenbosch University and Monash University. He is a clinical embryologist at IVFAustralia and as a scientific advisor for NeoGenix Biosciences. His research focuses on human embryology, male infertility, and technology in assisted reproduction.

Dale M. Goss[1,2,3,†], Steven A. Vasilescu[1,2,†], Phillip A. Vasilescu[2], Simon Cooke[3], Shannon HK. Kim[3,4], Gavin P. Sacks[1,3,4], David K. Gardner[2,5], Majid E. Warkiani[1,2,6,*]

Automatic SpermSearch



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Evaluation of an artificial intelligence-facilitated sperm detection tool in azoospermic samples for use in ICSI

Author: Dale M. Goss,Steven A. Vasilescu,Phillip A. Vasilescu,Simon Cooke,Shannon HK. Kim,Gavin P. Sacks,David K. Gardner,Majid E. Warkiani
Publication: Reproductive BioMedicine Online
Publisher: Elsevier
Date: July 2024

Automatic SpermSearch

Proof of concept

RBMO

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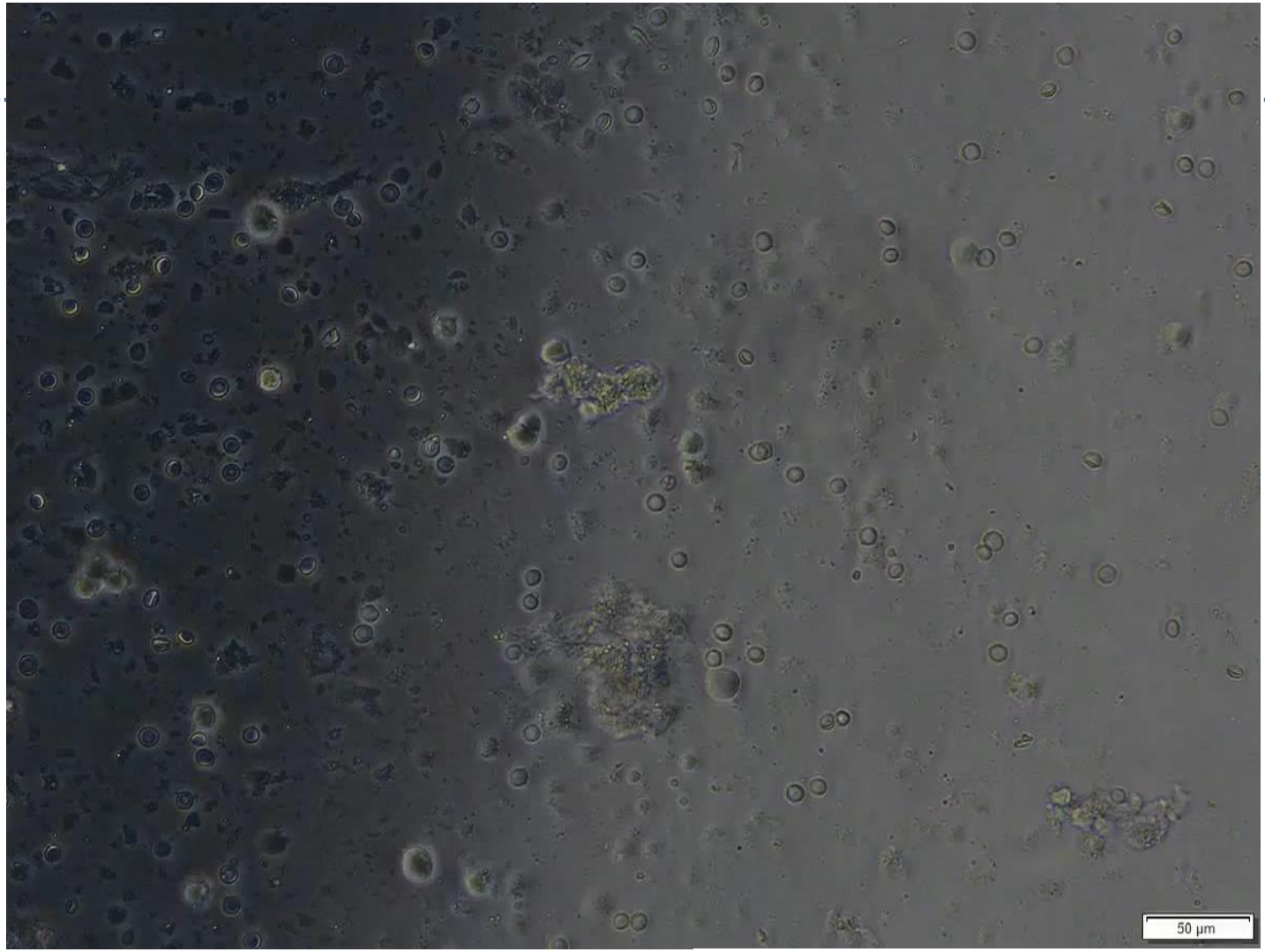
Automatic SpermSearch



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Publication: Reproductive BioMedicine Online
Publisher: Elsevier
Date: July 2024

AI in IVF

Oocytes

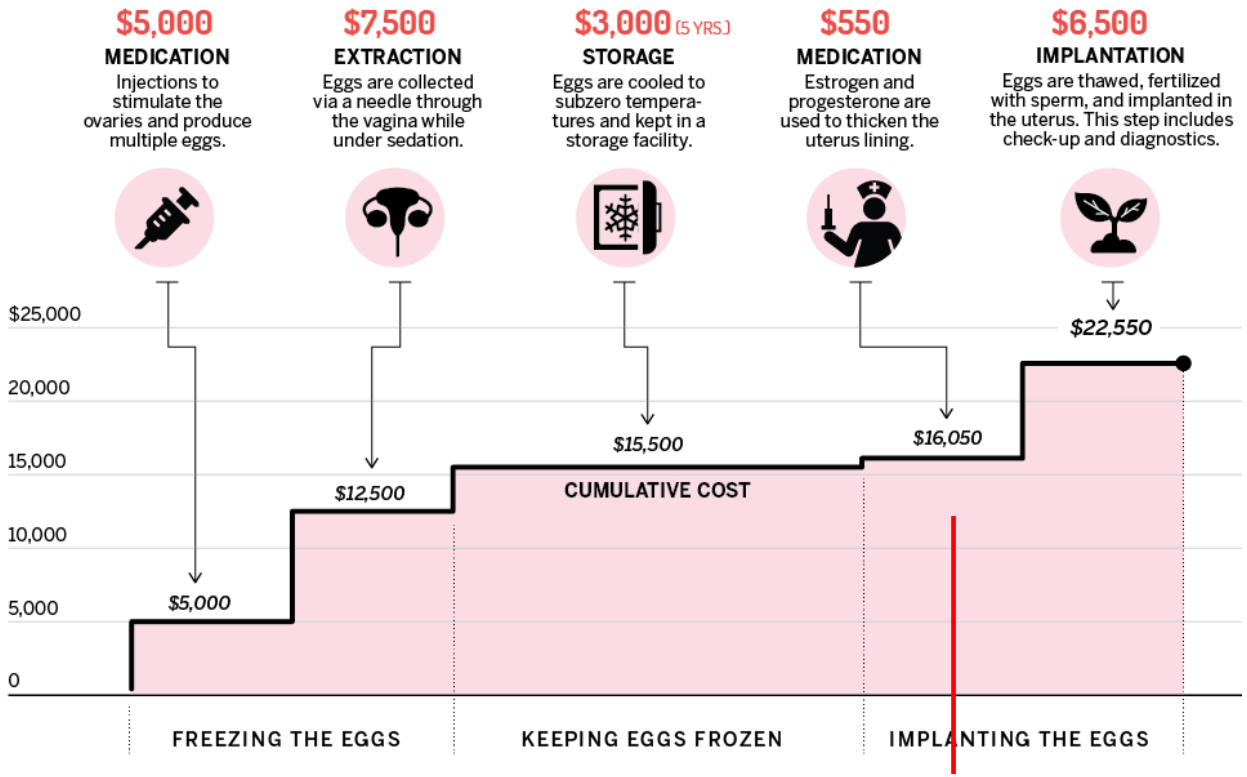
theguardian

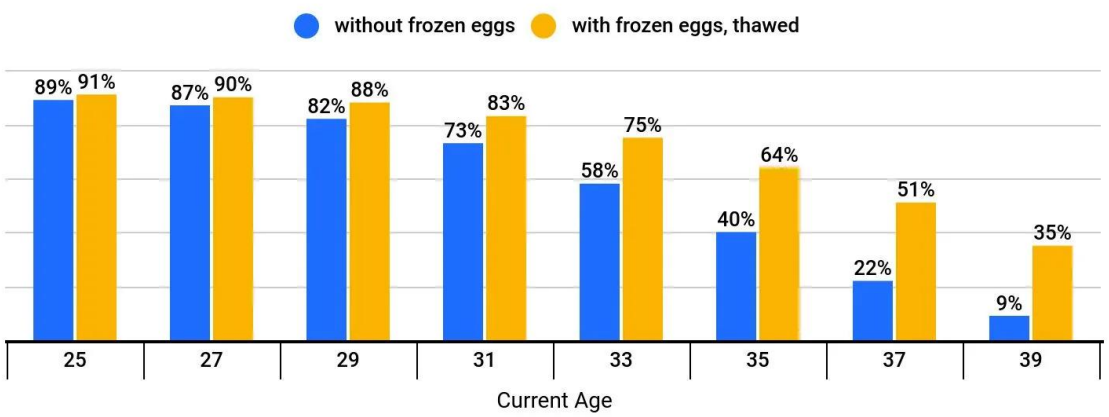
Apple and Facebook offer to freeze eggs for female employees

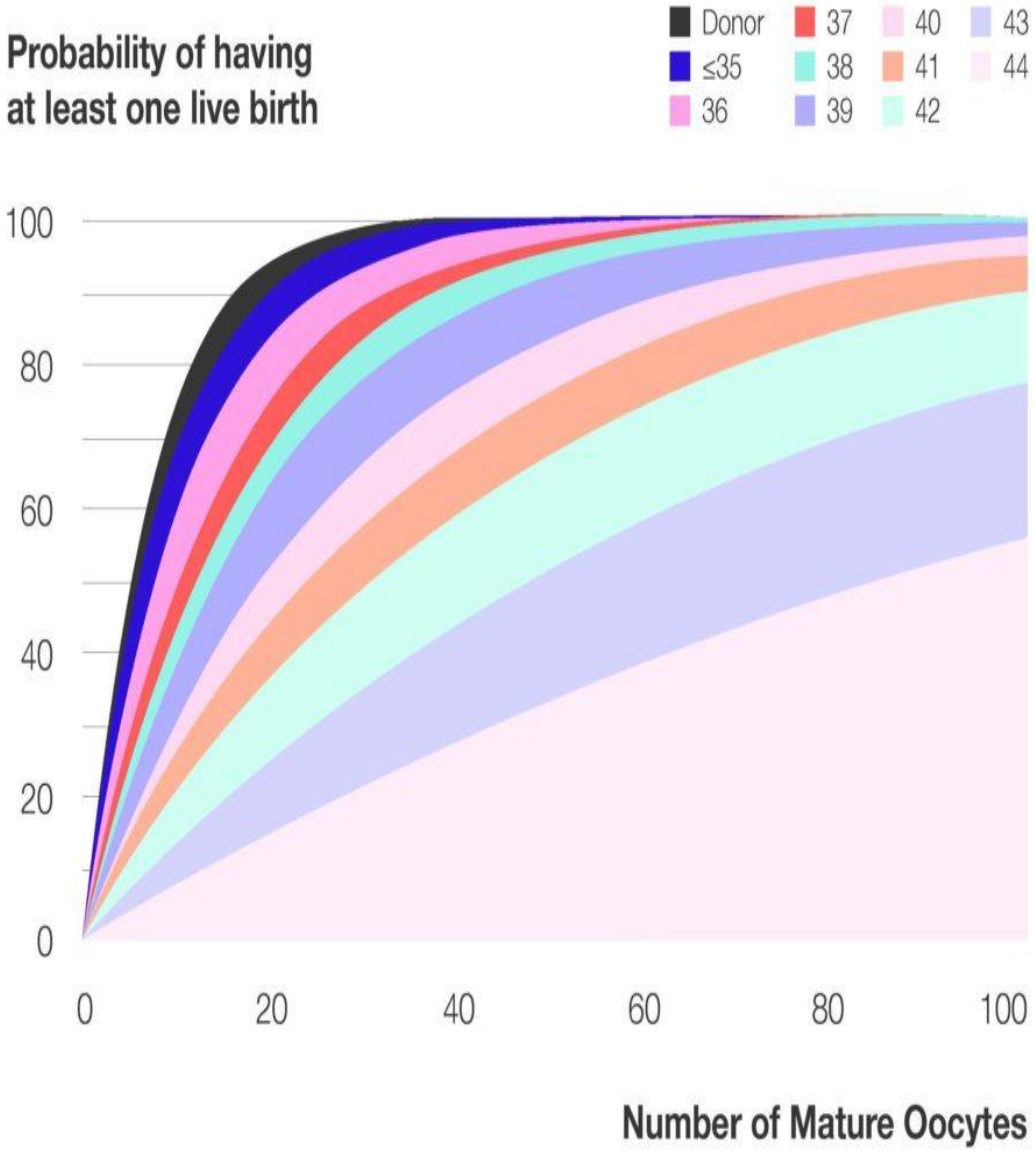
Facebook will pay up to $20,000 while Apple will provide perk from January in effort to attract more women

The New York Times

Pentagon to Offer Plan to Store Eggs and Sperm


$5,000
MEDICATION
Injections to stimulate the ovaries and produce multiple eggs.
$7,500
EXTRACTION
Eggs are collected via a needle through the vagina while under sedation.
$3,000 (5 YRS.)
STORAGE
Eggs are cooled to subzero tempera-tures and kept in a storage facility.
$550
MEDICATION
Estrogen and progesterone are used to thicken the uterus lining.
$6,500
IMPLANTATION
Eggs are thawed, fertilized with sperm, and implanted in the uterus. This step includes check-up and diagnostics.
$25,000
20,000
15,000
10,000
5,000
0
$5,000
$12,500
$15,500
$16,050
$22,550
CUMULATIVE COST
FREEZING THE EGGS
KEEPING EGGS FROZEN
IMPLANTING THE EGGS

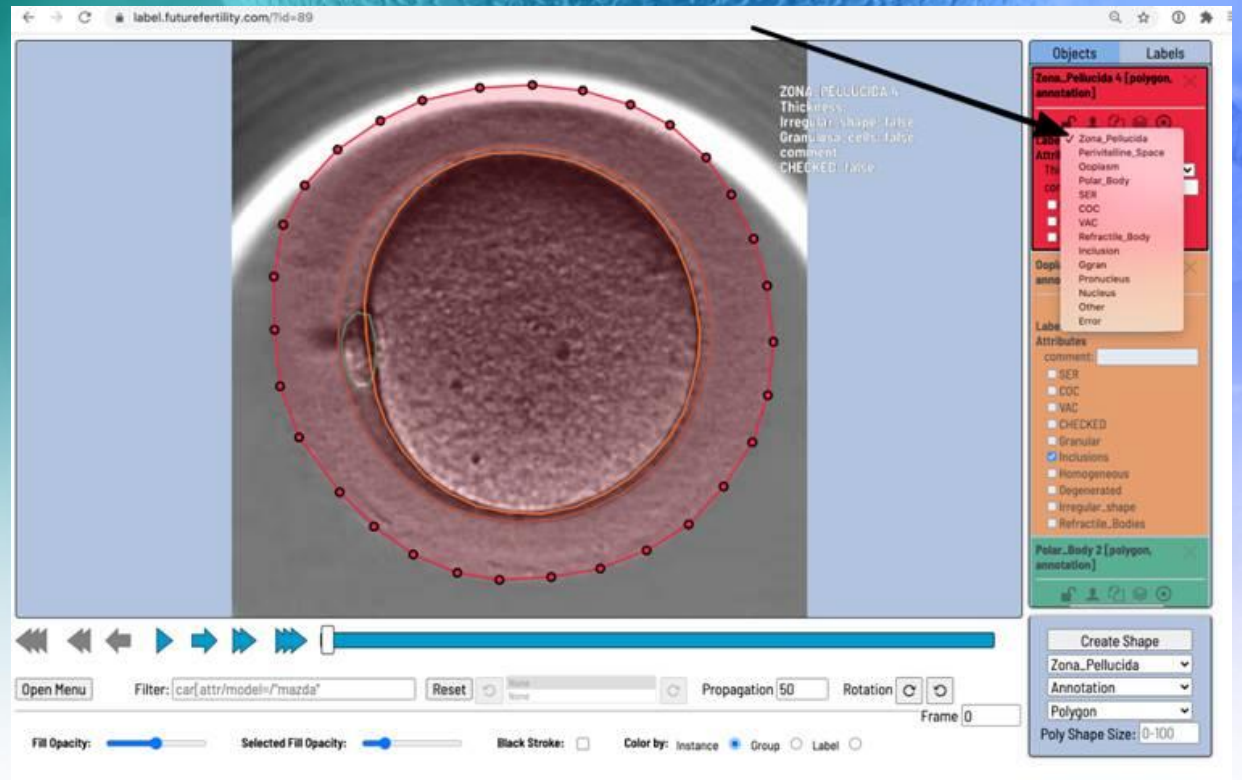

Chances of Having a Baby 7 Years Later
without frozen eggs
with frozen eggs, thawed
89% 91%
87% 90%
82% 88%
73% 83%
58% 75%
40% 64%
22% 51%
9% 35%
25
27
29
31
33
35
37
39
Current Age


Probability of having at least one live birth
Donor
≤35
36
37
38
39
40
41
42
43
44
100
80
60
40
20
0
0
20
40
60
80
100
Number of Mature Oocytes

Future Fertility

Products | What We Do | For Clinicians | For Patients | About Us | Request Info | News | Press

Artificial Intelligence
for Reproductive Medicine



Maria Doe's Report

OOCYTES

You have **10** mature oocytes frozen

BLASTOCYSTS

Based on VIOLET assessment of your 10 oocytes your chances of developing blastocysts are:

Number of Blastocysts	1-3	**4-7**	8-10
Probability	2.4%	**54.0%**	12.9%

Narrow Prediction: 4-5 Blastocysts With Probability of 54.0%.
At Least 1 Blastocyst: Probability of 99%

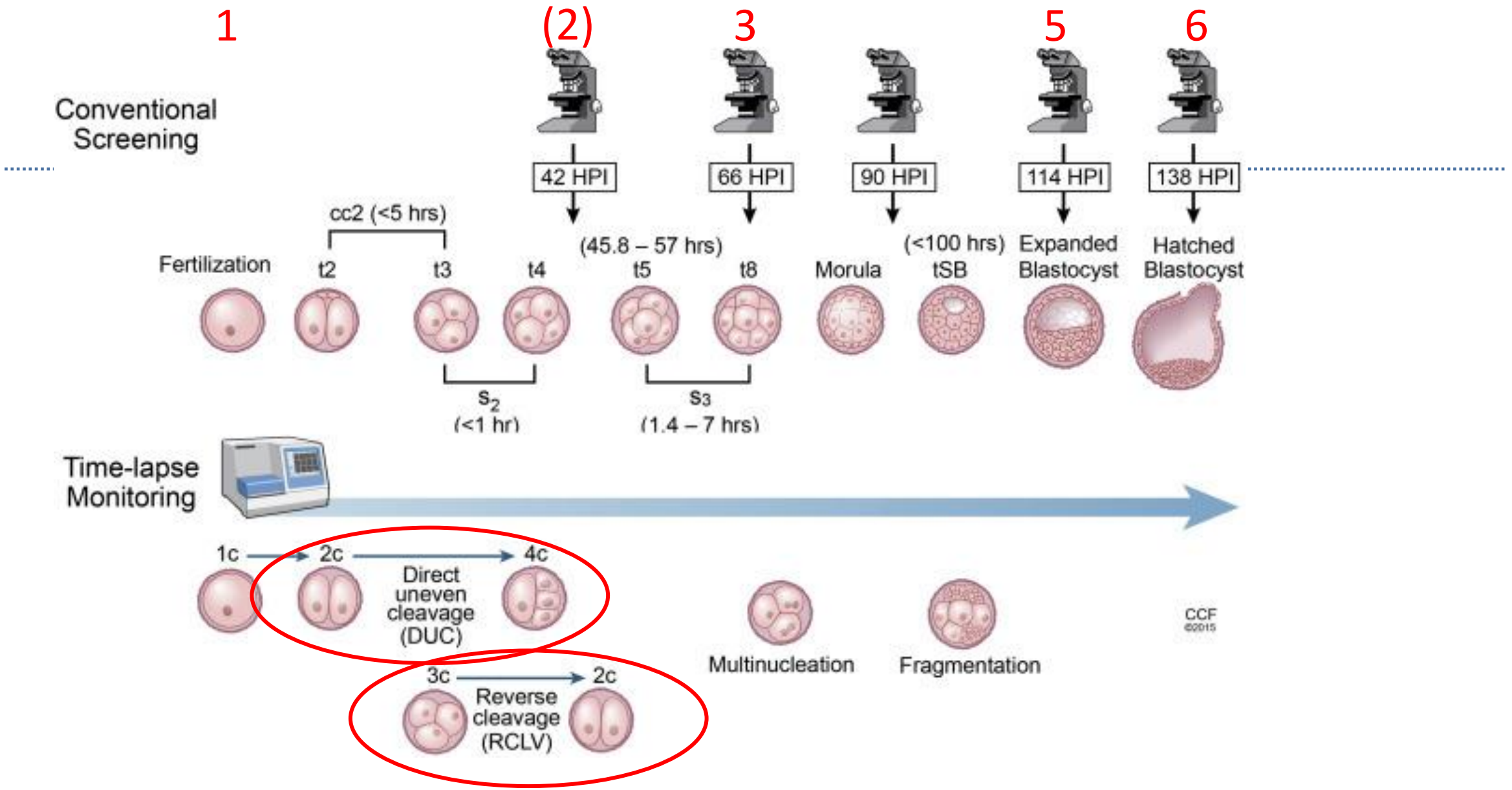
LIVE BIRTH

Based on VIOLET assessment and Statistical Modeling your chance of achieving a live birth from your 10 oocytes is:

At least one live birth - **42.3%**

AI in IVF

Embryos



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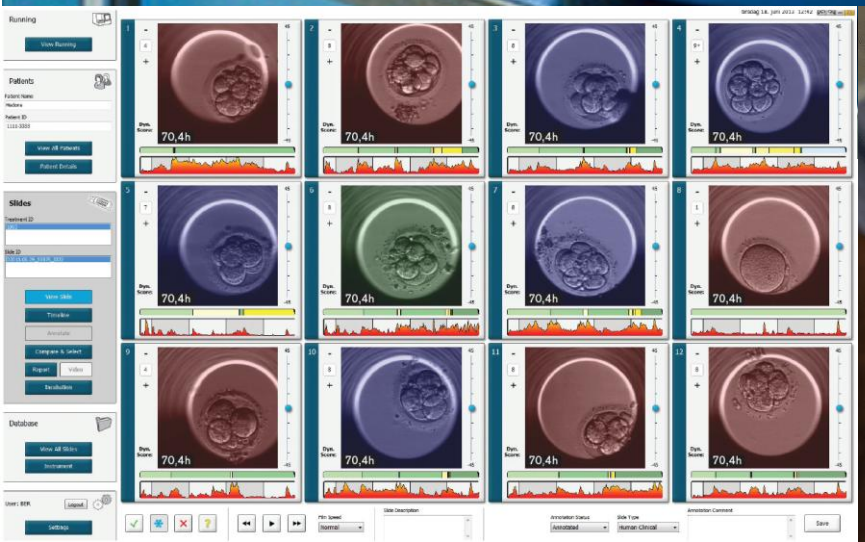
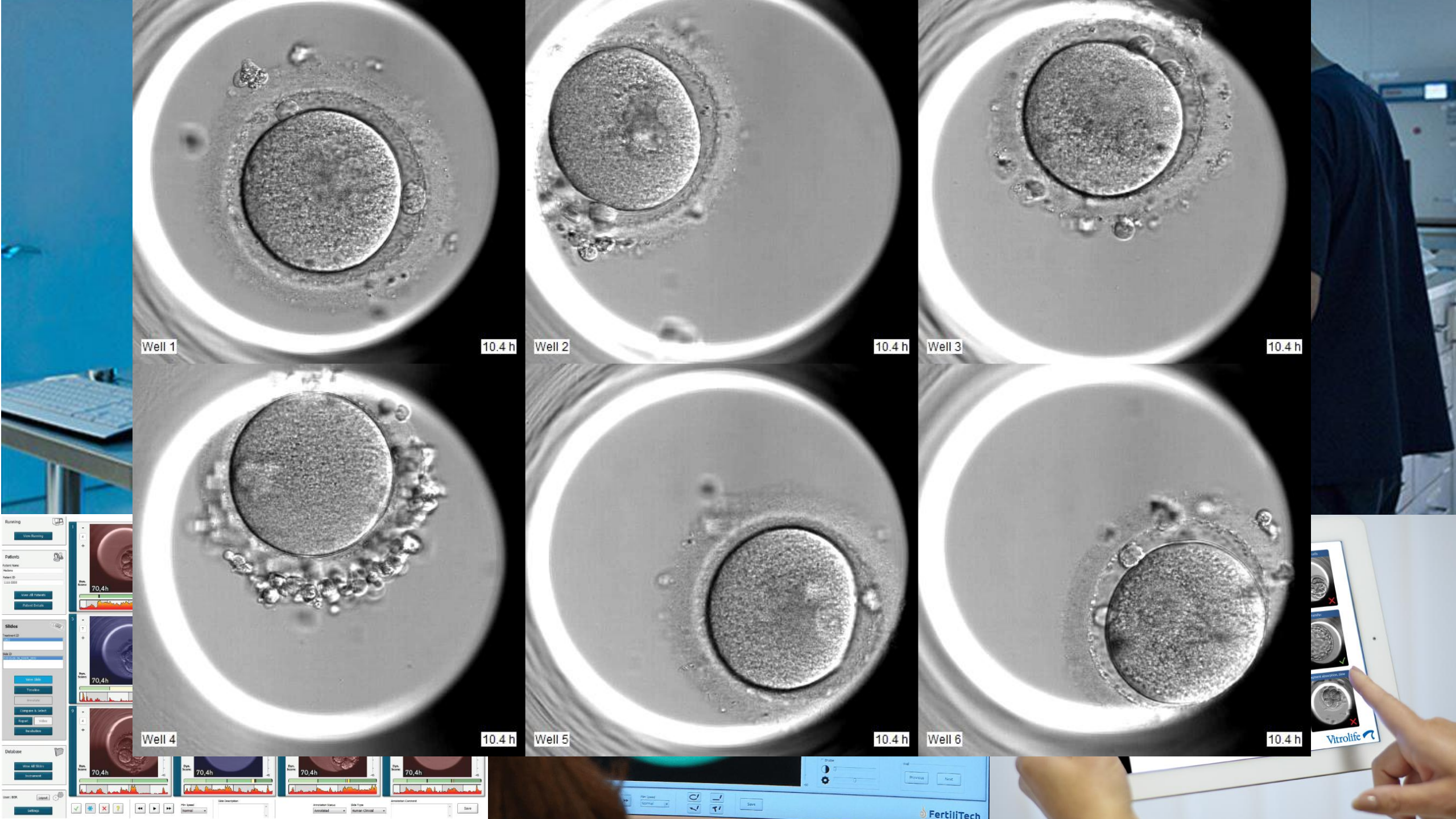
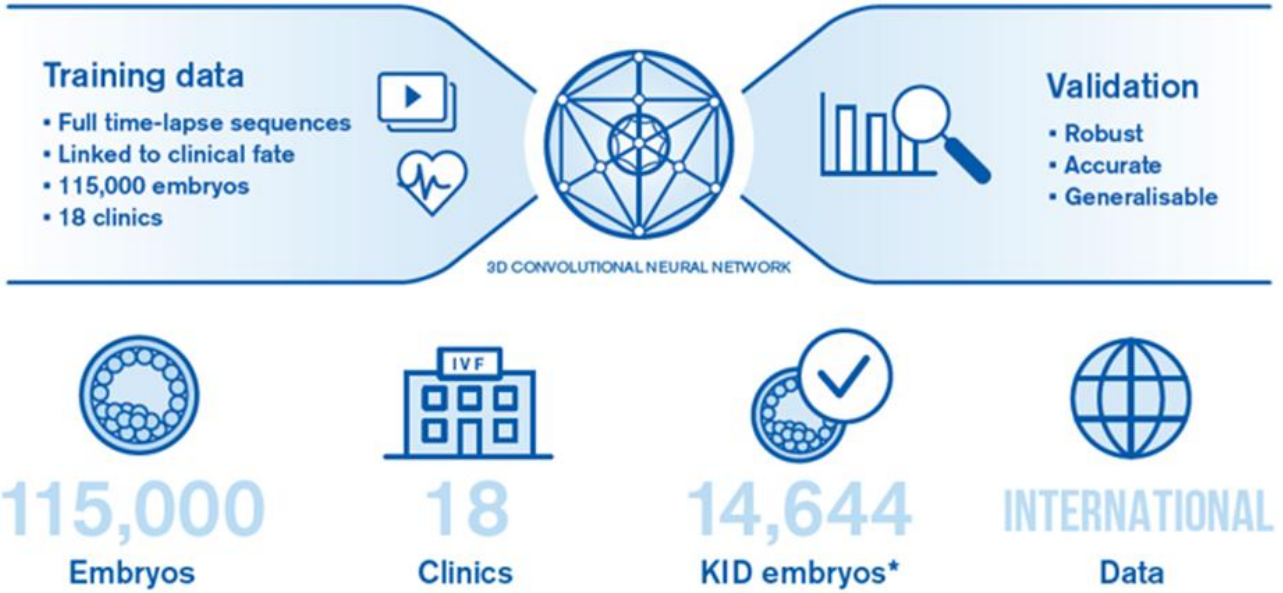

Running
View Running
Patients
View All Patients
Patient Details
Slides
View Slide
Timeline
Annotate
Compare & Select
Repeat
Video
Incubation
Database
View All Slides
Instrument
Settings
70,4h


FertiliTech


Vitrolife


Well 1
10.4 h
Well 2
10.4 h
Well 3
10.4 h
Well 4
10.4 h
Well 5
10.4 h
Well 6
10.4 h
70,4h
Vitrolife
FertiliTech

iDAScore



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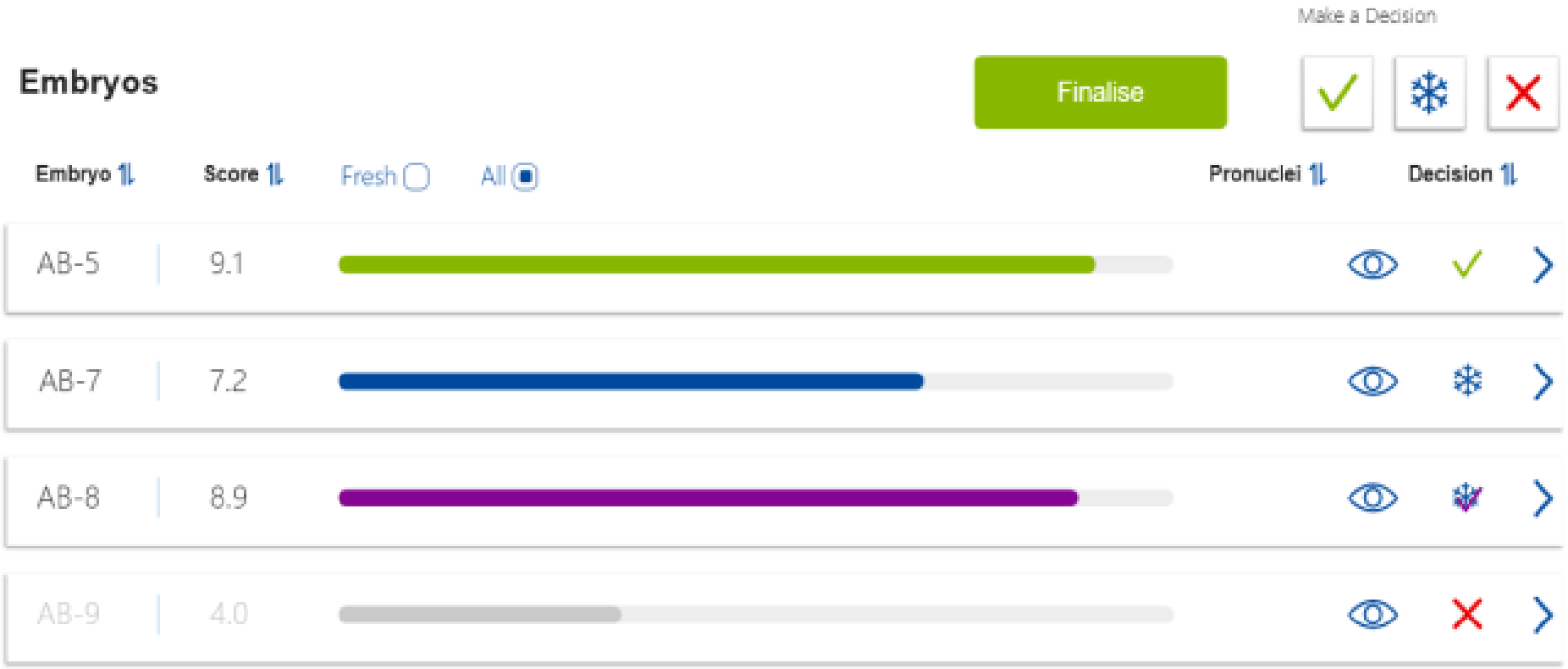
iDAScore



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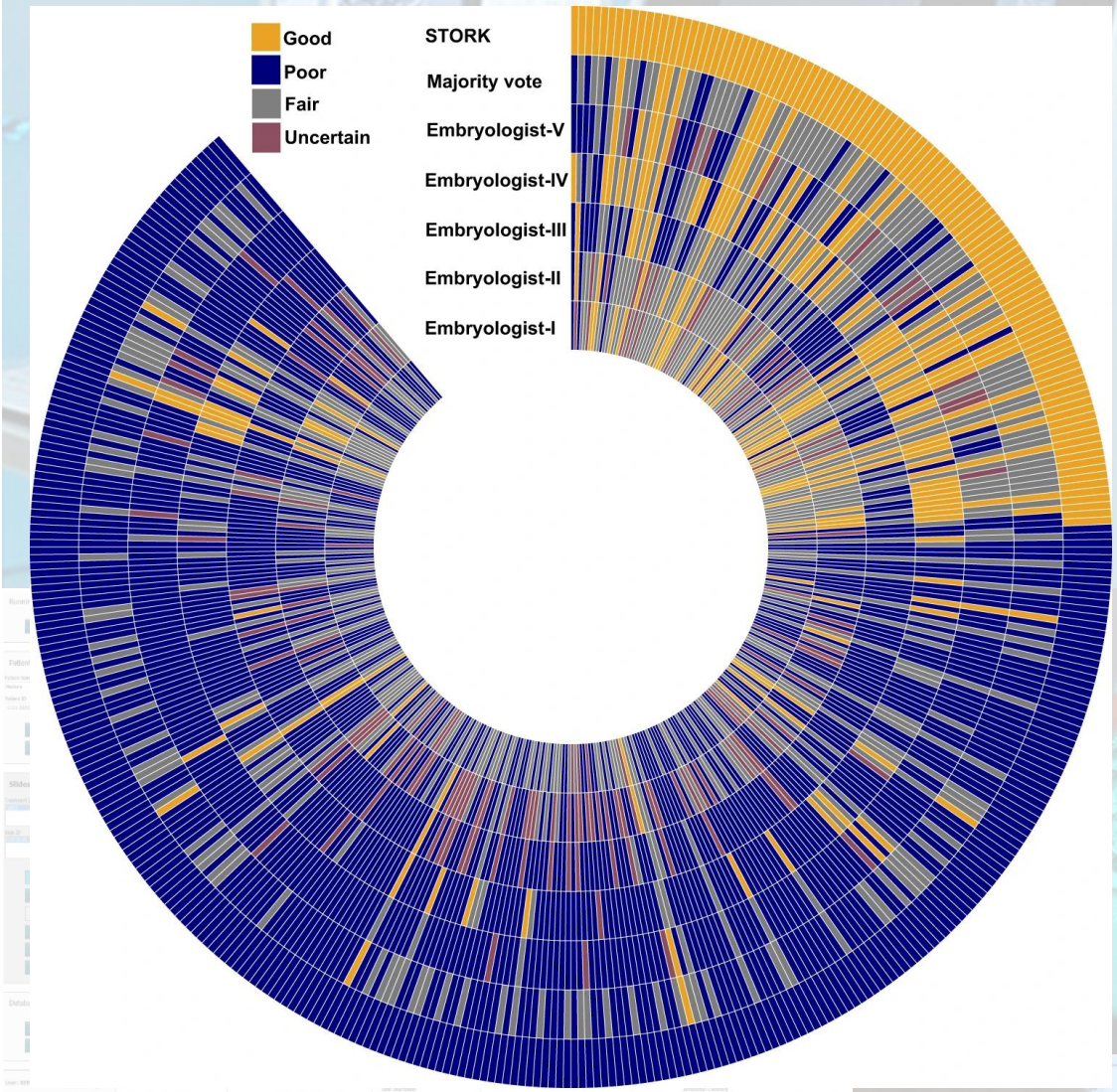

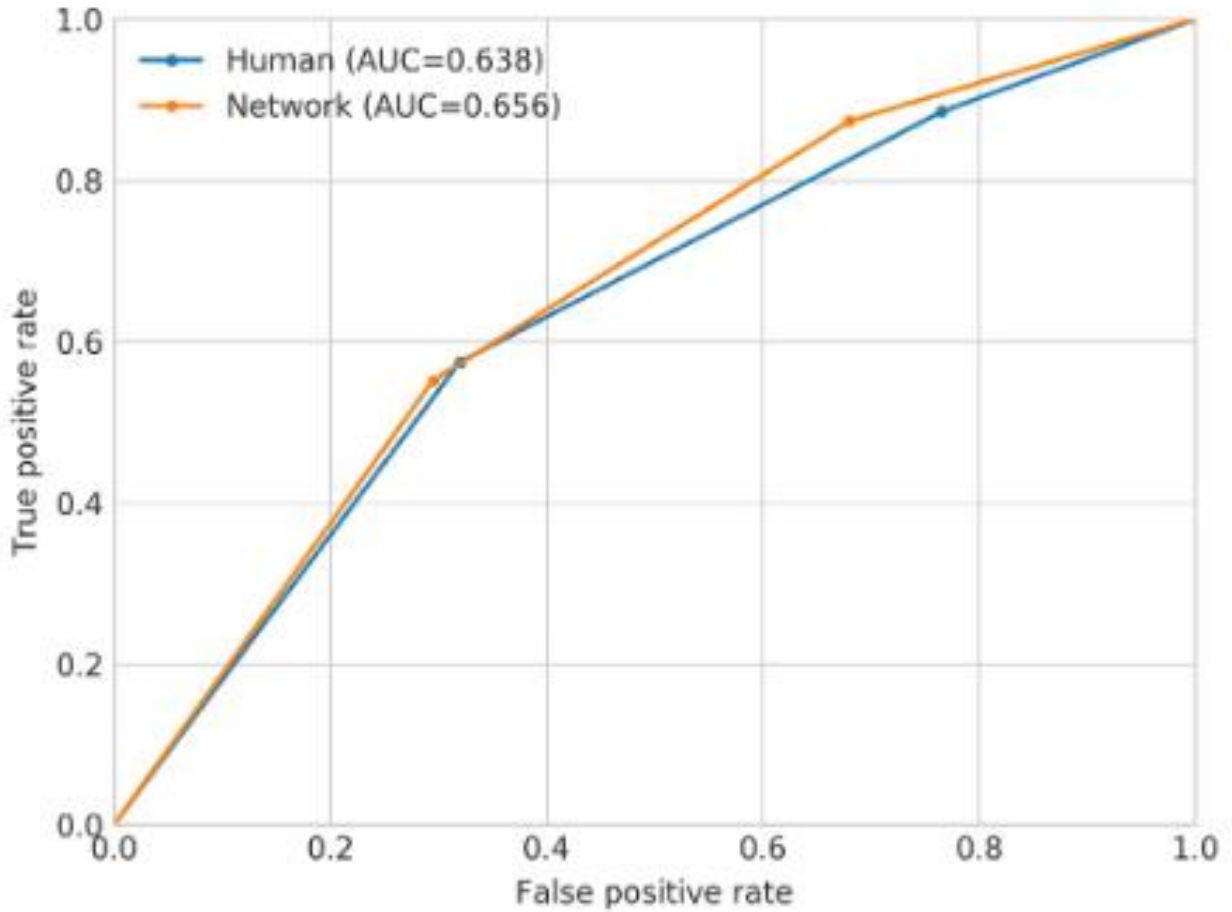

Fig. 5. ROC curves for human embryologists and the network.

Fairtility Chloe

CHLOE™ is an AI-based decision support tool.

Fairtility

33% ↓

Less time on mundane adminstrative work[1]

50% ↑

Increase in embryologist annual capacity[1]

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Fairtility Chloe

IVF LONDON
Care · Innovation · Excellence

Transparency to the patient: improving patient experience, engagement and understanding by granting them access to view their embryo culture videos.

Bhatia, C.[1]; Doshi, A.[1]; Sharma, S.[1]; Zepeda, A.[2]; Brualla, A.[2]; Hickman, C.[2]
[1]IVF London, UK. [2]Fairtility, Israel

Objective

To assess the impact of access to embryo videos on patients' IVF experience

Results

All patients replied that having access to a live video of their embryos developing in real-time would have a positive impact in the understanding of their IVF treatment.

95% of respondents replied it would have a positive impact in their IVF experience.

80% prefer to have access to "all of the embryos, whether progressing as expected or not".

75% replied this experience would influence their decision to come back to the same clinic for another cycle.

75% would like to be informed if embryo development abnormalities are identified.

74% answered they would feel "Calmer and more relaxed".

22x times patients accessed their embryo videos since March 2023.

95% rated "highly" the value of having access to live embryo images during their IVF treatment alongside verbal communication with their embryologist.

85% replied they would like real-time access to their embryo videos with the remaining preferring after embryo culture.

→ **21%** would feel "stressed and anxious" and the remaining 5% no effect at all

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AI to predict aneuploidy and mosaicism

AJOG Glob Rep. 2022 Nov; 2(4): 100103.
Published online 2022 Sep 19. doi: 10.1016/j.xagr.2022.100103
PMCID: PMC9574883
PMID: 36275401

Application of machine learning to predict aneuploidy and mosaicism in embryos from in vitro fertilization cycles

José A. Ortiz, PhD,[1,*] Ruth Morales, PhD,[1] Belén Lledó, PhD,[1] Juan A. Vicente, PhD,[2] Julio González, PhD,[3] Eva M. García-Hernández, PhD,[1] Alba Cascales, MSc,[1] Jorge Ten, PhD,[4] Andrea Bernabeu, PhD, MD,[5] and Rafael Bernabeu, PhD, MD[5]

nature › scientific reports › articles › article

Article | Open access | Published: 09 February 2023

Development of an artificial intelligence based model for predicting the euploidy of blastocysts in PGT-A treatments

Zhenya Yuan, Mu Yuan, Xuemei Song, Xiaojie Huang & Weiqiao Yan

Scientific Reports **13**, Article number: 2322 (2023) | Cite this article

1610 Accesses | **5** Citations | Metrics

ELSEVIER

Fertility and Sterility
Volume 117, Issue 4, April 2022, Pages 738-746

Original article

Machine learning for prediction of euploidy in human embryos: in search of the best-performing model and predictive features

Stefanie De Gheselle M.Sc. [a], Céline Jacques Ph.D. [b], Jérôme Chambost M.Sc. [b], Celine Blank Ph.D., M.D. [c], Klaas Declerck B.Sc. [a], Ilse De Croo M.Sc. [a], Cristina Hickman Ph.D. [b], Kelly Tilleman Ph.D. [a]

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AI in IVF

Other relevant examples

ICSIA

[Intracytoplasmic sperm injection ICSI | Automated ICSI | ICSI technology | IVF (youtube.com)]

Optimizing the artificial ovulation (OPU planning)

Small centres like to avoid weekends – Big centres like to spread…

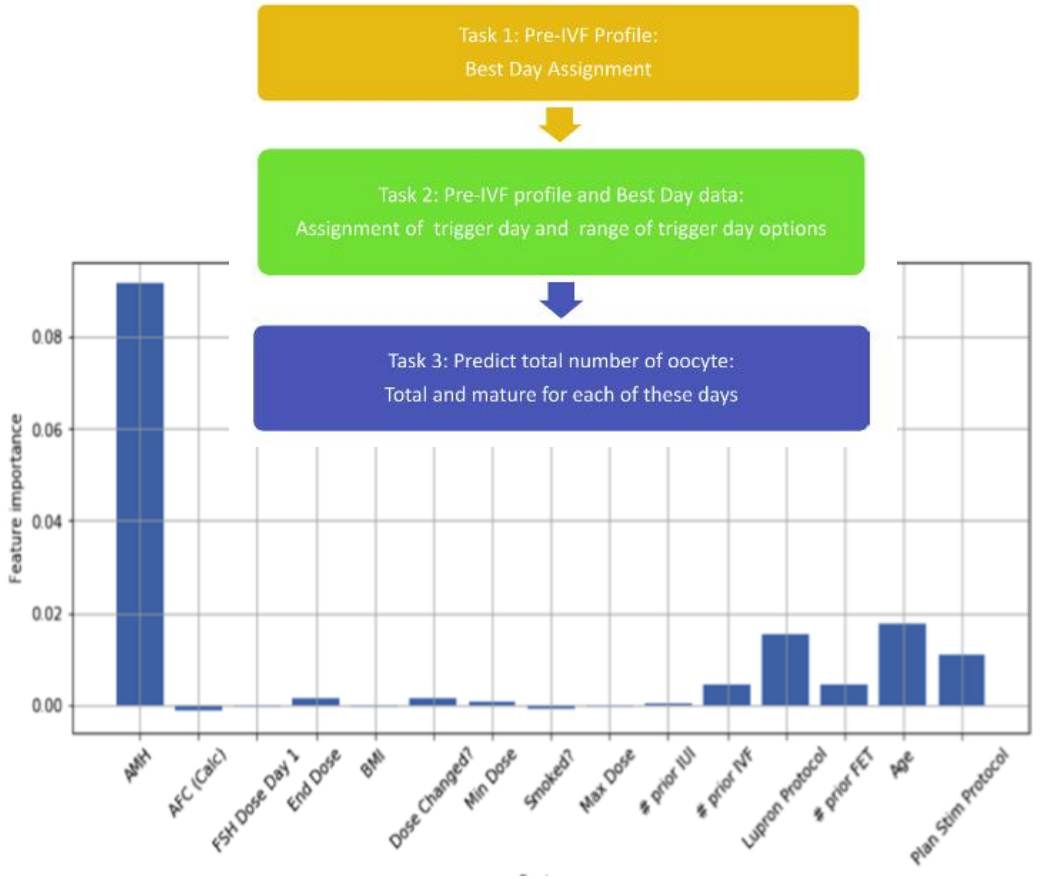
An artificial intelligence platform to optimize workflow during ovarian stimulation and IVF: process improvement and outcome-based predictions

BIOGRAPHY

Gerard Letterie is a board-certified Reproductive Endocrinologist, a partner in Seattle Reproductive Medicine, Seattle WA and co-founder of Quick Step Analytics LLC.
He completed a Residency in Obstetrics and Gynecology at Walter Reed Hospital in Washington DC and a fellowship in REI at the National Institutes of Health, Bethesda, MD, USA.

Gerard Letterie[1,*], Andrew MacDonald[2], Zhan Shi[3]

RBMO VOLUME 44 ISSUE 2 2022



ALIFE

INPUTS

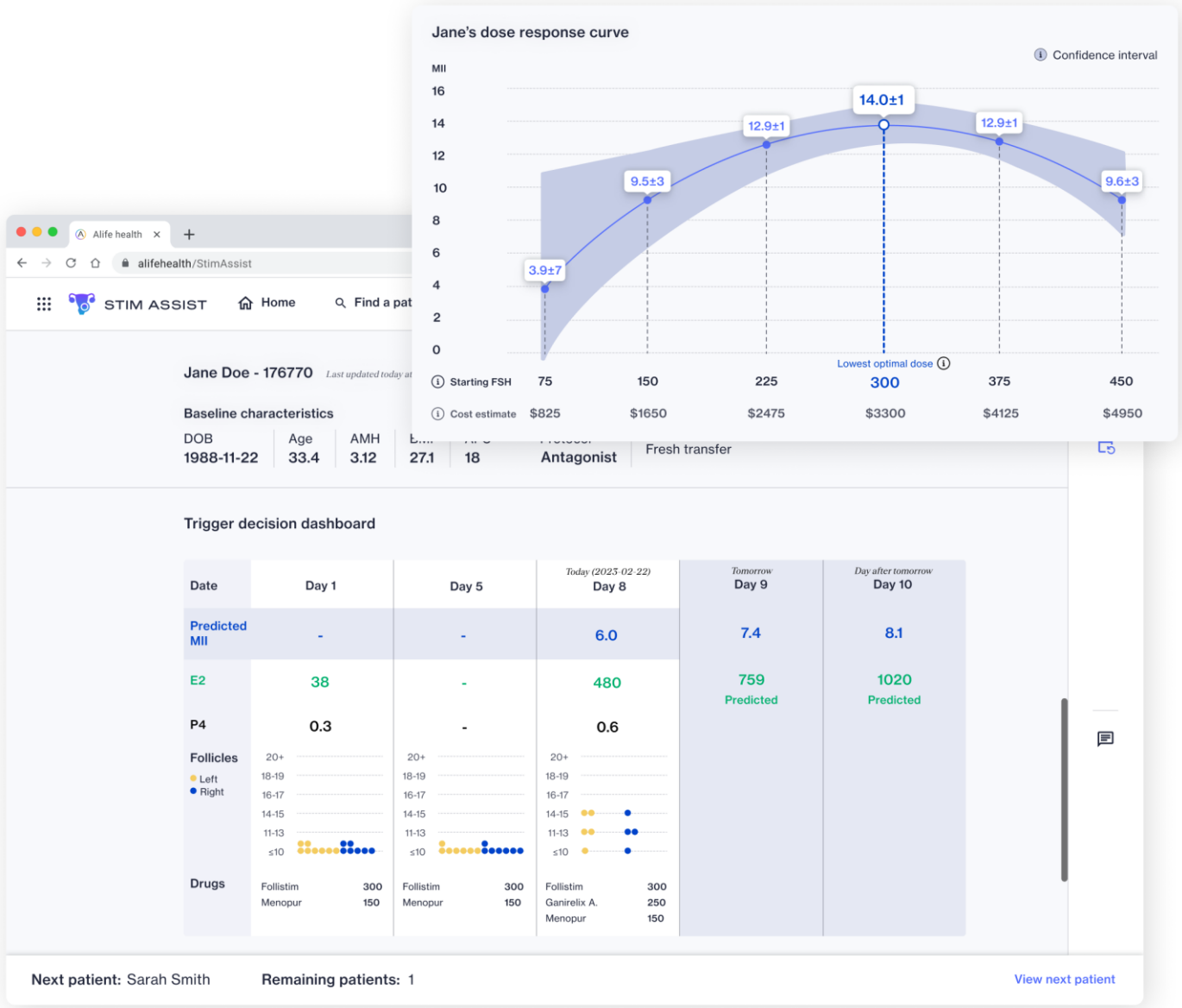
Age | BMI | AMH | AFC

↓

Alife interpretable machine learning algorithms

↓

MII predictions for starting dose of FSH



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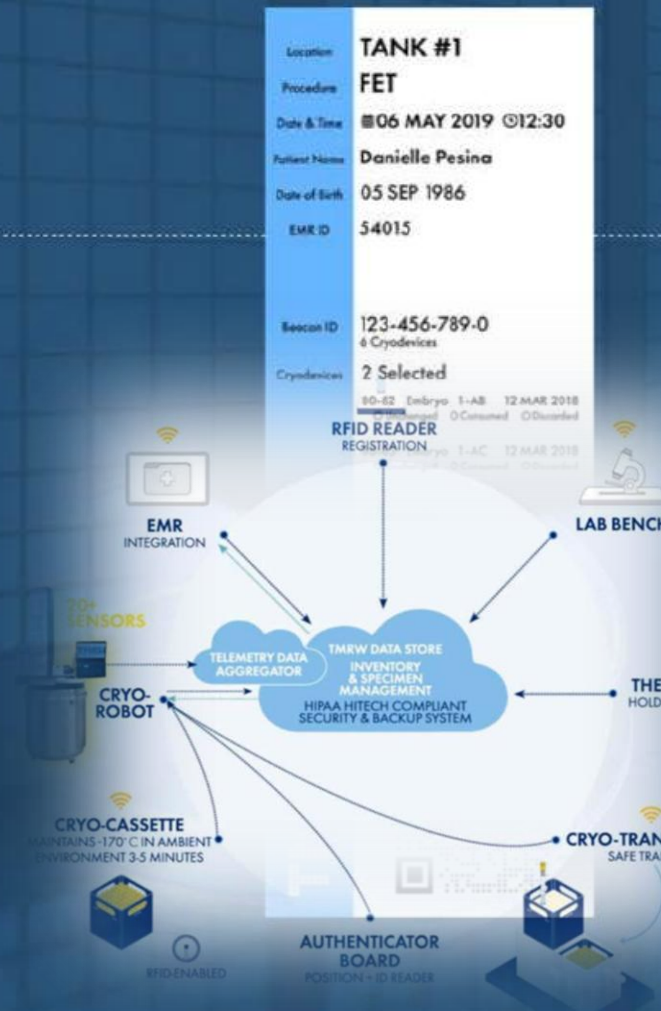
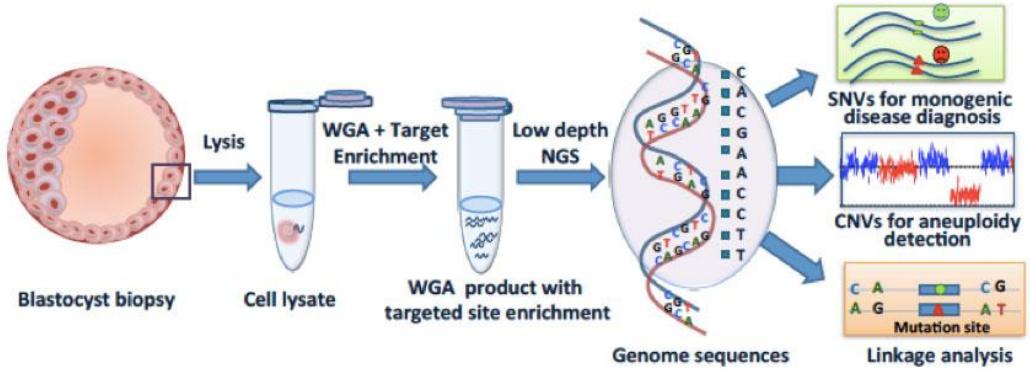
< Previous Article | September 2019 Volume 112, Issue 3, Supplement, Page e116 | Next Article >

Initial validation of an automated cryostorage and inventory management system

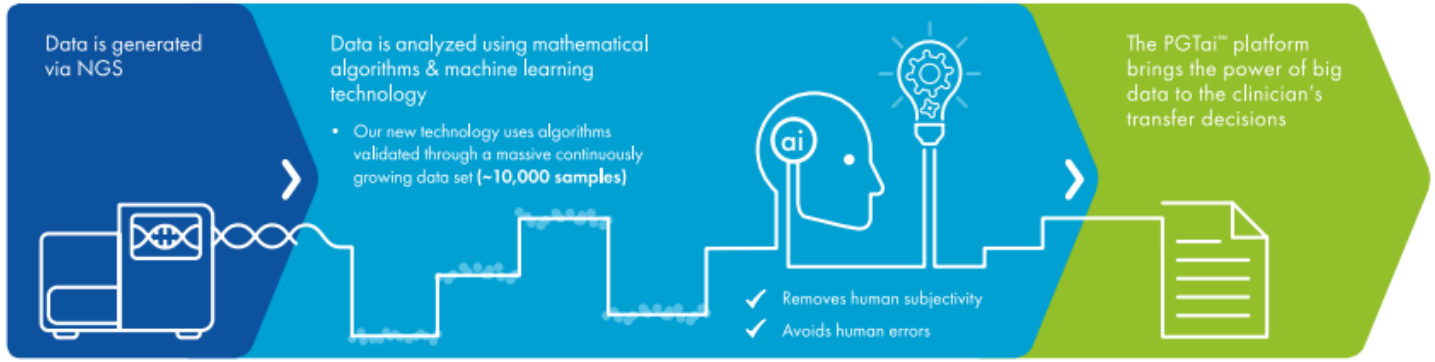
Timothy Allen Sharp, B.S.[a], William N. Garbarini Jr., MBA[b], Chad A. Johnson, PhD[a], Ann Watson, B.A.[a], Rachel Greenberg, B.A.[a], Kathryn J. Go, PhD[a]

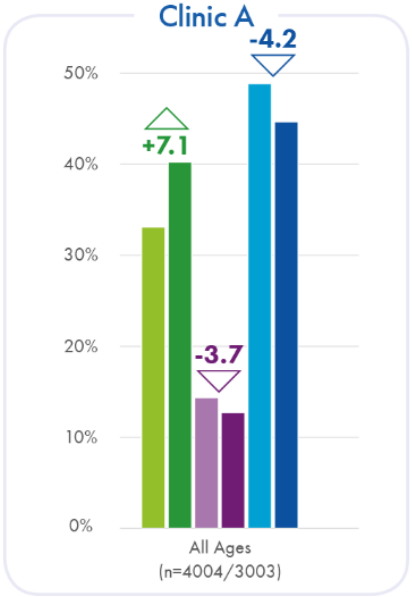
P-20 Tuesday, October 15, 2019 6:30 AM

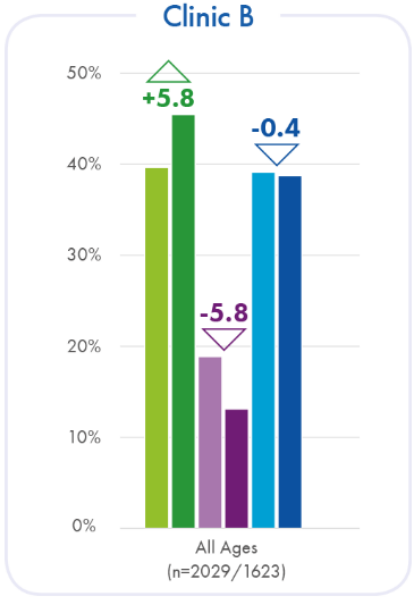


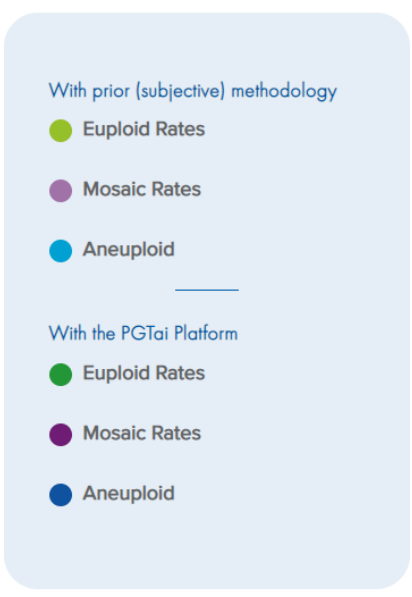


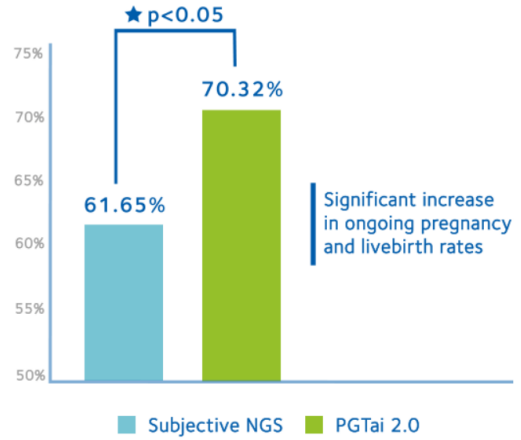
PGTai Technology

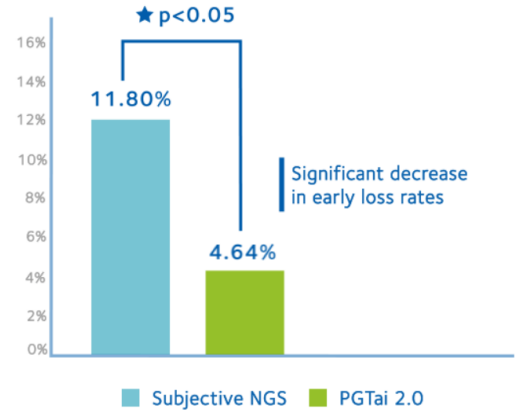












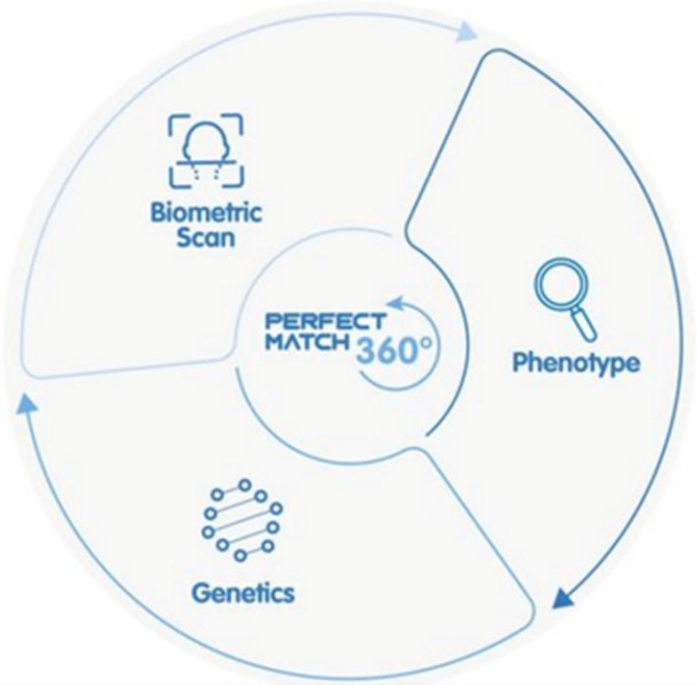
PGTai℠

A new PGT-A interpretation and reporting platform

LEARN MORE

Donor matching: Perfect Match 360°

Perfect Match 360°: Artificial intelligence to find the perfect donor match



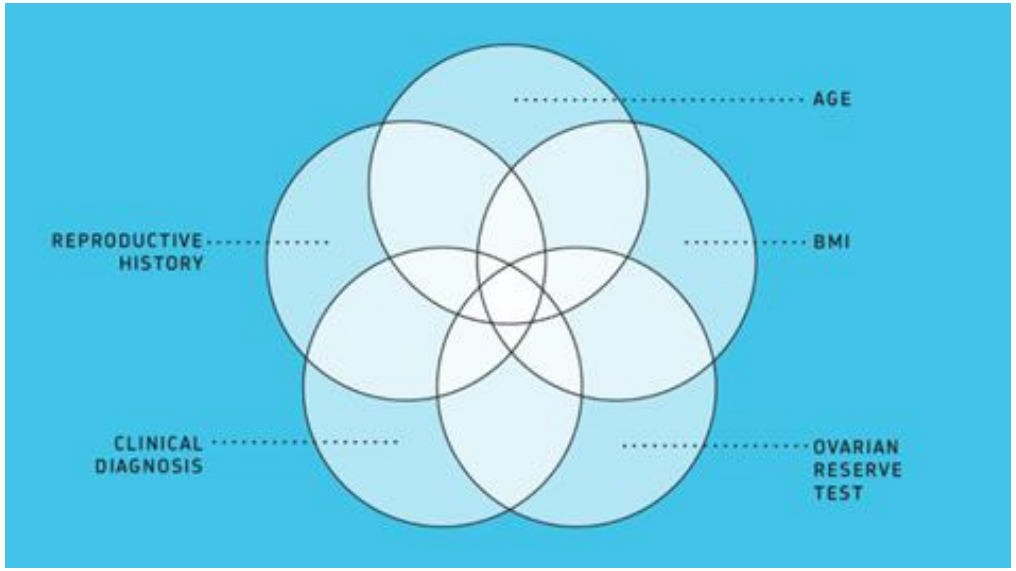
univfy

Patient Retention Improved by 2-5x!

Univfy's holistic platform makes it easier for fertility patients to move from their first visit to using the treatment recommended by their provider — maximizing each woman and couples' chances of conceiving. **Patients counseled by their providers with the support of Univfy are 2-5x more likely to use IVF treatment over a first or repeat IUI or no treatment.** This improvement applies across diverse patient populations and socioeconomic environments.

The Univfy® PreIVF™ Report

The Univfy Report is personalized to you and scientifically validated using your center's data. Through technology developed by Stanford University researchers, Univfy uses a rigorous scientific process to develop and validate a customized prediction model for each center in the Univfy Network.



Your Fertility® Counseling Concierge

- ✓ Dedicated Experts
- ✓ Personalized to Empower Decisions
- ✓ Saves Time and Disappointment

Univfy® PreIVF Report Supports Provider Counseling

- ✓ Accurate, Individualized Prognosis
- ✓ Powers Refund Warranty – Caps Costs, Risks
- ✓ BBVA Express Healthcare Loan

Provider Services

- ✓ Univfy® Patient CRM
- ✓ Univfy® Run Reports Program
- ✓ Univfy® Business Analytics

apricity

The next-generation fertility clinic

We leverage medical excellence with personalised human care and the latest technology, to bring you the best experience possible and maximise your chances of success.

Learn more

Time To Calculate

Explore our AI tools, designed to help you optimise natural fertility or estimate chances of success through treatment.

Time To Compare

Our treatments cost the same as clinics, but going through us means you unlock the Apricity suite of benefits.

conceivable LIFE SCIENCES

The World's First AI-Powered Automated IVF Lab - AURA

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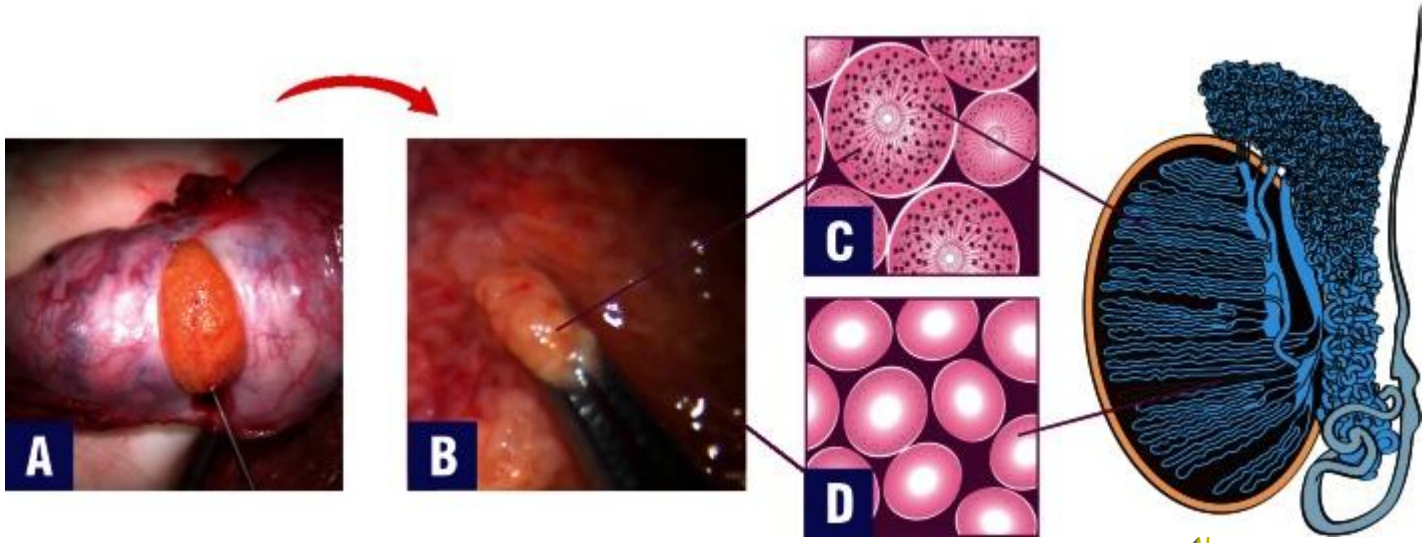
AI in IVF

AI in Brussels IVF

T’Easy

- TEsticular Sperm Extraction - TESE
- Patients with Azoospermia (no sperm in ejaculate)
  - Chirurgical retrieval



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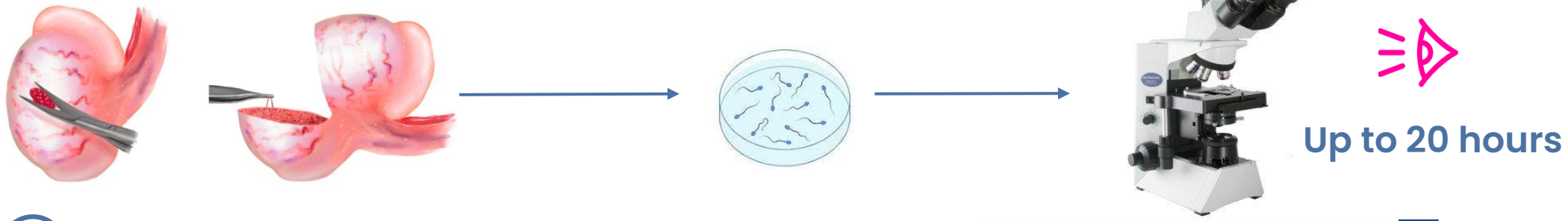
Use case & problem

- Problem
  - Time consuming (manual) sperm search
  - Special skill required
  - Risk of false negatives (cfr paper: mistakes in the lab during the day)
- Solution
  - New automated solution could boost TESE usage
  - Objective decision making
  - Higher precision



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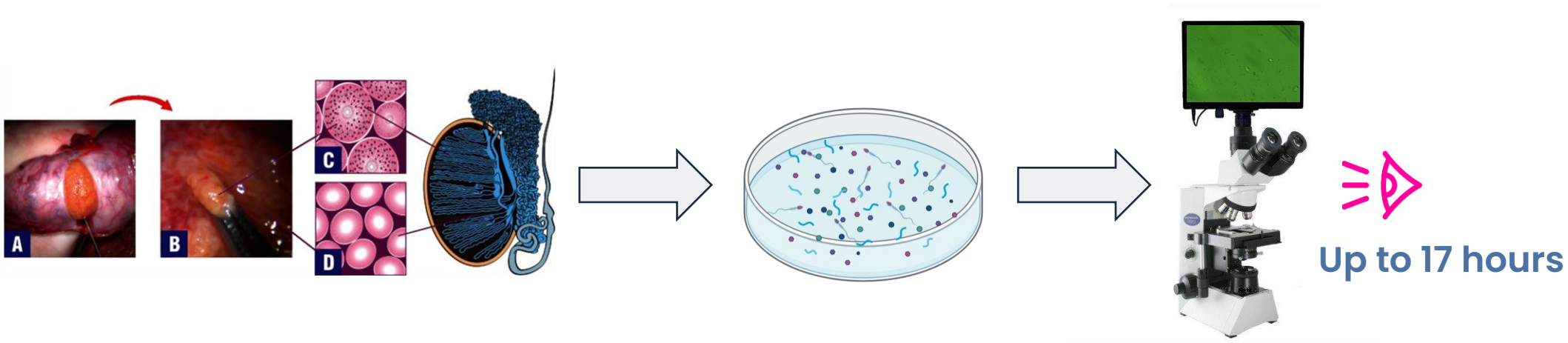
TESE: First case of interest

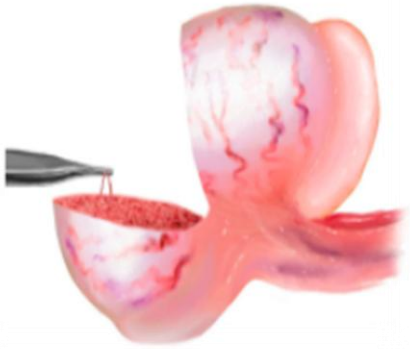
- TESE sperm search for ICSI
  - Very time consuming (1 case total of 17 hours)
  - Average 61 minutes (average 8 oocytes / n=479 cycles)
  - Total search time TESE (2023-2024): 258 hours / 32 working days

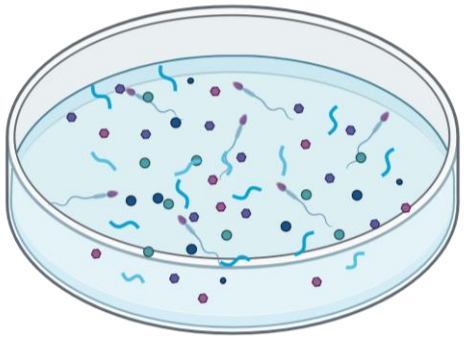


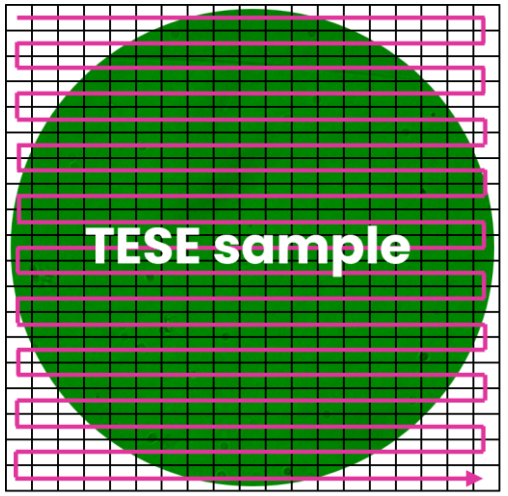
Solution

T’Easy, making TESE easy…

- Solution
  - New fully automated sperm detection tool
  - Higher precision
  - Faster procedure
  - Help making the crucial call: objective support for deciding when to stop searching







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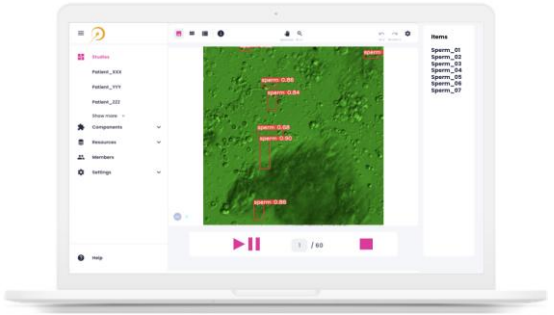
Research

Can an AI-powered solution offer a solution? (Accuracy/faster/better/more affordable?)

Overall solution will be a combination of:

Automated stage



Application

Microscope

AI model

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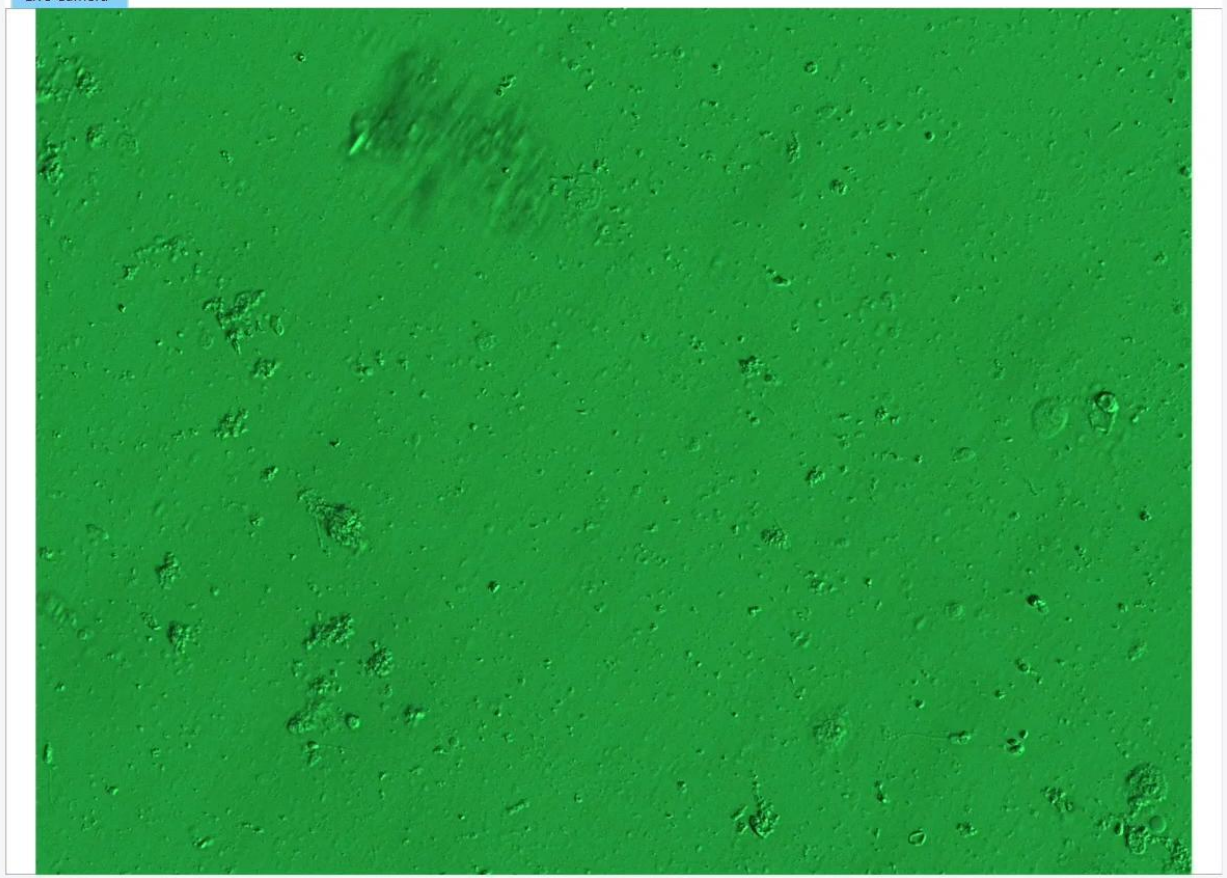
T'EASY SESSION - 23.06.2025

CAMERA ...

Live Camera



CONTROLS

Step Sizes

X -475

Y 355

Z 25

X: 0 Y: 0 Get Position

Z: 0 A: 0 Set Position

Auto Focus | Fit Drop | Go To Fit

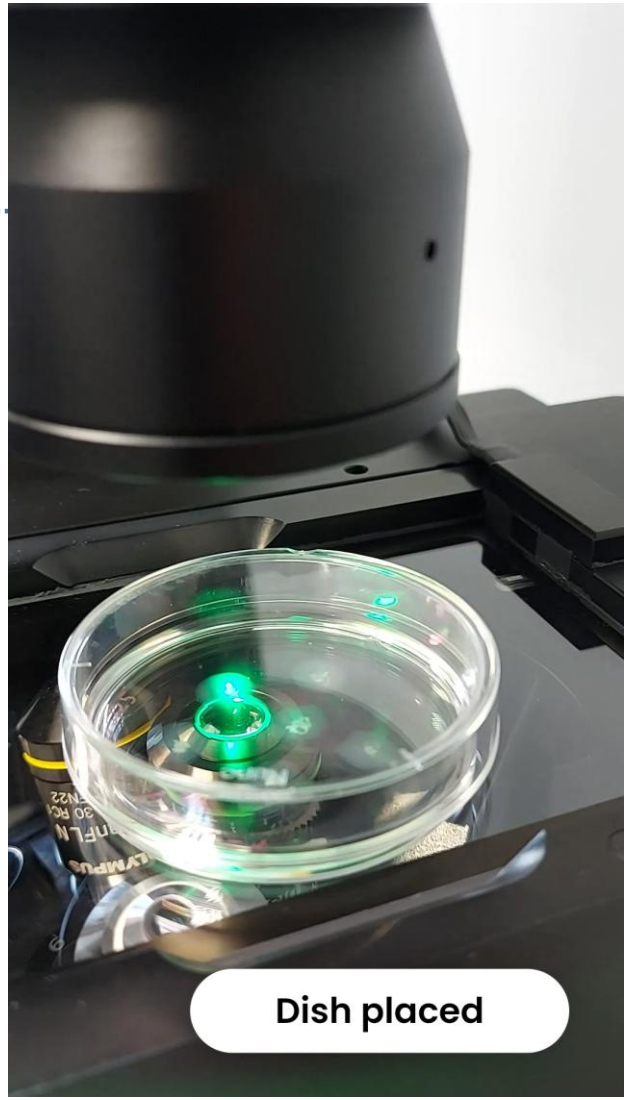
Scan Drop | Capture Drop

1 : (64170 , 36927 , -855)
2 : (62745 , 37832 , -769)
3 : (62745 , 38435 , -767)
4 : (62745 , 36927 , -775)
5 : (62745 , 39039 , -767)

Go To

Add Current

Remove Selected



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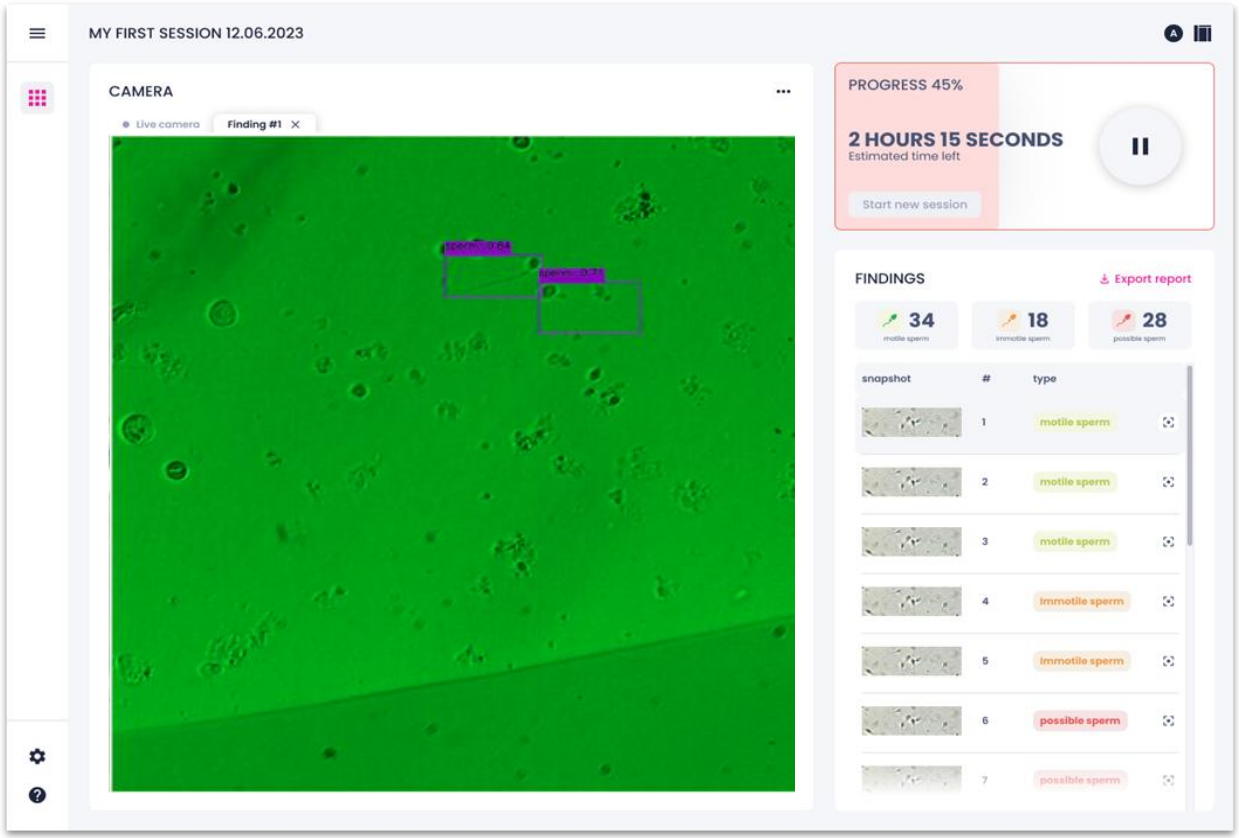
Automated sperm search

- List of findings
  - Visual control of progress
  - Motile/Immotile
  - X,Y and Z coordinate
  - Go back to findings to pick up the sperm



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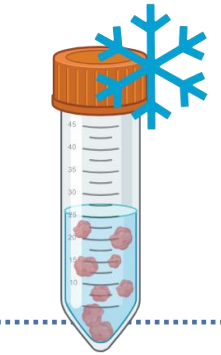
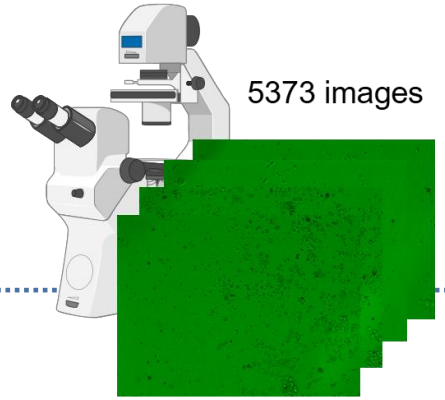
Phase 1
Training AI model

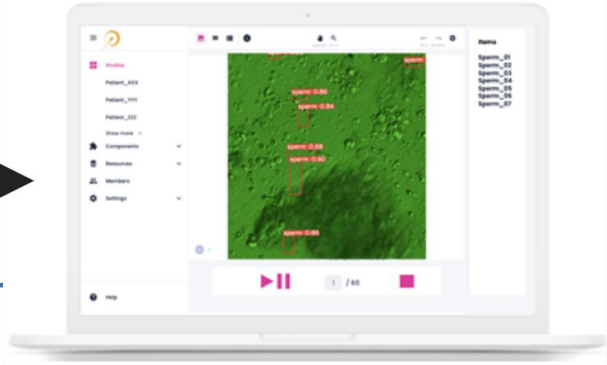
- Manual labeling sperm (January 2022 – November 2024)
- Annotation in duplicate by 2 highly skilled operators
- Draw bounding box around sperm



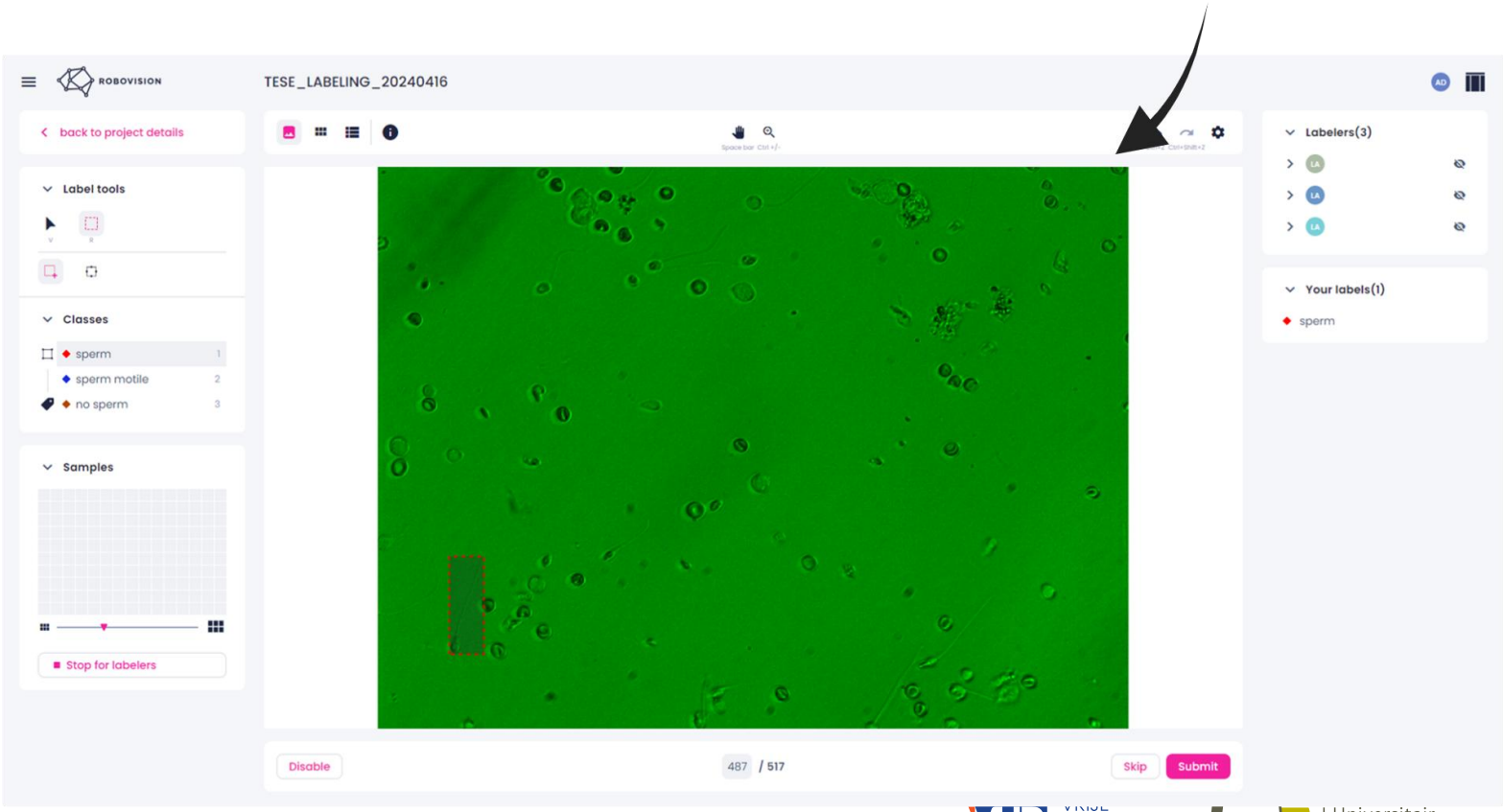
22 frozen TESE samples



5373 images



Robovision labeling platform



Created with BioRender.com

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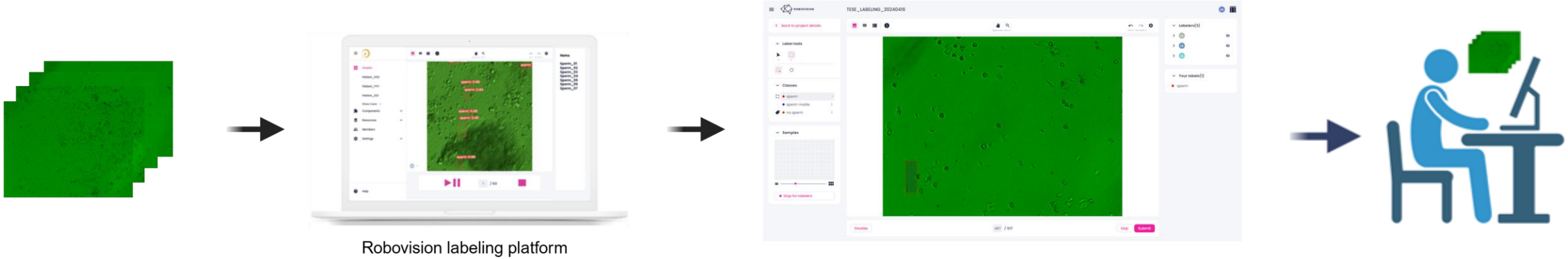
Phase 2
Predictive labelling

- Testing AI model – predictive labelling
  - Providing images for self-annotation by the AI platform
  - Recall: proportion of actual positives correctly identified as positive
  - Precision: proportion of detected positives that are truly relevant



Robovision labeling platform

Phase 2
Predictive labelling

	#Images	#Sperm	Recall %	Precision %
Test set 1	464	1912	95,0	94,8
Test set 2	1933	4382	89,1	80,7

- High accuracy in sperm detection (above 80% is “good”, above 90% is “excellent”)
- Areas for improvement

Recall: proportion of actual positives correctly identified as positive
Precision: proportion of detected positives that are truly relevant

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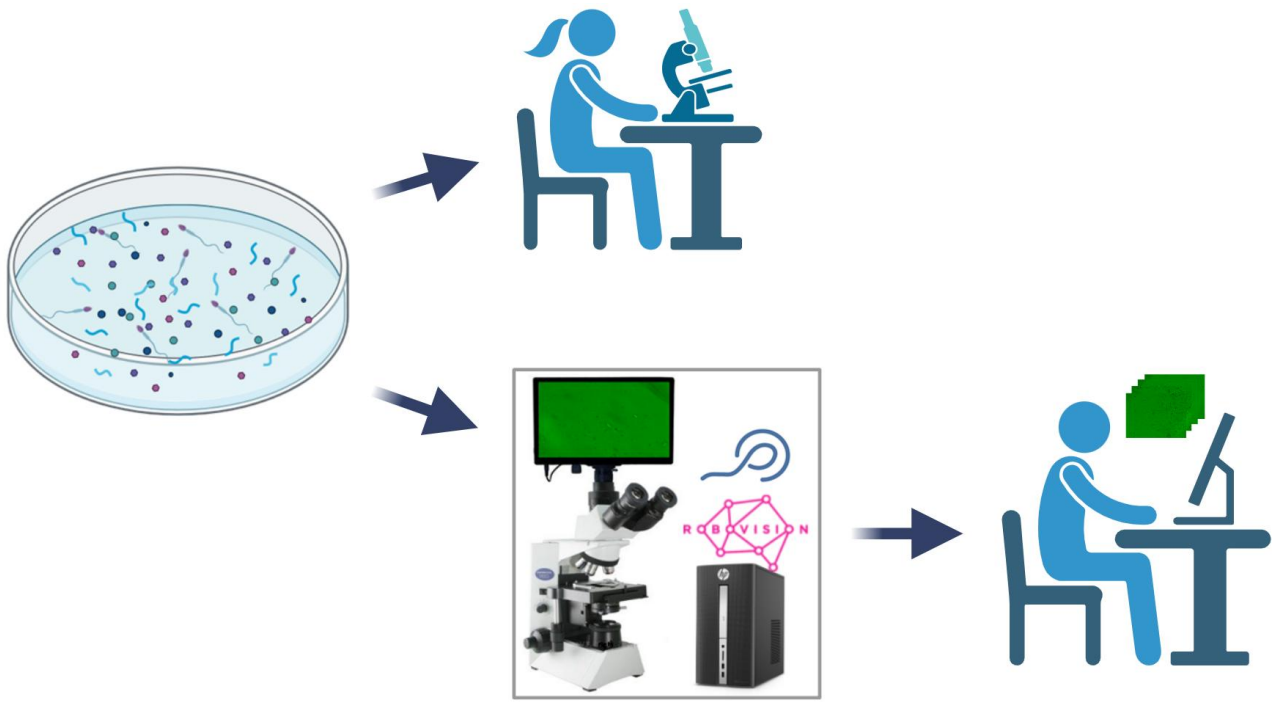
Phase 3
Proof of concept

- Proof of concept
  - Comparison: Human operator vs. T'Easy (manual sperm search vs. automated)

Same sample
Same droplet 10 µl



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Phase 3

Proof of concept: Human versus T'Easy

	Live	Static images					
# Sperm	T'Easy	Confirmed T'Easy	Human	False positives	Missed detection	Precision	Recall
Sample 1	309	304	340	5	36	98,4%	89,4%
Sample 2	227	223	240	4	17	98,2%	92,9%

Time (min)	T'Easy	Human
Sample 1	10	23
Sample 2	10	14

Automated sperm search

Which samples can benefit?

- Ejaculates
  - Azoospermia
  - Cryptozoospermia
  - Post-Vasectomy samples
- Testicular
  - Microsurgical Epididymal Sperm Aspiration (MESA)
  - Fine needle aspiration (FNA)
  - Testicular sperm extraction (TESE)

Summary

	hour	working days
total time saved	1302	171


Artificial intelligence is a tool, not a threat.
Rodney Brooks
quotefancy

Thank you
Questions?

koen.wouters@uzbrussel.be

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