Aplicação Clínica da IA na Análise do Fator Masculino

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FERTGROUP
Fertility Medical Group
Instituto Sapientiae

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Associação Instituto Sapientiae

Declaração

Sem conflito de interesse para divulgar relacionado ao assunto desta palestra

Resolução do Conselho Federal de Medicina
nº 1.595/2.000

Inteligência Artificial é a simulação da inteligência humana em máquinas programadas para pensar e aprender!

The evolution of AI

1950s - Artificial Intelligence

Computing system that performs “cognitive” tasks
e.g. If **heart rate < 50bpm** then **call the nurse**

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Statistical models that extract patterns from simple data.
e.g. Here are the test results of some patients with sepsis.
Does this new patient have sepsis?

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1980s - Machine Learning

Statistical models that extract patterns from simple data.
e.g. Here are the test results of some patients with sepsis.
Does this new patient have sepsis?

2010s - Deep Learning

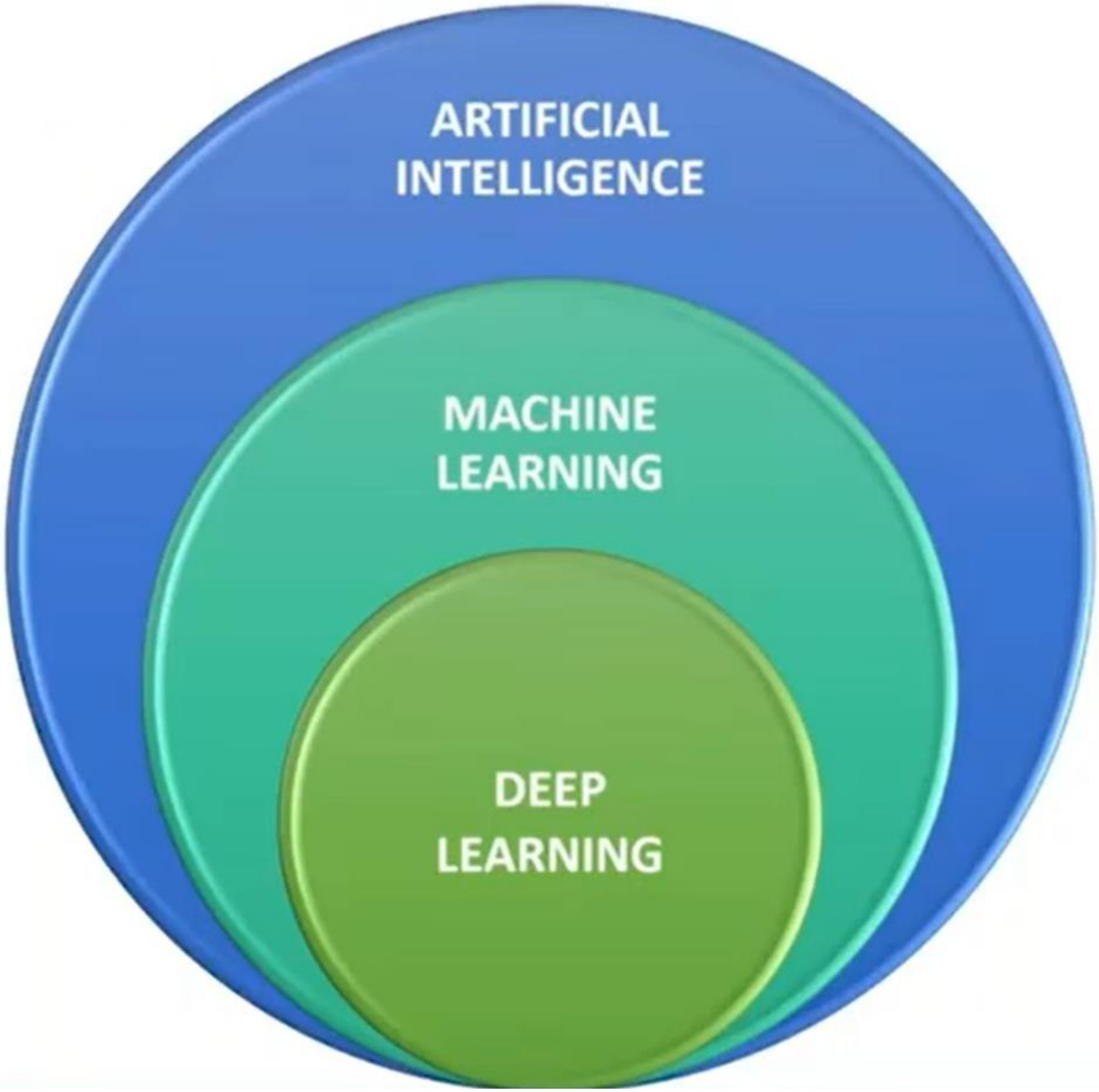
Powerful neural networks that learn from large amounts of complex data.
Here are 500,000 Chest X-Rays from patients with pneumonia.
What is the the chance that the patient with this new Chest X-Ray has pneumonia?

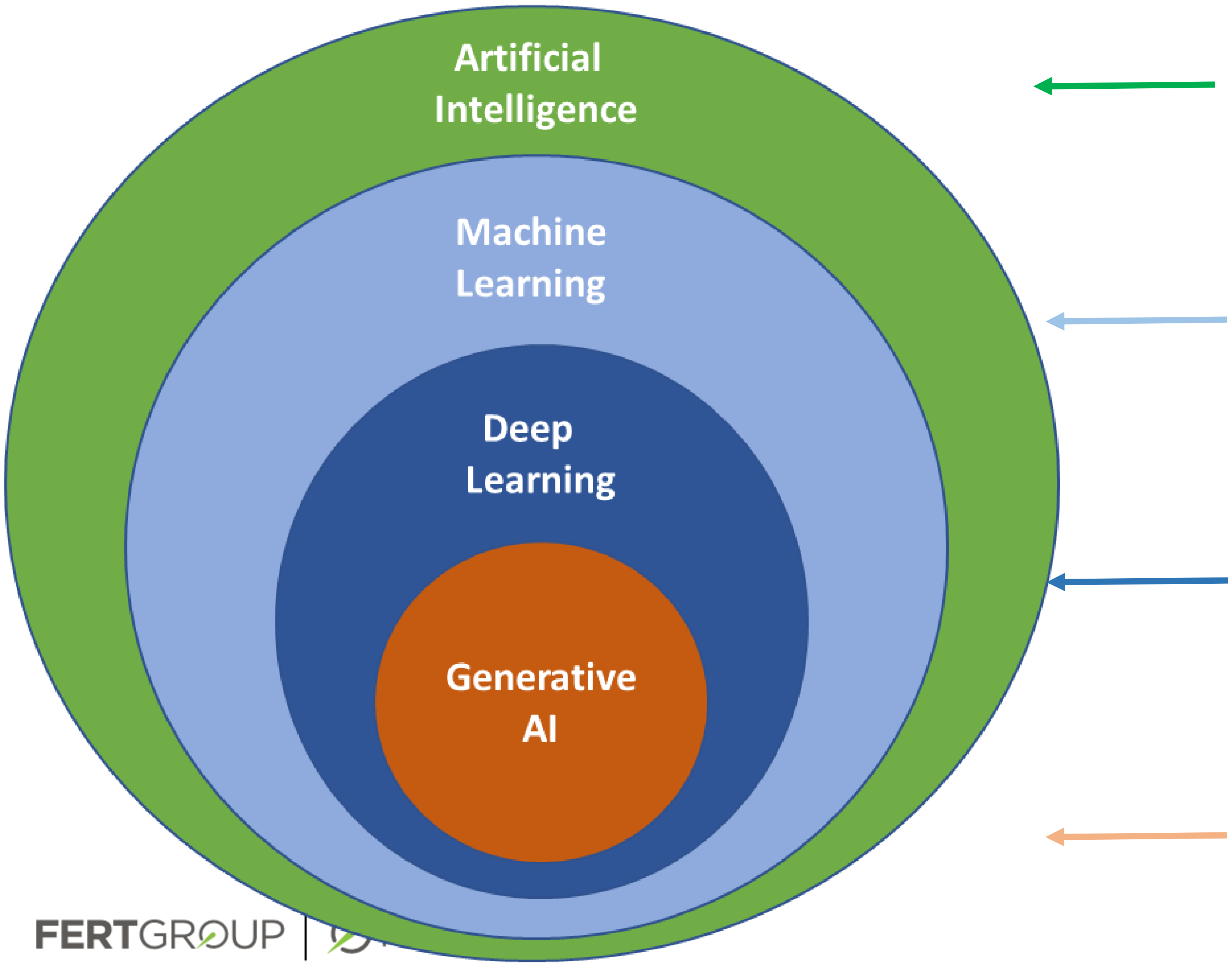
The evolution of AI

1950s - Artificial Intelligence

1980s - Machine Learning

2010s - Deep Learning



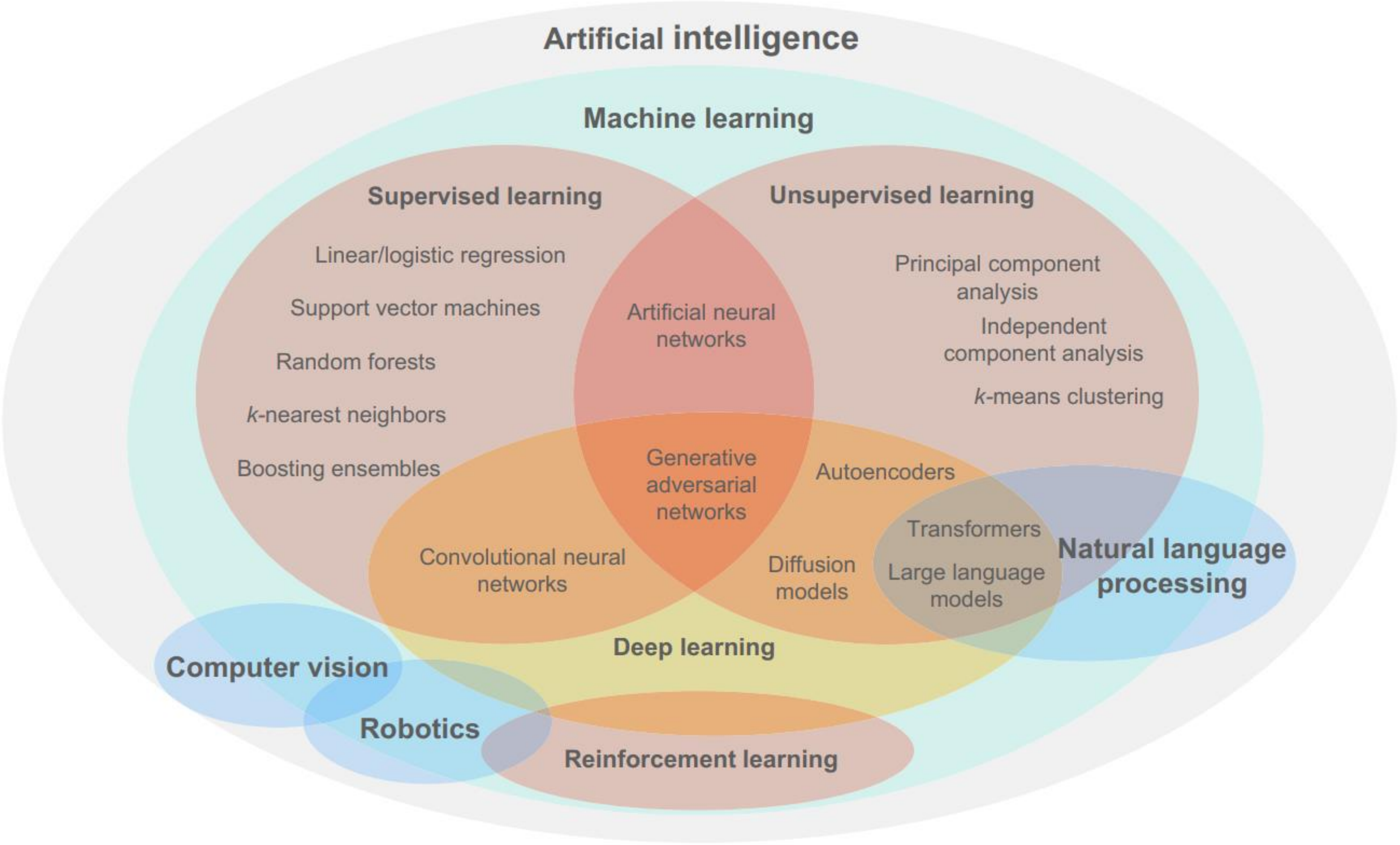


Inteligência Artificial: Envolve emular o comportamento humano, **utilizando máquinas para aprender e executar tarefas** sem a necessidade de instruções explícitas sobre o resultado pretendido.

Machine Learning: é um subconjunto da IA que se refere a **sistemas que podem aprender por si próprios**. Os modelos de ML coletam dados e ajustam-nos a um algoritmo, para fazer previsões.

Deep Learning: Baseado em **redes neurais artificiais e consiste em múltiplas entradas, saídas e camadas ocultas.** Cada camada contém unidades que transformam os dados de entrada em informações que a próxima camada pode usar para uma determinada tarefa preditiva.

IA generativa: é um subconjunto de modelos de aprendizagem profunda que pode **produzir novos conteúdos com base no que é descrito na entrada**. A coleção de modelos generativos de IA que podem produzir linguagem, código e imagens.



Artificial intelligence
Machine learning
Supervised learning
Unsupervised learning
Linear/logistic regression
Support vector machines
Random forests
k-nearest neighbors
Boosting ensembles
Artificial neural networks
Principal component analysis
Independent component analysis
k-means clustering
Generative adversarial networks
Autoencoders
Transformers
Convolutional neural networks
Diffusion models
Large language models
Natural language processing
Deep learning
Computer vision
Robotics
Reinforcement learning

Aplicação da IA na reprodução assistida

IA na medicina reprodutiva é um caminho sem volta

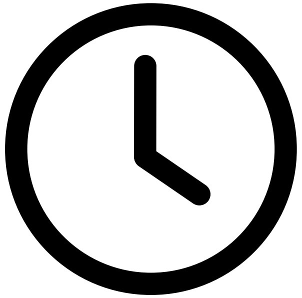
Diminuição na carga de trabalho no laboratório

Aconselhamento de pacientes

Compreensão dos motivos para falha de fertilização/implantação

Segurança na tomada de decisão

Quanto mais cedo a informação vier, melhor



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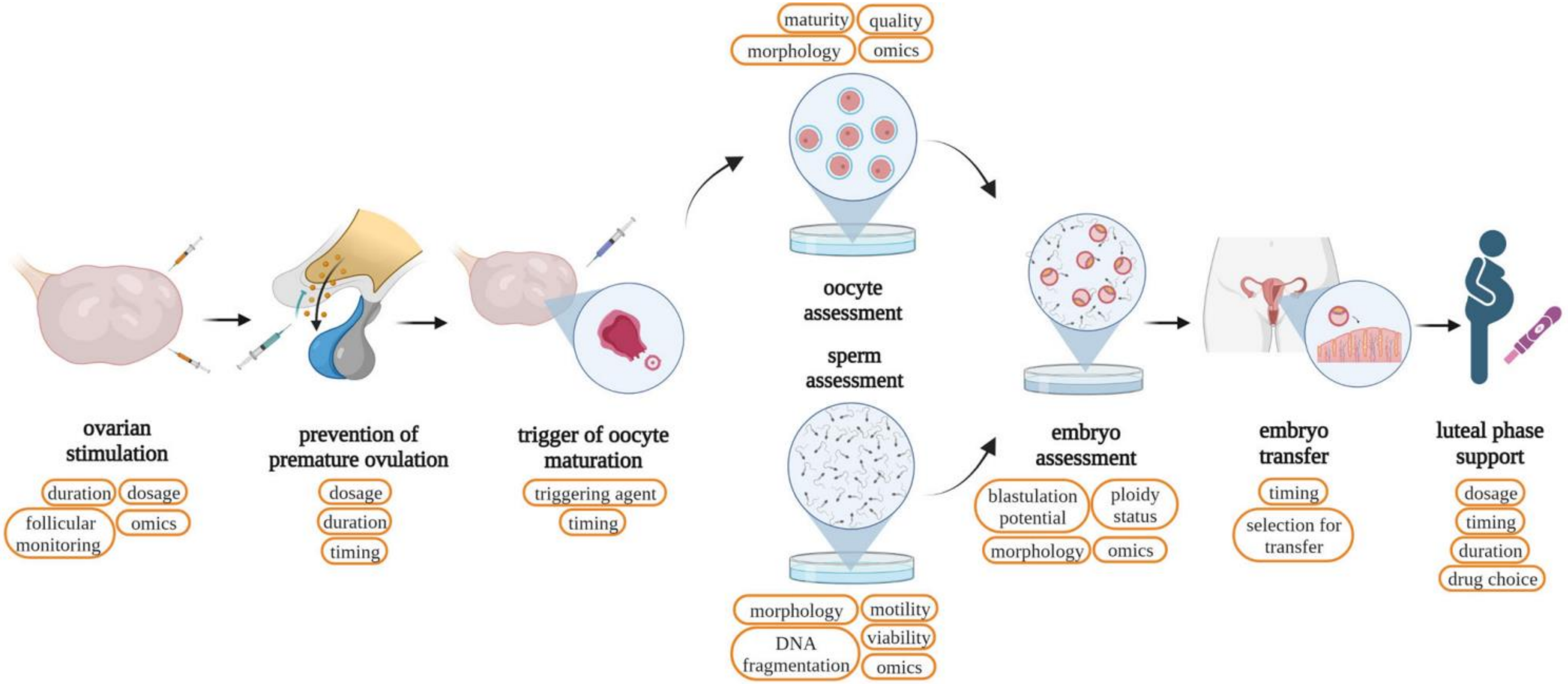

npj Digital Medicine (2024) 7:55 ; https://doi.org/10.1038/s41746-024-01006-x

O que está sendo automatizado?

- At home patient preparation and monitoring: Sama, Embie
- Automated Ultrasound reading: Cycle Clarity, FolliScan (Mim.AI), Imma
- Non-invasive oocyte retrieval: Butterfly Bio
- Automated dish preparation
- Automated denudation: Overture
- Automated sperm pick up: Baibys, Quart
- Egg and embryo vitrification and warming: Overture
- ICSI: Overture, Cornell University, Conceivable, Fertilis
- Embryo selection by AI: too many companies
- Non-Invasive assessment of endometrial function: Matris
- Artificial uterus: Vitara

***Most innovation is now occurring in start ups**, not IVF centers (private equity is squeezing research) nor Universities (no government funding)*

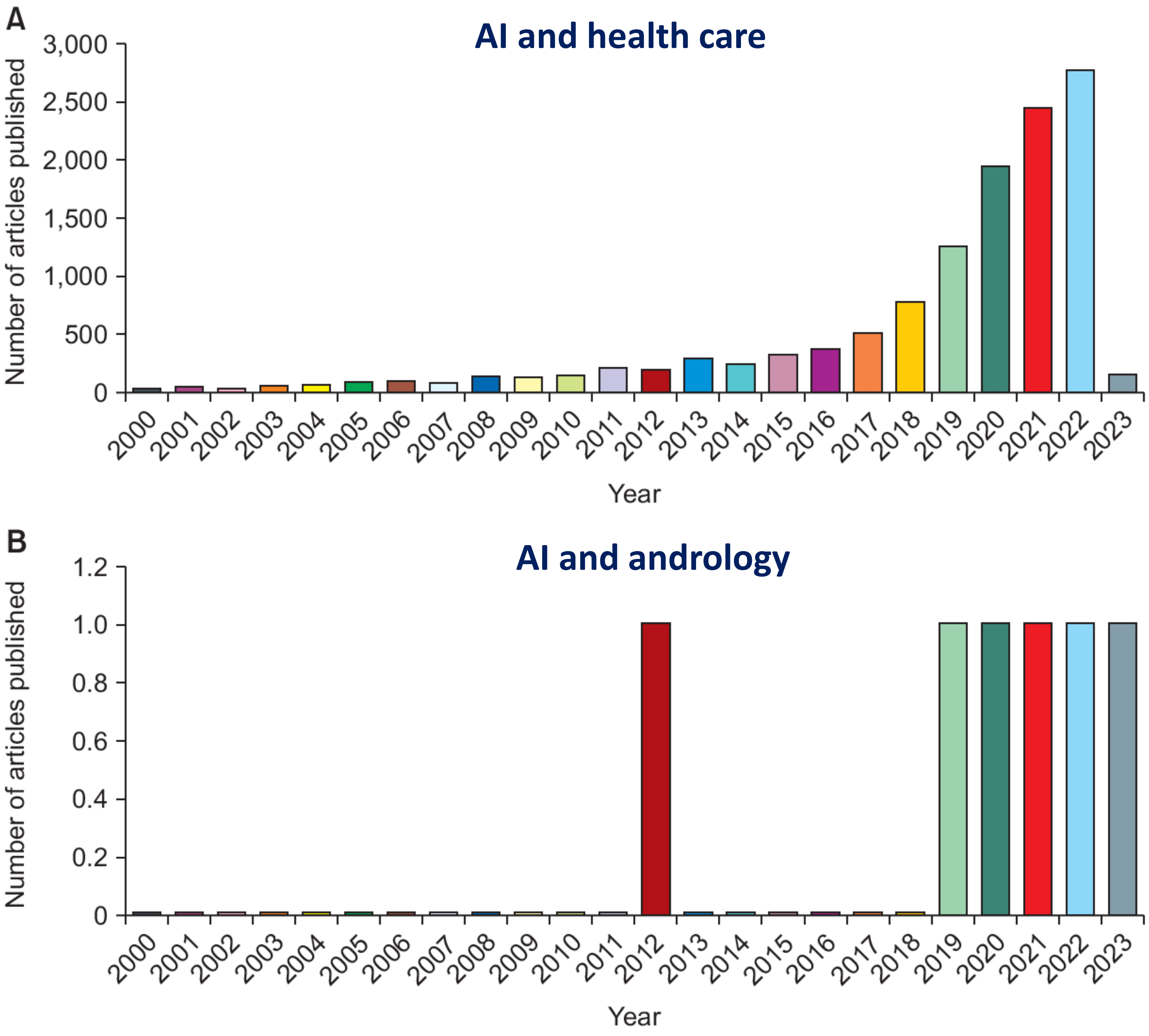

Fig. 1. Number of articles on artificial intelligence and health care (A), and on artificial intelligence and andrology (B) published since the 2000s (source: Scopus; accessed on January 2023).

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World J Mens Health 2024 Jan 42(1): 39-61https://doi.org/10.5534/wjmh.230050

Table 2. Summary of various artificial intelligence (AI) technologies in andrology[a]

AI technologies in andrology	Purpose	Company name	Article type: Research/ Method/ Review	Supporting papers
a) Currently used in clinical care				
Smartphone sperm analysis	Sperm motility	Yo test	Research	
Chromatographic immunoassay technology	Sperm analysis	SpermCheck	Research	
Chromatographic immunoassay technology	Sperm analysis	Fertell	Research	
Centrifugal motion to determine sperm cell count	Sperm analysis	Trak Male Fertility Testing System	Research	
Smartphone sperm analysis	Concentration and motility	Men's Loupe	Research	
Colorimetric dye technology	Motility	Swim Count Sperm Quality	Review	
Colorimetric dye technology	Motility	FertilitySCORE	Review	
Smartphone sperm analysis	Concentration and motility	SEEM® (Recruit Lifestyle Co., Ltd.)	Research	
Smartphone sperm analysis	Sperm count	ExSeed Home Sperm test	N/A	N/A
Artificial intelligence optical microscopic (AIOM) technology	Sperm concentration, motility and seminal pH	LensHooke™ X1 PRO (X1 PRO)	Research	
Computer assisted sperm analysis	Sperm analysis	Microptic SCA	Research	
b) Undergoing clinical trials				
Evaluating Piezo-ICSI. - The EPI Study	Microinjection (ICSI) is performed using the Piezo-ICSI technique.			NCT04669652
Convolutional Neural Network in Ovarian Follicle Identification	Mask Region-based Convolutional Neural Network in Ultrasound Follicle Identification			NCT04545918
Evaluating iDA Selection Ability. The VISA Study	iDAScore®			NCT04969822
Use of Artificial Intelligence for Clinical Assessment of Assisted Reproductive Techniques and IVF Outcomes (AI in ART)	AI to analyze 3-D ultrasound			NCT04255615

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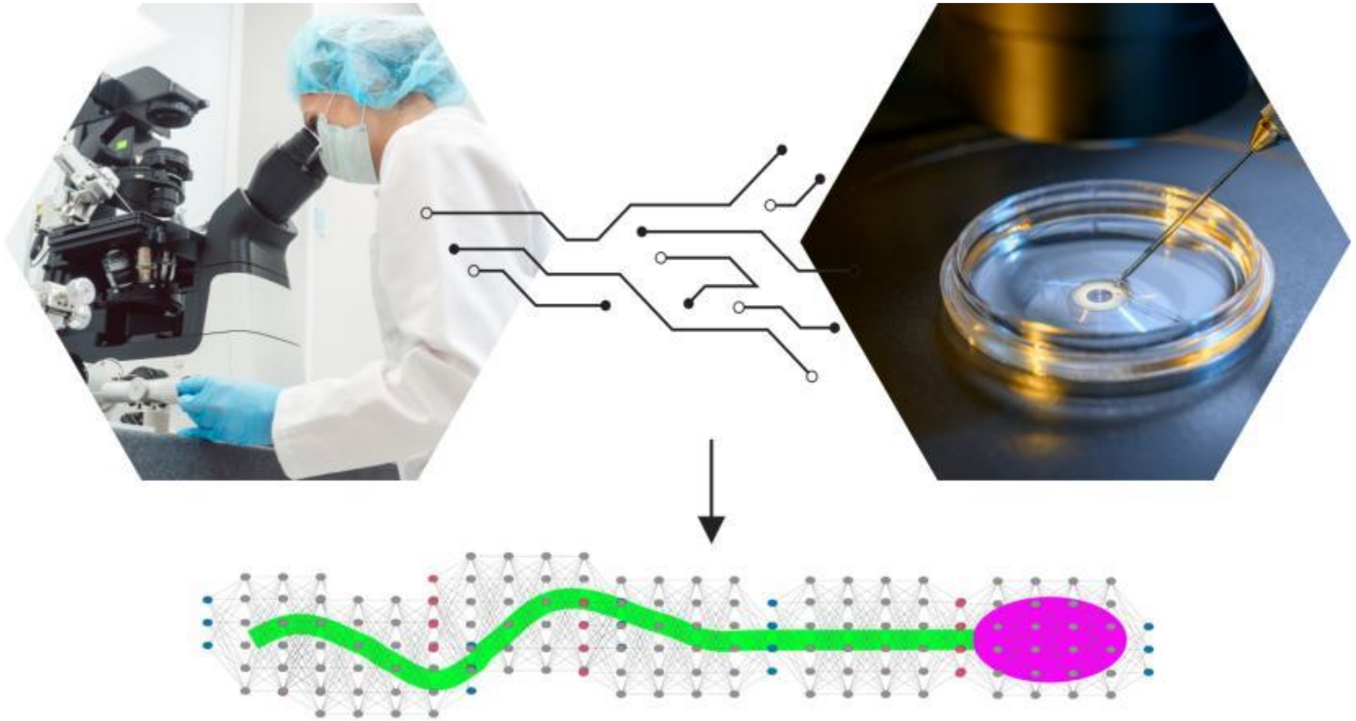
World J Mens Health 2024 Jan 42(1): 39-61https://doi.org/10.5534/wjmh.230050

Table 2. Continued 1

AI technologies in andrology	Purpose	Company name	Article type: Research/ Method/ Review	Supporting papers
c) Currently in the research and development phase				
Artificial neural network	Sperm morphology		Research (abstract)	
Image recognition algorithm	Sperm motility		Research	
	Chromosomal abnormalities in azoospermic males, semen analyses, sperm identification		Review	
In the medical field, three main categories of AI methods are used: (1) machine learning, (2) natural language processing, and (3) robotic surgery. Integrated AI component with image analysis Various algorithms of machine learning: - Decision tree - Random forest - Supports vector machines (SVM) - Naïve Bayes classifier - Neural network and deep learning: - Neural networks and deep learning - Unsupervised learning	Select and predict which spermatozoon has the best quality to implement the treatment success rate	Current applications of AI in reproductive medicine are limited and largely semi-automatic. Further studies are needed on diagnostic aspects and for personalized treatment, a competent remote medical system, and automated reproduction assisted by AI	Review	
Neural networks	To predict the effects of environmental pollution and lifestyle habits on human sperm concentration and motility		Research	
Decision Tree (DT), Multilayer perceptron (MLP), Navie Bayes (Kernel), support vector machine (SVM) plus Particle swarm optimization (PSO), and SVM	Influence of lifestyles and environmental pollution on sperm parameters and fertility rate		Research	
VGG16, a deep convolutional neural network	Sperm morphology		Research	
The following three models of supervised machine learning models were evaluated: logistic regression, random forest, and support vector machine	Predict the benefit that patients with varicocele will have from varicocele repair.		Research	
Report sixteen approaches to AI and ML	All of the following parameters were taken into account: sperm morphology, sperm identification, identification of follicles empty or containing oocytes, prediction of embryo cell stages, prediction of blastocyst formation, assessment of human blastocyst quality, prediction of live birth from blastocysts, improvement of embryo selection, and development of optimal controlled ovarian hyperstimulation protocols.		Conference review	
Automated, artificial intelligence optical microscopic (AIOM)-based technology, LensHooke™ X1 PRO (X1 PRO)	Sperm concentration, motility, and seminal pH		Research	
			Research	

World J Mens Health 2024 Jan 42(1): 39-61https://doi.org/10.5534/wjmh.230050

Inteligência Artificial no Laboratório de Andrologia



- **Computer-Assisted Semen Analysis – CASA**
- **IVOS II**
- **IMSI**

- **IA na Análise Seminal**

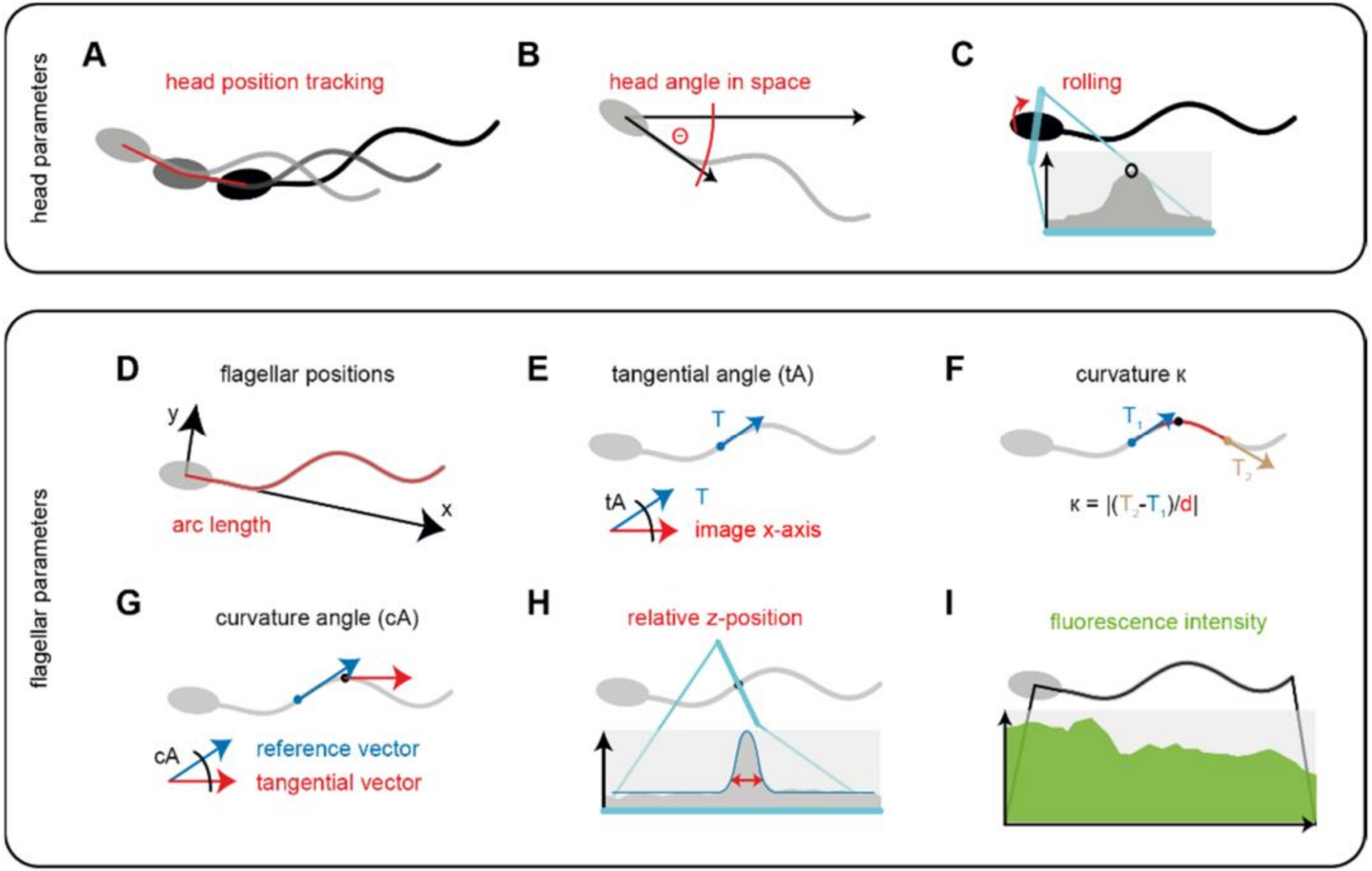
cells

Article

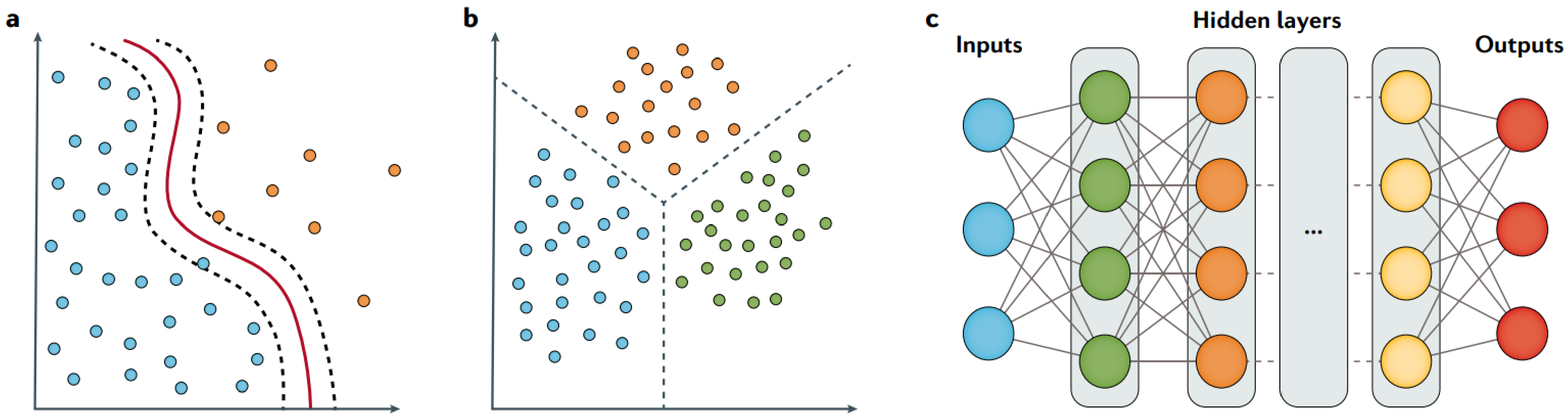
SpermQ–A Simple Analysis Software to Comprehensively Study Flagellar Beating and Sperm Steering

Cells **2019**, *8*, 10; doi:10.3390/cells8010010

- Sperm Count
- Sperm Motility
- Sperm Morphology
- Volume
- pH Level
- Vitality



Machine learning strategies:
classification (part a), clustering (part b) and artificial neural network



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Nature Reviews; doi.org/10.1038/s41585-021-00465-1

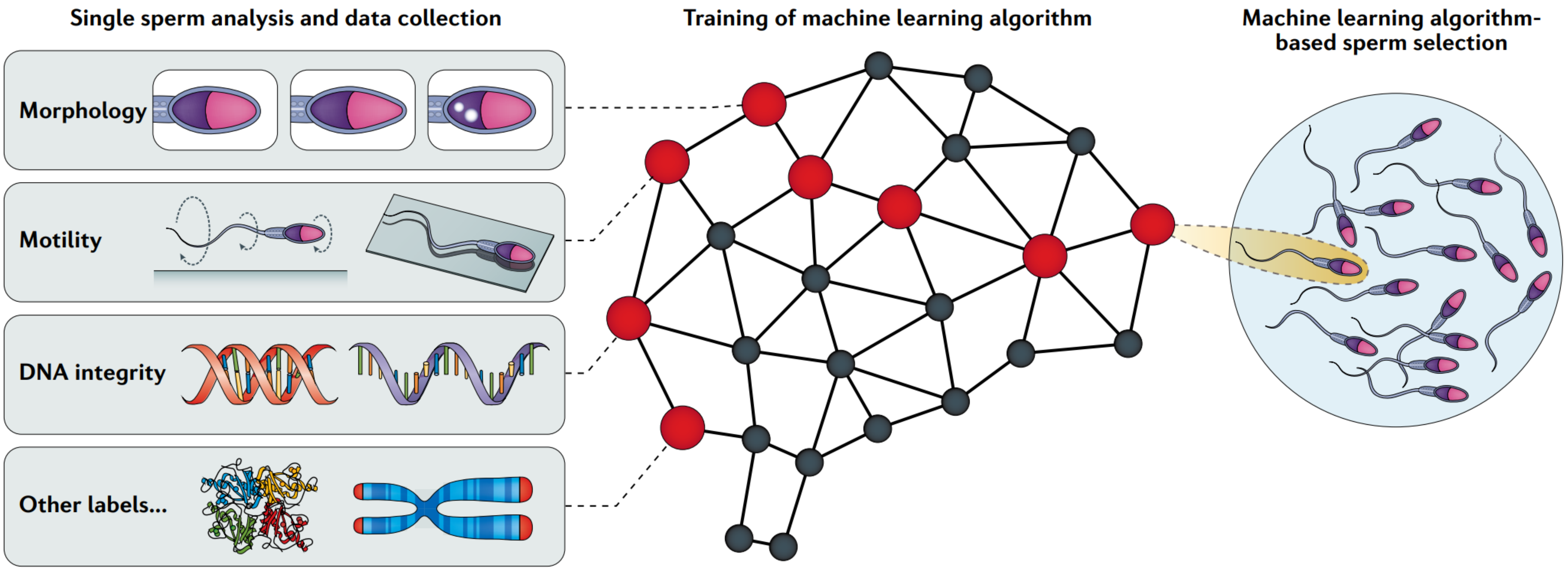
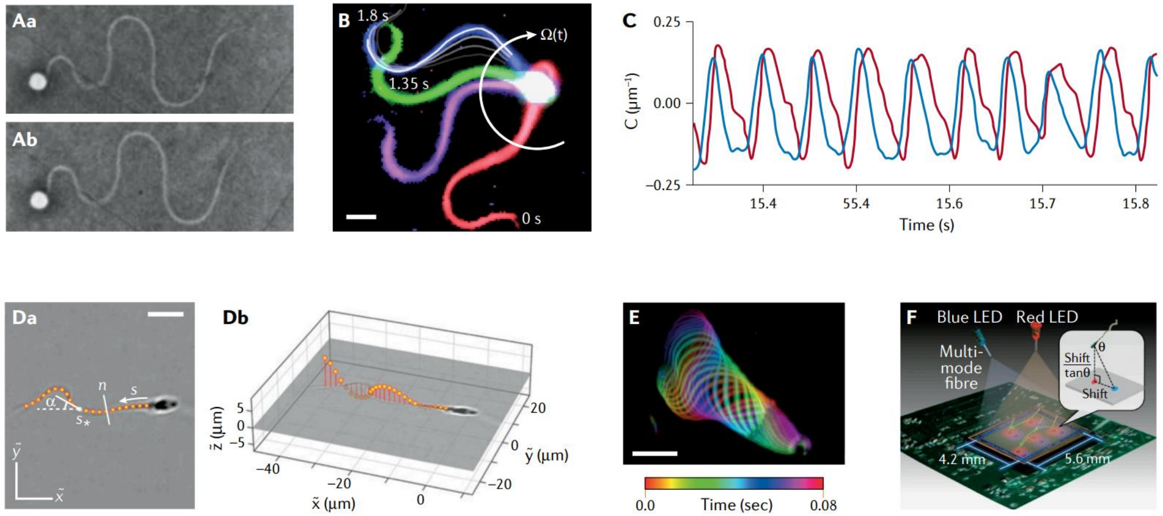


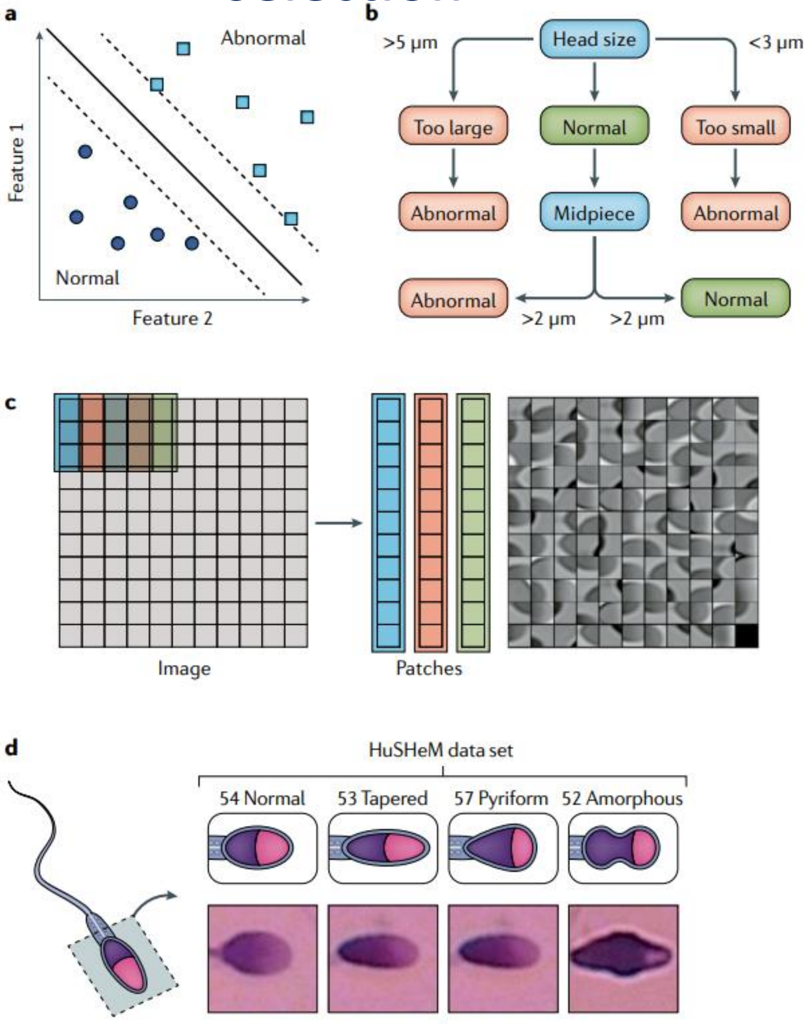
Fig. 1 | **Creating a machine learning algorithm for sperm selection.** Morphology, motility, DNA integrity and other sperm quality metrics can be used to train a machine algorithm for sperm selection with single-sperm resolution. The potential for the use of machine learning in sperm selection is motivation for accelerating the study of single-sperm quality.

Nature Reviews; doi.org/10.1038/s41585-021-00465-1

Machine learning for sperm motility selection



Machine learning for sperm morphology selection



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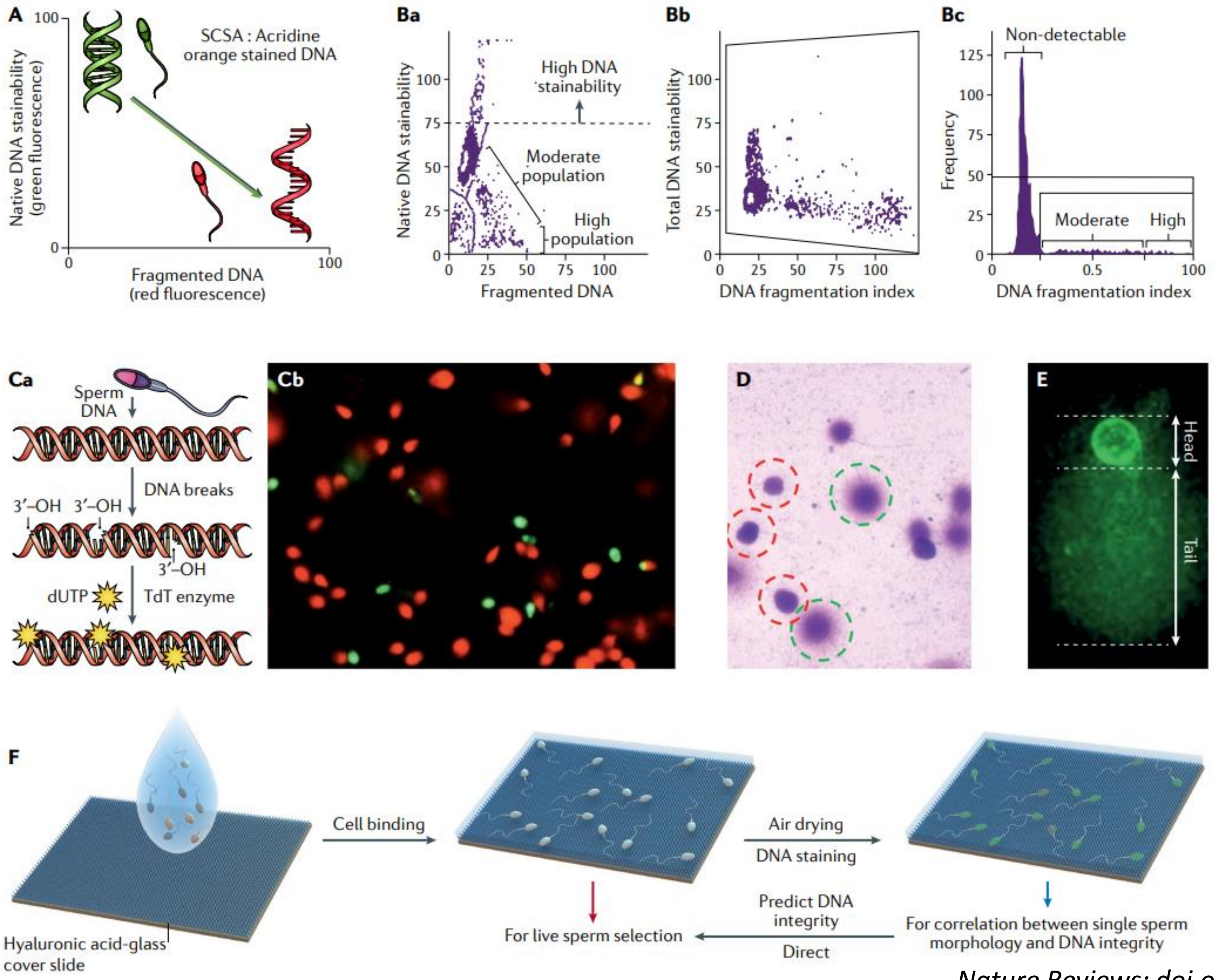
Nature Reviews; doi.org/10.1038/s41585-021-00465-1

Machine learning for sperm DNA fragmentation



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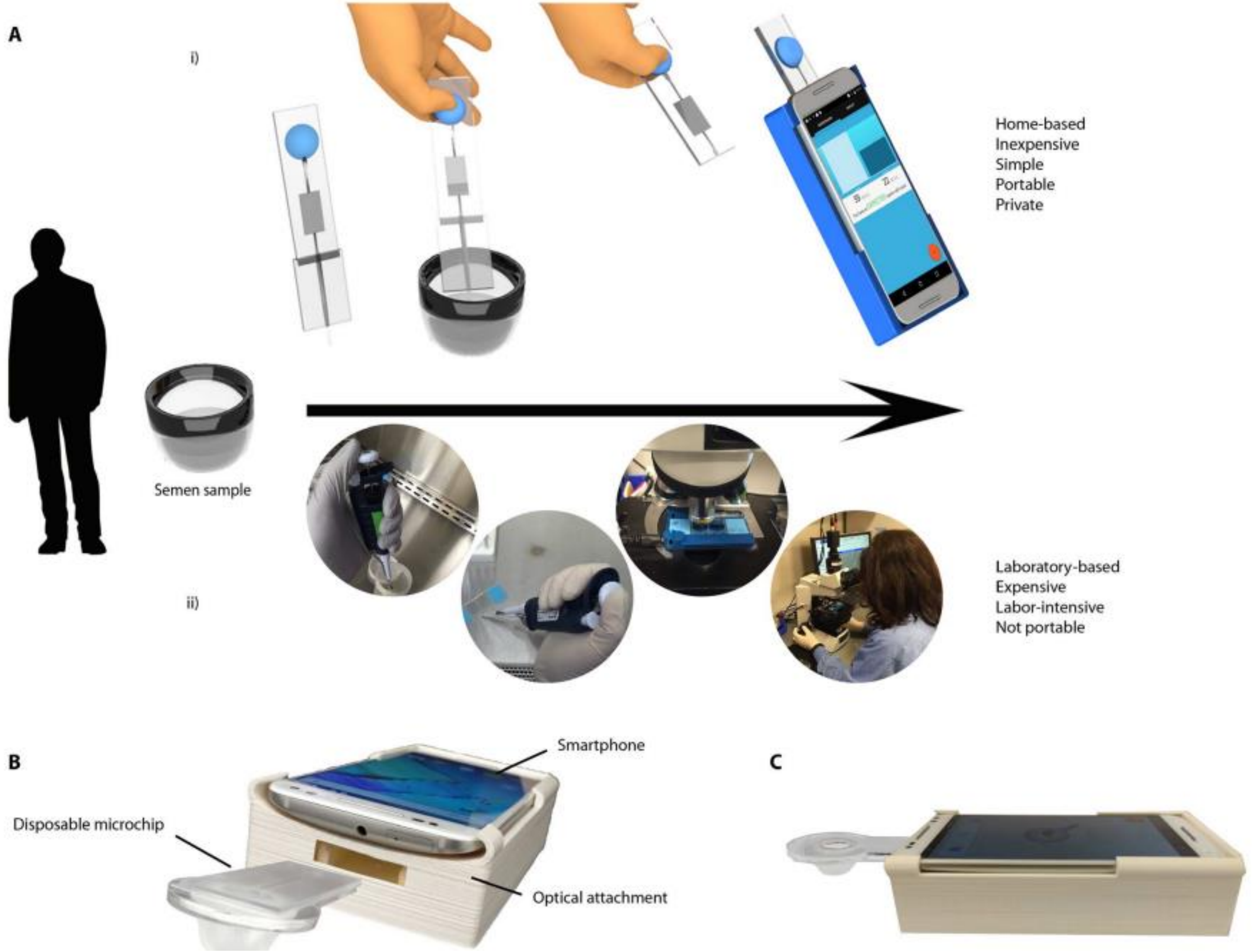
Nature Reviews; doi.org/10.1038/s41585-021-00465-1

Home sperm testing device versus laboratory sperm quality analyzer: comparison of motile sperm concentration

INFERTILITY

An automated smartphone-based diagnostic assay for point-of-care semen analysis

Manoj Kumar Kanakasabapathy,[1] Magesh Sadasivam,[1]* Anupriya Singh,[1]* Collin Preston,[1] Prudhvi Thirumalaraju,[1] Maanasa Venkataraman,[1] Charles L. Bormann,[2] Mohamed Shehata Draz,[1] John C. Petrozza,[2] Hadi Shafiee[1,3]†



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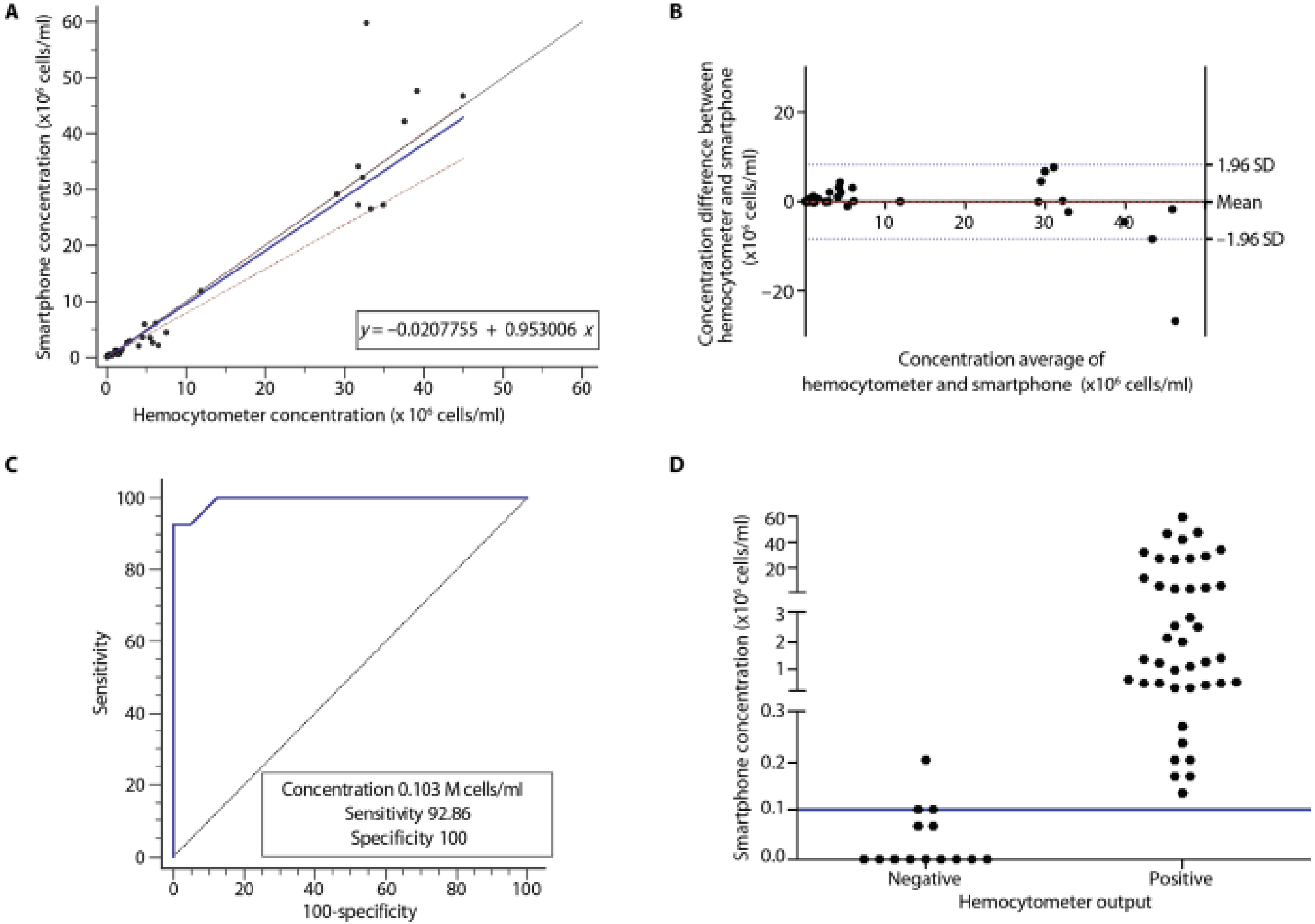

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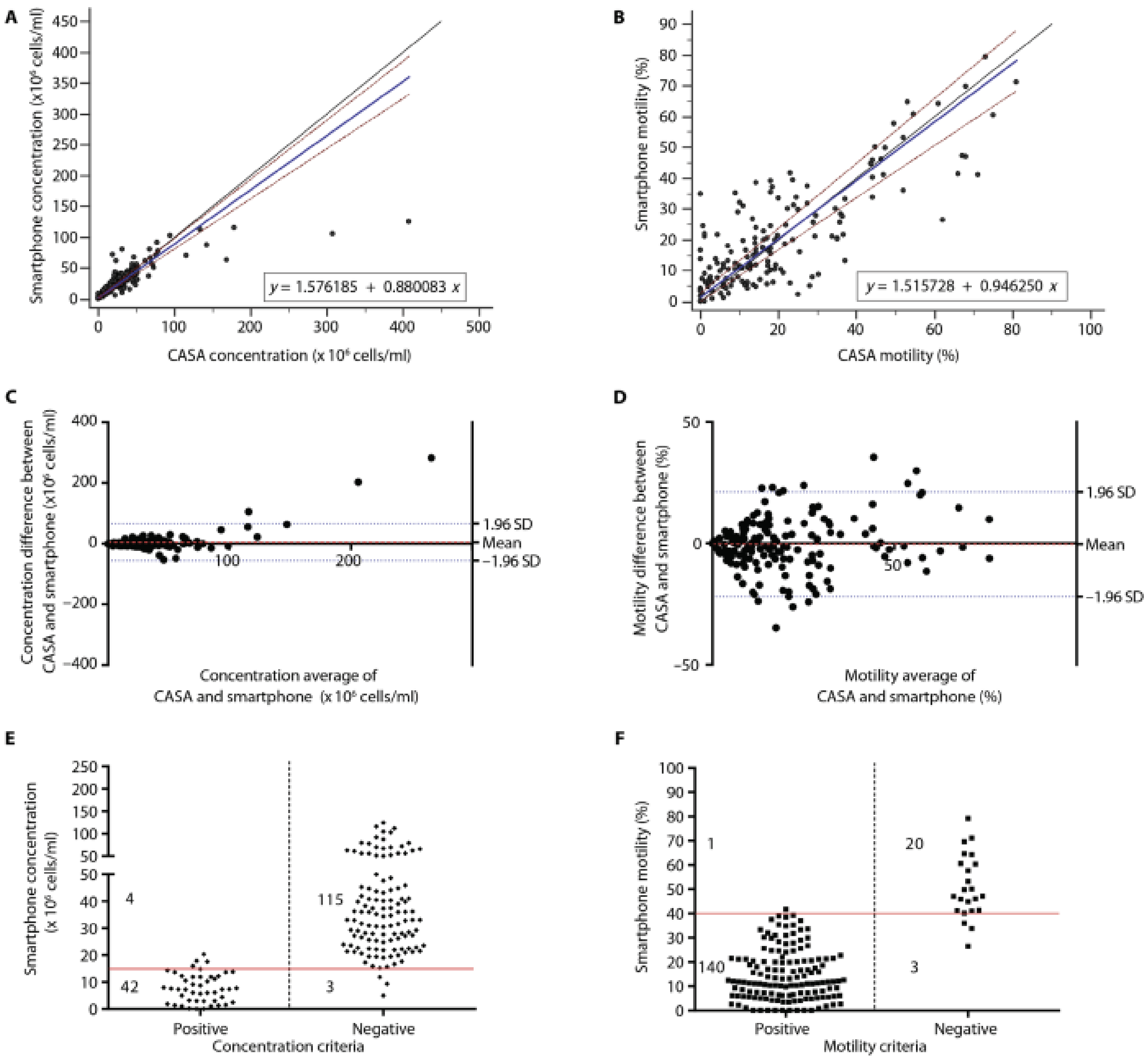
Kanakasabapathy et al., *Sci. Transl. Med.* 9, eaai7863 (2017) 22 March 2017



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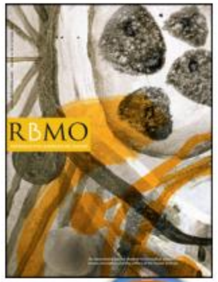
Kanakasabapathy et al., Sci. Transl. Med. 9, eaai7863 (2017) 22 March 2017

1 RBMO VOLUME 49 ISSUE 1 2024 103910

RBMO



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

BIOGRAPHY

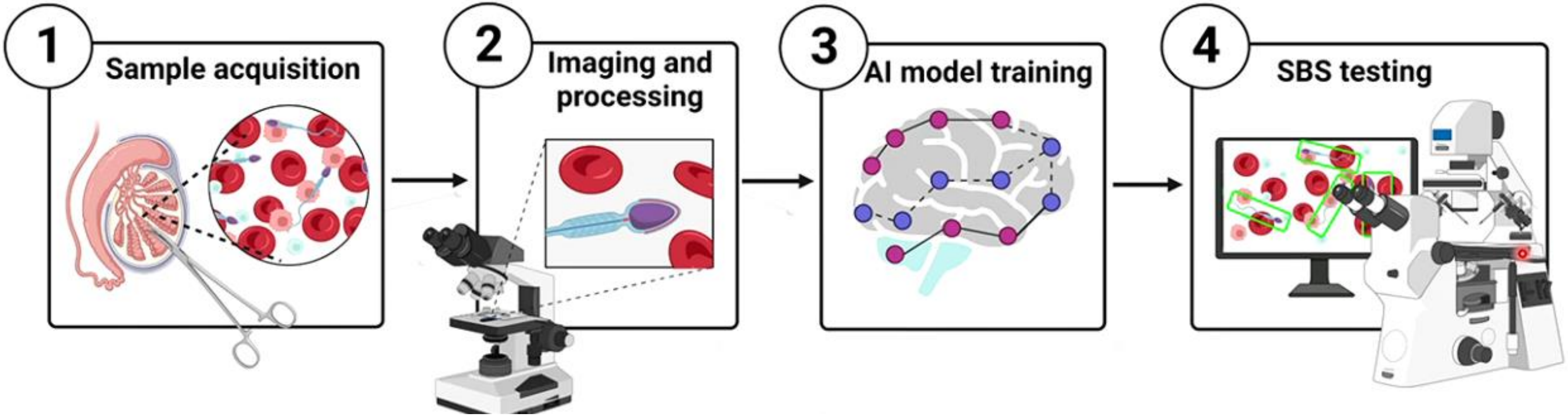
Dale Goss is a PhD student at the University of Technology Sydney and a graduate of Stellenbosch University and Monash University. He is a clinical embryologist at IVFAustralia and as a scientific advisor for NeoGenix Biosciences. His research focuses on human embryology, male infertility, and technology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

Background

- Up to 10 hours of searching
- Operator dependent
- Surgical approaches
- Variable success rates

https://doi.org/10.1016/j. rbmo.2024.103910

Study Workflow



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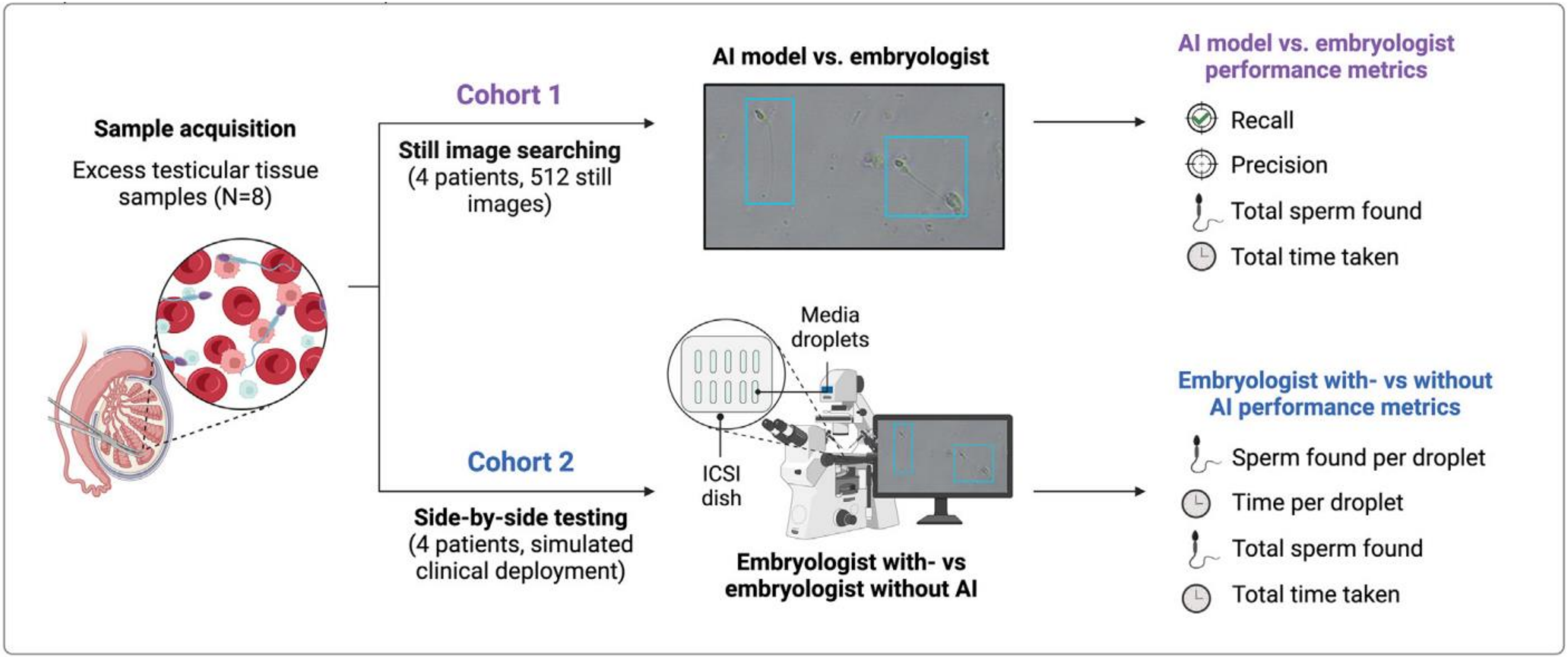
https://doi.org/10.1016/j. rbmo.2024.103910



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https://doi.org/10.1016/j. rbmo.2024.103910

Results
Searching time

- Embryologists mean of 33.91s per image

- AI average of 0.019s per image

AI = 10 sec in total Embryologist = 9400 sec or 5 hours

https://doi.org/10.1016/j. rbmo.2024.103910

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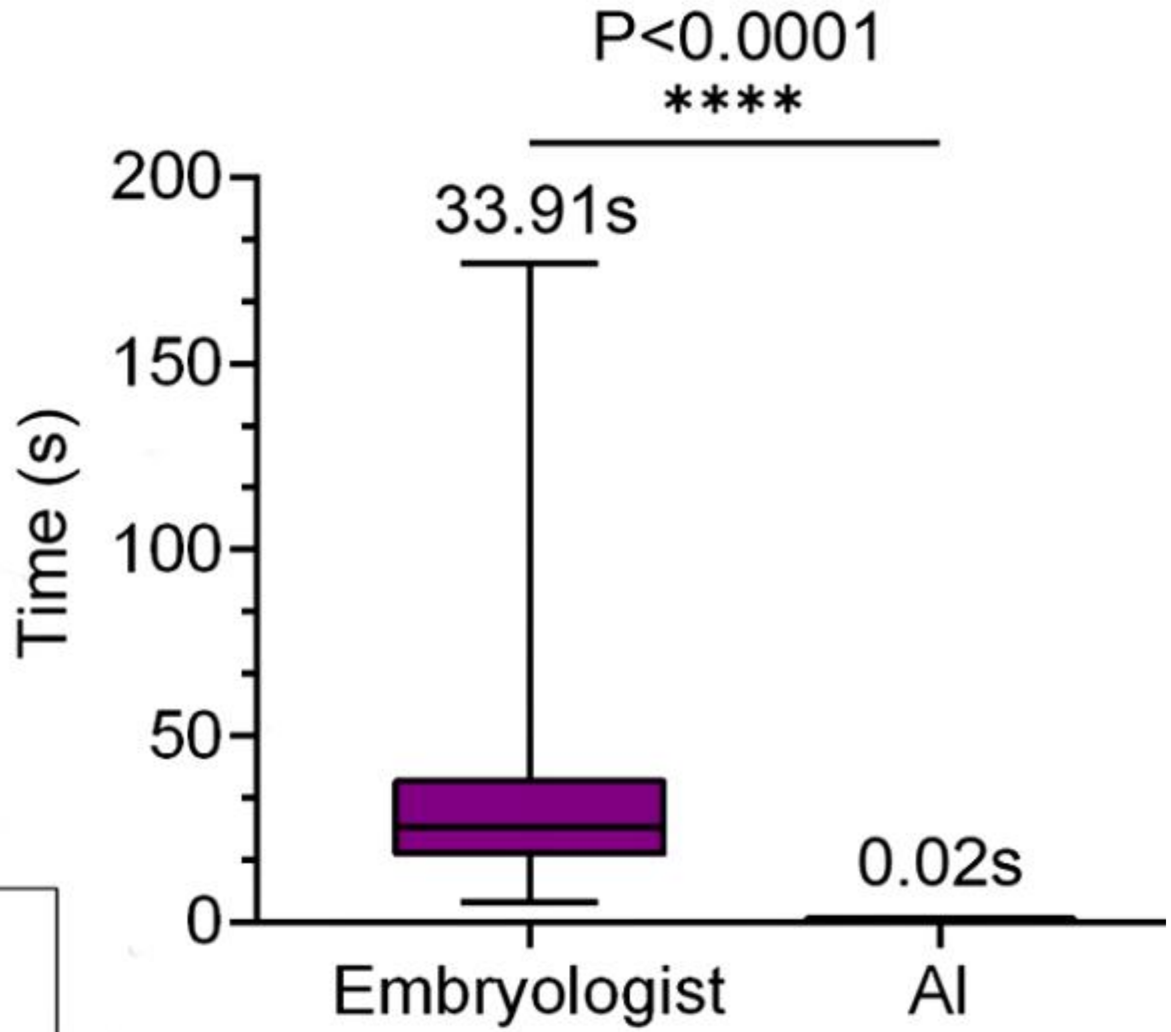
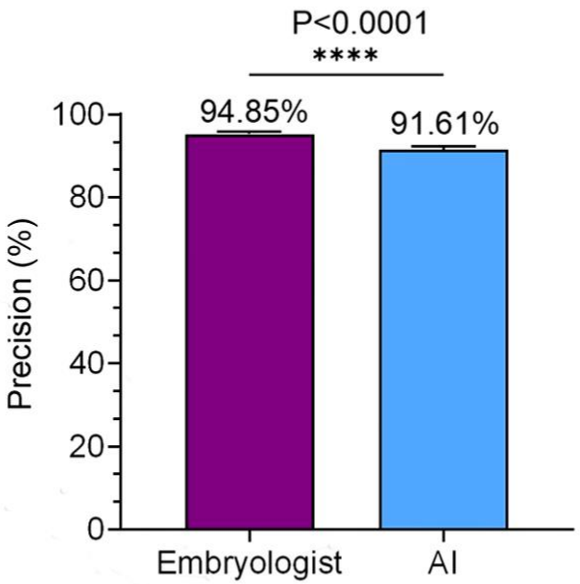


https://doi.org/10.1016/j. rbmo.2024.103910

Results
Precision

- Embryologists’ precision = 94.85%
- AI precision = 91.61%



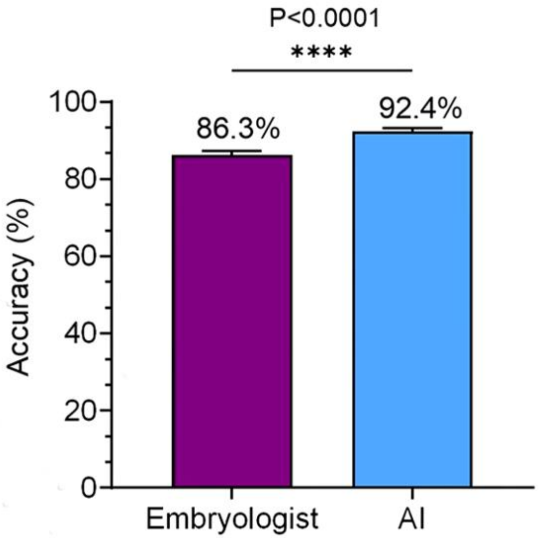
Results
Accuracy

- Embryologists' accuracy = 86.3%

Missed = 320/3826
False +ves = 55
3175 sperm found

- AI accuracy = 92.4%

Missed = 184/3826
False +ves = 285
3234 sperm found



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https://doi.org/10.1016/j. rbmo.2024.103910

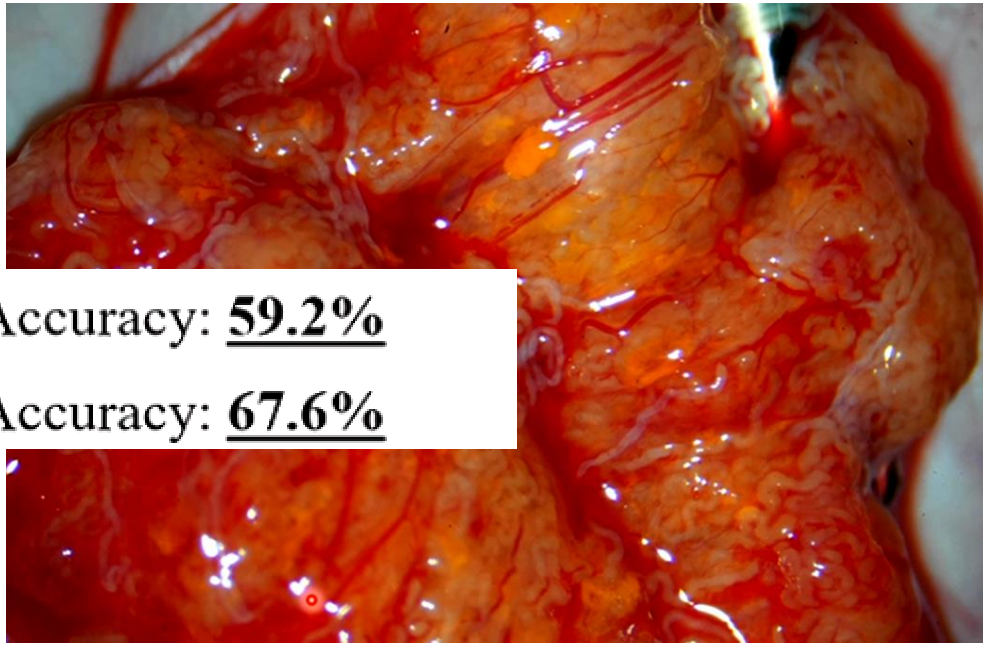
eshre
SCIENCE MOVING PEOPLE MOVING SCIENCE
European Society of Human Reproduction and Embryology

IDENTIFYING SEMINIFEROUS TUBULES FOR SPERM RETRIEVAL DURING MICRODISSECTION TESTICULAR SPERM ECTRACTION (M-TESE) USING DEEP LEARNING

Svenska Läkaresällskapet

Angel Elenkov

LUNDS UNIVERSITET



Model trained on <u>**5**</u> patients: Accuracy: <u>**59.2%**</u>

Model trained on <u>**7**</u> patients: Accuracy: <u>**67.6%**</u>

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▪ Sperm retriavel

Authors	Quality Grade	Algorithms Used	Data Source	Outcome	Accuracy
Bachelot et al., 2023 [37]	80%	ML, SVM, RF, GBT, XGB, LR, DL, KNN	Age, BMI, tobacco consumption, FSH and LH assessment, T, inhibin B, prolactin, karyotype and search for Y-chromosome microdeletion, urogenital history (cryptorchidism, infection, trauma, gonadotoxic therapy, urogenital surgery, and varicoceles).	The presence/absence of spermatozoa after examination of the surgical specimens. A positive outcome was defined as obtaining enough spermatozoa for the ICSI procedure.	The models achieved an accuracy greater than the 60%, with the best performance of RF (84.6%), GBT (76.9%), and XGB (80.8%).
Zeadna et al., 2020 [38]	80%	GBT, MvLRM	Baseline hormonal profile (before TESE) of serum FSH, LH, and T	The cutoff value for successful sperm retrieval was the presence of at least one viable of mature sperm in the testicular tissue.	AUC = 0.807 for predicting the presence of spermatozoa in patients with NOA.
Ramasamy et al., 2013 [39]	100%	ANN, LR	Clinical and laboratory data of sperm extraction	Development of an ANN and nomogram to predict sperm retrieval with microdissection testicular sperm extraction.	Nomogram accuracy: 59.6% ANN accuracy: 59.4%
Ma et al., 2011 [40]	90%	Three ANNs with feed forward-back propagation architecture were used	Leptin and FSH level	Leptin resulted in a good assistant marker for NOA diagnosis. ANNs improved the prediction accuracy of sperm retrieval.	ANN1 performance resulted in the best in the prediction of sperm recovery in NOA patients (AUC = 0.83).

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Artificial Neural Networks: A Review of the Literature. Healthcare 2024, 12, 781. https://doi.org/10.3390/ healthcare12070781

▪ Azoospermia não-obstrutiva

Authors	Quality Grade	Algorithms Used	Data Source	Outcome	Accuracy
Zhou et al., 2023 [62]	74%	LASSO, Boruta, SVM-RFE, Random Forest	Transcriptome sequencing data of testicular cells. Immunohistochemical staining data for protein expression levels	An RF model based on the transcription factors ETV2, TBX2, and ZNF689 was successfully developed to diagnose NOA.	RF model achieved an AUC of 1000 and an F-measure of 1000.
Peng et al., 2023 [63]	90%	ANN, LASSO, SVM-RFE, LR, RF	RNA-binding protein-related genes. Testicular samples, clinical samples. scENA-seq data	An ANN diagnosis model based on RNA-binding proteins DDX20 and NCBP2 was developed. The ANN model exhibited reliable predictive performance in multiple cohorts	Training cohort (GSE9210) scored 74.1% of accuracy, GSE45885 the 90.3%, GSE45887 the 85.0%, while local cohort only the 59.1%
Samli & Dogan, 2004 [64]	100%	ANN, Logistic Regression	Patient age, duration of infertility, serum hormone levels, and testicular volumes	The NN correctly predicted the outcome in 59 of the 73 test set patients (80.8%)	The accuracy of the ANN model is 80%. The accuracy of the LR model is 66%.

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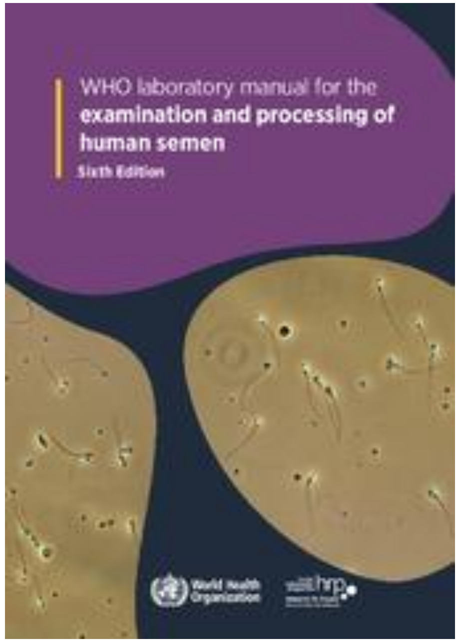
Artificial Neural Networks: A Review of the Literature. Healthcare 2024, 12, 781.
https://doi.org/10.3390/ healthcare12070781

- **IA na seleção espermática para TRA**

Análise Seminal

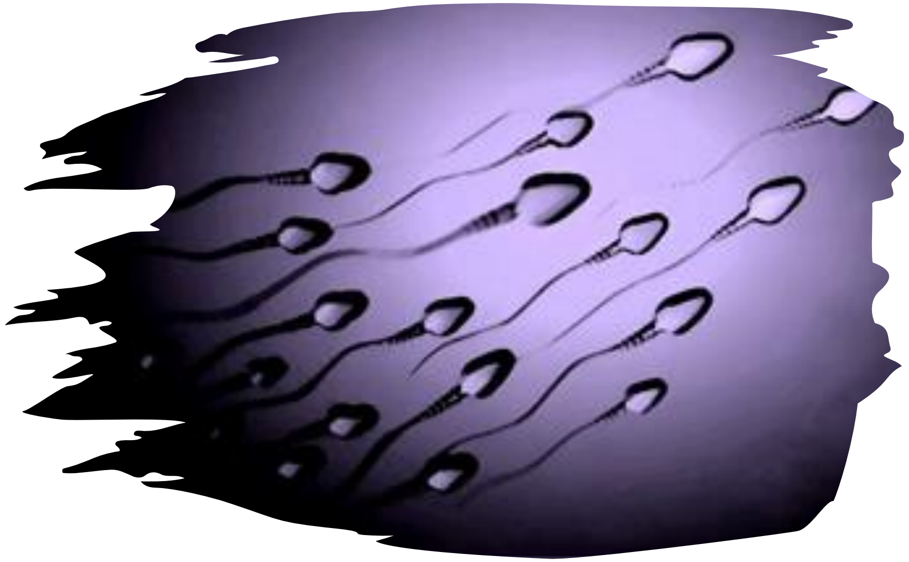
- Avaliação manual de uma amostra de sêmen usando um microscópio é demorada e requer treinamento extensivo;

- Além disso, a validade do manual a análise do sêmen tem sido questionada devido à reprodutibilidade limitada e, muitas vezes, alta variação interpessoal.

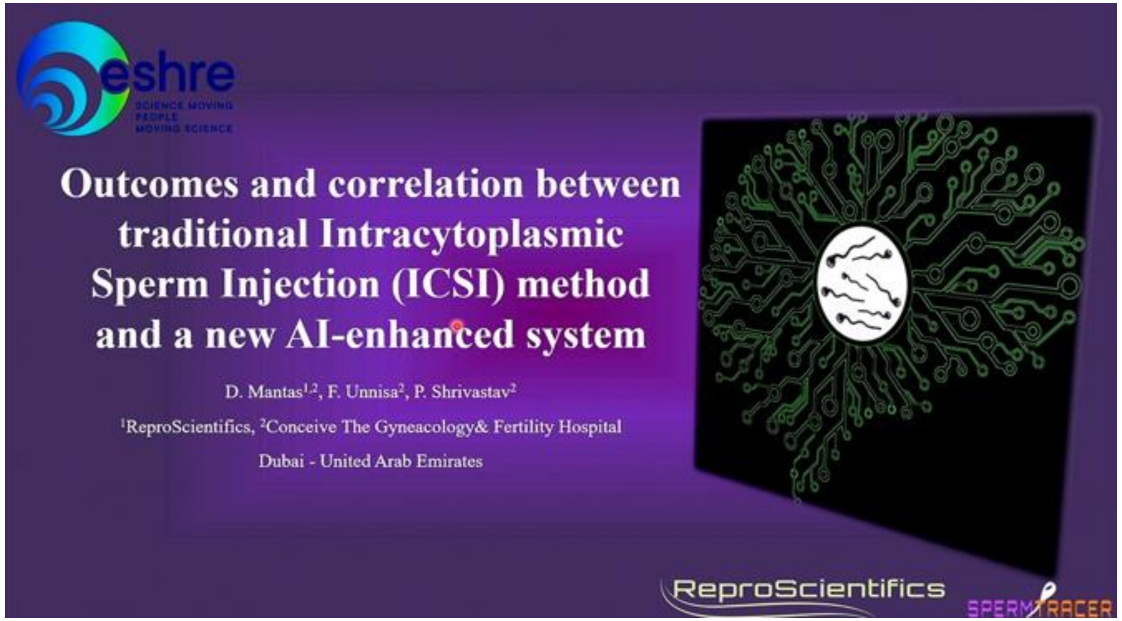


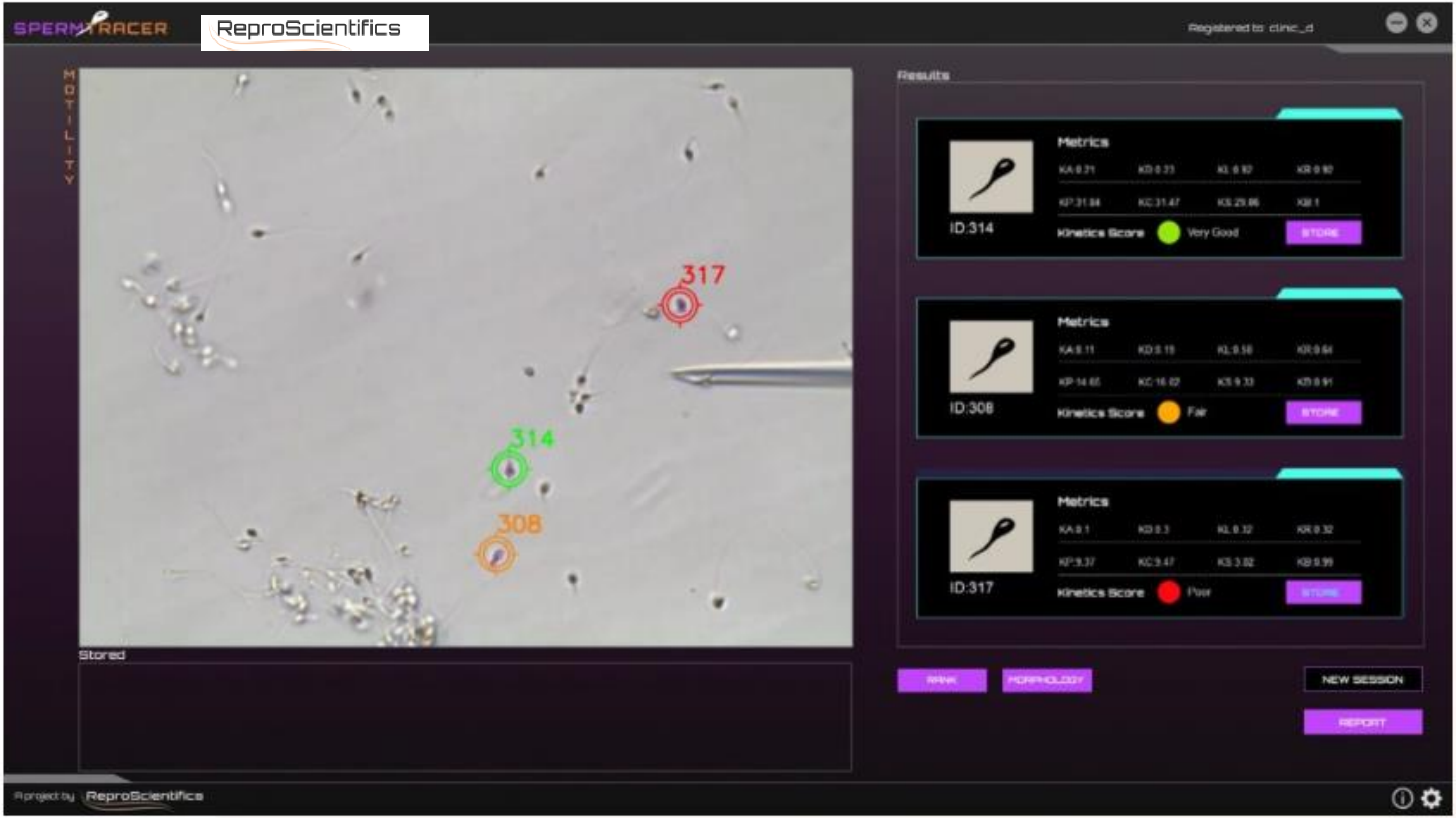
Seleção espermática para ICSI

- Manual
- Imprecisa
- Subjetiva
- Difícil de ensinar / aprender
- Falta de padronização




The future of assisted reproduction with the help of AI
The Neural Miracle:
Deep Neural Network
SPERMTRACER
With DNNs, we achieve accuracy &
real-time analysis during ICSI


eshre
Outcomes and correlation between traditional Intracytoplasmic Sperm Injection (ICSI) method and a new AI-enhanced system
D. Mantas[1,2], F. Unnisa[2], P. Shrivastav[2]
[1]ReproScientifics, [2]Conceive The Gyneacology& Fertility Hospital
Dubai - United Arab Emirates
ReproScientifics
SPERMTRACER


SPERMTRACER
ReproScientifics
MOTILITY
Results
317
314
308
Metrics
ID:314
Kinetics Score
Very Good
ID:308
Fair
ID:317
Poor
Stored
NEW SESSION
A project by ReproScientifics

Study Design

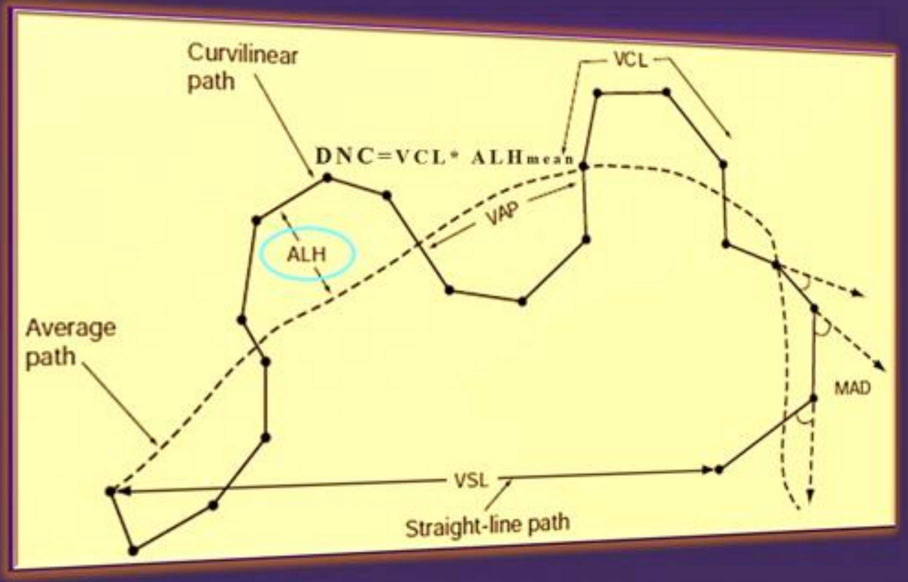
Data	Embryologists	Sperm Tracer
No Cases ICSI	26	26
Mean Age (years)	34.4	34.4
No Oocytes (M II)	188	80

Parameters Analyzed

Outcome
Fertilization (2PNs)
Cleavage
Good D3 embryos
Blastocyst Formation
Good Blastocysts (D5)

DNC - ALH	DNC: Degree of irregular movement ALH: measures the lateral movement
LIN= (VSL/VCL)	Indicates the straightness of the trajectory
STR= (VSL/VAP)	Degree of deviation from a straight path
VCL	Measures the velocity of spermatozoa along their curvilinear path as they move
VAP	Average velocity of sperms along their path, considering both straight & curved segments
VSL	Calculates: velocity of sperms along a straight line, regardless deviations from path
WOB= (VAP/VCL)	Quantifies the lateral displacement of the sperm head. Lower values less lateral movement or wobble

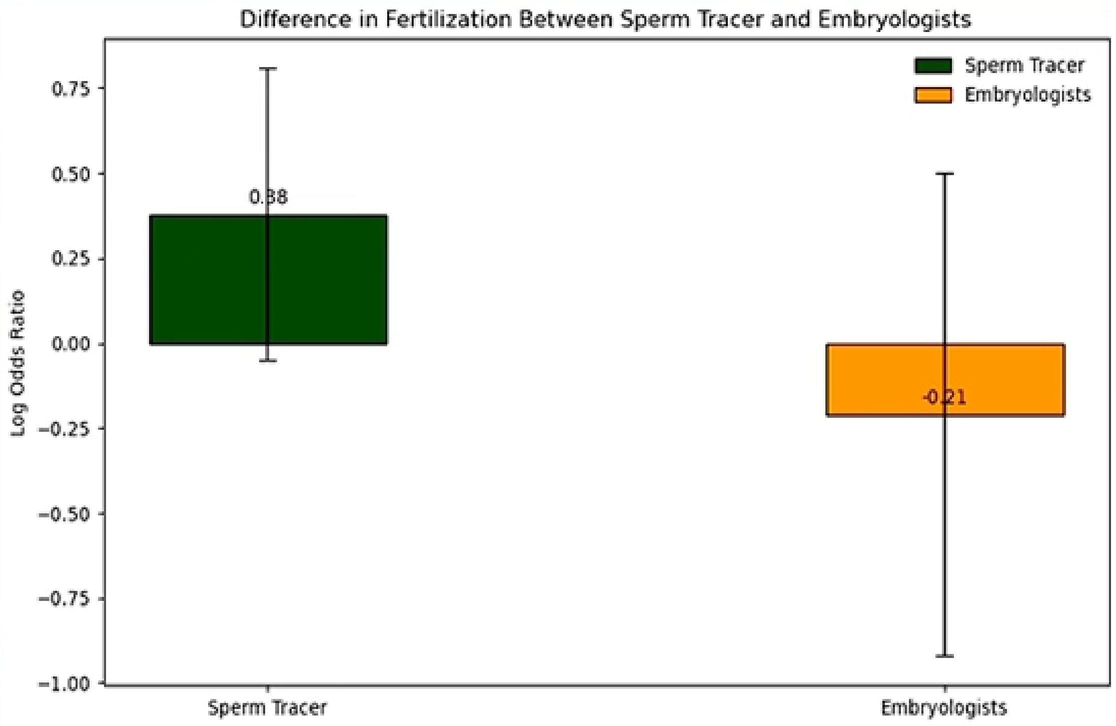
Visualization of Kinetic Parameters



Significant diferences between sperm parameters from FERT pos x FERT neg

Results and Outcomes

Outcome	Odds Ratio	95% Confidence Interval	p-value
Fertilization	1.46	[1.23, 1.89]	0.0224
Cleavage/2PNs	0.94	[0.61, 1.44]	0.7816
Cleavage/MII	0.79	[0.53, 1.18]	0.2519
Good Cleavage/2PNs	1	[0.60, 1.66]	0.9993
Good Cleavage D3 embryos	1.35	[0.74, 2.48]	0.3258
Blastocyst Formation	1.7	[0.73, 3.94]	0.2162
Good Blastocysts D5	0.84	[0.27, 2.57]	0.756



1 RBMO VOLUME 47 ISSUE 3 2023 103244

EDITORIAL

The success of ICSIA and the tough road to automation

RBMO has just published a paper by Nuno Costa-Borges and colleagues in which the authors announce the birth of the first babies following clinical application of automated intracytoplasmic sperm injection (ICSIA). This is an important achievement and a milestone. It is also welcome news to those who see the letter 'T' in 'ART' (assisted reproductive technology) as fundamental to progress in the field.

donated human oocytes with informed consent. The investigators followed a responsible path in introducing this technology (Brison et al., 2013) with exhaustive animal model experimentation and pre-clinical assessment culminating in the pilot study. They remain cautious and state their plans to refine and further develop the robot and follow the pilot study with a registered clinical trial. It is also noteworthy that the pilot study design

volume of laboratory work and the ubiquitous use of ICSI for all indications of infertility, again unlike in the early days when it was reserved for male factor infertility. Another technical variation is that the first polar body is routinely placed at the 12 or 6 o'clock position during injection rather than positioned relative to the putative area of germinal vesicle breakdown/spindle location and ooplasmic organelle concentration (Palermo et al.,

TABLE 1 **CONVENTIONAL, PIEZO-ICSI AND ICSIA DECONSTRUCTED**

Action	Conventional ICSI	Piezo-assisted ICSI	Achieved with ICSIA robot?	Remains human operator dependent with ICSIA?	Micromanipulation skill required?
Oocyte denudation and preparation for injection	+	+	No	Yes	No
Semen preparation with isolation of motile spermatozoa from seminal fluid	+	+	No	Yes	No
ICSI dish preparation	+	+	No	Yes	No
Placement and alignment of microtools on microtool holders	+	+	No	Yes	Yes
Placement of prepared sperm in PVP in the ICSI dish	+	+	No	Yes	No
Lowering of the ICSI needle	+	+	Yes	No	Yes, but obviated with ICSIA
Bringing microtools and cells into focus throughout the procedure	+	+	Yes	No	Yes
Selection and immobilization of a single spermatozoon	+	+	No	Yes	Yes
Aspiration of the sperm in the injection needle while controlling its position in the needle until injection	+	+	No	Yes	Yes
Centering the egg in the visual field	+	+	No	Yes	Yes
Lowering the holding pipette in the vicinity of the egg	+	+	Yes	No	Yes, but obviated with ICSIA

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Increasing suction on the holding pipette to hold and position the egg	+	+	No	Yes	Yes
Bringing the sperm to the tip of the needle	+	+	No	Yes	Yes
(P) Holding the sperm a safe distance from the tip of the needle	N/A	+	No	Yes	Yes
Advancing the needle toward the zona pellucida of the egg	+	+	Yes	No	Yes, but obviated with ICSIA
(P) Once at the zona pellucida, releasing a pulse to 'drill' the zona	N/A	+	Yes	No	Yes, but obviated with ICSIA
Pressing against and penetrating the zona pellucida	+	N/A	N/A	N/A	Yes, but obviated with ICSIA
(P) Withdrawing the needle to release residual zona material & bring the sperm to the tip	N/A	+	Yes	No	Yes, but obviated with ICSIA
Breaking the oolemma either with aspiration or by pressure or 'stirring'	+	N/A	N/A	N/A	Yes
(P) Reinserting the needle through the drilled zona, advancing to the oolemma and pressing until halfway in the oocyte	N/A	+	Yes	No	Yes, but obviated with ICSIA
(P) Delivering a pulse to break the oolemma	N/A	+	Yes	No	Yes, but obviated with ICSIA
Ejecting the sperm into the egg, while controlling the amount of PVP/buffer being injected	+	+	No	Yes	Yes
Withdrawing the needle from the cytoplasm	+	+	Yes (but intervention would be needed if sperm moves back with the needle)	No (but intervention would be needed if sperm moves back with the needle)	Yes
Releasing the egg and lifting the microtools to remove the ICSI dish	+	+	No	Yes	Yes
Removing the dish from the platform and moving the injected egg/s out of the ICSI dish into a culture dish and into the incubator	+	+	No	Yes	No

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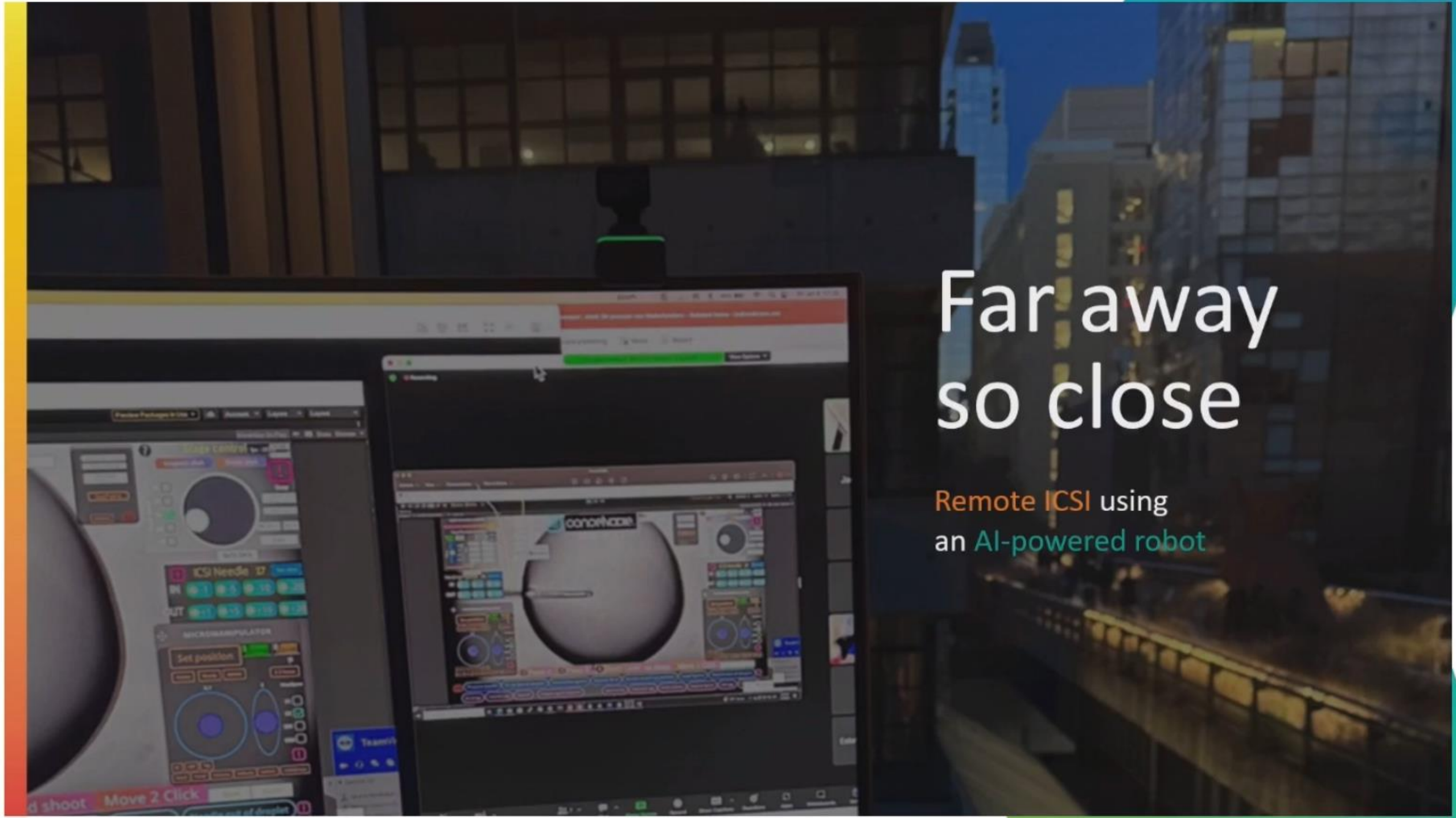

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Automated ICSI

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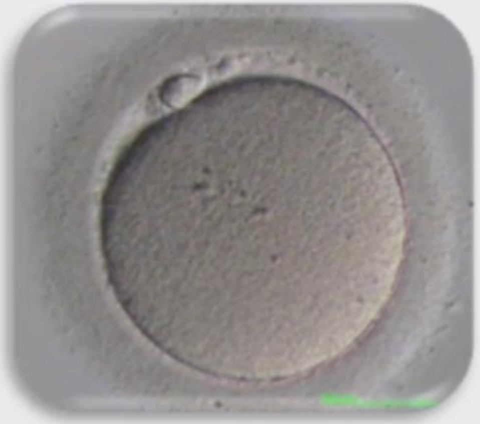
position the sperm, uh, right at the tip of the needle.

ICSI completly automated

15 Automated Routines

- Prepare needle
- Go to sperm droplet
- Immobilize sperm
- Second shot
- Needle in pickup position
- Load sperm
- Needle out of droplet



- Go to egg
- Hold the egg
- Open ZP
- Sperm in tip
- Penetrate egg
- Break oolemma
- Deposit sperm
- Finish ICSI

Broken into 38 automated sperm sub-commands:

Prepare needle

- Move stage to service droplet
- Change objective to 40X
- Bring needle to work position
- Focus the needle
- Detect needle tip
- Set meniscous calib position
- Activate piezo cleaning
- Activate aspiration control
- Verify meniscous position

Go to sperm drople

- Send needle to home position
- Move stage to PVP droplet
- Change objective to Laser
- Focus droplet edge
- Bring needle to work position

Immoblize sperm

- Automatic sperm detection
- Sperm motility evaluation and ranking
- Tracking of selected sperm
- Computing interception trajectory
- Laser – sperm positioning
- Laser activation
- Verification of perm immobilization
- Verification of safe laser interaction

Second shot

- Detect immobilized sperm
- Change to high mag camera
- Activate sperm tail detection
- Find middle tail position
- Position stage in middle tail
- Activate laser

Needle in pick up postion

- Center immobilized sperm
- Bring needle to sperm region
- Activate sperm tail tip detection
- Bring needle Z to tail tip plane
- Activate needle positioning routine

Laod sperm

- Detect immobilized sperm head
- Track sperm and needle tip
- Activate smart aspiration control
- Determine if sperm is inside needle
- Activate sperm stabilization control

Broken into 42 automated egg sub-commands:

Go to egg

- Move stage to egg droplet
- Find the egg
- Move stage to bring the egg to the middle of field of view
- Change to 40X magnification
- Find the egg
- Move stage to bring the egg to the middle of field of view

Hold the egg

- Bring holding pipette to work position
- Detect holding pipette tip
- Detect egg's holding point
- Move the holding pipette next to egg
- Activate aspiration in holding pipette
- Autofocus the egg

Open ZP

- Detect zona pellucida inner and outter limits
- Determine lasing spot
- Move the holding pipette to position the egg under the laser target
- Activate laser

Sperm in tip

- Bring needle to work position
- Detect needle tip
- Determine egg initial injection position
- Move needle to egg initial injection position
- Detect sperm in needle
- Iteratively increase pressure on needle
- Activate sperm position control

Penetrate egg

- Determine egg final injection position A and B
- Move the needle to the egg final injection position A
- Reduce speed and move the needle to the egg final injection position B

Break oolemma

- Determine oolema membrane deformation
- Avtivate piezo pulse
- Determine oolema membrane rupture

Deposit sperm

- Detect needle tip
- Detect sperm position inside the needle
- Detect meniscus position
- Activate positive aspiratipon control
- Determine if the sperm has passed needle position

Finish ICSI

- Move needle left using a slow speed
- Stop for 2 seconds
- Move needle to initial injection position using fast speed
- Move needle to work position
- Bring the needle out of the droplet
- Appli positive pressure on the egg
- Bring the holding pipette out of the droplet

conceivable Pilot clinical trial

January 2024: 22 human eggs

Survival rate	Normal fertilization rate	Blastocyst formation rat
95%	68%	73%

Clinicaltrials.gov: NCT06074835 IRB approval: RA-2023-01 IRB ID: CONBIOÉTICA-09-CEI-001-20170131

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Pregnancies using automation

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Launching January 2025

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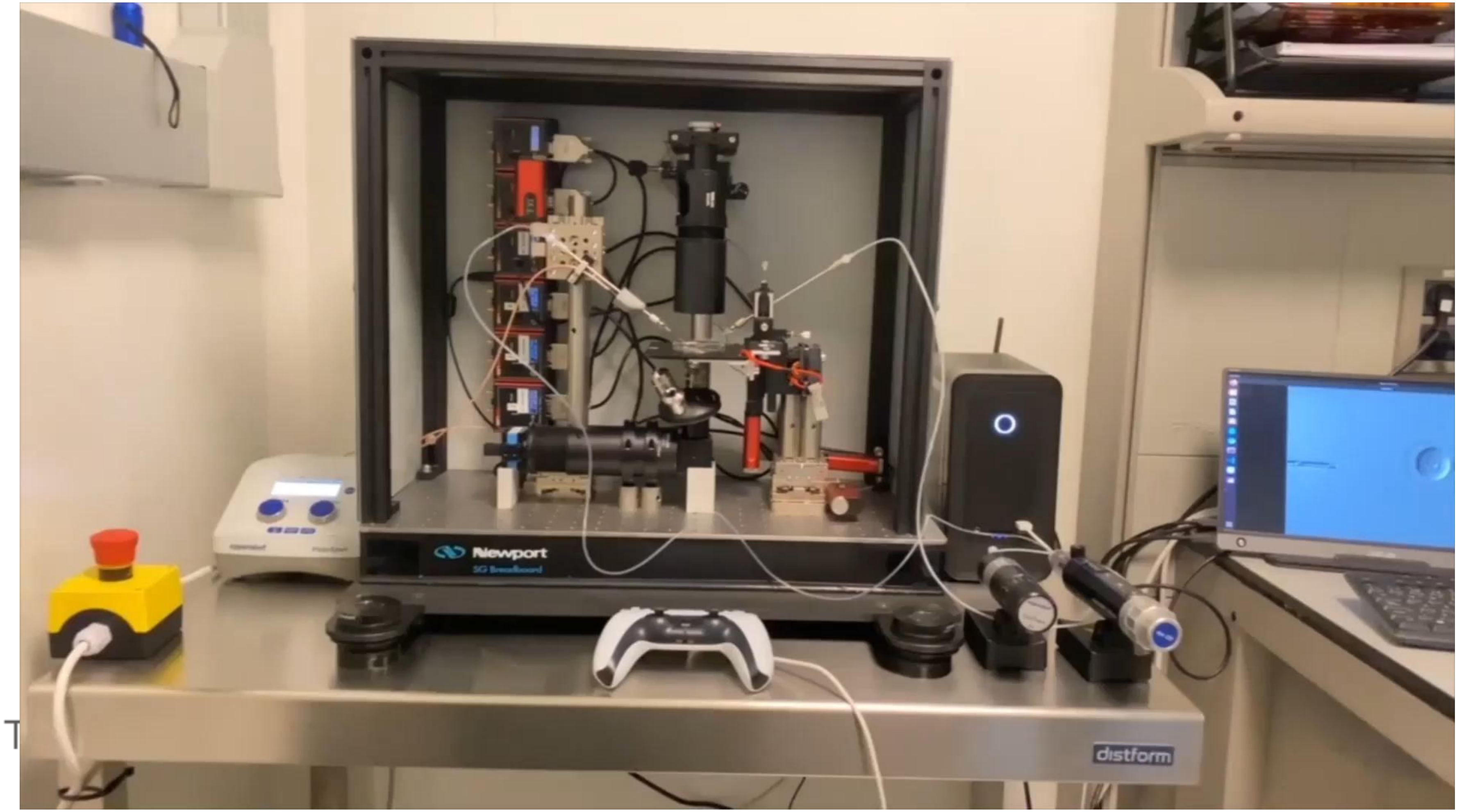
ARTICLE

First babies conceived with Automated Intracytoplasmic Sperm Injection

BIOGRAPHY

Santiago Munné is Chief Innovation Officer at Overture Life. He has published over 260 peer-reviewed publications and multiple prize papers. He developed the first assays of preimplantation genetic testing for aneuploidy, obtaining the first pregnancies. Santiago Munné has cofounded Reprogenetics, Recombine, Phosphorus, MedAnswers, Overture Life and HoMu Health ventures.

Nuno Costa-Borges[1], Santiago Munné[2,*], Eduard Albó[2], Sergi Mas[2], Carolina Castelló[1], Guillem Giralt[2], Zhuo Lu[3], Charles Chau[3], Mònica Acacio[1], Enric Mestres[1], Queralt Matia[1], Laura Marquès[4], Mariona Rius[5], Carmen Márquez[6], Ivette Vanrell[7], Aïda Pujol[8], Daniel Mataró[8], Michelle Seth-Smith[2], Luis Mollinedo[2], Gloria Calderón[1], John Zhang[3]



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Inteligência Artificial na Andrologia Clínica

Andrology. 2024 Jul 17. doi: 10.1111/andr.13693. Online ahead of print.

Artificial intelligence and clinical guidance in male reproductive health: ChatGPT4.0's AUA/ASRM guideline compliance evaluation

Oya Gokmen [1], Tugba Gurbuz [2], Belgin Devranoglu [3], Muhammet Ihsan Karaman [4]

Affiliations + expand

PMID: 39016301 DOI: 10.1111/andr.13693

Avaliar a eficácia do ChatGPT4.0 em responder a consultas clínicas sobre infertilidade masculina, em conformidade com as diretrizes da AUA/ASRM.

- Na categoria ***verdadeiro/falso***, a precisão inicial foi de 92%, ***que aumentou para 94%*** até o final do período do estudo. Para perguntas ***de múltipla escolha***, a precisão ***melhorou de 85% para 89%.***

- Inicialmente, algumas respostas não estavam totalmente alinhadas com as diretrizes da AUA/ASRM. No entanto, ***ao final dos 60 dias, essas respostas se tornaram mais abrangentes e clinicamente relevantes, indicando uma melhoria na capacidade do modelo de gerar respostas conformes às diretrizes (p < 0,05).***

Andrology. 2024 Jul 17. doi: 10.1111/andr.13693

Chatbots vs andrologists: Testing 25 clinical cases

Ophélie Perrot [1], Aurelie Schirmann [2], Adrien Vidart [2], Cyrille Guillot-Tantay [2], Vincent Izard [2], Thierry Lebret [2], Bernard Boillot [2], Benoit Mesnard [2], Cedric Lebacle [3], François-Xavier Madec [2]

Affiliations + expand

PMID: 38599321 DOI: 10.1016/j.fjurol.2024.102636

- Analisou as respostas de 32 especialistas, 18 residentes e três *chatbots* (ChatGPT v3.5, v4 e Bard) para 25 casos clínicos de andrologia.

- ***Os especialistas obtiveram uma pontuação média mais alta*** (m=11/12,4 σ=1,4) do que o ChatGPT v4 (m=10,7/12,4 σ=2,2, p=0,6475), ChatGPT v3.5 (m=9,5/12,4 σ=2,1, p=0,0062) e Bard (m=7,2/12,4 σ=3,3, p<0,0001).

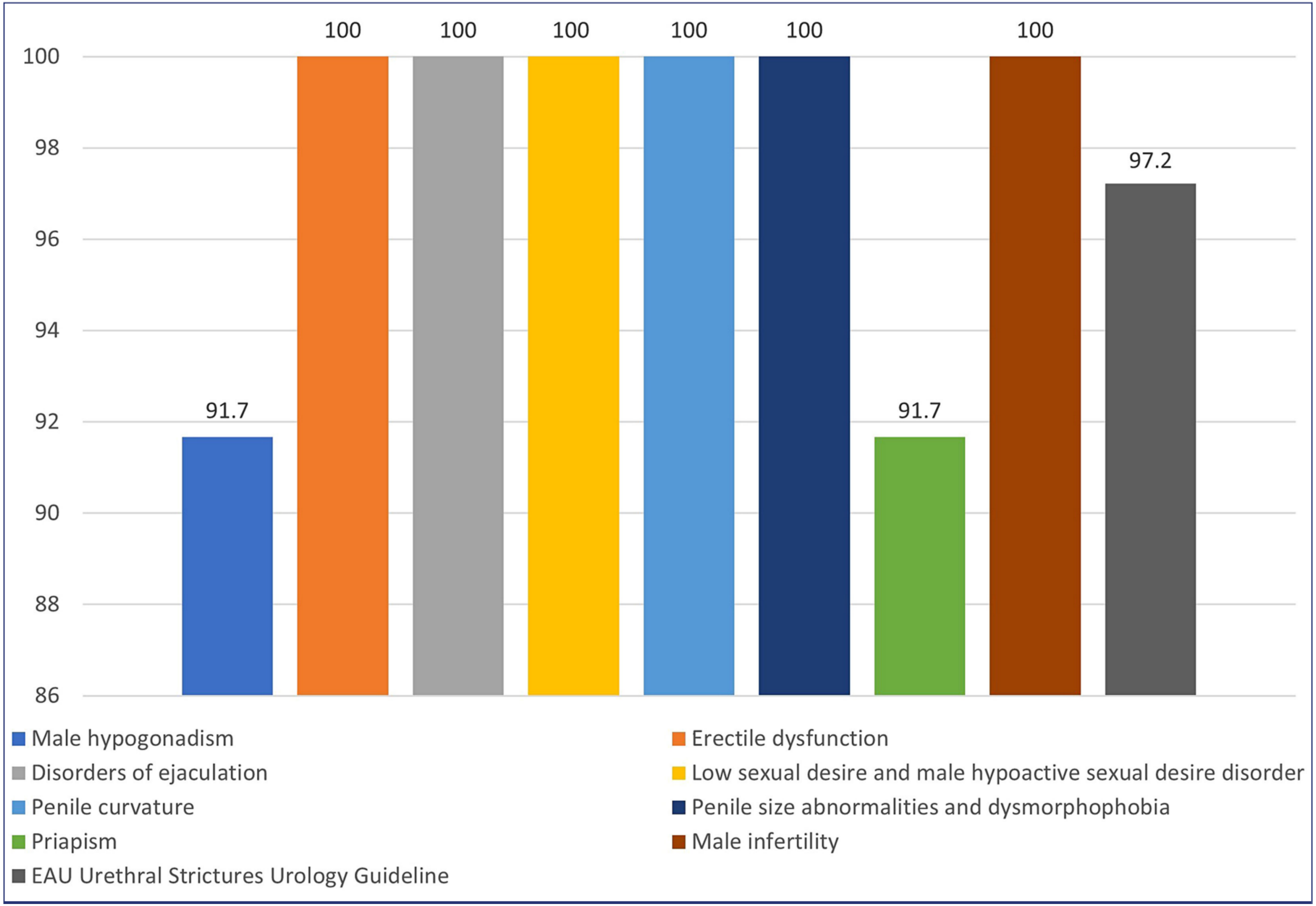
- *Os residentes obtiveram uma pontuação méd*ia (m=9,4/12,4 σ=1,7) ***maior que a do Bard*** (m=7,2/12,4 σ=3,3, p=0,0053***), mas menor que a do ChatGPT v3.5*** (m=9,5/12,4 σ=2,1, p=0,8393) e ***v4*** (m=10,7/12,4 σ=2,2, p=0,0183).

Urol Res Pract. 2023 Nov;49(6):365-369. doi: 10.5152/tud.2023.23171.

Assessing the Performance of Chat Generative Pretrained Transformer (ChatGPT) in Answering Andrology-Related Questions

Ufuk Caglar [1], Oguzhan Yildiz [1], M Fırat Ozervarli [2], Resat Aydin [2], Omer Sarilar [1], Faruk Ozgor [1], Mazhar Ortac [2]

- De 136 perguntas avaliadas, ***108 atenderam aos critérios***.
- Destas, ***87,9% receberam respostas corretas e adequadas***, 9,3% foram corretas, mas insuficientes, e 3 respostas continham tanto informações corretas quanto incorretas.
- ***Nenhuma pergunta foi respondida completamente errada.***



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Urology Research and Practice 2023;49(6):365-369 DOI: 10.5152/tud.2023.23171

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Fertility problems

AI-modelled test for male infertility could soon be with GPs, researchers say

Initial blood test without need for semen analysis could 'make screening more accessible'

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scientific reports

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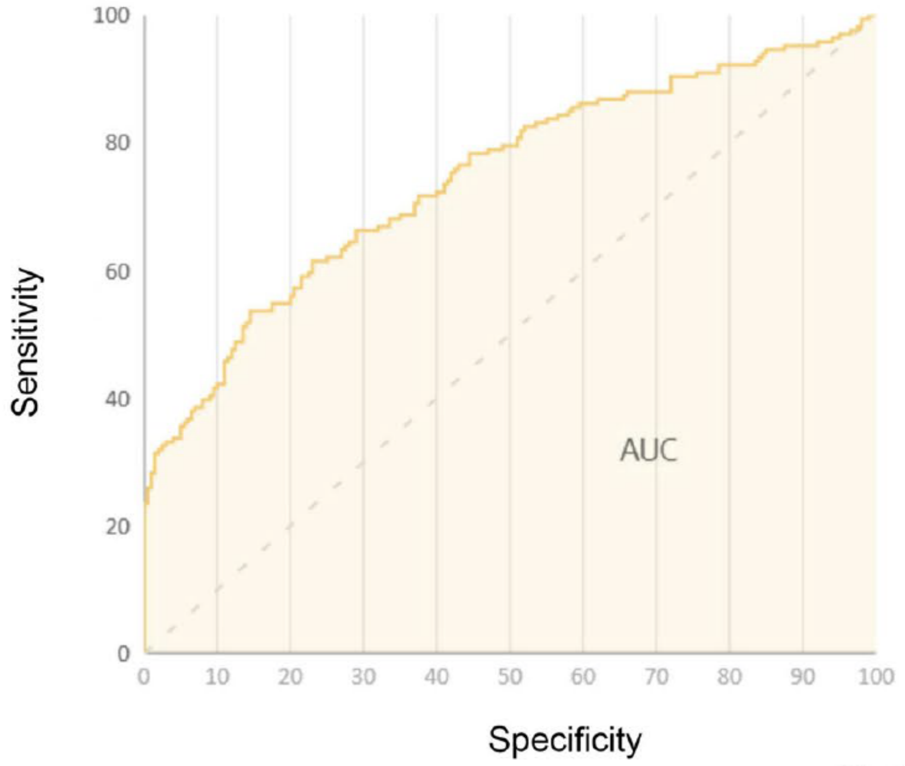
OPEN

A new model for determining risk of male infertility from serum hormone levels, without semen analysis

Hideyuki Kobayashi, Masato Uetani, Fumito Yamabe, Yozo Mitsui, Koichi Nakajima & Koichi Nagao

Scientific Reports | (2024) 14:17079 | https://doi.org/10.1038/s41598-024-67910-0



Accuracy	63.39%
Precision	56.61%
Recall	82.53%
F-value	67.16%

Threshold 0.30

Accuracy	69.67%
Precision	76.19%
Recall	48.19%
F-value	59.04%

Threshold 0.49

The AI prediction model validated the results for OA with a 70% accuracy and for NOA with 100% accuracy.

Prediction accuracy

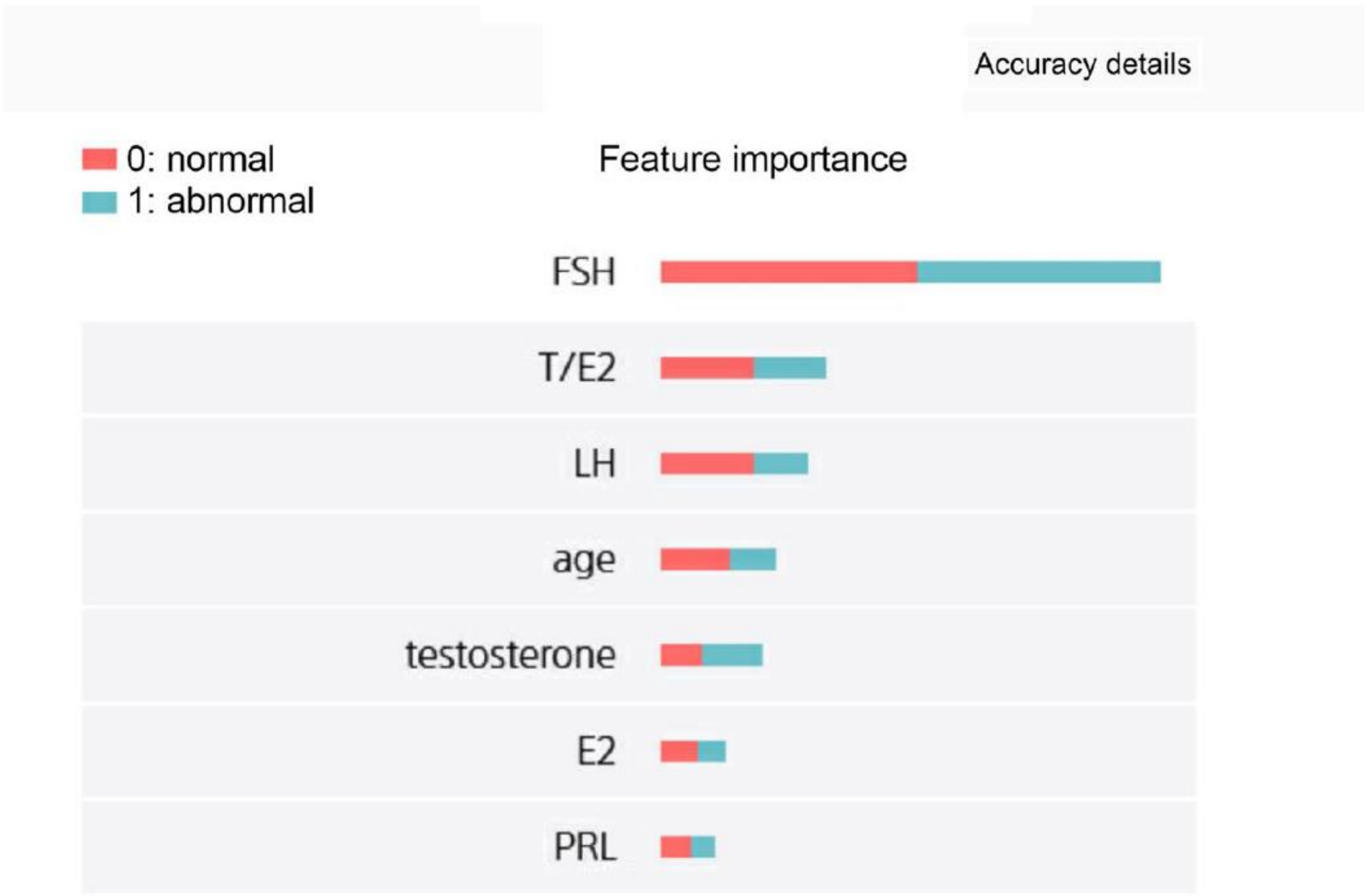
Prediction accuracy level

★★★★☆

AUC 74.42%

			Accuracy evaluation
AUC	88~100%	★★★★★	very high
	74~88%	★★★★☆	high
	63~74%	★★★☆☆	standard
	56~63%	★★☆☆☆	low
	0~56%	★☆☆☆☆	very low

Scientific Reports | (2024) 14:17079 | https://doi.org/10.1038/s41598-024-67910-0



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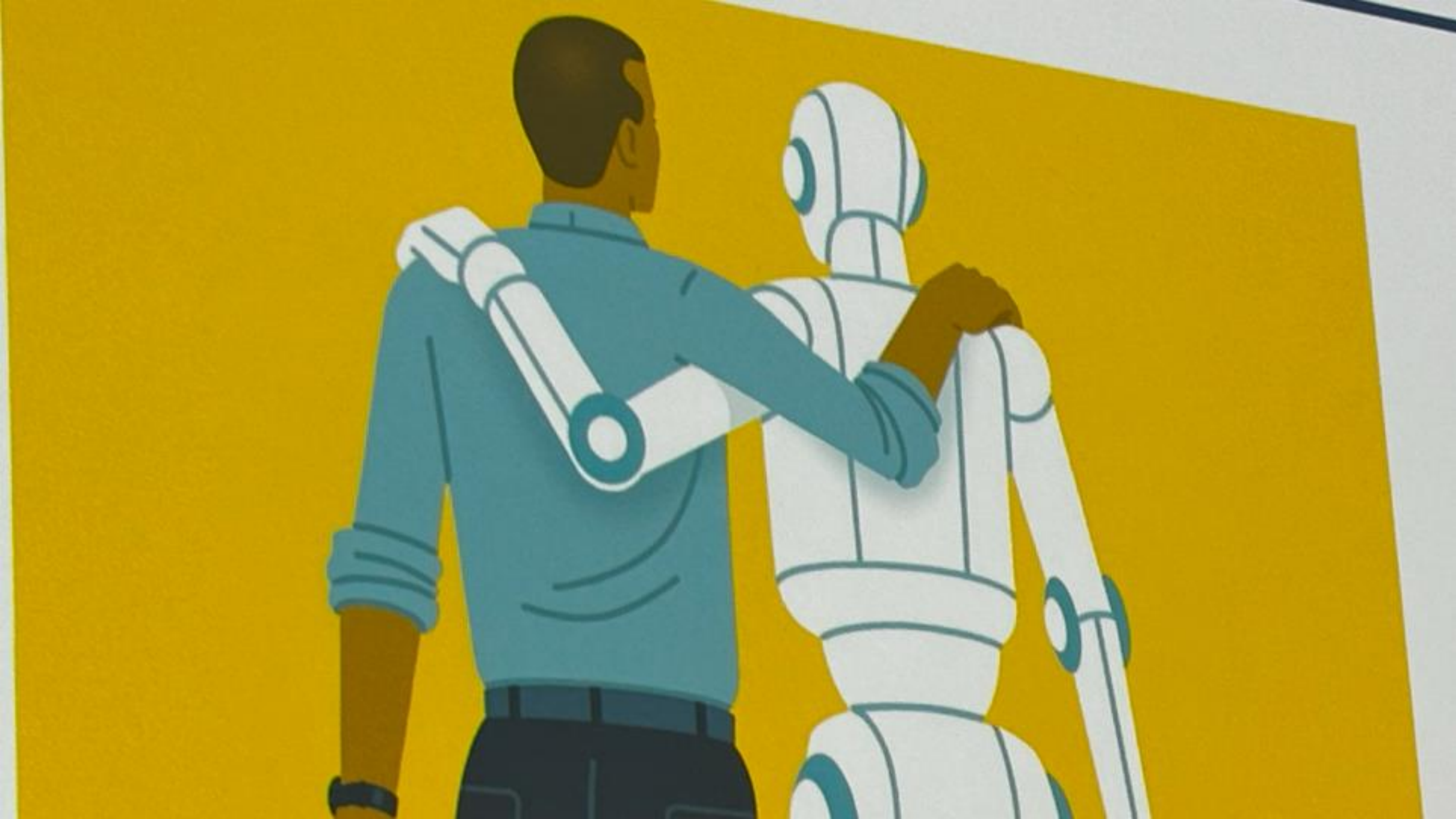
Robots can help us do IVF better.

Never tired

Never distracted

Always consistent & precise




Obrigado!

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