

L'IA appliquée à l'AMP simplifie la prédiction : le modèle FORTUNE

GYNAZUR 2026

Dr. André GUERIN

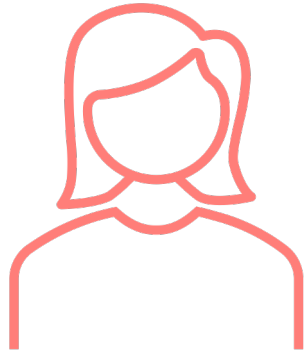
Dept francophone IVI

Barcelona

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Médecine friendly prédire le futur

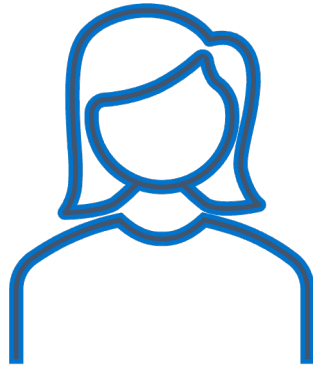


- Avant: plus facile?

- **Patientes plus jeunes**
- **Protocole normatif de base**
 - Protocole Long agoniste
 - hCG
 - Jour3 ET
- **Peu d'hyperstimulation**
- **Peu de réponse ovarienne basse**



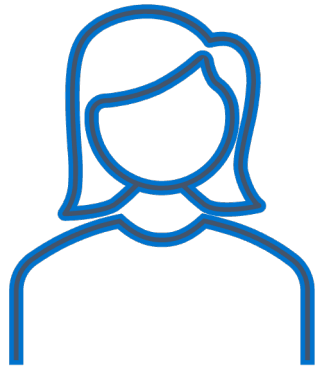
Médecine friendly prédire le futur



- En 2026
 - Âge moyen a augmenté ++
 - Reserve ovarienne a baissé
 - Plus de cycles effectués en amont
 - Disparition des hyperstimulations
 - Peu de normo répondeuses
 - Pourcentage élevé de basse réponse++++++



Médecine friendly prédire le futur



- Taux d'abandon d'un programme FIV:
 - Système avec remboursement : **25%**
 - Système sans remboursement : **50%**
- Une PMA “plus friendly”
- En 2026
 - Réduire l'impact émotionnel négatif en expliquant mieux les chances de succès de façon précise et valide.....Personnalisation



Echec dimplantation controverses certitudes



Human Reproduction Open, 2023, 2023(3), hoad023

<https://doi.org/10.1093/hropen/hoad023>

ESHRE Pages

ESHRE good practice recommendations on recurrent implantation failure[†]

ESHRE Working Group on Recurrent Implantation Failure, D. Cimadomo ¹, M.J. de los Santos ², G. Griesinger ^{3,4}, G. Lainas ⁵, N. Le Clef ⁶, D.J. McLernon ⁷, D. Montjean ⁸, B. Toth⁹, N. Vermeulen ⁶, and N. Macklon ^{10,*}

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⁹Gynecological Endocrinology and Reproductive Medicine, Medical University Innsbruck, Innsbruck, Austria

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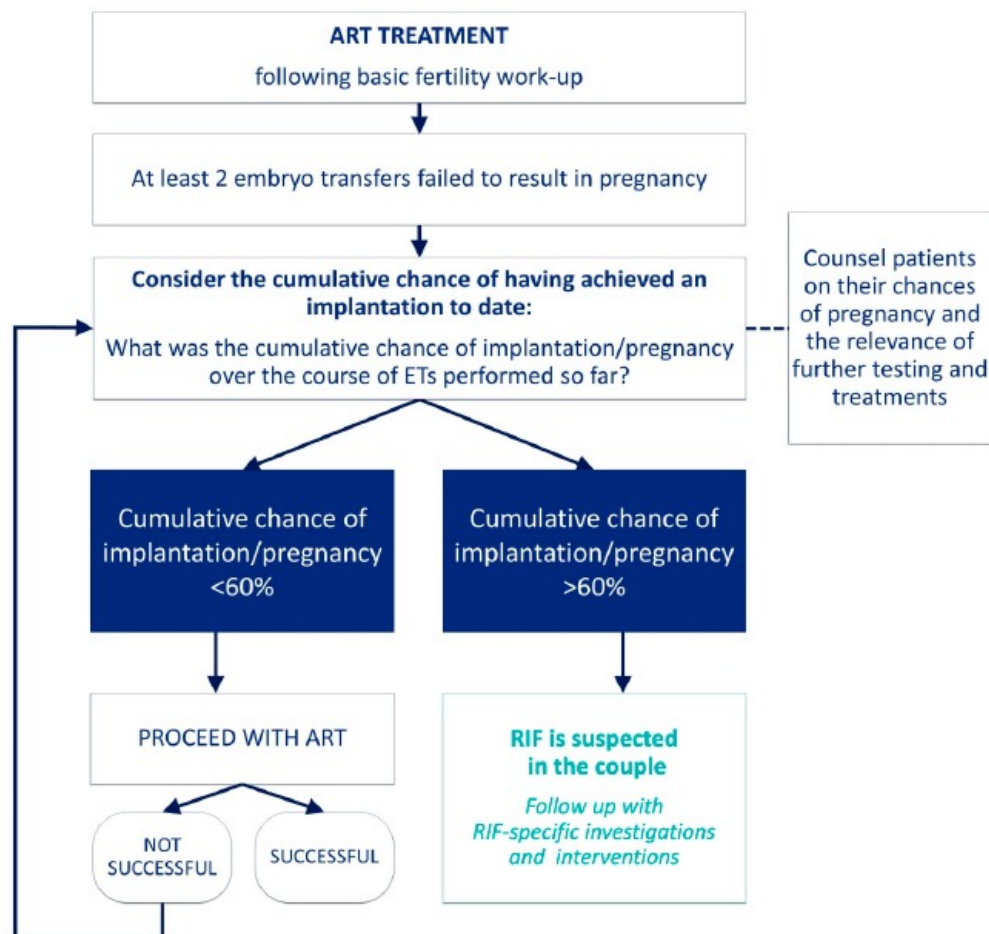
*Correspondence address. ESHRE Central Office, BXL7—Building 1, Nijverheidslaan 3, B-1853 Strombeek-Bever, Belgium. E-mail: guidelines@eshre.eu  <https://orcid.org/0000-0003-2436-2316>.

[†]ESHRE pages content is not externally peer reviewed. The manuscript has been approved by the Executive Committee of ESHRE.



Echec d'implantation controverses certitudes

♀	☐ Medical history ☐ Physical examination ☐ Pelvic 2D ultrasound for detection of structural abnormalities, where needed with additional imaging ☐ Assessment of ovulatory function through a menstrual calendar and laboratory testing ☐ AMH or other ovarian reserve testing
♂	☐ Medical history ☐ Physical examination ☐ Semen analysis





Echec d'implantation controverses certitudes

Crude estimation based on the clinic's pregnancy rates

It is recognized that carrying out individual calculations per patients may not always be feasible. An alternative approach could be to make an estimation, based on the clinic's pregnancy rate for specific patient groups. For the example presented in the table, published pregnancy data were used.

While there will be some women who might be expected to have a 60 % chance of implantation after just embryo transfer, the minimum number for identifying implantation failure to be 'recurrent' should be two'.

	Maternal age	Implantation rate / pregnancy rate ¹	Cumulative likelihood of implantation for each embryo transfer (embryos of unknown euploidy)						RIF THRESHOLD of >60%
			FIRST ET (n=1)	SECOND ET (n=2)	THIRD ET (n=3)	FOURTH ET (n=4)	FIFTH ET (n=5)	SIXTH ET (n=6)	
Embryos of unknown euploidy	<35	31,5	31,5	53,1	<u>67,9</u>	78,0	84,9	89,7	Intervene after 3 ETs
	35-39	25,9	25,9	45,1	59,3	<u>69,9</u>	77,7	83,4	Intervene after 4 ETs
	≥40	15	15,0	27,8	38,6	47,8	55,6	<u>62,3</u>	Intervene after 6 ETs
Euploid embryos	<35	68,4	<u>68,4</u>	90,0	96,8	99,0	99,7	99,9	Intervene after 2 ETs
	35-40	64,1	<u>64,1</u>	87,1	95,4	98,3	99,4	99,8	Intervene after 2 ETs
	>40	58,0	58,0	<u>82,4</u>	92,6	96,9	98,7	99,5	Intervene after 2 ETs



Echec d'implantation controverses certitudes

Rate of true recurrent implantation failure is low: results of three successive frozen euploid single embryo transfers

Paul Pirtea, M.D.,^{a,b} Dominique De Ziegler, M.D.,^b Xin Tao, Ph.D.,^c Li Sun, Ph.D.,^c Yiping Zhan, Ph.D.,^c Jean Marc Ayoubi, M.D.,^b Emre Seli, M.D.,^{a,d} Jason M. Franasiak, M.D., H.C.L.D.,^a and Richard T. Scott Jr., M.D., H.C.L.D.^a

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Does recurrent implantation failure exist? Prevalence and outcomes of five consecutive euploid blastocyst transfers in 123 987 patients

Pavan Gill^{1,†}, Baris Ata^{2,3,†}, Ana Armanz^{4,5}, Danilo Cimadomo⁶, Alberto Vaiarelli⁶, Human M. Fatemi⁷, Filippo Maria Ubaldi⁶, Juan A. Garcia-Velasco⁴, and Emre Seli^{1,8,*}

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⁸Department of Obstetrics, Gynecology and Reproductive Sciences, Yale School of Medicine, New Haven, CT, USA

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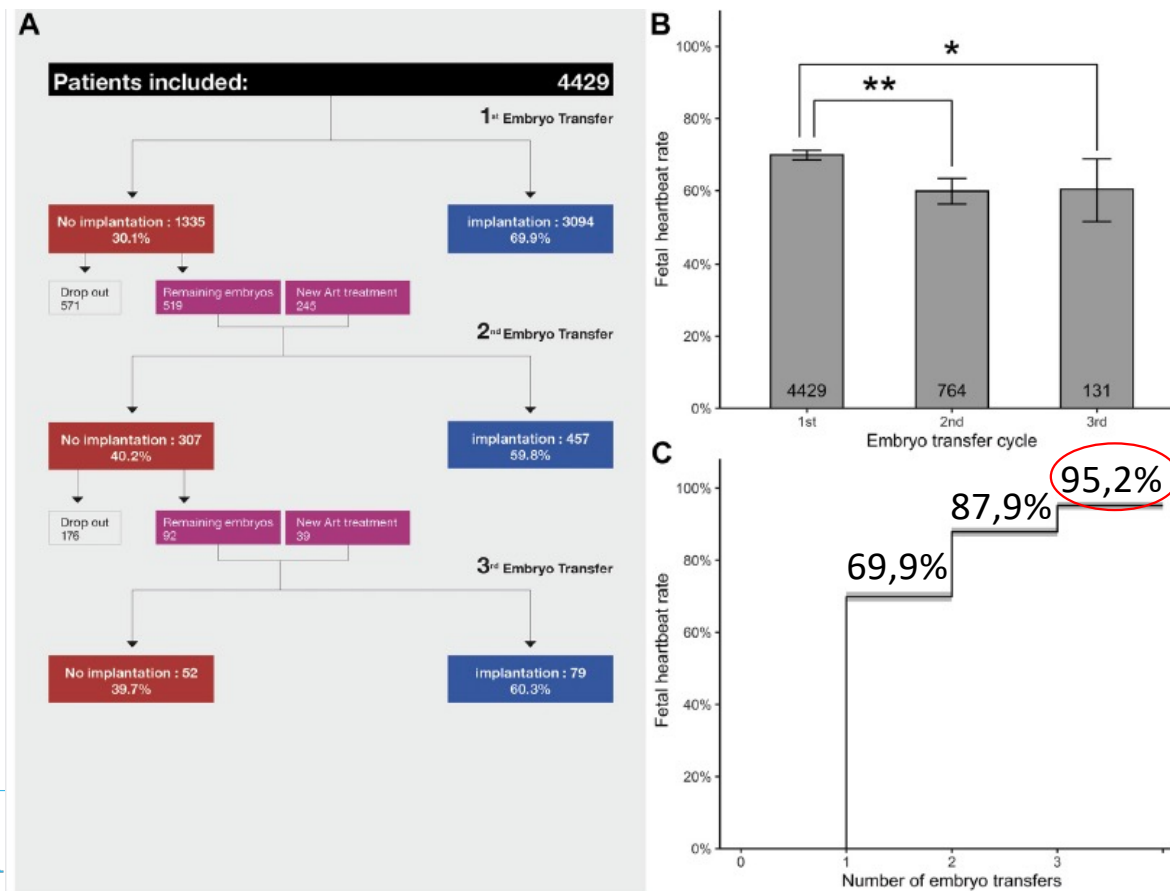
[†]These authors contributed equally to this work.





Echec d'implantation controverses certitudes

Résultats: taux d'implantation





Echec d'implantation controverses certitudes

Infertility

Does recurrent implantation failure exist? Prevalence and outcomes of five consecutive euploid blastocyst transfers in 123 987 patients

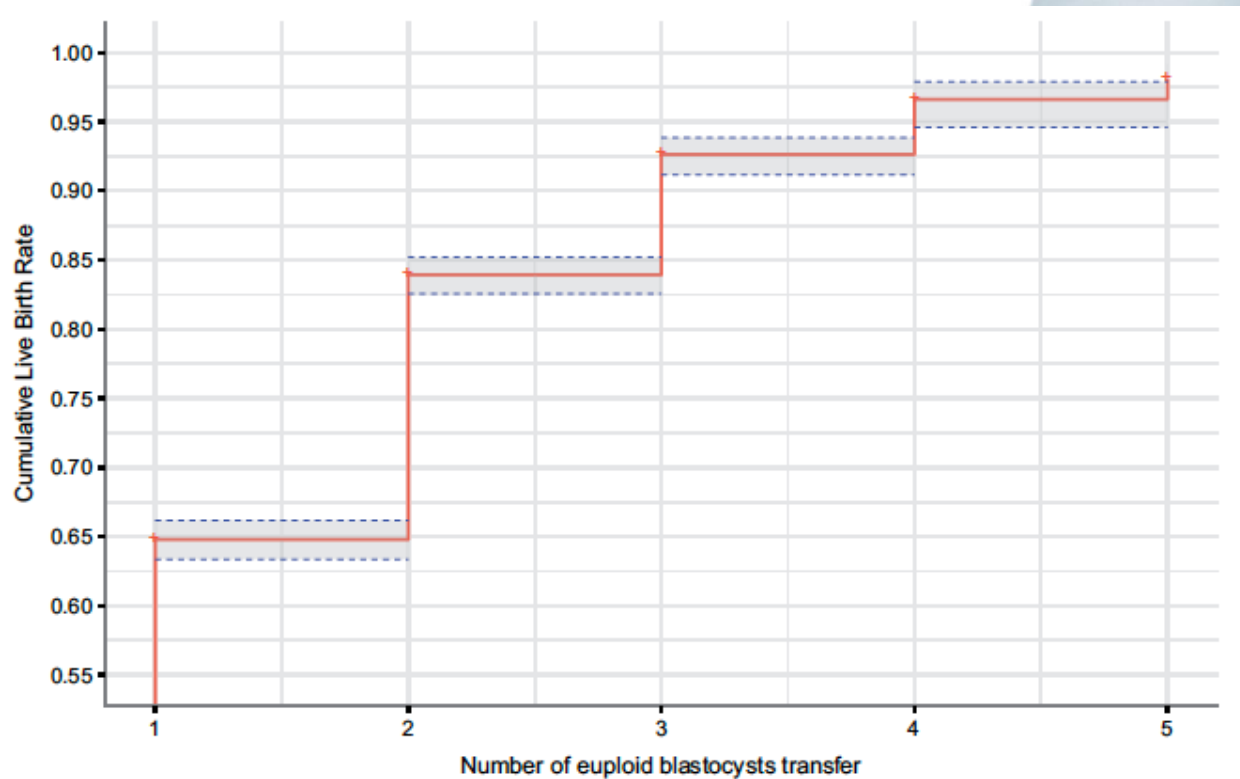
Pavan Gill ^{1,†}, Baris Ata ^{2,3,†}, Ana Arnanz^{4,5}, Danilo Cimadomo ⁶, Alberto Vaiarelli ⁶, Human M. Fatemi ⁷, Filippo Maria Ubaldi⁶, Juan A. Garcia-Velasco⁴, and Emre Seli ^{1,8,*}

HYPOTHÈSE la prévalence du RIF pourrait être de moins de 5 % si on continue à transférer le 4e et le 5eme embryons euploïdes après les échecs répétés antérieurs

Reprises de l'étude antérieure après l'échec du 3eme embryon et études des transferts du 4eme et 5eme embryons euploïdes



Echec d'implantation controverses certitudes



[Gill et al. Hum Reprod, 39: 974-80, 2024]



Réserve ovarienne basse: les solutions

TABLE 1

Criteria used to define patients that poorly respond to ovarian stimulation among randomized controlled trials assessing different treatment modalities.

Criteria	Median (IQR) or n (%)
No. of criteria in the definition	
Maximum no.	2 (1–3)
Minimum no.	1 (1–2)
Criteria related to patients' demographics	
Patients' age,	4 (9%)
>35 y	1
>38 y	1
>40 y	2
Previous cycle cancellation	14 (30%)
Ovarian reserve markers	
Antral follicle count	4 (9%)
<5	1
<7	1
<12	2
High basal FSH (cycle D3) value	10 (21%)
>8.5	1
>10	4
>12	1
>15	2
Not stated	2
Previous cycle(s) characteristics	
No. of follicles on the final day of stimulation	21 (45%)
≤2	4
≤3	11
≤4	4
≤5	2
No. of oocytes retrieved	19 (40%)
≤2	2
≤3	8
≤4	7
≤5	2
No. of mature oocytes retrieved	5 (11%)
≤3	4
≤4	1
Levels of E ₂ on the final day of stimulation	16 (34%)
450	1
500	9
Other higher threshold	6
Good quality embryos	2 (4%)
Gonadotropin doses per day	14 (30%)
225 IU	2
300 IU	7
Other/not stated	5

- Poor responders

A systematic review of randomized trials for the treatment of poor ovarian responders: is there any light at the end of the tunnel?

Nikolaos P. Polyzos, M.D., Ph.D., and Paul Devroey, M.D., Ph.D.

47 randomized trials

Concept – **Bologna criteria “ESHRE”**

- simple, reproducible, clearly defined criteria
- 1st attempt to unify criteria
- At least two of:

1. Previous cycle with PR (≤ 3 oocytes)
2. AFC $< 5-7$ fols or AMH $< 0.5-1.1$ ng/mL
3. > 40 years or other risk factors (ChT, surgery...)



Réserve ovarienne basse: les solutions

Bologne 2011:

Manque de clarté de la définition des facteurs de risques

Informations limitées sur la normalité des marqueurs de réserve ovarienne

Formation de groupes hétérogènes

Ne traite pas la réponse sous optimale

Ne traite pas la patiente jeune avec réponse ovarienne basse

Groupe Poseideon 2016:

Mauvais pronostic reproductif

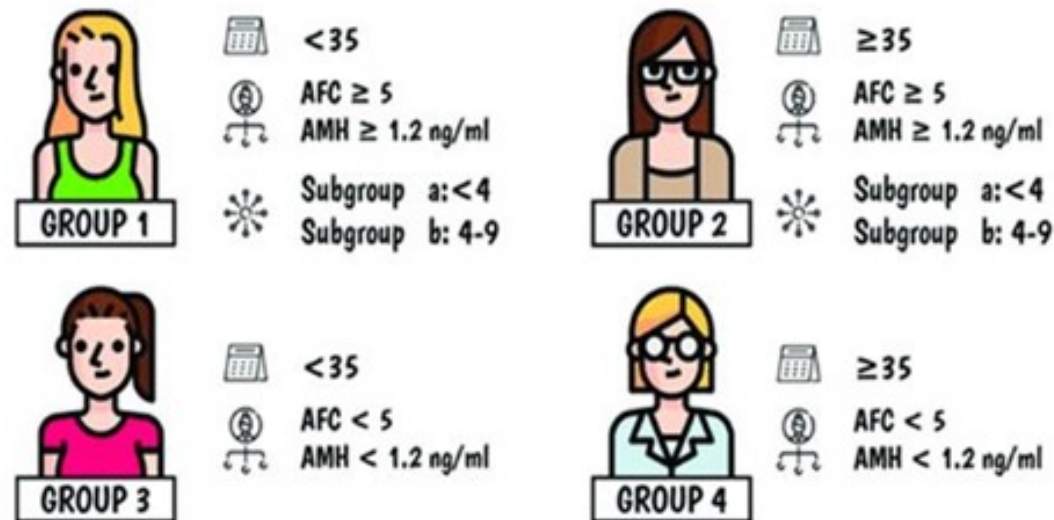
Taux cumulatif de naissance vivante (ICMART)

1.Age(taux d'aneuploidie embryonnaire espéré)

2.Marqueurs de réserve ovarienne (CFA et/ou AMH)

3.Nombres d'ovocytes récupérés dans un cycle de stimulation antérieur





1. Age
2. Ovarian Biomarkers (AMH and/or AFC)
3. No. oocytes retrieved if previous OS cycle



Réserve ovarienne basse: les solutions

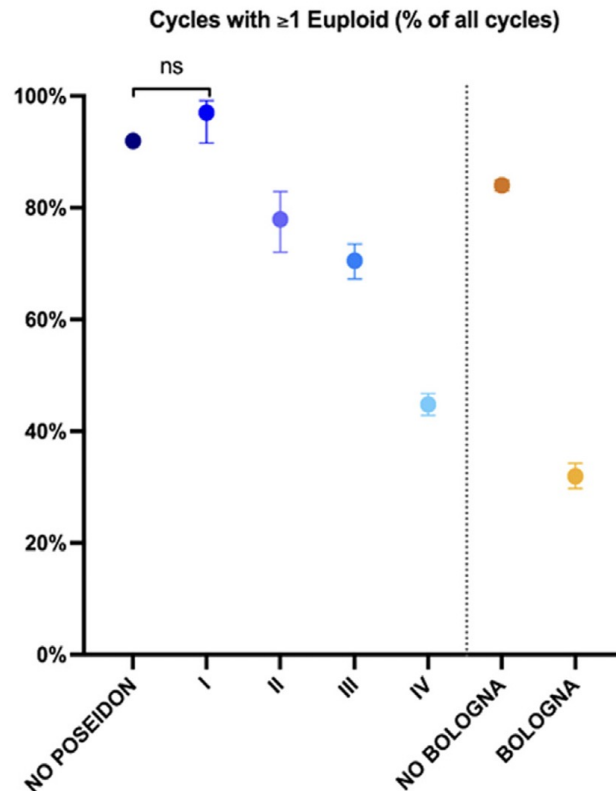
- Poseidon Criteria - 2016

Patient Oriented Strategies Encompassing Individualized Oocyte Number





Réserve ovarienne basse: les solutions



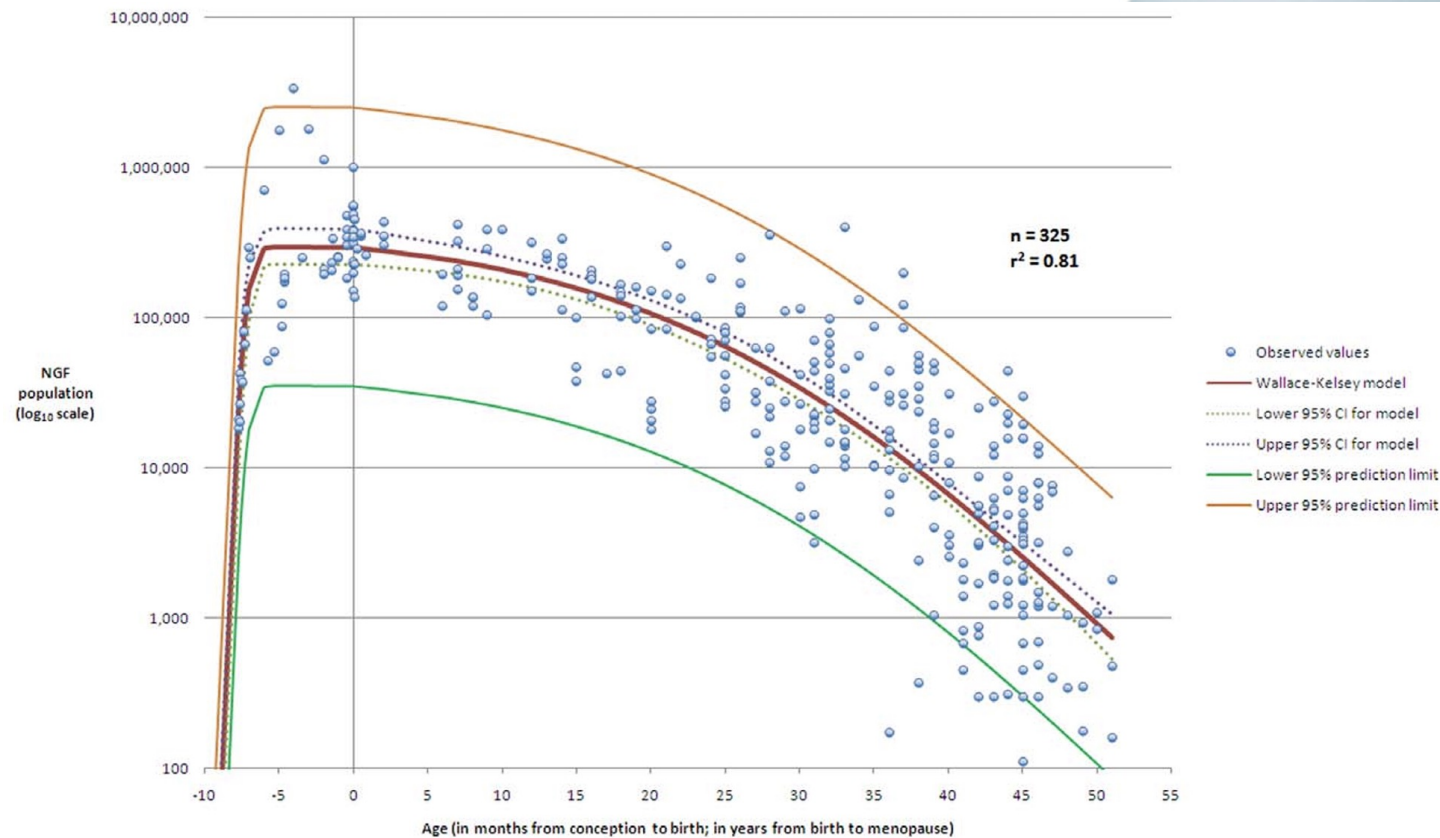
Bologna vs. POSEIDON criteria as predictors of the likelihood of obtaining at least one euploid embryo in poor ovarian response: an analysis of 6,889 cycles

Andres Reig, M.D.,^{a,b} Juan A. Garcia-Velasco, M.D.,^{c,d,e} and Emre Seli, M.D.^{a,f}

^a IVIRMA New Jersey, Basking Ridge, New Jersey; ^b Thomas Jefferson University, Philadelphia, Pennsylvania; ^c IVIRMA Madrid, Madrid, Spain; ^d IVI Foundation, Health Research Institute La Fe, Valencia, Spain; ^e Rey Juan Carlos University, Madrid, Spain; and ^f Yale University, New Haven, Connecticut



Ovocytes, blastocysts, blastocysts euploides





Ovocytes, blastocysts, blastocysts euploides

taux Blastulation

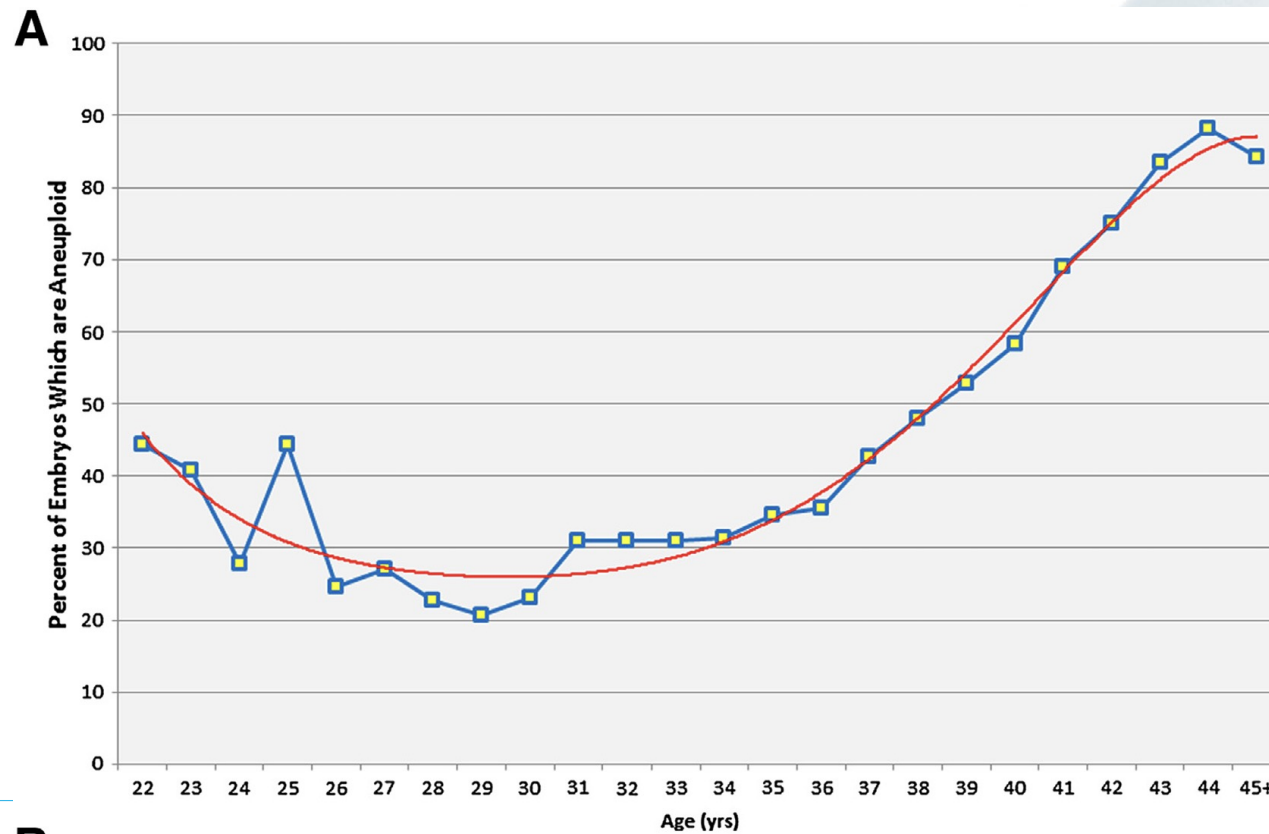
Female age in years, SART categories					
Variables	<35	35-37	38-40	41-42	>42
Estradiol closest to trigger day	2517.0 (1680.8-3539.0)	2103.4 (1372.0-2942.0)	1917.0 (1212.0-2844.0)	1612.0 (1058.8-2557.2)	1496.0 (961.6-2403.5)
Trigger type					
• Both hCG and GnRH agonist	1791 (49.3)	962 (53.0)	1237 (49.8)	661 (43.8)	585 (43.9)
• hCG only	607 (16.7)	443 (24.4)	811 (32.6)	663 (44.0)	630 (47.2)
• GnRH agonist only	1234 (34.0)	410 (22.6)	437 (17.6)	184 (12.2)	119 (8.9)
Sperm source					
• Autologous	3475 (95.7)	1736 (95.6)	2317 (93.2)	1393 (92.4)	1204 (90.3)
• Donor	157 (4.3)	79 (4.4)	168 (6.8)	115 (7.6)	130 (9.7)
Oocytes retrieved	15.0 (10.0-22.0)	12.0 (7.0-18.0)	10.0 (6.0-16.0)	8.0 (5.0-13.0)	7.0 (5.0-12.0)
MII oocyte count	11.0 (7.0-16.0)	9.0 (5.0-13.0)	8.0 (5.0-12.0)	6.0 (4.0-10.0)	6.0 (3.0-9.0)
2PN count	9.0 (5.0-14.0)	7.0 (4.0-11.0)	6.0 (4.0-10.0)	5.0 (3.0-8.0)	4.0 (2.0-7.0)
Total blastocyst count	5.0 (3.0-8.0)	4.0 (2.0-6.0)	3.0 (1.0-5.0)	2.0 (1.0-4.0)	1.0 (0.0-2.0)
Euploid blastocyst count	4.0 (2.0-6.0)	2.0 (1.0-4.0)	1.0 (0.0-3.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)
Maturation rate, % (MII per oocytes retrieved)	77.4 (64.7-87.5)	76.9 (63.6-88.2)	77.8 (66.7-90.0)	77.8 (63.9-90.0)	75.0 (62.5-90.9)
Fertilization rate, % (2PN per MII)	85.0 (73.9-94.4)	85.7 (73.6-100.0)	84.2 (72.7-100.0)	85.7 (71.4-100.0)	83.3 (66.7-100.0)
Blastulation rate, % (blastocyst per 2PN)	57.1 (40.0-74.0)	54.5 (37.5-73.3)	50.0 (33.3-66.7)	40.0 (20.0-60.0)	28.6 (0.0-50.0)
Euploidy rate, % (euploid per tested)	80.0 (66.7-100.0)	69.6 (50.0-100.0)	50.0 (33.3-75.0)	28.6 (0.0-50.0)	0.0 (0.0-33.3)

SART, Society of Assisted Reproductive Technology; MII, Metaphase II; 2PN, two nuclei.
Values are presented as median and interquartile range (continuous) or count and percentage of the total (categorical).



Ovocytes, blastocysts, blastocysts euploides

PGTA blastocysts euploides



[Franasiak JM et al, Fertil Steril, 2014]



Prédire l'Avenir; FORTUNE

Le modèle FORTUNE

Forecasting Outcomes of Reproductive
Treatments Using artificial Networks





Prédire l'Avenir; FORTUNE



human
reproduction

Human Reproduction, 2025, 00(00), 1–16
<https://doi.org/10.1093/humrep/deaf163>
Original Article

Infertility

Forecasting Outcomes of Assisted Reproductive Treatments Using Artificial Networks (FORTUNE) classification system: a new prognostic model to predict euploid blastocyst yield in patients undergoing IVF

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[†]These authors contributed equally to this work.

ABSTRACT

STUDY QUESTION: Can a prediction model classify IVF patients into distinct prognostic groups based on their expected yield of euploid blastocysts?

SUMMARY ANSWER: Five distinct prognostic groups were identified, with chance of obtaining at least one euploid blastocyst ranging from <1% to 2% in very poor to ~95% in very good prognosis groups.

WHAT IS KNOWN ALREADY: Euploid blastocyst yield is a critical determinant of IVF success. While female age strongly influences embryo euploidy, other factors like ovarian reserve markers, partner age, and BMI may also contribute. Current approaches rely on basic and somewhat arbitrary classification of ovarian reserve markers and patient age, which are unable to represent the granular multidimensional relationship between them. A systematic approach to classify patients based on their expected euploid yield would enable better treatment planning and patient counseling.

STUDY DESIGN, SIZE, DURATION: A retrospective analysis of 10 774 IVF cycles from 8256 couples undergoing pre-implantation genetic testing for aneuploidy (PGT-A) of all available blastocysts from years 2020 to 2023 and a temporal validation cohort of 2089 cycles of 2089 patients from year 2024. The prediction model was developed using generalized additive models for location, scale, and shape using a development cohort from 2020 to 2023, and cross-validated through exhaustive 5-fold cross-validation. Temporal validation was performed using an entirely separate cohort from 2024. Model performance was assessed through calibration plots and discrimination metrics.

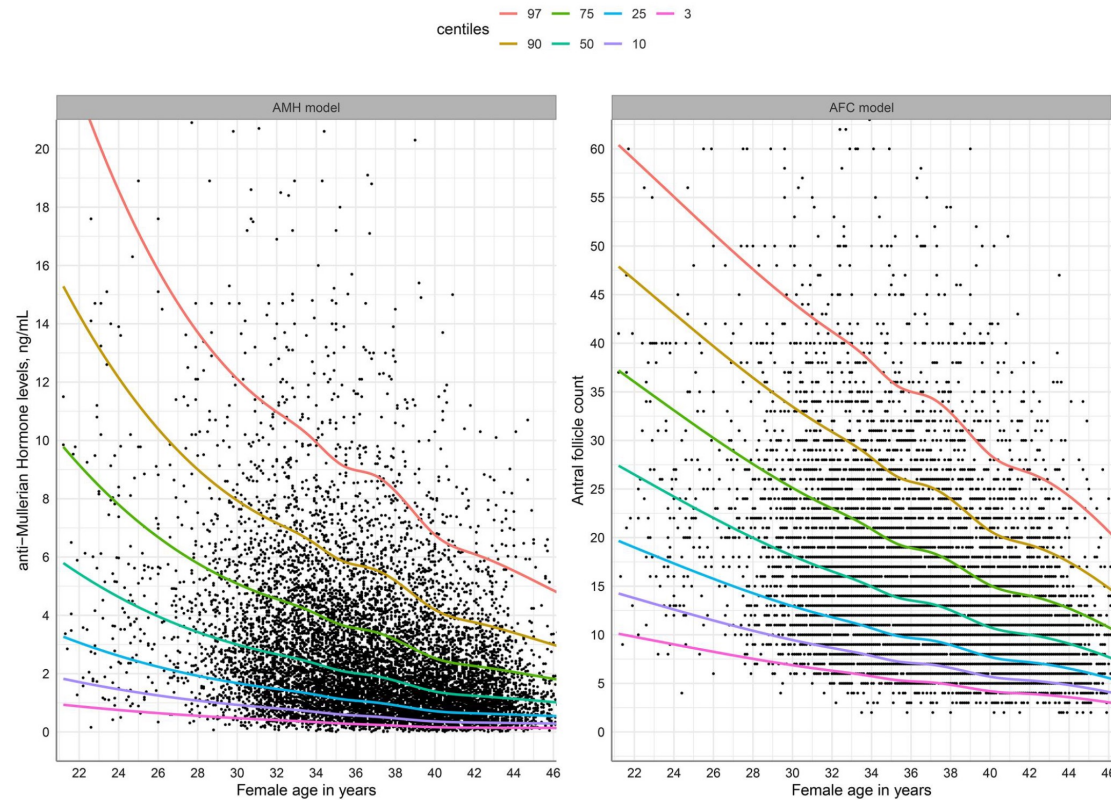
PARTICIPANTS/MATERIALS, SETTING, METHODS: Couples undergoing IVF with PGT-A of all their available blastocysts were included. Model included female age, partner age, anti-Müllerian hormone (AMH), antral follicle count, and BMI as predictors. Non-linear associations were captured using neural networks and restricted cubic splines. Missing data were handled using multivariate imputation by chained equations.

MAIN RESULTS AND THE ROLE OF CHANCE: The median female age was 36.3 years (IQR: 33.3–39.5) and AMH was 2.0 ng/ml (IQR: 1.0–3.8). Models for predicting ≥1, ≥2, and ≥3 euploid blastocysts yield achieved very good discrimination performance in 5-fold cross-validation samples with mean AUCs of 0.854, 0.849, and 0.861, respectively. Models showed negligible shrinkage (<1%) between training and cross-validation sets with near-perfect calibration slopes (mean: 1.00, IQR: 0.99–1.01) and intercepts (mean: 0.015, IQR: 0.00–0.03). Using predicted absolute counts of euploid blastocysts, five distinct prognostic groups were created based on predicted euploid blastocyst yield. Patients in the very poor prognosis group had 98.3% probability of obtaining no euploid blastocysts after stimulation while the probabilities were 80.2%, 47.5%, 15.8%, and 4.7% in poor, borderline, good, and very good prognosis groups. The chances of obtaining ≥3 euploid blastocysts were 79.8%, 43.7%, 8.9%, 0.2%, and 0% in very good, good, borderline, poor, and very poor prognosis groups. In the temporal validation set (n = 2089), which constituted the first cycles of patients that were treated, the rates of no euploid blastocysts obtained at the end of stimulation were 100.0%, 82.6%, 47.4%, 13.1%, and 4.4% in the very poor, poor, borderline, good, and very good prognosis groups. The rates of three or more euploid blastocysts obtained at the end of stimulation in the temporal validation set were 83.5%, 51.0%, 10.7%, 0.6%, and 0.0% for very good, good, borderline, poor, and very poor prognosis groups. The FORTUNE (Forecasting Outcomes of Reproductive Treatments Using artificial Networks) model is available for use and





Prédire l'Avenir; FORTUNE



10774 cycles de FIV
provenant de 8256 couples
entre 2020 et 2023

2089 cycles chez 2089
patientes en 2024
(validation temporelle)



Prédire l'Avenir; FORTUNE

Patient Parameters

Clinical Measurements

AMH (ng/mL)

AFC

Female Age

Partner Age

BMI

Calculate Prediction

Enter all values and click 'Calculate Prediction' to compute outcomes.

Results

AMH Distribution

AFC Distribution

Female Age Z-Score

Partner Age Z-Score

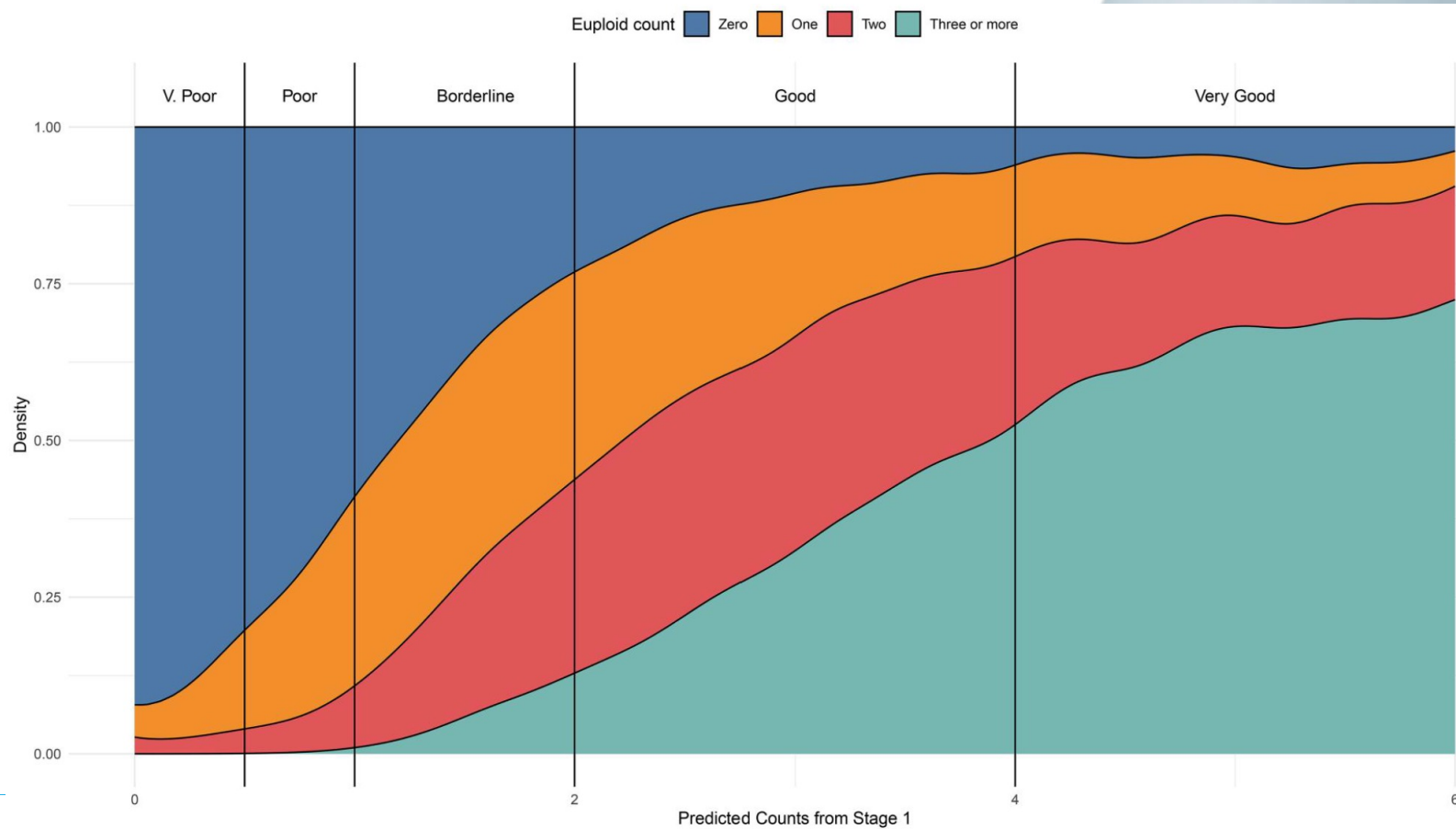
BMI Z-Score

Prognostic Category

Probability Distribution

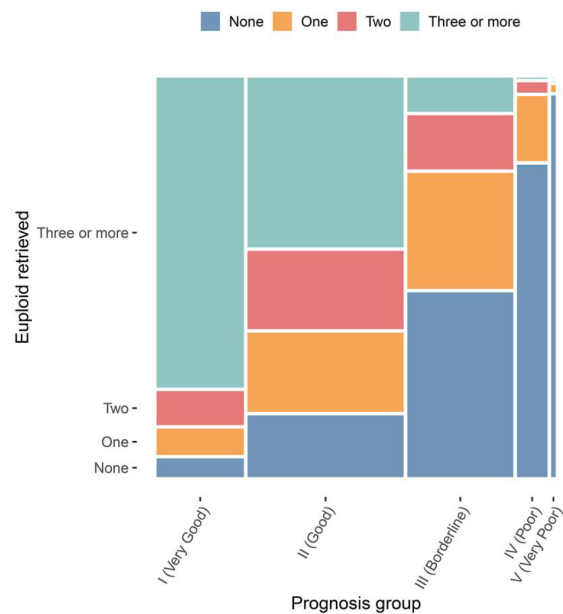


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Euploid Retrieval by Prognosis Group					
Retrieved Euploid	I (Very Good)	II (Good)	III (Borderline)	IV (Poor)	V (Very Poor)
None	4.7% (116)	15.8% (692)	47.5% (1416)	80.2% (686)	98.3% (116)
One	6.7% (164)	20.3% (888)	29.8% (889)	16.8% (144)	1.7% (2)
Two	8.8% (215)	20.1% (878)	13.8% (412)	2.7% (23)	NA
Three or more	79.8% (1958)	43.7% (1908)	8.9% (265)	0.2% (2)	NA

<https://epsilon-kappa-analytics.shinyapps.io/FORTUNE/>



Prédire l'Avenir; FORTUNE

Clinical Measurements

AMH (ng/mL)

2

AFC

15

Female Age

38

Partner Age

35

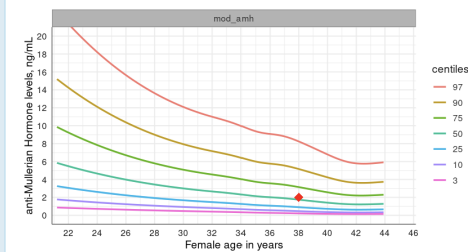
BMI

29

Calculate Prediction

Enter all values and click 'Calculate Prediction' to compute outcomes.

AMH Distribution



Female Age Z-Score

0.18

Partner Age Z-Score

-0.64

BMI Z-Score

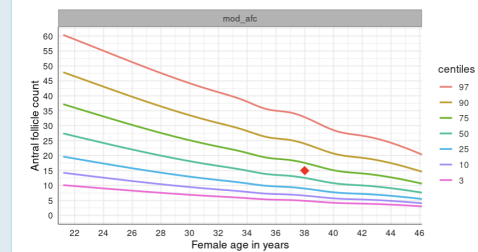
0.45

Prognostic Category

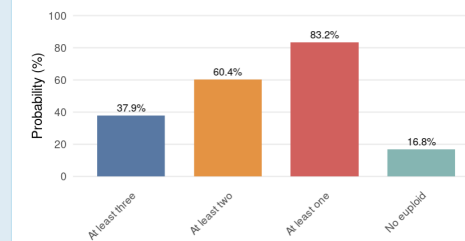
Good

Patients categorized under Good prognosis still enjoy relatively favorable reproductive parameters, though not quite at the top tier. Their outcomes show a more balanced distribution: while around half can still yield three or more euploid embryos, there is an increased portion—about 1 in 6 patients—who obtain no euploid embryos.

AFC Distribution



Probability Distribution





Prédire l'Avenir; FORTUNE

Clinical Measurements

AMH (ng/mL)

2

AFC

15

Female Age

39

Partner Age

35

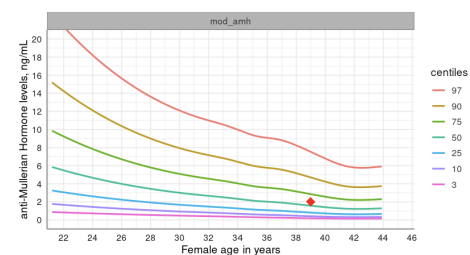
BMI

29

Calculate Prediction

Enter all values and click 'Calculate Prediction' to compute outcomes.

AMH Distribution



Female Age Z-Score

0.39

Partner Age Z-Score

-0.64

BMI Z-Score

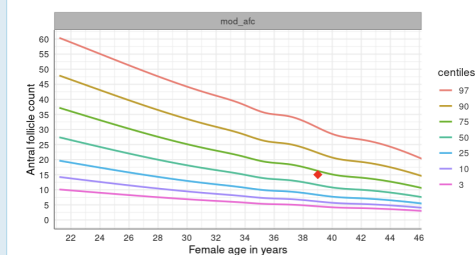
0.45

Prognostic Category

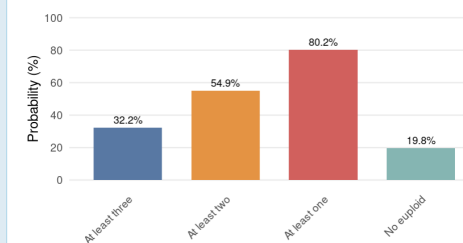
Good

Patients categorized under Good prognosis still enjoy relatively favorable reproductive parameters, though not quite at the top tier. Their outcomes show a more balanced distribution: while around half can still yield three or more euploid embryos, there is an increased portion—about 1 in 6 patients—who obtain no euploid embryos.

AFC Distribution



Probability Distribution





Prédire l'Avenir; FORTUNE

Clinical Measurements

AMH (ng/mL)

0.5

AFC

5

Female Age

42

Partner Age

50

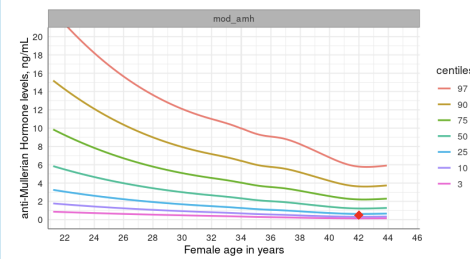
BMI

22

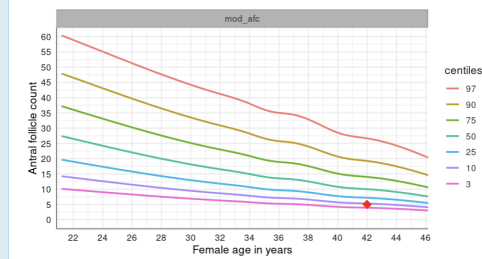
Calculate Prediction

Enter all values and click 'Calculate Prediction' to compute outcomes.

AMH Distribution



AFC Distribution



Female Age Z-Score

1.15

Partner Age Z-Score

1.75

BMI Z-Score

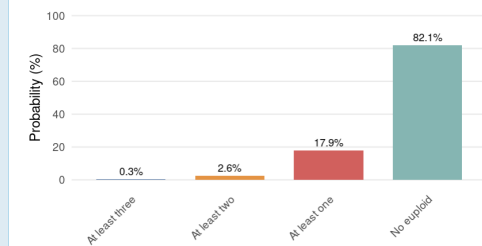
-0.79

Prognostic Category

Poor

Those with a Poor prognosis have more pronounced fertility challenges. Factors may include advanced maternal age, very low ovarian reserve, or other reproductive limitations. Over 80% in this group retrieve no euploid embryos. This category signals that the odds of achieving multiple chromosomally normal embryos are slim.

Probability Distribution





IA la prédiction selon le modèle FORTUNE

Plus que jamais les patientes et patients en PMA ont besoin d'être soutenu dans une approche efficace et bien expliquée.(PMA Friendly)

Le Modele Predictor IA est une possibilité d'évaluer de manière précise les chances de succès du patient en FIV et donc de mieux lui expliquer le parcours idéal qui pourrait augmenter ces chances de succes.

Cette approche validée par un groupe controle est extrapolable aux pays qui n'ont pas encore acces a la FIV DPI pour âge avancée de la patiente.

On espere qu'elle pourra réduire le nombre de patients qui abandonnent précocément le programme de traitement...



Echec d'implantation controverses certitudes

Merci pour votre écoute,

Remerciements au Pr Juan Antonio Velasco, au dr Erkan kalafat, Dr Baris Ata, dr Sergio Cavallero à ...Elisa Nicoletti.