AIBT
Associazione Italiana
di Immunogenetica
e Biologia dei Trapianti

XXX
Congresso
Nazionale

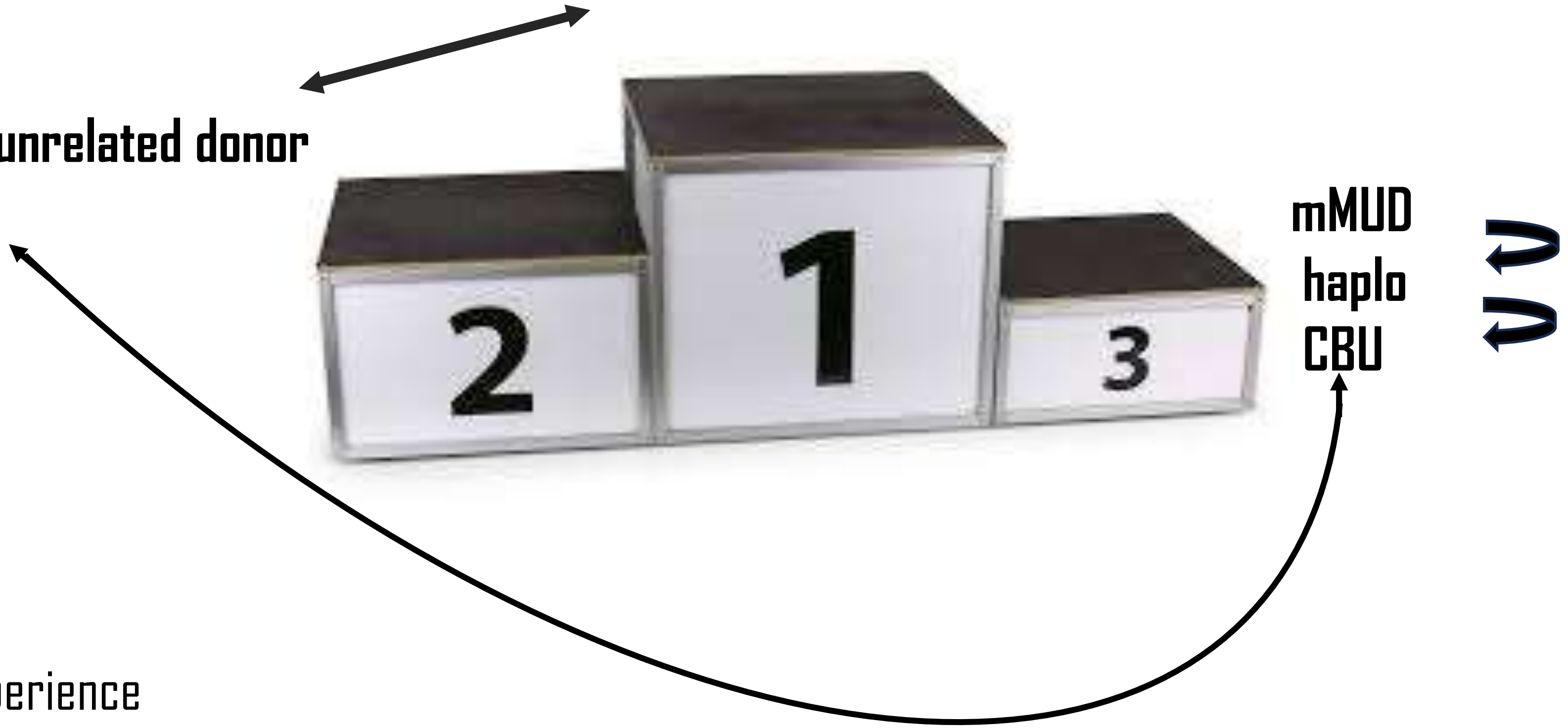
Napoli, 10/12 ottobre 2024

"The programme of this event has been approved by the EFI Education Committee"

L´uso dell´intelligenza artificiale nella valutazione della compatibilita HLA ai fini della selezione del miglior donatore di cellule staminali: creazione di un modello prototipo e sviluppi futuri

Roberto Crocchiolo

XXX Congresso Nazionale AIBT - 11 ottobre 2024



HLA-identical sibling

Matched unrelated donor

mMUD
haplo
CBU

- Donor age
- Timing
- Center experience

Shouval R et al., Lancet Haematol 2019

Stem cell donor selection: factors

HLA

Patient-donor matching

Donor-specific anti-HLA Abs

non-HLA

Donor age

Gender

ABO

CMV

Parity

Registry

Aim of the study

- To develop a calculator of 2-y OS according to the type of stem cell donor, to support the transplant physician during the selection for a pre-determined patient

HLA-identical sibling
2-y OS = *X*

Matched unrelated donor
2-y OS = *Y*

mMUD
haplo
CBU
2-y OS = *Z*

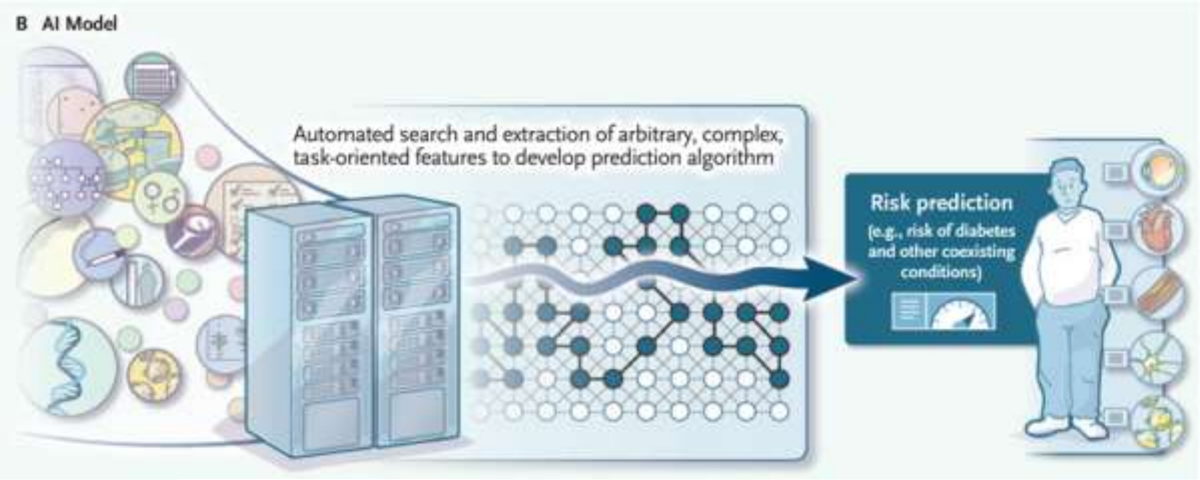
Stefania Cacace, PoliMI

Regression analysis

AI models

$$Y_p=\beta_0+\beta_1x_1+\beta_2x_2+\ldots+\beta_kx_k+\sigma\Phi^{-1}(p)$$

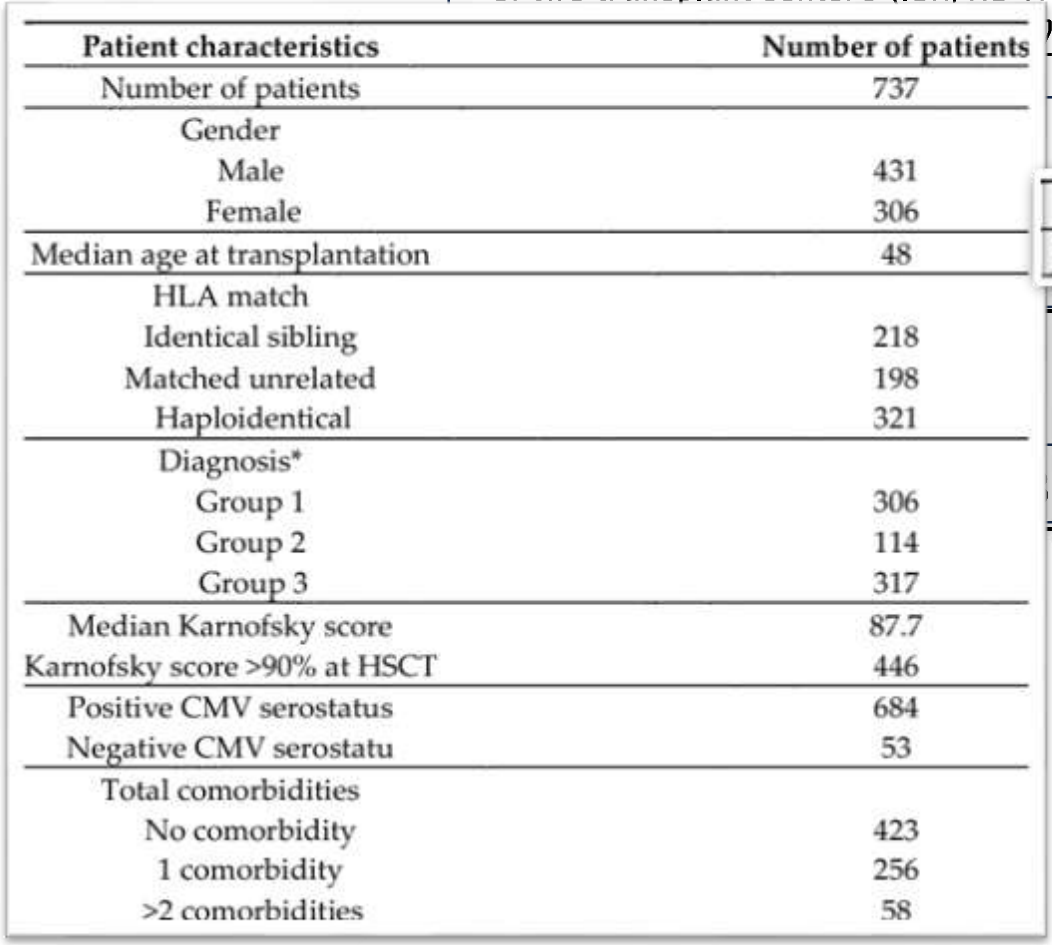
1. Y_p: Represents either the failure time or the logarithm of the failure time, depending on the distribution of the data.
2. $\beta_0,\beta_1,\ldots,\beta_k$: Regression coefficients.
3. $x_1,x_2,\ldots,x_k$ predictor variables.
4. σ: A scale parameter (for most distributions) or shape parameter (for Weibull distribution).
5. $\Phi-1(p)$: The p-th quantile of the standardized life distribution.



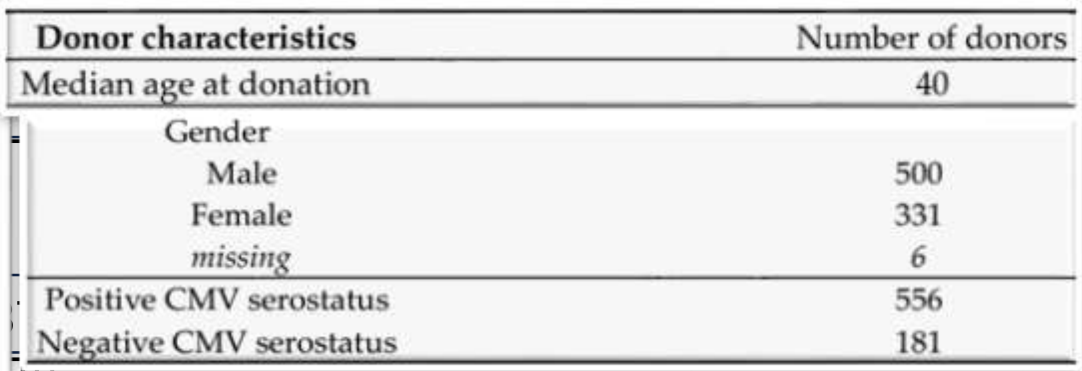
Validation

NEJM 2023;389;13

Real-world data obtained from clinical electronic charts
of two transplant centers (ICH, AO Vittorio Emanuele), interval Jul 2010 - Jan 2022



Patient characteristics	Number of patients
Number of patients	737
Gender	
Male	431
Female	306
Median age at transplantation	48
HLA match	
Identical sibling	218
Matched unrelated	198
Haploidentical	321
Diagnosis*	
Group 1	306
Group 2	114
Group 3	317
Median Karnofsky score	87.7
Karnofsky score >90% at HSCT	446
Positive CMV serostatus	684
Negative CMV serostatu	53
Total comorbidities	
No comorbidity	423
1 comorbidity	256
>2 comorbidities	58



Donor characteristics	Number of donors
Median age at donation	40
Gender	
Male	500
Female	331
missing	*6*
Positive CMV serostatus	556
Negative CMV serostatus	181

Crocchiolo R et al., submitted

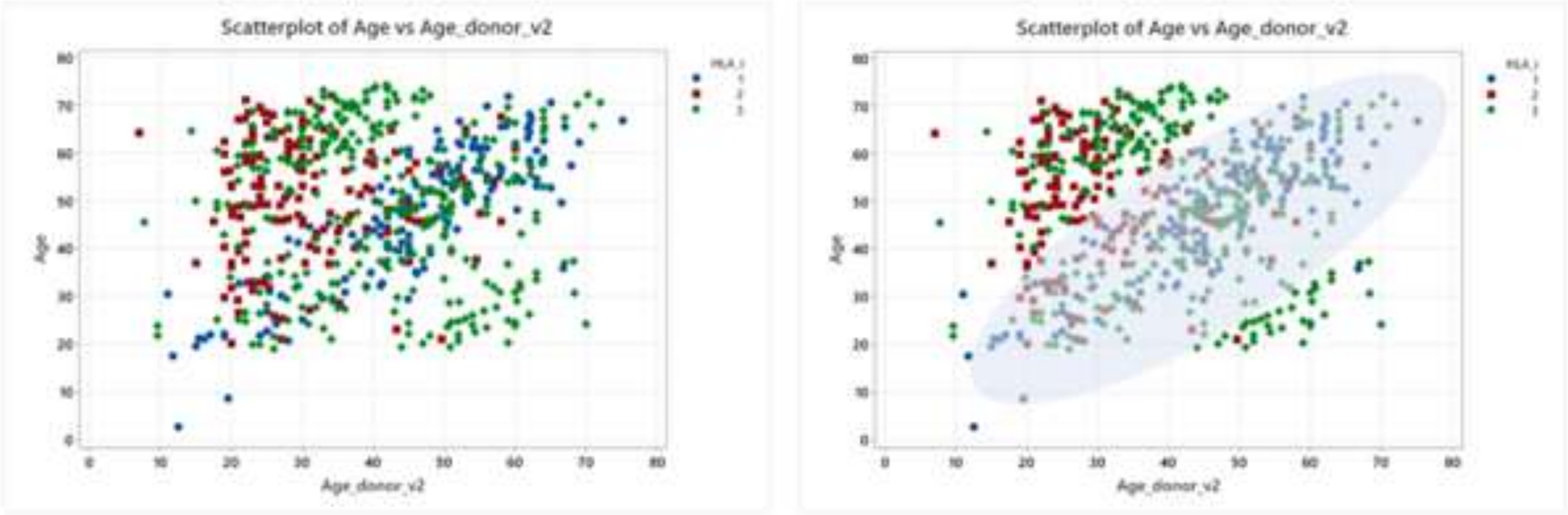
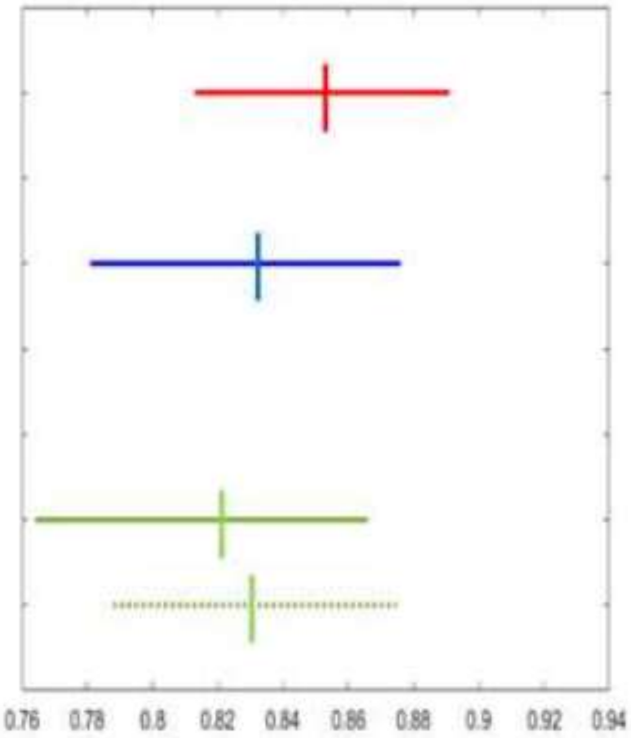


Figure 1. Scatterplots of patient and donors ages by HLA match types. The X axis represents the age of the donor, while the Y axis the age of the patient. Each point represents a donor-patient pair and is color-coded: HLA-identical sibling (blue), unrelated donor (red), haploidentical donor (green).

Crocchiolo R et al., submitted

	Age	Diagnosis	HLA	Sorror	Age_donor	2y-OS	CI_l	CI_u
━━━	45	AL in CR1	HLA-id sibling	0	45	0.856	0.813	0.891
━━━	45	AL in CR1	MUD 10/10	0	30	0.834	0.781	0.876
━━━	45	AL in CR1	haplo	0	20	0.821	0.764	0.866
■ ■ ■ ■ ■	45	AL in CR1	haplo	0	45	0.836	0.788	0.875



Crocchiolo R et al., submitted

GITMO
GRUPPO ITALIANO PER IL TRAPIANTO DI MIDOLLO OSSEO, CELLULE STAMINALI EMOPOIETICHE E TERAPIA CELLULARE

n = 22,241 HSCTs

Random survival forest
https://mednexus.org/doi/full/10.1097/CM9.0000000000001539

Extreme gradient boosting [XGB]
https://www.nature.com/articles/s41598-021-86327-7

Deep learning
https://ojs.aaai.org/index.php/AAAI/article/view/11842

Bayesian hierarchical Cox Proportional model
https://www.nature.com/articles/s41598-021-03645-6

Bayesian Additive Regression Trees (BART)
https://www.researchgate.net/publication/363058671_Bayesian_Additive_Regression_Trees_for_Predicting_Colon_Cancer_Methodological_Study_Validity_Study

Conclusions

- Feasibility of developing a tool (calculator) that may help transplant physicians in the decision-making process → prototype
- AI models = regression
- Novelty → all donor types

- AI is expected to outperform with large dataset (ongoing)

Acknowledgments

Sistema Socio Sanitario
Ospedale Niguarda
Regione Lombardia

Roberto Crocchiolo [1], Stefania Cacace [2], Giuseppe Milone [3], Barbara Sarina [4], Alessandra Cupri [3], Salvatore Leotta [3], Giulia Giuffrida [3], Andrea Spadaro [3], Jacopo Mariotti [4], Stefania Bramanti [4], Alice Fumagalli [4], Maria Pia Azzaro [3], Sebastiana Toscano [3] and Quirico Semeraro [2]

[1] Servizio di Immunoematologia e Medicina Trasfusionale, ASST Grande Ospedale Metropolitano Niguarda, Milano, Italy
[2] Dipartimento di Meccanica, Politecnico di Milano, Milano, Italy
[3] Ematologia, Azienda Ospedaliera Vittorio Emanuele, Catania, Italy
[4] Ematologia, Istituto Clinico Humanitas, Rozzano, Italy

HUMANITAS
RESEARCH HOSPITAL

POLITECNICO
MILANO 1863