



# Machine learning to improve organ donation rates and make better matches

Artificial Intelligence Based Transplant Decision Support System

The **19<sup>th</sup>**  
International Congress of  
**Nephrology, Dialysis  
and Transplantation**  
(ICNDT)

12-15 December 2023  
Homa Hotel, Tehran

TEHRAN  
2023

# Background

- ✓ Every year, in the US, hundreds of thousands of patients receive life-saving, cost-effective organ transplants, while thousands still wait, and over five hundreds die because not enough organs are available.
- ✓ As the demand for kidney transplants continues to rise, it's crucial for us to gain insights into the factors contributing to organ failure and explore effective solutions.

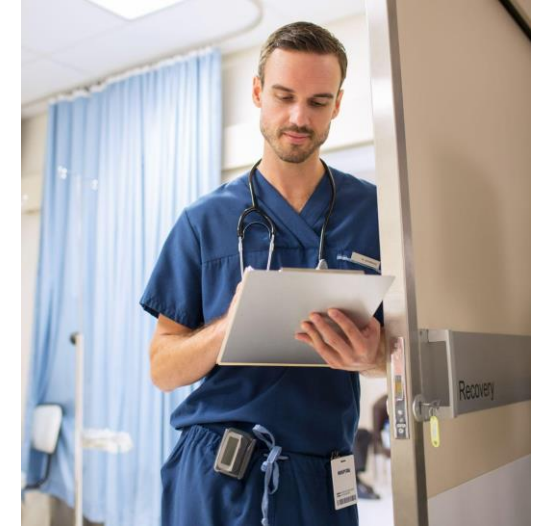
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9970360/>



# Current Situation

## ✓ Potential Donors

It is currently very difficult to predict which potential Donation after Circulatory Death (DCD) donors will die within a timeframe that permits successful organ donation



# Current Situation

## ✓ Recipients

The current recipient decision process is based on very limited and crude information and does not provide very insightful decision-making information.



# Current Situation


In 2021, there were:

- ✓ 25,487 transplants
- ✓ 139,025 people waiting for a transplant
- ✓ 5,011 people who died while waiting for a transplant
- ✓ 4,056 individuals too sick for a transplant



# Current Situation

\$1.2 Million in Health Canada  
Funding for Revolutionary AI-  
Based Organ Transplant Solution.



The screenshot shows the Government of Canada website with the following content:

- Government of Canada / Gouvernement du Canada
- Search Canada.ca
- Navigation menu: Jobs, Immigration, Travel, Business, Benefits, Health, Taxes, More services
- Breadcrumbs: Canada.ca → Innovation, Science and Economic Development Canada → Programs → Innovative Solutions Canada
- Section title: **Machine learning to improve organ donation rates and make better matches**
- From: [Innovation, Science and Economic Development Canada](#)
- Icon: A teal square with a white line-art illustration of a hand holding a heart.
- Text: Health Canada seeks technological approaches in Deep Learning and Artificial Intelligence to predict the success of possible donor-recipient matches and transplant outcomes to support evidence-based decision-making about organ donation and transplantation.
- Sponsoring department: Health Canada
- Funding mechanism: Grant
- Opening date: August 23, 2019
- Closing date: October 18, 2019 14:00 Eastern Daylight Time
- [Phase 1 award recipients](#)

<https://www.ic.gc.ca/eic/site/101.nsf/eng/00070.html>

# Balancing the Transplant Gap

- ✓ A decision support tool can be the key to balancing the gap between donor and recipient pools:
  - Expanding/enlarging the donor pool
  - Improving the transplant outcome through a higher quality matchmaking



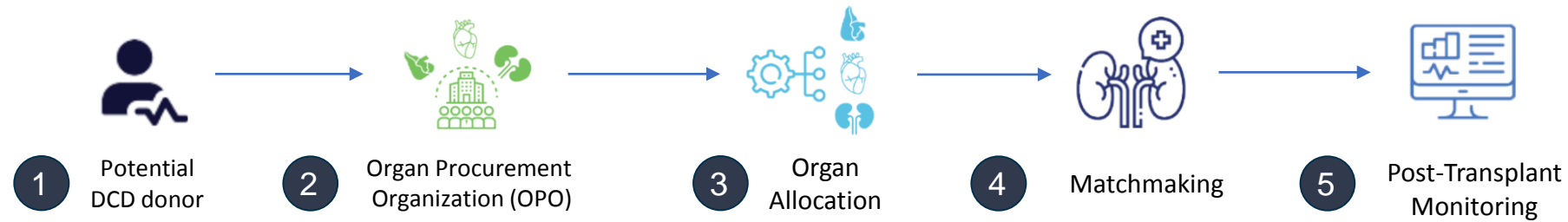
# Balancing the Transplant Gap

- ✓ In addition, understanding when organ failure occurs is vital for timely interventions.
- ✓ Early detection can significantly impact the success of kidney transplants, emphasizing the need for comprehensive monitoring.





# End-to-End Solution

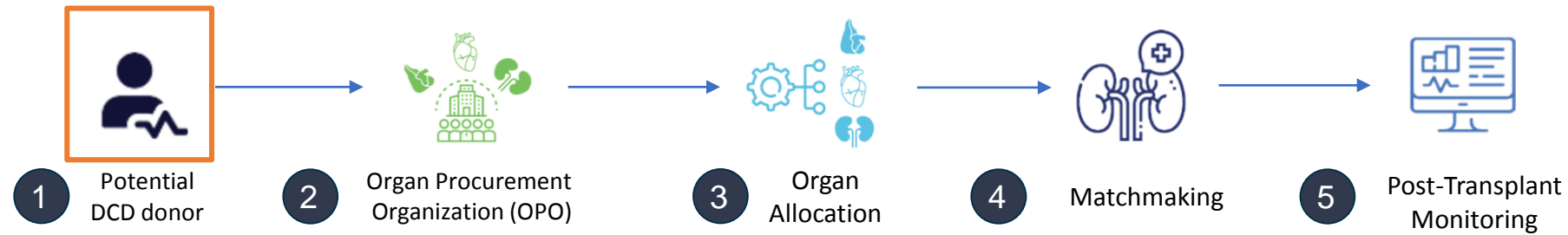


✓ Organnect.ai provides end-to-end solutions for:

- DCD Donor death prediction
- Pre-Transplant matchmaking
- Post-Transplant monitoring



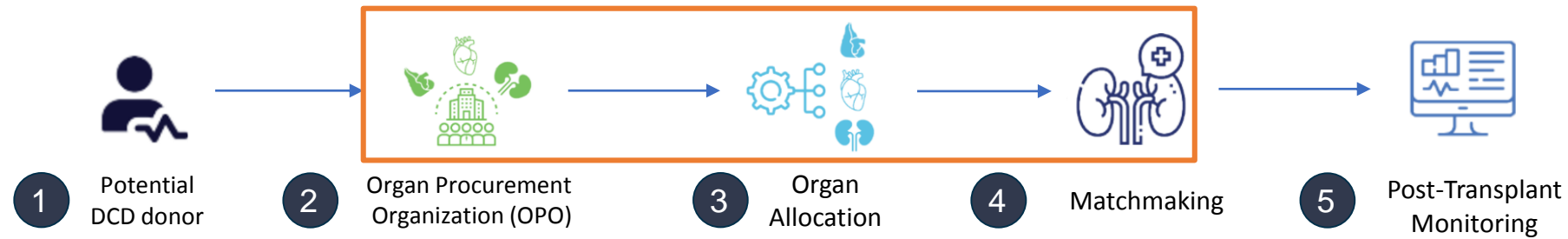
# End-to-End Solution



- ✓ Individualized prediction of time of death with confidence interval.
- ✓ Personalized probability of death for a 30-day time horizon.

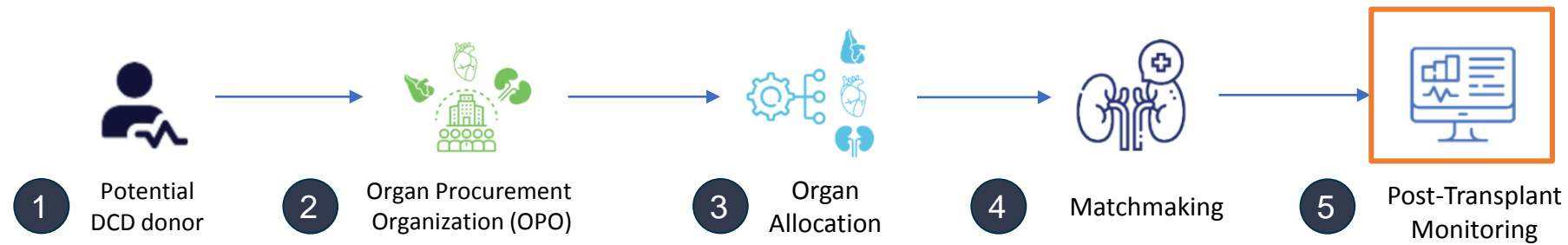


# End-to-End Solution



- ✓ Provides probability of organ failure for a pair of donor and recipient over an extended time horizon.
- ✓ Ranks the candidates based on predicted outcomes.
- ✓ Provides evidence-based prediction learnt from previous matches.

# End-to-End Solution



- ✓ Provides probability of organ failure for the transplant recipient for an extended time period
- ✓ Predicts the effect of immunosuppressive regimens and care plan on the graft functionality



# Training Data

- ✓ Scientific Registry of Transplant Recipient (SRTR) database is collected by Organ Procurement and Transplant Network (OPTN) on transplant programs and organ procurement organizations.
- ✓ This database has transplant records of a number of organs. But for the purpose of this project, only the Kidney Transplant data was used for training and development of our model.



# Training Data

- ✓ The total number of records of kidney transplants is 458,506 which includes the patients from 1987 to 2020.
- ✓ The SRTR dataset consists of several tables to track the patients before and after the transplant surgery. The organ matching/monitoring module uses tables with the stage "Pre" for pre-graft and "Post" for post-graft modules.



# Training Data

Table	Stage	# of Selected Variables
DONOR_DECEASED	Pre/Post	65
DONOR_DISPOSITION	Pre/Post	2
DONOR_LIVE	Pre/Post	64
IMMUNO	Post	52
FOL_IMMUNO	Post	51
REC_HISTO	Pre/Post	74
TX_KI	Pre/Post	115
TXF_KI	Post	41
Total		472

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# Case Study

- ✓ Case Study: #1 - 2010
- ✓ Organnect.ai as a decision support tool Pre-Transplant.
- ✓ Kidney Transplant Record from US Transplant Center





# Case Study

## Donor:

- ✓ Male - Age of 48
- ✓ BMI of 40
- ✓ Cause of death: Stroke
- ✓ History hypertension
- ✓ No history of diabetes
- ✓ Terminal serum creatinine 2.12 mg/dl

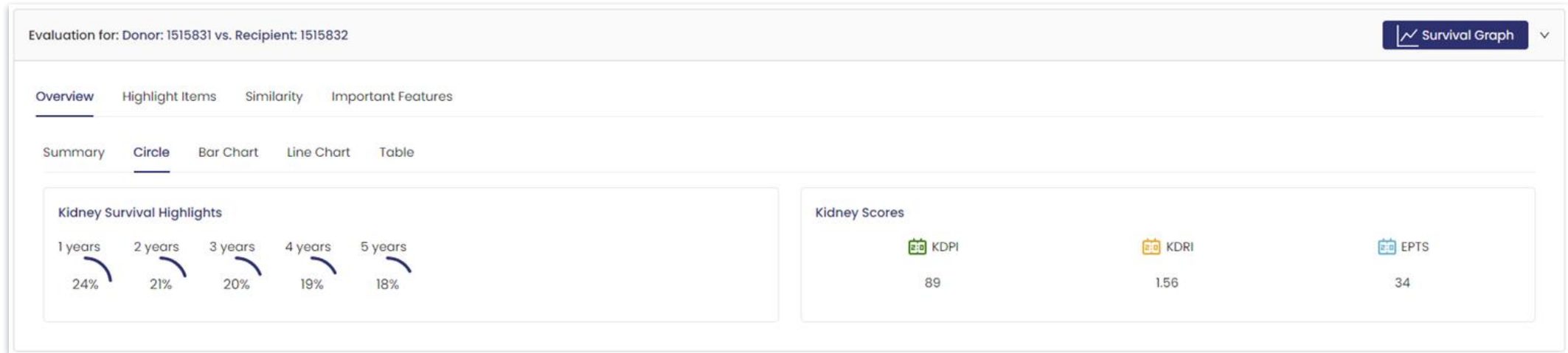
## Recipient:

- ✓ Male - Age of 55
- ✓ Diagnosed for Hypertensive Nephrosclerosis
- ✓ Considering only pre-transplant variables



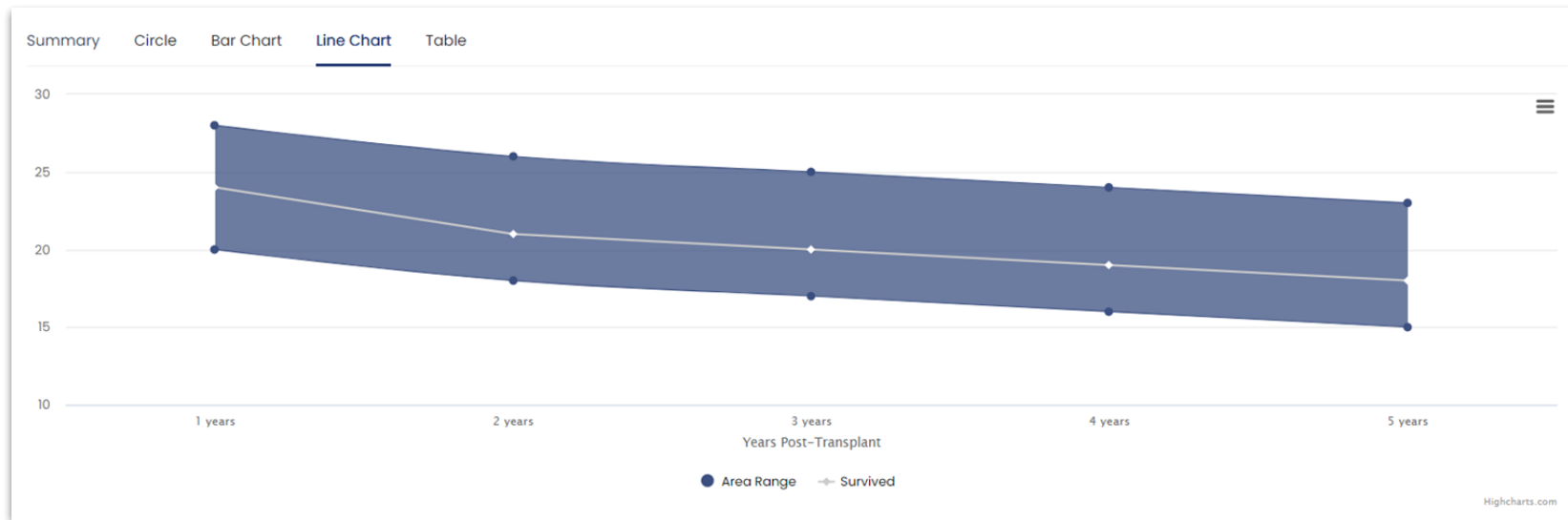
# Case Study

- ✓ Low chance of graft survival after transplant
- ✓ High KDPI, KDRI consistent with Organnect.ai that donor is not a suitable candidate



# Case Study

- ✓ Consistent low probability of graft survival in next years
- ✓ Narrow confidence interval across all predictions



# Case Study

## Prediction:

- ✓ 24% chance of graft survival in year 1

## Outcome:

- ✓ Graft failure in 2.5 months



# Case Study

- ✓ Case: #2- 2011
- ✓ Organnect.ai as a decision support tool Post-Transplant.
- ✓ Kidney Transplant Record from US Transplant Center



# Case Study

## Donor:

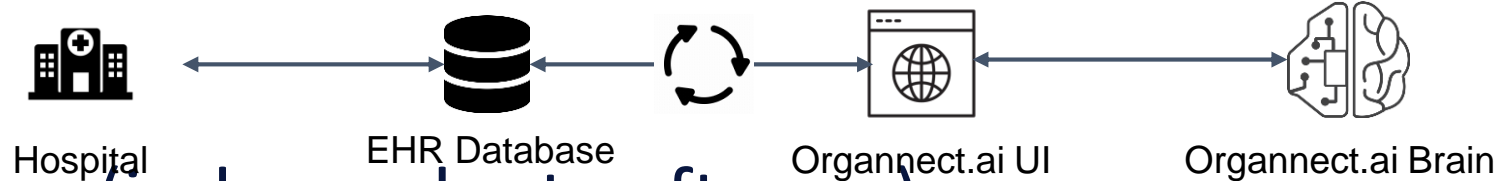
- ✓ Male - Age of 39
- ✓ BMI of 33
- ✓ Cause of death Anoxia
- ✓ No history of diabetes or hypertension
- ✓ Terminal serum creatinine 0.6 mg/dl

## Recipient:

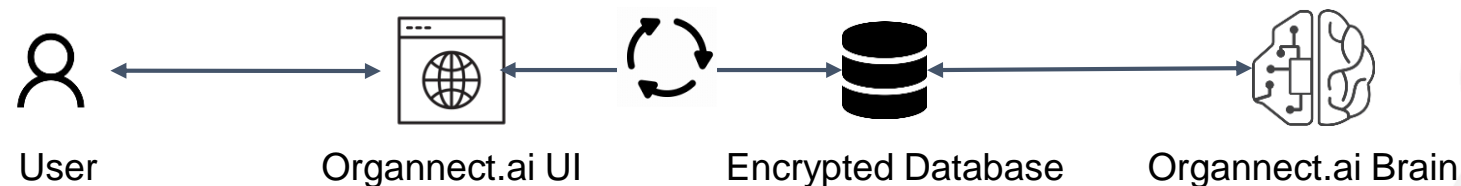
- ✓ Female - Age of 49
- ✓ Considering only pre-transplant variables
- ✓ Diagnosed for Systemic Lupus Erythematosus (SLE)
- ✓ Transplant Year 2011
- ✓ Graft loss in 45 months due to chronic rejection

# Integration Into Hospitals

- ✓ Integration with current EHR/patient management systems



- ✓ Standalone (independent software)



# Comparison

- ✓ Personalized and interpretable predictions
- ✓ Considers all donors and recipients clinical measurements
- ✓ Updated and real-time prediction as new data becomes available

**OPTN**  
ORGAN PROCUREMENT AND  
TRANSPLANTATION NETWORK

KDPI    KDR  
|

**afflo**

**iTransplant**<sup>SM</sup>  
MEDICAL INFORMATION SYSTEMS

**APACHE II Score**  
Estimates ICU mortality.

 Paris Transplant Group  
Kidney, Heart, Lung & Liver

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2023



# Advantages

- ✓ Better hospital resource management for transplantation
- ✓ Inform caregivers about status of patient in real-time
- ✓ Continuously learn from new ICU/transplant data
- ✓ Cloud-based system which can integrate into existing tools



# Peer Reviewed

- ✓ A Survival Model based on Sequence to Sequence Architecture (2022) - Machine Learning for Healthcare
- ✓ Comparison Of EPTS And PRA With An AI Based Model To Predict Short Term Transplant Survivorship (2023) - ATC
- ✓ Organ Survival Prediction Of High Risk Recipients Based On Reverse Survival Model (2023) - ATC



# Thank You!

