

Implementing a Swap Transplant Program Experiences and Challenges

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Vish Billa

Nephrologist & Transplant Physician

Associate Professor of Nephrology, Bombay Hospital

Director, Apex Kidney Care

Coordinator Apex Swap Transplant Registry

India vs EU

Land Area (As of 2017)

- EU : 4.42 million km²
- India : 3.28 million km²
- *EU is **1.4 times** bigger than India*

Population (As of Feb 01, 2017)

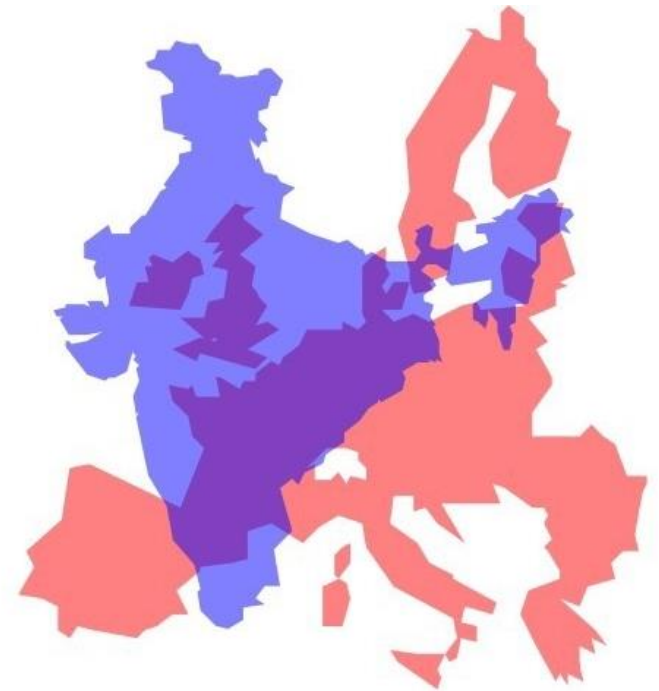
- EU : 508 million
- India : 1342 million
- *India has **2.6 times** the population of EU*

Number of languages

- EU : 24 Official with some 100 other
- India : 22 Official with some 1600 other

Member states:

- EU : 28
- India: 29

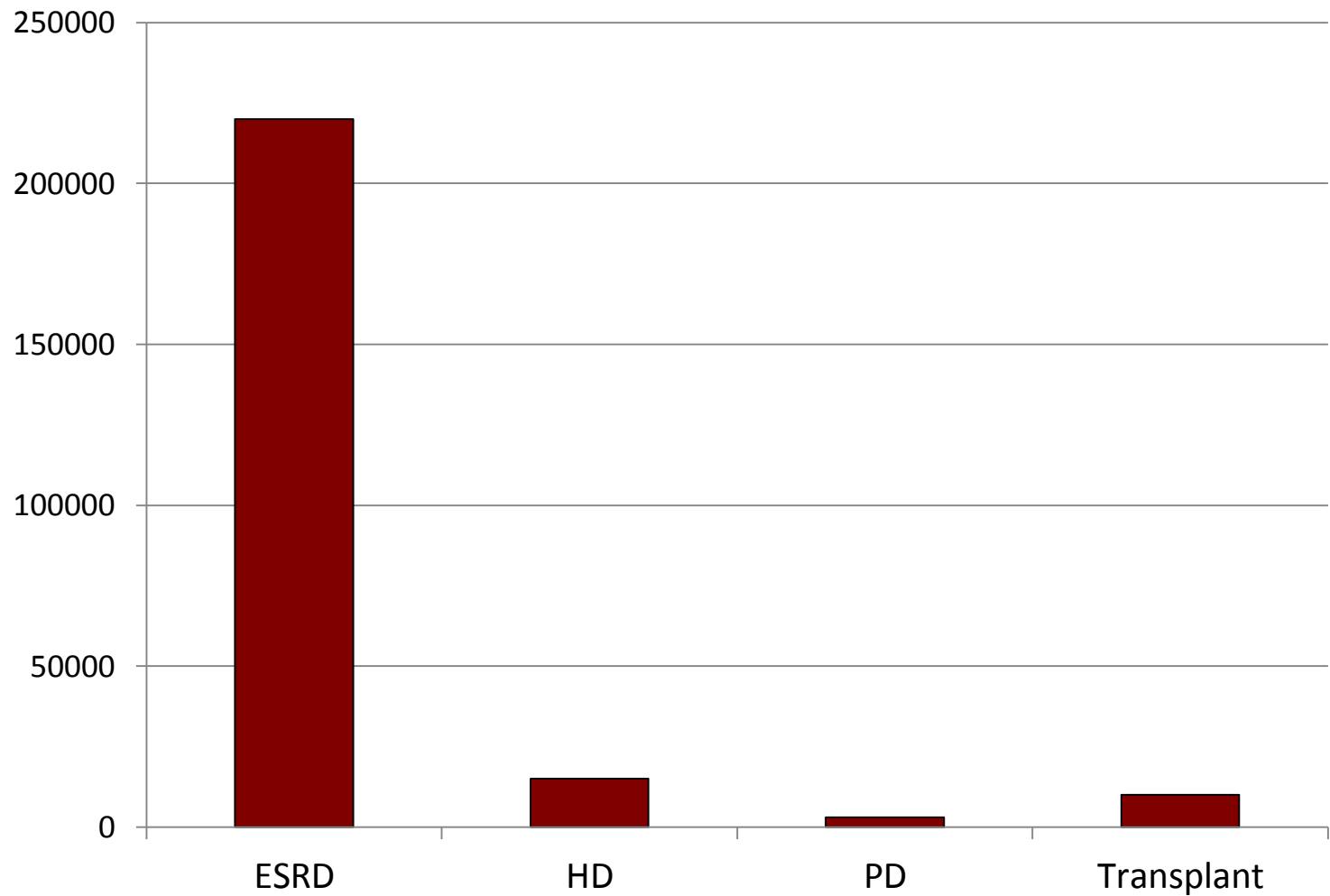


The CKD problem in India

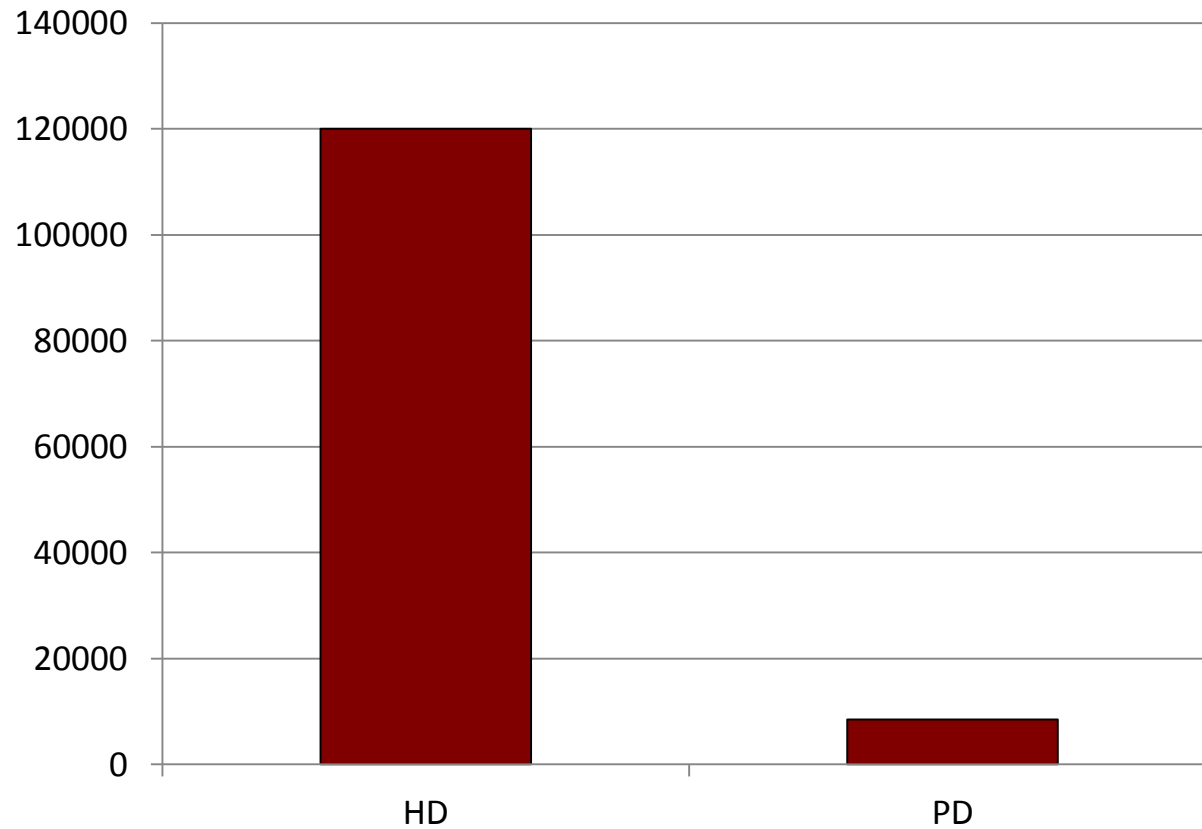
A few numbers..

- Reported prevalence of CKD in different regions ranges from <1% to 13%,
- Population: 1.3 billion (90million CKD)
- 1850 Nephrologists
- Dialysis cost : USD 20/session
- Transplant cost: USD 10000

Incident rates of ESRD and RRT by modality (2017)



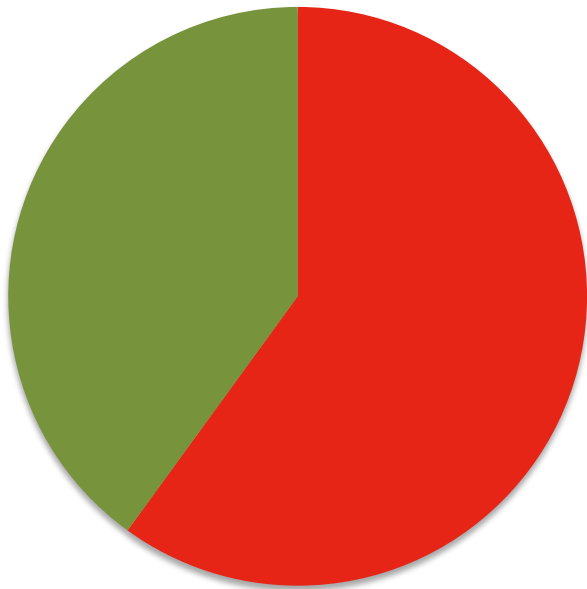
Prevalent patients on RRT (2017)



The Transplant scenario in India

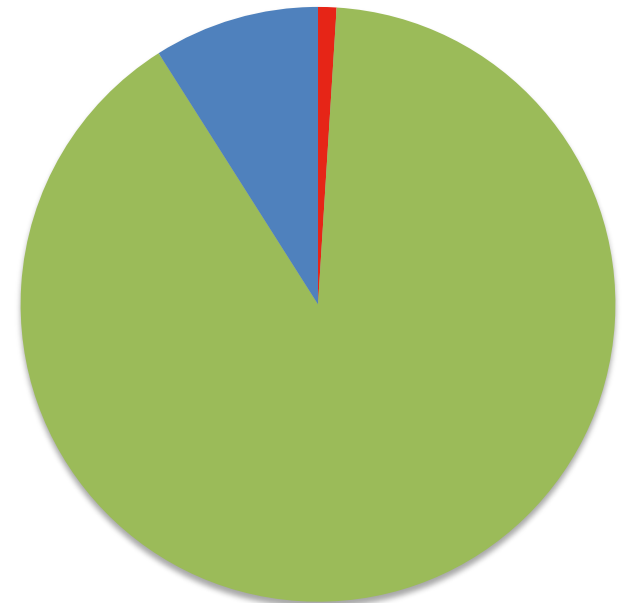
1994 – Watershed year for Transplants

Pre 1994



Post 1994

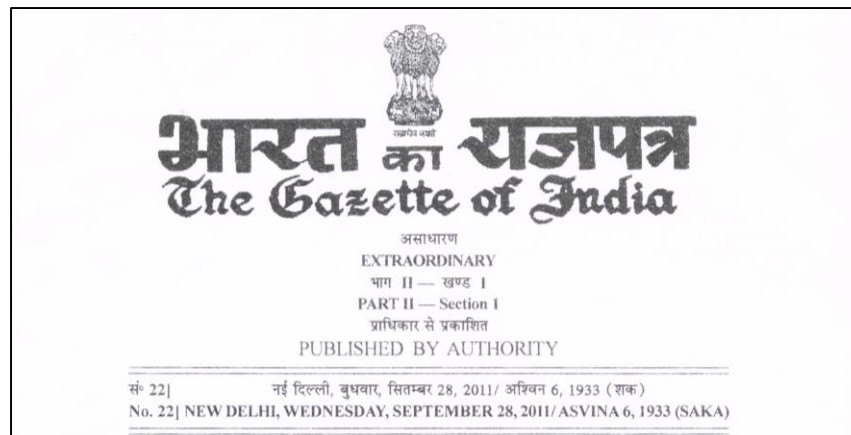
■ LURDT
■ LRDT
■ DDT



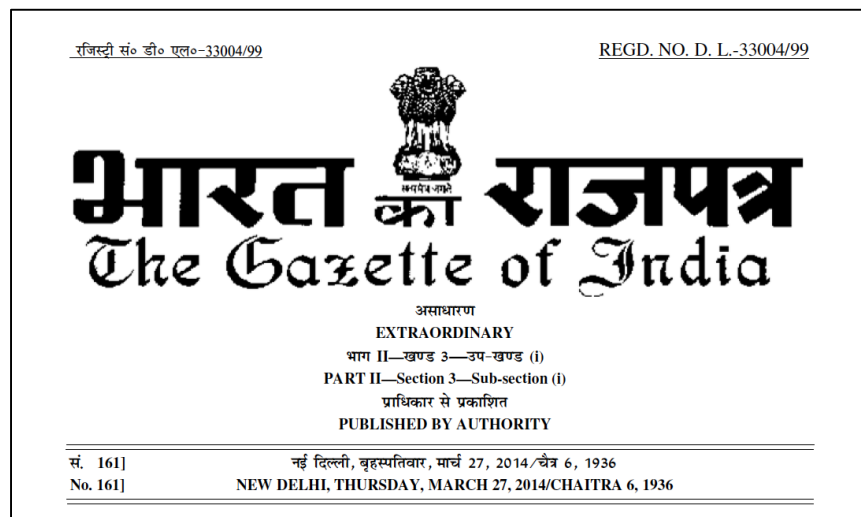
1994

Ministry of Law, Justice and Company Affairs
(Legislative Department)
New Delhi, the 11th July, 1994
The following Act of Parliament received the assent of the President on the 8th July,
1994 and is hereby published for general information:-
THE TRANSPLANTATION OF HUMAN ORGANS ACT, 1994
No.42 OF 1994
[8th July, 1994]

2011



2014



Transplant laws became very severe

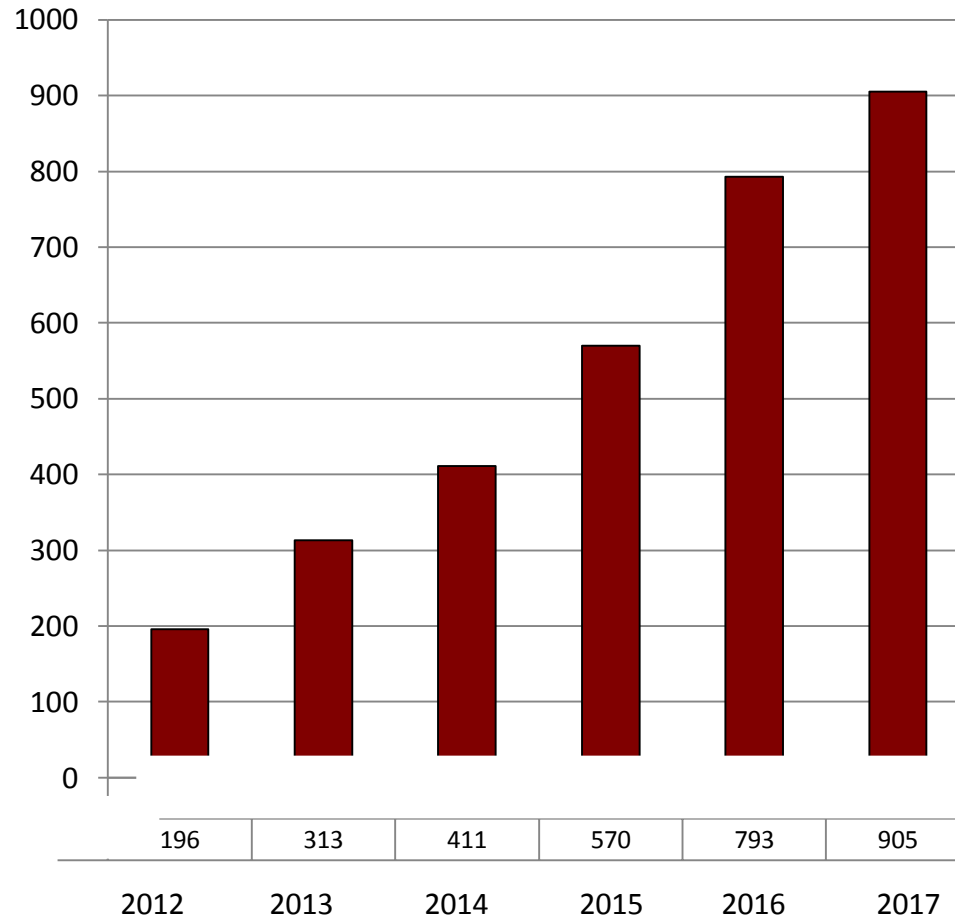


- The Nephrologist became the favorite whipping boy for anything that went wrong.
- ✓ Unrelated transplants stopped
- ✗ Related transplants procedural delays

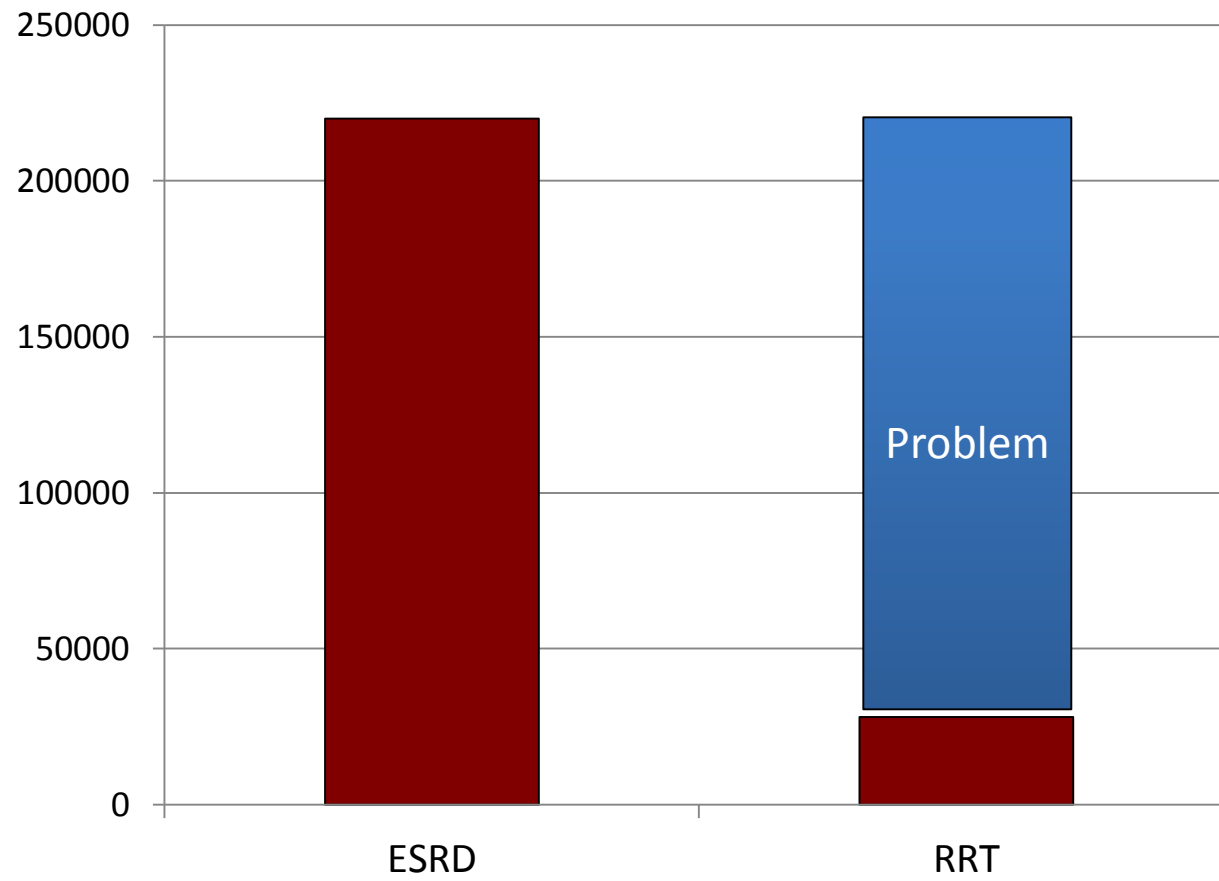
Who can donate a kidney?

- **Related donor:** 1⁰ relations, spouse, grandparents
- **Unrelated donor:** in laws, cousins, uncles, aunts, **KEP**
- **Emotionally related:**
- **Altruistic donation: Not legal**

No. of Deceased Donors



Incident rates of ESRD and RRT (2017)



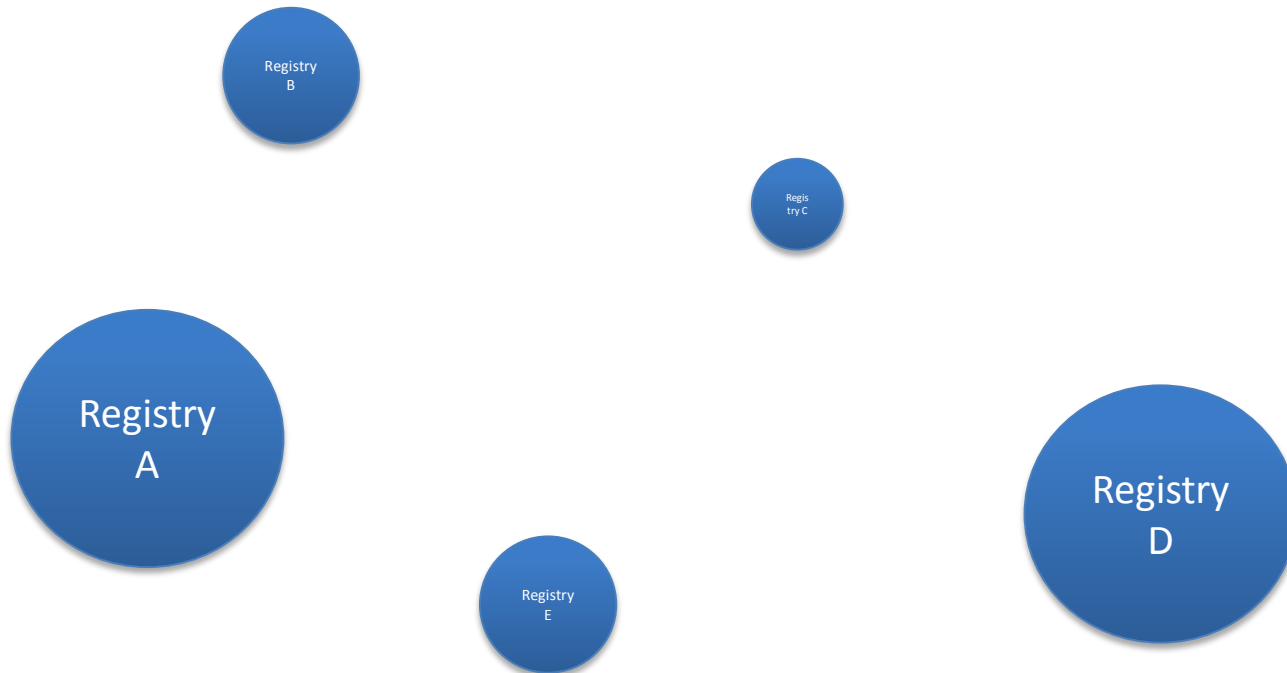
ASTRA



APEX SWAP TRANSPLANT REGISTRY

**"From each according to his ability,
To each according to his need"**

Multiple Registries, different philosophies



ASTRA today

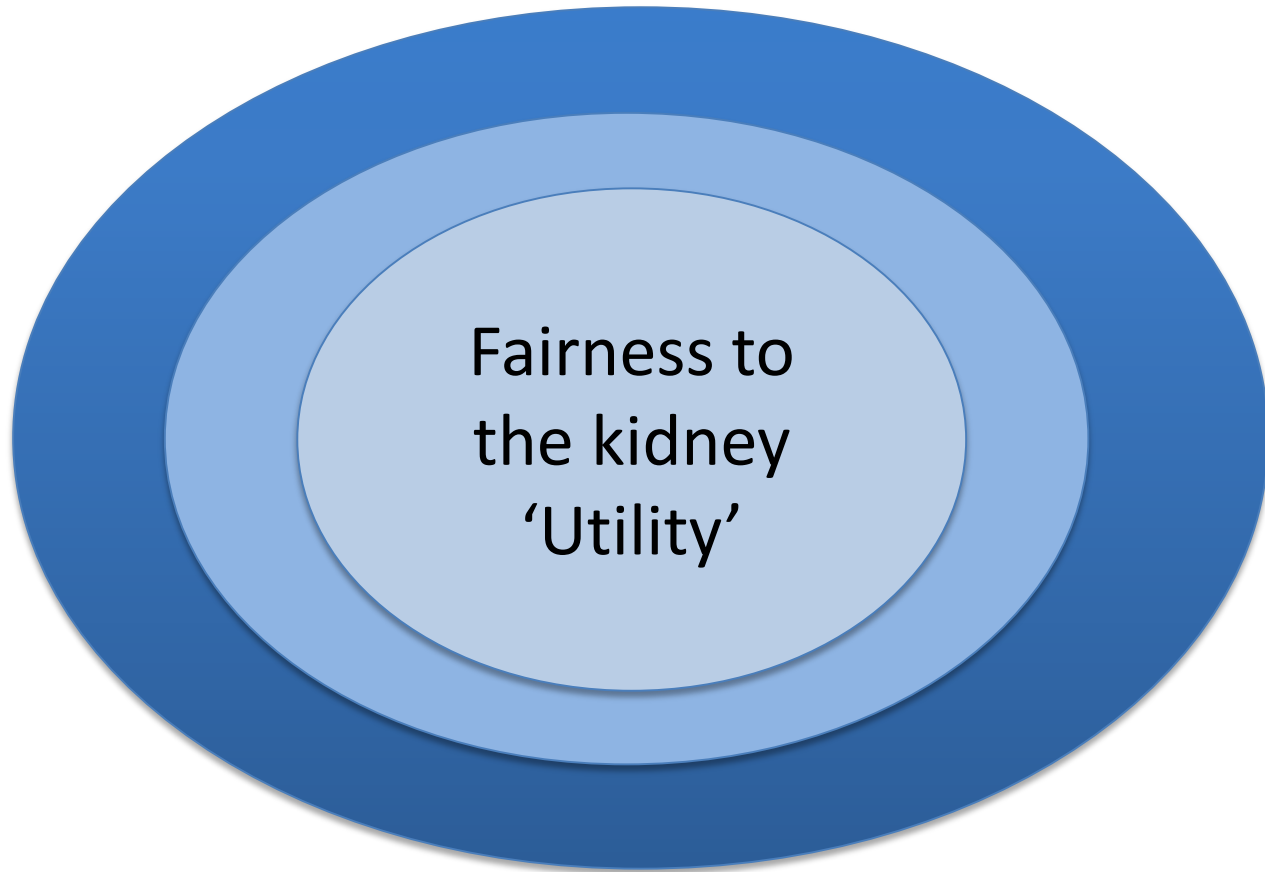
- **Established:** 2011
- **Objective:**
To aid patients to identify swap pairs
- **Data as of date:**
351 registrations,
51 transplants (2 chains - 5 pairs & 6 pairs)
- **Charge to the patient:** Nil

Principles followed in writing a code

- Legal
- Ethical
- Philosophical

In collaboration with The Dept. of Industrial Engineering and Operations Research,
Indian Institute of Technology, Mumbai

1. Fairness to the community: **Cardinality**
2. Fairness to the patient: **Equity**
3. Fairness to the kidney: **Utility**



1. Fairness to the community: Cardinality

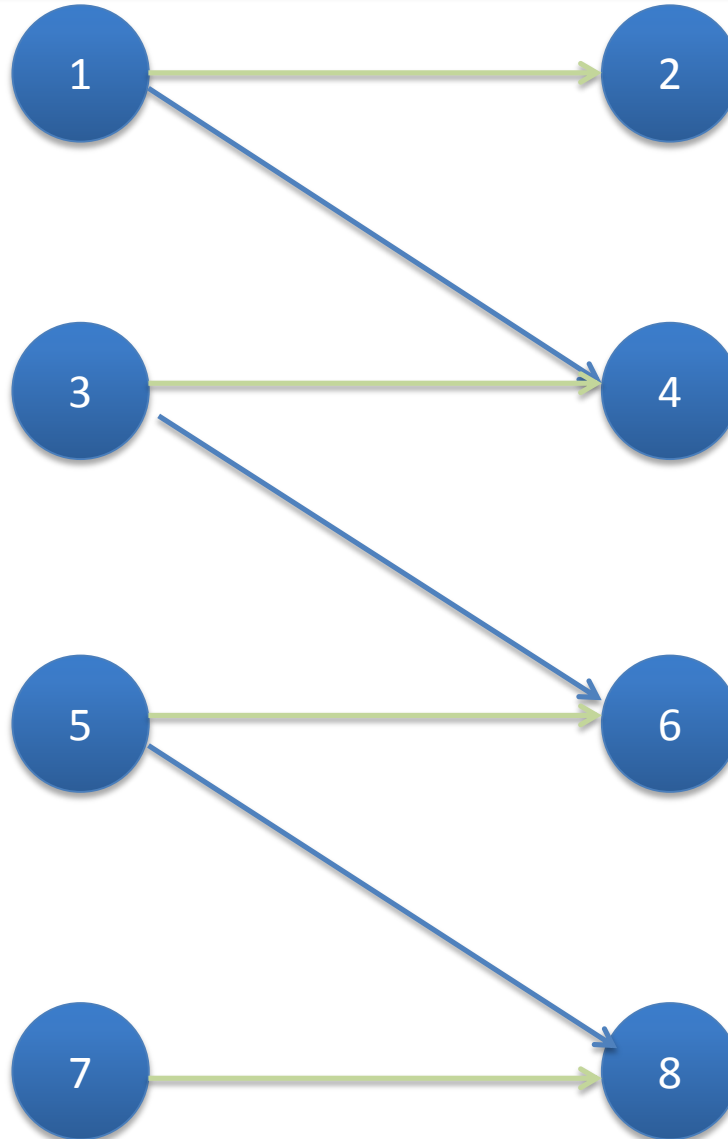
Cardinality 3

Option 1

1>>4

3>>6

5>>8



Cardinality 4

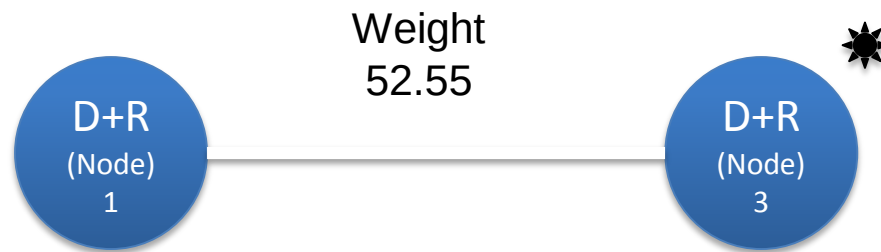
Option 2

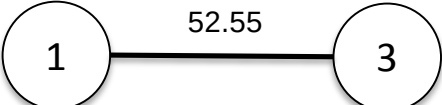
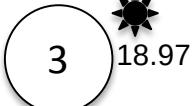
1>>2

3>>4

5>>6

7>>8



	Mutually incompatible D-R pair with serial number 1
	Feasible binary swap between pairs with index 1 and 3 and with total added score of 52.55
	Mutually compatible D-R pair with serial number 3 and added score 18.97

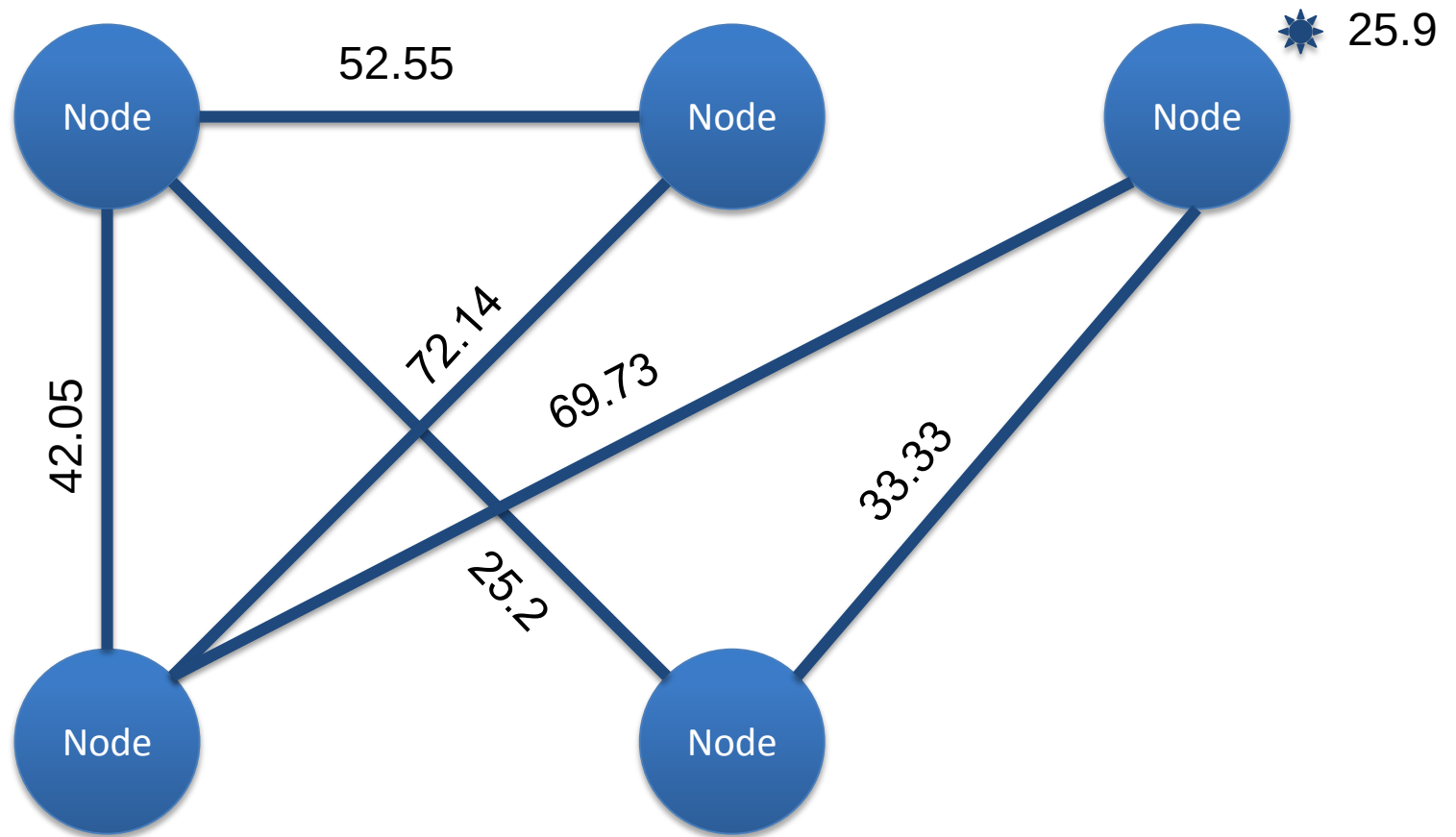
Assumptions

Application Objectives			
1.Achieve max. no. 'Cardinality'	2. Achieve Fairness 'Equity'	Score 80%	3. Achieve max. graft survival 'Utility' Score 20%
	Time since swap Registration		HLA mismatch number Age difference bet D and R
	Time on dialysis		
	Failed vascular access		
	Blood group		
	Sensitised recipient		

S.No	Parameter	Values taken								Weightage
Fairness										
1	PRA%	0-9	10-79	≥80					0.7	
		15	20	25						
2	O recipient	Yes	No						0.45	
		25	0							
3	AB donor	Yes	No						0.3	
		25	0							
4	Failed vascular accesses	0	1	2	≥3				0.8	
		1	12	20	25					
5	Waiting time on dialysis	If 0<=x<=5, then f(x)=x², if x≥5, the f(x)=25							0.75	
6	Period from registration	If 0<=x<=5, then f(x)=2.5*x, if x≥10, then f(x)=25							0.2	
Utility										
1	HLA mismatches	0	1	2	3	4	5	6	0.45	
		25	22	23	20	17	16	15		
2	Age diff. bet. D and R	fx=25*exp(-x²/50)							0.35	

1. Fairness to the patient: Equity
2. Fairness to the kidney: Utility

} Score



MAIN NAVIGATION

[Recipient](#)
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TOTAL REGISTRA...

317


TOTAL TRANSP...

53


BINARY SWAPS

42

DOMINO SWAPS

2

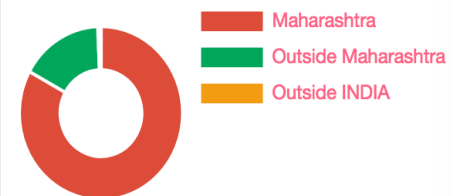

IN-PROCESS SW...

6

Registrations by Location

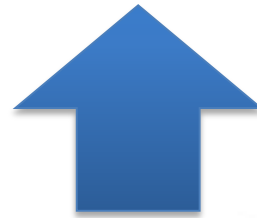


Registrations



Challenge: Getting patients to register.

- Inform patients **via** Nephrologists
- Inform patients on the deceased donor waitlist **via** Govt.



Media Attention for India's first Domino Swap Kidney Transplant...

Five patients benefit from India's first "domino" kidney swap

Cheryl Travasso

Mumbai

A team of 10 nephrologists and 20 urologists has performed India's first domino kidney transplantation.

The operations were carried out on 25 June in 10 operating theatres in three hospitals in Mumbai and involved five patients—four from Maharashtra and one from Rajasthan.

Currently only one patient in 10 who develops kidney failure in India has a kidney transplantation, 95% of them receiving the organ from a living family donor. In developed countries most kidney transplants (about 90%) are from cadaveric donors.

To increase access to kidney transplantations, five nephrologists in Mumbai set up the Apex Swap Transplant Registry (ASTRA) to facilitate swaps between incompatible recipient-donor pairs. For a nominal fee these pairs can register on the ASTRA website, which then uses a mathematical model to match donor-recipient pairs who can swap organs. For example, if there are two families A and B, the donor of family A gives a kidney to the recipient in family B, while the donor in family B gives a kidney to the recipient in family A. Once a match is identified, the two primary nephrologists of the patients plan the operations. In the 30 months since its inception the registry has facilitated 27 such swaps.

What made the operations on 25 June unique was that this was the first case of a domino kidney swap—a complex chain of kidney transplantations between five donor-recipient pairs. However, Viswanath Billu, a leading nephrologist and director of Apex Kidney Care, said it had been "an uphill task" to convince administrators and officials that a domino swap was merely "a swap at the wholesale rather than the retail" level.

The Indian Supreme Court ruled in early 2011 that kidney swaps were legal, although it did not mention "domino swaps." The first domino swap was planned for November 2011, but in the time it took to obtain the required permissions one of the patients died, and the swap collapsed.

The operations on 25 June involved four husband-wife pairs and one father-daughter pair. Two operations were carried out at the Hinduja Hospital, and four each at Bombay Hospital and Hirmanandani Hospital. The matched donor and recipient were brought together under one roof for surgery. So far all the recipients are doing well.

GLOBAL EDITION

सामना
सर्वातरी सर्वातरी

मुंबईत पहिल्यांदाच एकाच वेळी पाच किडनी प्रत्यारोपण

एकच वेळी पाच किडनी प्रत्यारोपण करण्यात आले. या प्रत्यारोपणाने पाच किडनी प्रत्यारोपण करून देण्यात आले. या प्रत्यारोपणाने पाच किडनी प्रत्यारोपण करून देण्यात आले.

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THE TIMES OF INDIA

40 docs perform first domino kidney swap

LIVES LINKED FOREVER

The article describes the first domino kidney transplant in India, performed on June 25 in Mumbai. It involved 40 doctors and 10 operating theatres. The process allowed five incompatible donor-recipient pairs to swap kidneys, saving five lives. The article highlights the role of the Apex Kidney Care and the ASTRA registry in facilitating such swaps.

DNA

Bravo! City docs hit the bull's-eye

Clear urgent transplants in four weeks!

The article reports on the successful completion of the first domino kidney transplant in India. It mentions that the operation was performed by a team of 40 doctors across 10 hospitals in Mumbai. The article also notes that the transplant was a significant milestone for the city's medical community.

hindustantimes

5 patients get new kidneys in record op at 3 city hospitals

TRANSPLANT INDUSTRY: Doctors helped match four families from Andhra and one from Rajasthan

The article discusses the first domino kidney transplant in India, which took place on June 25 in Mumbai. It mentions that the operation was performed by a team of 40 doctors across 10 hospitals. The article also notes that the transplant was a significant milestone for the city's medical community.

The Indian EXPRESS

Give and take in kidney chain

LIVE SWAPS SAVING 5 LIVES: MUMBAI HOSPITALS CONNECTED DONORS' KIDNEYS TO RECIPIENTS THROUGH A CHAIN OF SWAPS

The article reports on the first domino kidney transplant in India, performed on June 25 in Mumbai. It mentions that the operation was performed by a team of 40 doctors across 10 hospitals. The article also notes that the transplant was a significant milestone for the city's medical community.

मुंबई मसला

पहली बार 'डोमिनो किडनी ट्रांसप्लांट'

The article reports on the first domino kidney transplant in India, performed on June 25 in Mumbai. It mentions that the operation was performed by a team of 40 doctors across 10 hospitals. The article also notes that the transplant was a significant milestone for the city's medical community.

प्रहार

मुंबईत पहिल्यांदाच पाच किडनी प्रत्यारोपण

The article reports on the first domino kidney transplant in India, performed on June 25 in Mumbai. It mentions that the operation was performed by a team of 40 doctors across 10 hospitals. The article also notes that the transplant was a significant milestone for the city's medical community.

2

Mumbai doctors perform India's first domino kidney transplant

The article reports on the first domino kidney transplant in India, performed on June 25 in Mumbai. It mentions that the operation was performed by a team of 40 doctors across 10 hospitals. The article also notes that the transplant was a significant milestone for the city's medical community.

ASTRA job profile





Pair 1

Transplant
Coordinator



Hospital
Authorization
Committee



Government
Authority



Pair 2

Transplant
Coordinator

- Collating Documents
- Preparing Affidavits

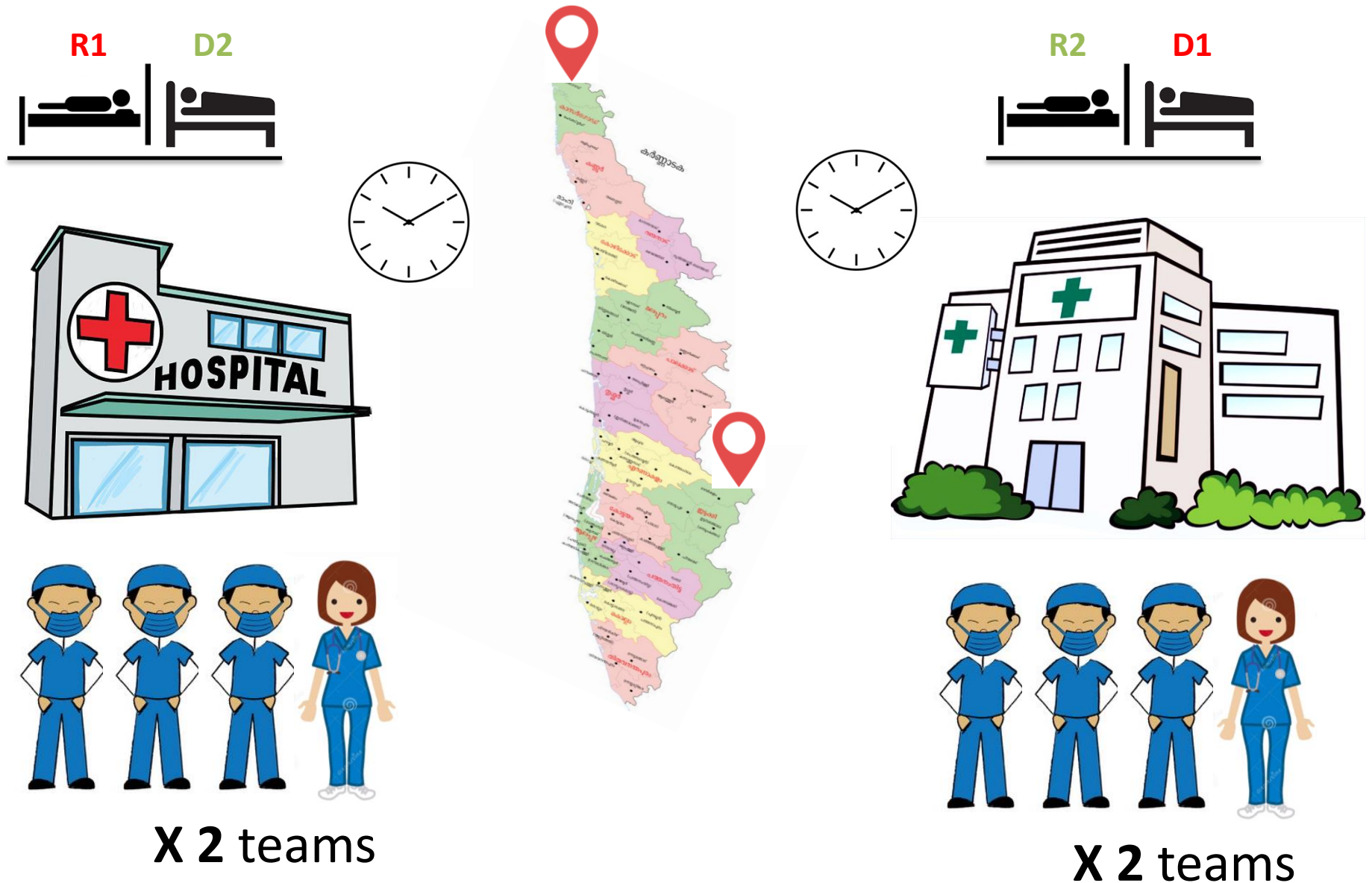
Hospital
Authorization
Committee

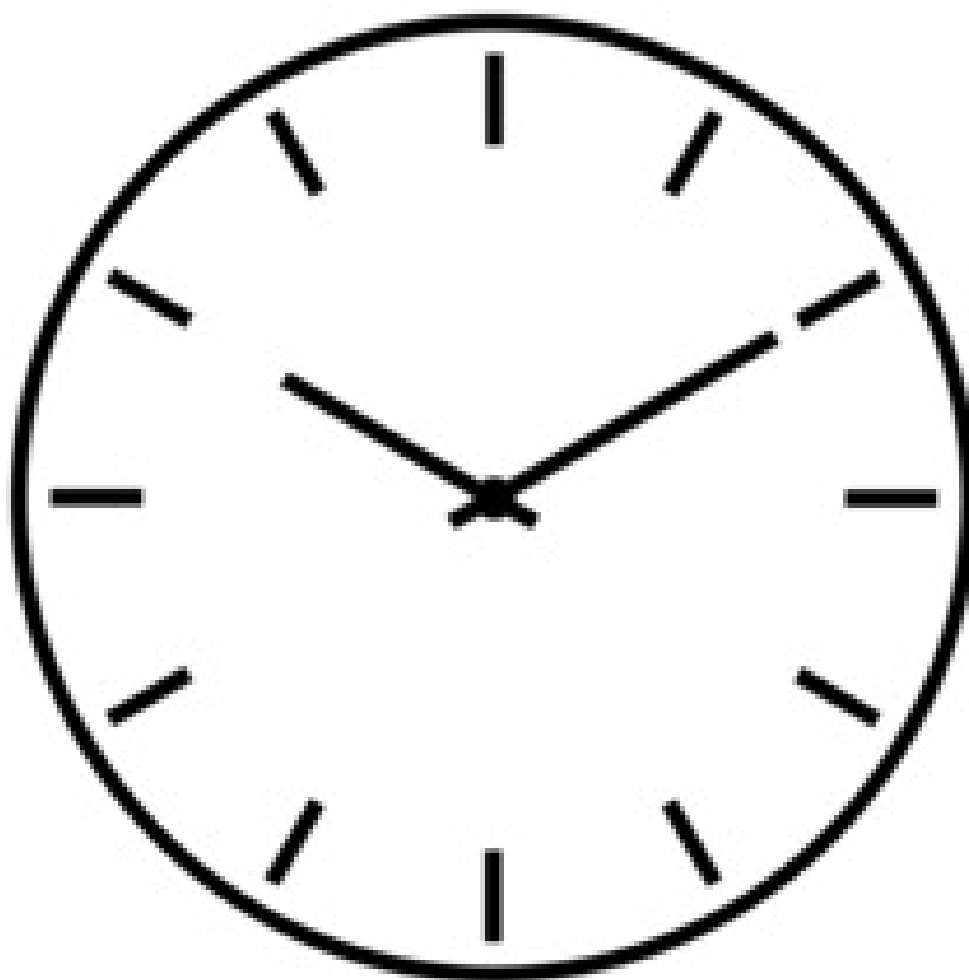
- Interview the pairs
- Establishing Proof of relationship

Government
Authority

- Interviewing the pairs
- Establishing proof of relationship
- Giving final permission

Implementing the swap transplant

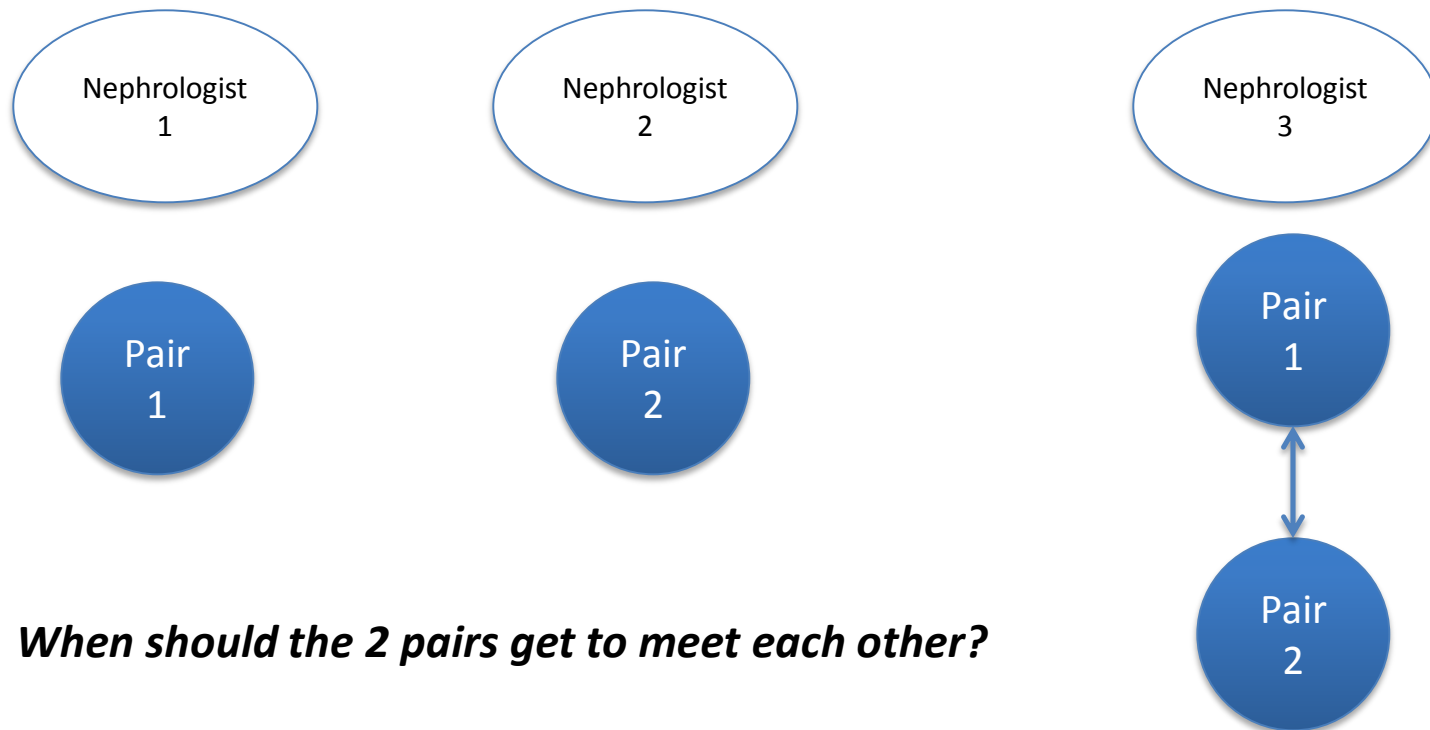




Challenge 1

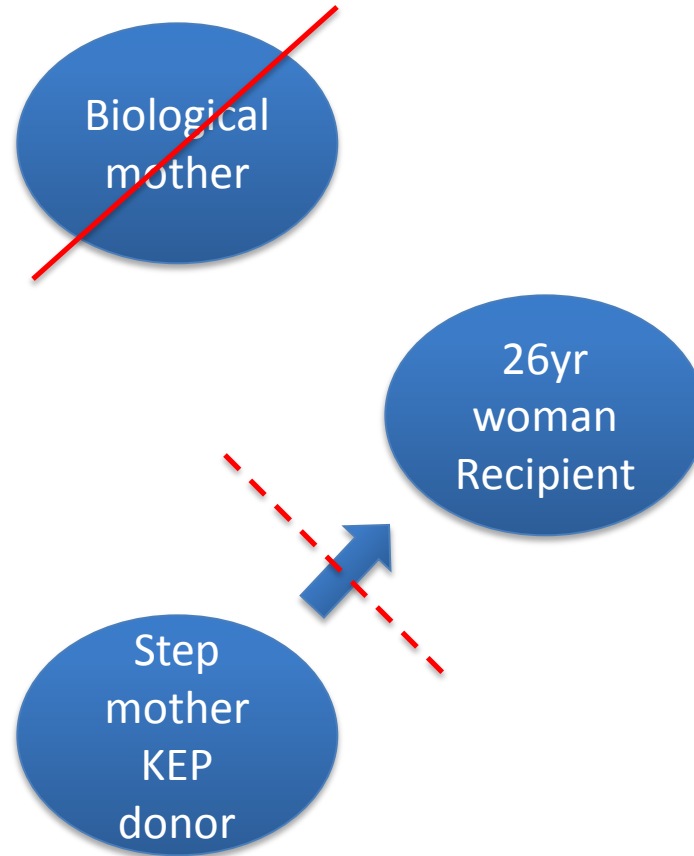
Pair A and Pair B, matched by ASTRA.

Undergo documentation and Govt permission under 2 different 1⁰ Nephrologists at Hospital X and Hospital Y



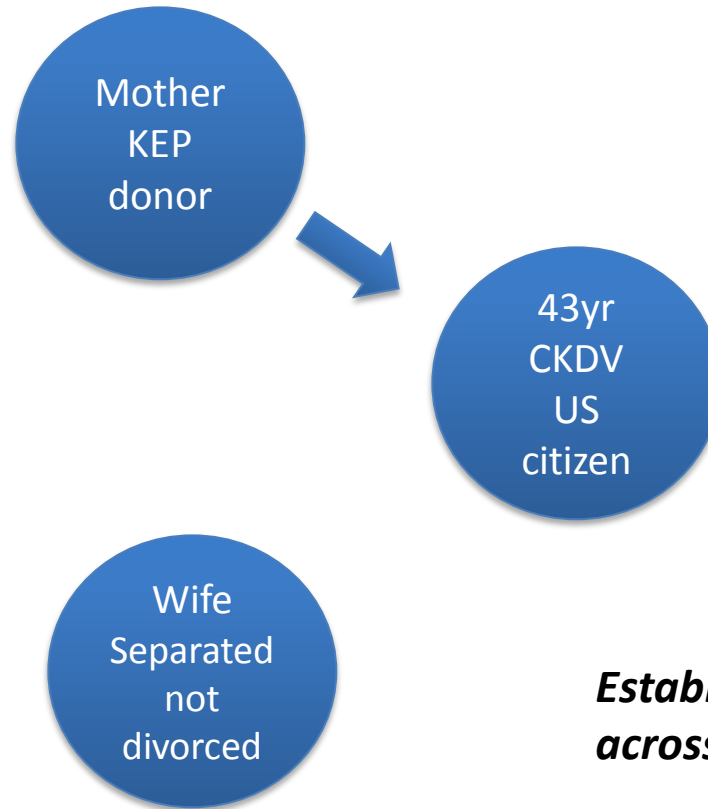
When should the 2 pairs get to meet each other?

Challenge 2



**Extreme situations need extreme solutions.
Procedures need to be inclusive in such situations.**

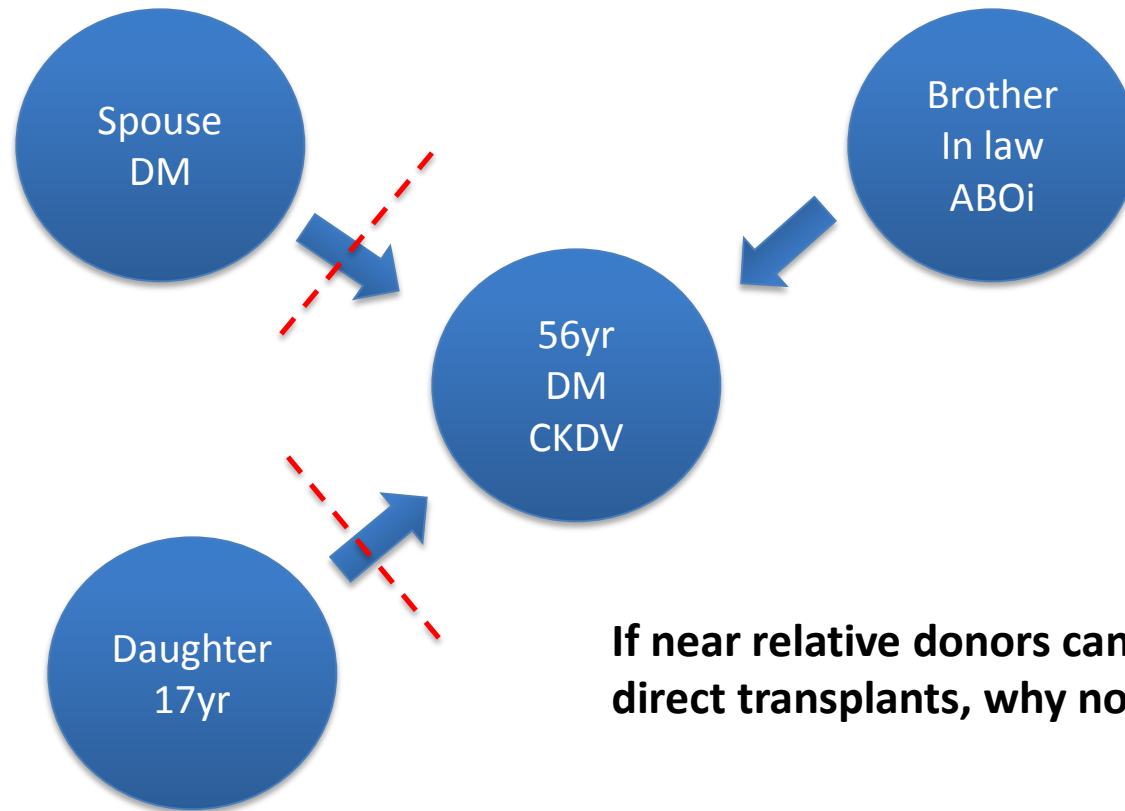
Challenge 3



***Establishing uniformity in practices
across Hospitals***

1. NOC from the country of citizenship
  2. Consent from the separated but not legally divorced wife
- Moved to another Hospital Y, papers processed and successfully transplanted.

Challenge 4



If near relative donors can be considered for direct transplants, why not in swaps?

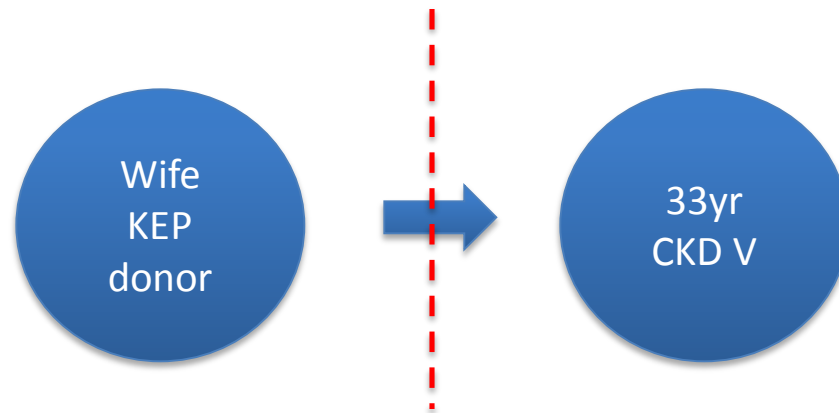
The Law states that only 1st degree relatives could be swap donors.

No transplant permission granted for 6 months.

Multiple meetings with with several government authorities to explain the case

Eventually translated into a successful transplant after 1 year.

Challenge 5



Challenge: If a wife wants to donate to her husband, can her parents come in the way?

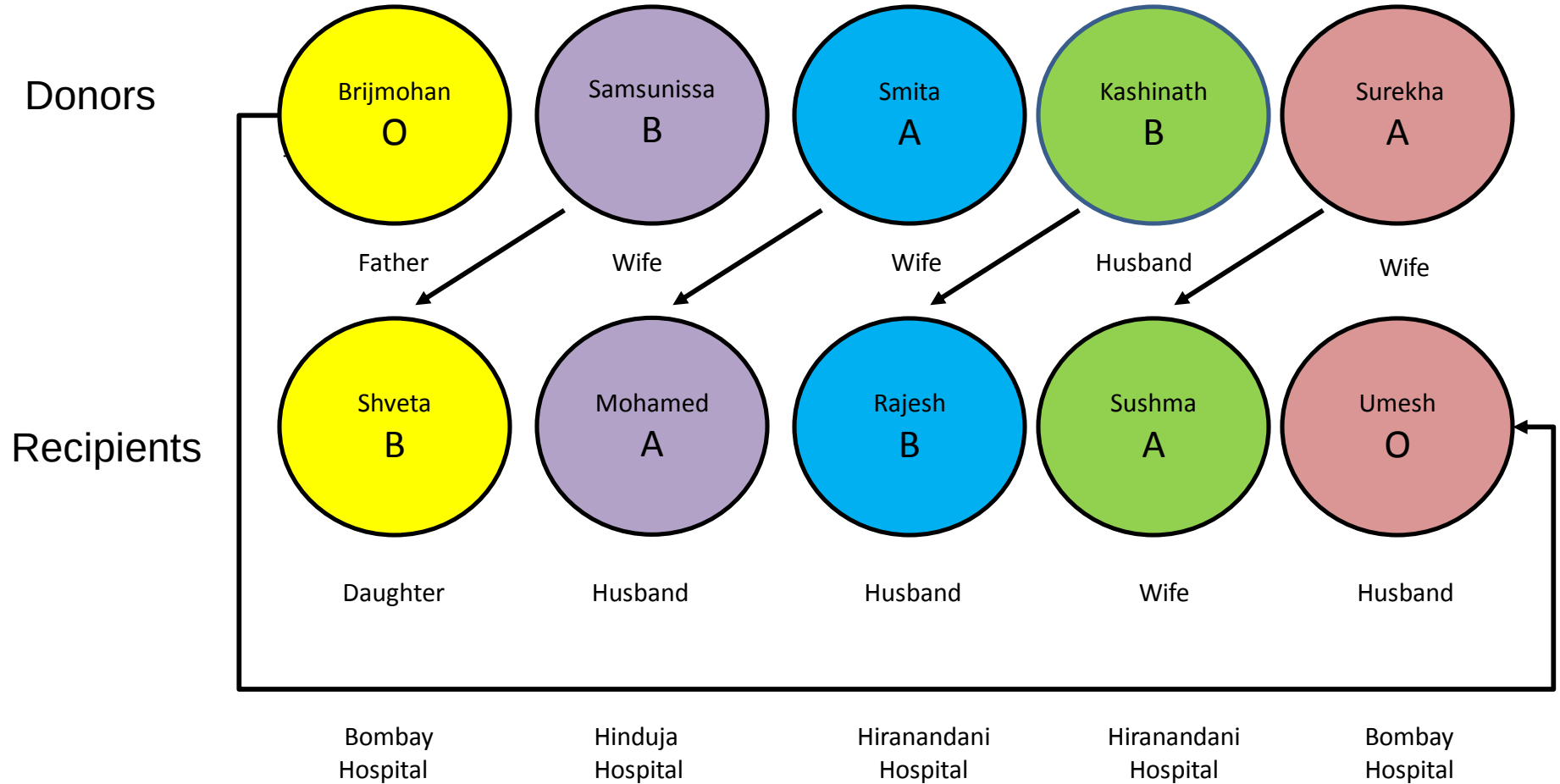
(Consent for medical termination of pregnancy in India:

A woman's exclusive domain, no place for man's concurrence)

Challenge 6

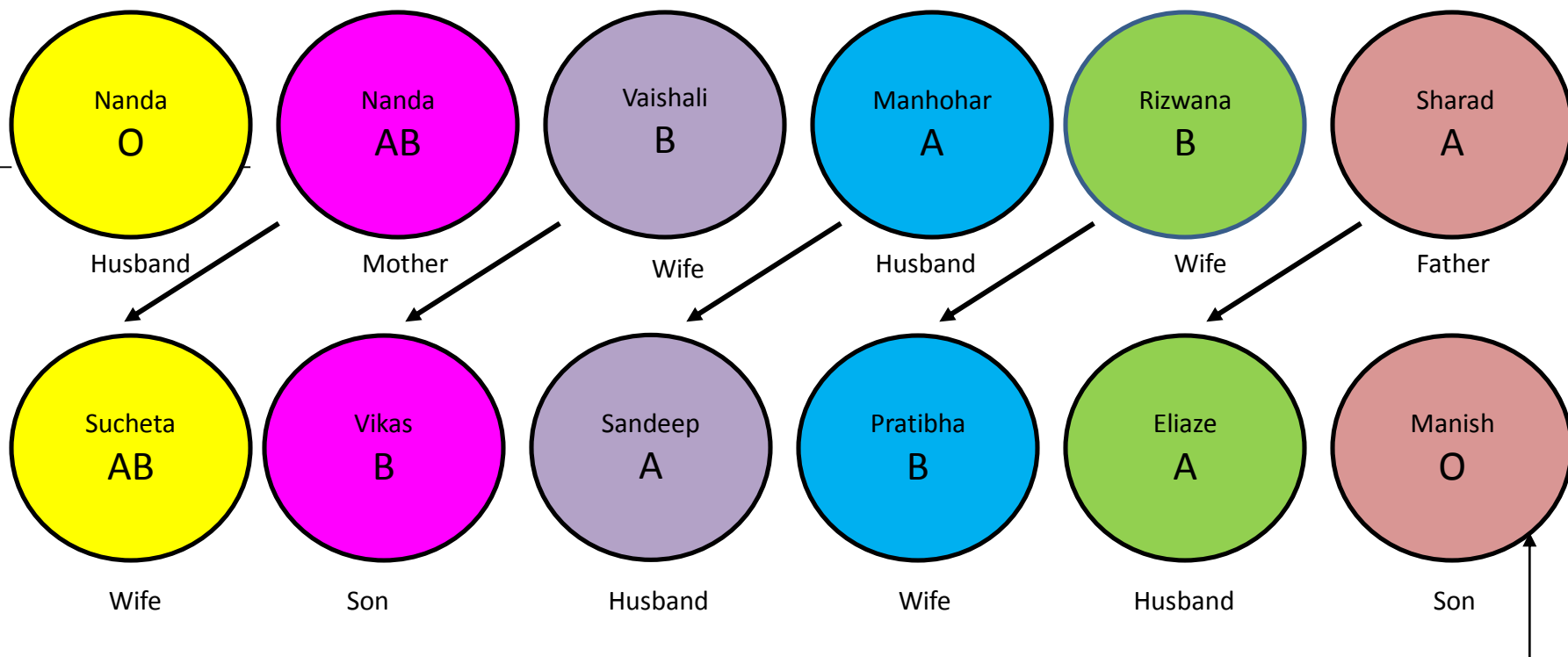
- 2014
- Chain 1, 5 pairs simultaneous exchange.
- One pair was domiciled in another state: Rajasthan
- That states Govt. Authority refused permission for the KEP chain, since there is no mention of this term in the Gazzette.

Chain I: 2013



Chain II: 2014

Donors



Recipients

Bombay
Hospital

Hiranandani
Hospital

Hinduja
Hospital

Bombay
Hospital

Hiranandani
Hospital

Bombay
Hospital

Challenge 7: Strange requests!

- Want a Hindu kidney only
- Want a female kidney only
- Want a kidney with a GFR >50 only

Challenge 8

- Kidneys travelling or Donors travelling
- Simultaneous deployment versus Sequential deployment
- Public Hospital versus Private Hospital



Transplant
Coordinator



Hospital
Authorization
Committee



Appropriate
Authority



Challenge 9



Hackers trying to corner this database. Database security

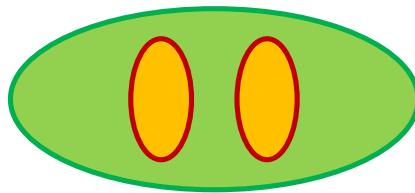
A successful paired exchange program

- Large number of registrants
- Healthcare infrastructure
- A single large Cohesive registry
- Cohesive Nephrologists
- Professional discipline
- Uniform hospital policies

Linking the Swap Registry with the Deceased Donor Waitlist

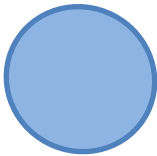
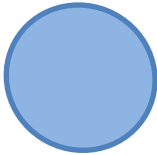
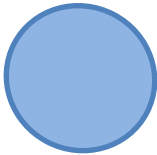
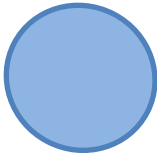
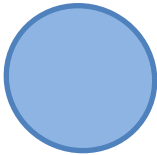
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2 recipients on the
cadaveric list
receive 2 kidneys

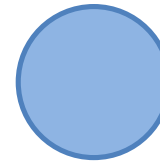
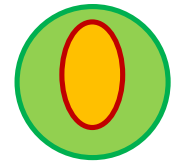
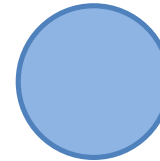
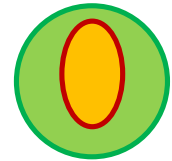
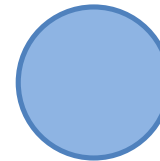
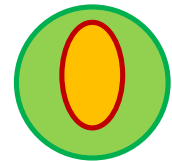
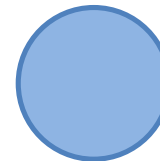
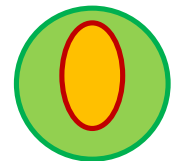
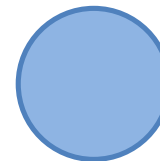
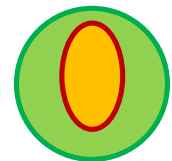


1 Deceased donor

5 patients in ASTRA receive kidneys



1 cadaveric donor can generate
7 kidney transplants



Deceased donor Wait list

ASTRA wait list

A Novel Method to Increase the Kidney Donor Pool: A Fusion Model Linking the Deceased Donor Waitlist to a Paired Kidney Exchange Program

Viswanath Billa^{1,2,*}, Utkarsh Verma³, Deepa Usulumarty⁴, Narayan Rangaraj⁵, Ganesh Sanap², Jatin Kothari⁶, Rajesh Kumar⁴, Shrirang Bichu¹

¹Department of Nephrology, Bombay Hospital, ²Apex Swap Transplant Registry-Apex Kidney Foundation, ³Department of Industrial Engineering and Operations Research, IIT Bombay, ⁴Department of Nephrology, Sushrut Hospital, ⁵Department of Nephrology, PD Hinduja Hospital, ⁶Department of Nephrology, Dr. L.H. Hiranandani Hospital, Mumbai, Maharashtra, India

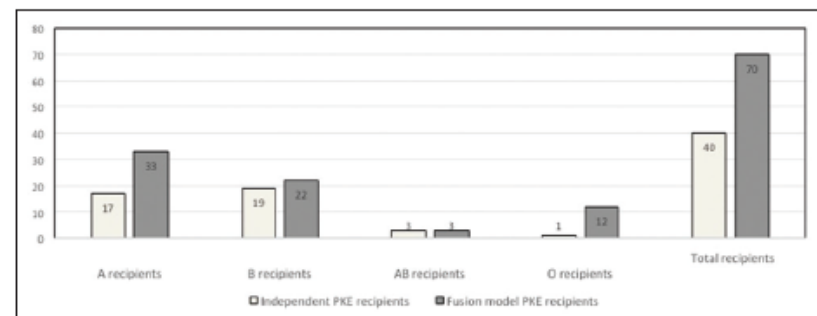


Figure 4: Blood group-wise comparison of the number of recipients benefited by the Fusion model versus a standalone Paired kidney exchanges registry (chain length 3)

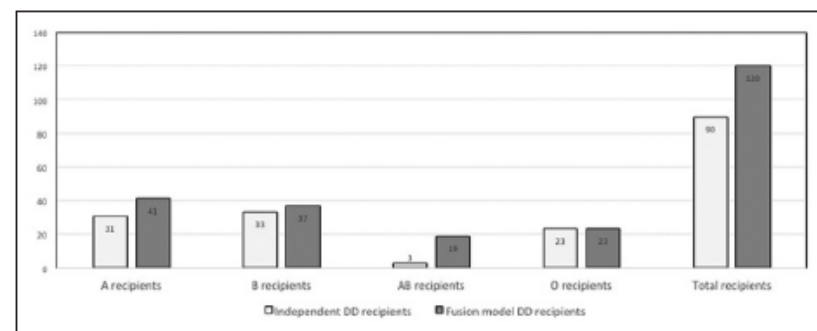
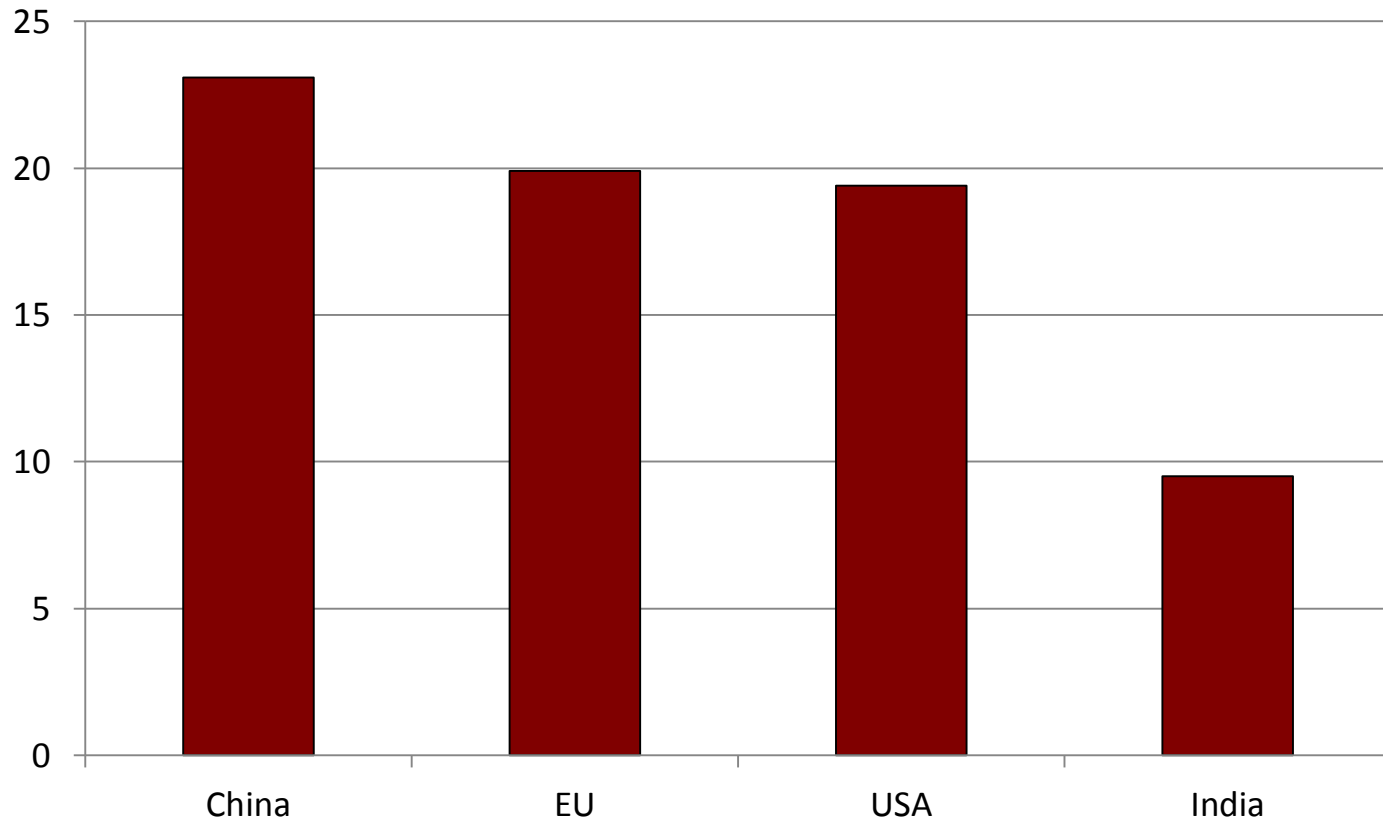


Figure 5: Blood group-wise comparison of the number of recipients benefited by the Fusion model versus a standalone deceased donor registry (chain length 3)

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