

# Simulation of the new ETKAS allocation algorithm

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Where innovation starts

1. Introduction
2. Simulation Framework
3. Simulation Results
4. Conclusion

Match quality, as measured by the number of mismatches on HLA-A,-B and -DR loci (#A, #B, #DR). For the new allocation mechanism, Eurotransplant defines the following mismatch categories.

- ▶ Full House:

$$\#A + \#B + \#DR = 0$$

- ▶ DR+:

$$\#DR = 0, \#A + \#B \leq 2$$

- ▶ DR0:

$$\#DR = 0, \#A + \#B > 2$$

- ▶ DR1:

$$\#DR = 1$$

- ▶ DR2:

$$\#DR = 2$$

## Current ETKAS

A tiered mechanism, with point-based ranking in each tier

- ▶ Tier 1: Patients with a *full house* match
- ▶ Tier 2: Pediatric patients (if donor is < 16 years)
- ▶ Tier 3: Other patients

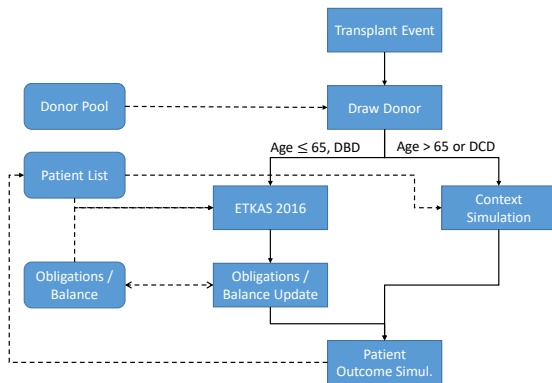
Within each tier a point system, with heavy weights for

- ▶ Match quality (#A + #B + #DR)
- ▶ Balance import and export
- ▶ Domestic and local transplants
- ▶ Time on dialysis

## Proposed ETKAS

- ▶ Hierarchical allocation mechanism
  - Highest match quality first (unless countries have large net import).
  - Domestic transplants, and "repayment" of international transplants.
  - Waiting time only as a tie-breaker
- ▶ Two variants
  - Second variant compromises a little on match quality in favour of domestic transplants.

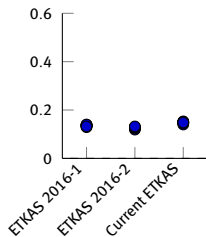
- ▶ Close to historical data (2004-2016)
  - Patient data.
  - Donor arrival times as historical.
- ▶ Some variation
  - Donor information drawn from 2013-2016.
- ▶ Simulation of information not available from historical data.
  - How long would a patient who received a transplant have stayed on the waiting list?
  - Will a recipient be re-registered after transplantation, and when?



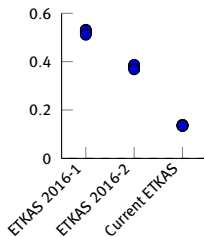
- ▶ Results are compared against a simulation of the point-based ETKAS match (version early 2018).
  - Direct comparison of the impact of the matching mechanisms.
- ▶ Simulation of current ETKAS immediately tests accuracy of simulation model.



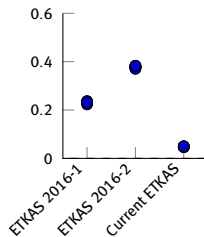
- ▶ Match Quality
- ▶ International Transfers
- ▶ Time to transplant



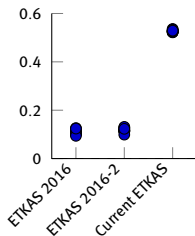
(a) Full House



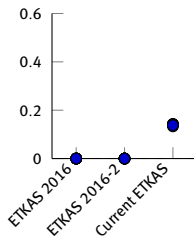
(b) DR+



(c) DRO



(d) DR1



(e) DR2

- ▶ ETKAS 2016 leads to higher match quality.
  - 85% perfect match on DR vs. 35% currently.
- ▶ Variant of ETKAS 2016 switches DR+ for DR0.

- ▶ ETKAS 2016 will lead to increased gross transfers.
  - In simulation 64-62% domestic transplants vs. 80+% under simulated current mechanism.
  - Differences are even larger for most countries, Germany relatively stable.
  - For Belgium around 40-45% domestic vs. 83% under simulated current mechanism.
  
- ▶ Effect on net transfers is limited.
  - Only consistent imbalances if countries have almost no recipients of particular blood types.

- ▶ Virtual elimination of dialysis time as a factor increases the variance in waiting times.
  - More chance of an early transplant
  - More chance of delisting a patient without transplant.

			1	2	3	4	5	6	7
BEL	Current		0.626	0.791	0.865	0.891	0.898	0.900	0.900
	Trans	2016-1	0.654	0.784	0.845	0.875	0.887	0.893	0.895
	Current		0.013	0.019	0.022	0.023	0.023	0.023	0.023
	Delist	2016-1	0.012	0.017	0.021	0.024	0.027	0.028	0.028

**Table:** Probability of transplant and permanent delisting without transplant after 1 to 7 years after listing for patients aged 50-64 at listing, arriving after simulation start, over 10 simulation runs.

- ▶ Note: In simulation, relatively more Belgian donors than in historical data.

- ▶ When (hypothetically) switching from Current ETKAS to ETKAS 2016, the waiting list contains patients that have already accumulated substantial time on dialysis.
  - These patients never had the opportunity of an early transplant.
  - Especially for patients aged (50-64), there is a noticeable increase of the probability of being delisted without transplant.
- ▶ Gradual introduction of new allocation system can lower shock.

- ▶ Quality of matches under ETKAS 2016 is higher than under Current ETKAS.
- ▶ Waiting time variance is larger under ETKAS 2016 than under Current ETKAS.
- ▶ ETKAS 2016 leads to much higher number of international kidney transfers; at the same time, net transfers remain small.