



**Penn State College of Medicine
Continuing Education**

**29th Annual Challenges in Critical Care: A
Multidisciplinary Approach**

Friday, August 15, 2025

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**Any names or ages used on the upcoming slides are fictitious
and not referring to an actual patient.**



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Normothermic Regional Perfusion

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Annual Challenges in Critical Care: A Multidisciplinary Approach
Hershey, PA
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Two Paths for Organ Donation

Donation After Brain-Death (DBD)

- BD is the irreversible cessation of all brain functions, including the brain stem. State law recognizes the diagnosis of brain death as a legal determination of death.
- Physicians follow hospital policy to ensure the BD patient is declared by testing that aligns with national AAN guidelines.



Following the optimization of all organs being evaluated & the identification of recipients, the donor is transported to the OR with all support mechanisms in place, which remain until after cross clamp occurs.

Donation After Circulatory Death (DCD)

- Option provided to families who understand a loved one's poor prognosis and may be considering end of life options.
- Gift of Life works in conjunction with the hospital and family to ensure appropriate testing and/or therapies are completed prior to the withdrawal of life-sustaining therapies.



Patient is transported to the operating room, where terminal extubation takes place. If the patient expires within the 60-minute timeframe, donation can occur.

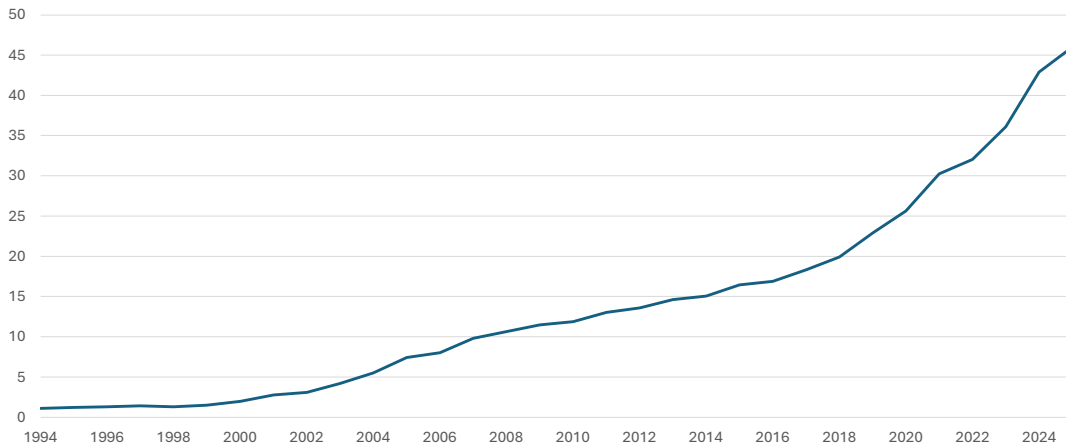
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Objectives

1. What is NRP and why is it beneficial?
2. What data support the benefit of NRP?
3. Are there any concerns surrounding NRP?
4. Thoracoabdominal (TA) vs. Abdominal (A) NRP: is there a difference (or just a distinction)?
5. Discuss NRP impact
 - a. Question: Can we eliminate liver (and kidney) waitlist deaths with NRP?
 - b. Answer: Yes! (and yes, over a longer time frame)

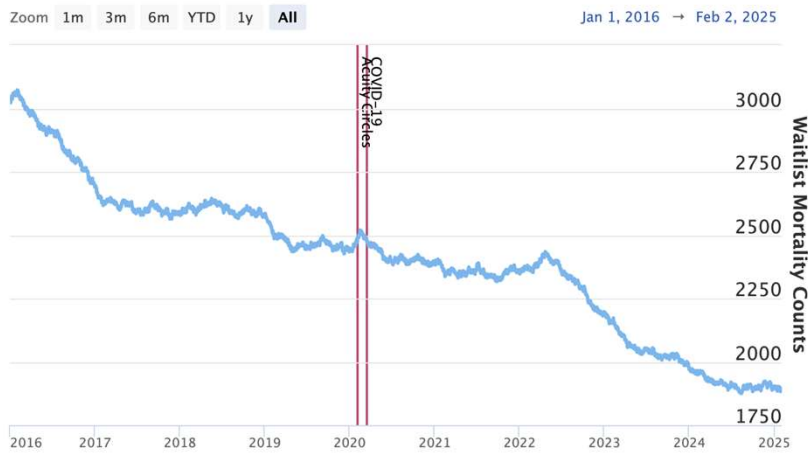
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% US deceased donors that are DCD

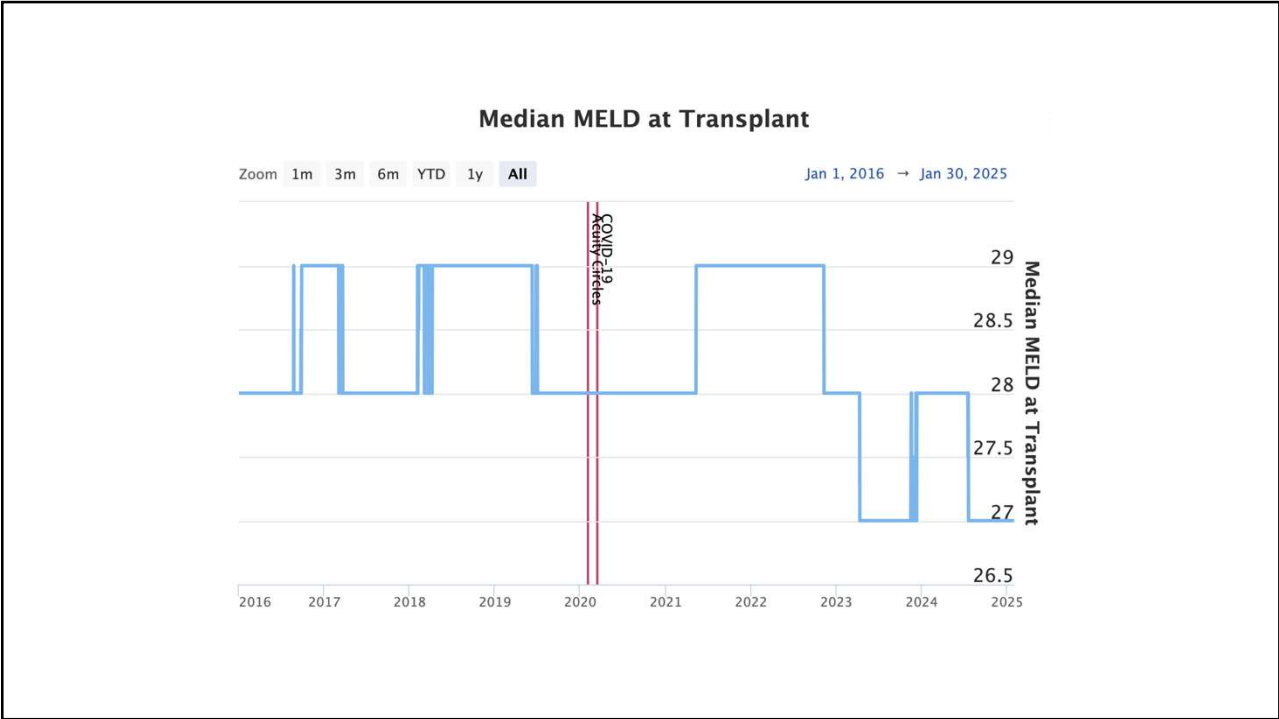


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Waitlist Mortality Counts - Liver



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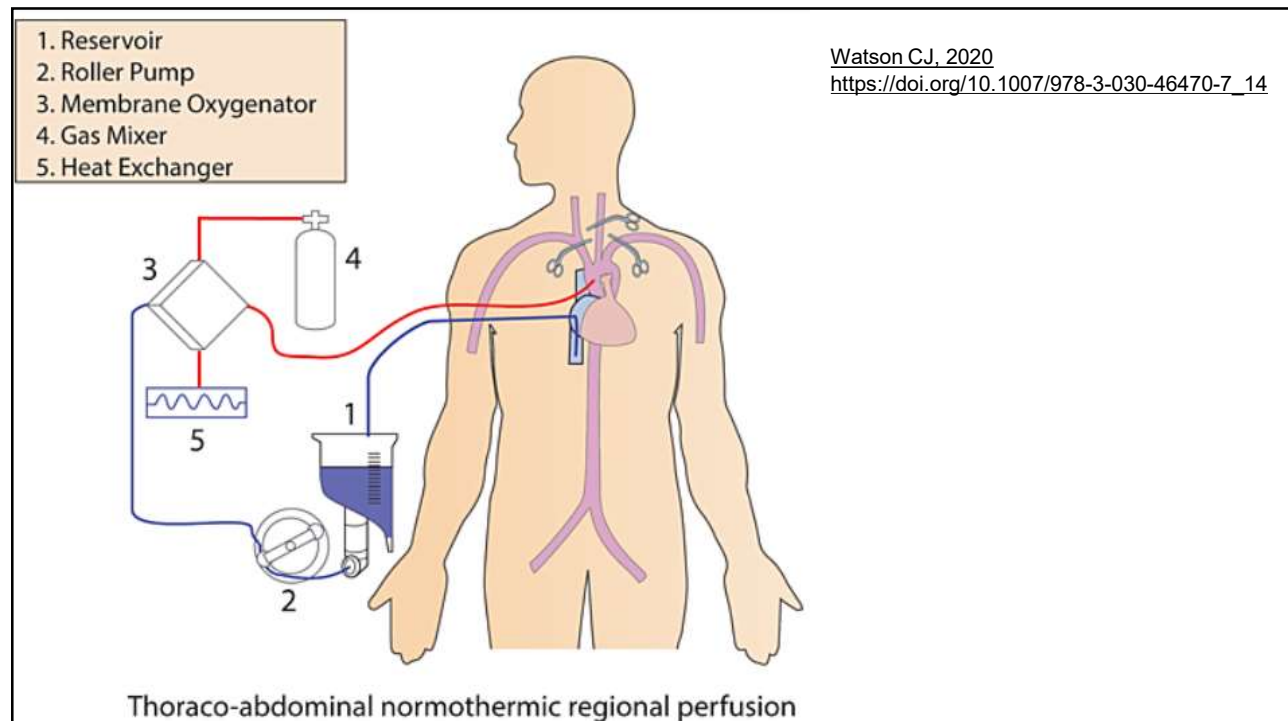
- Thought experiment

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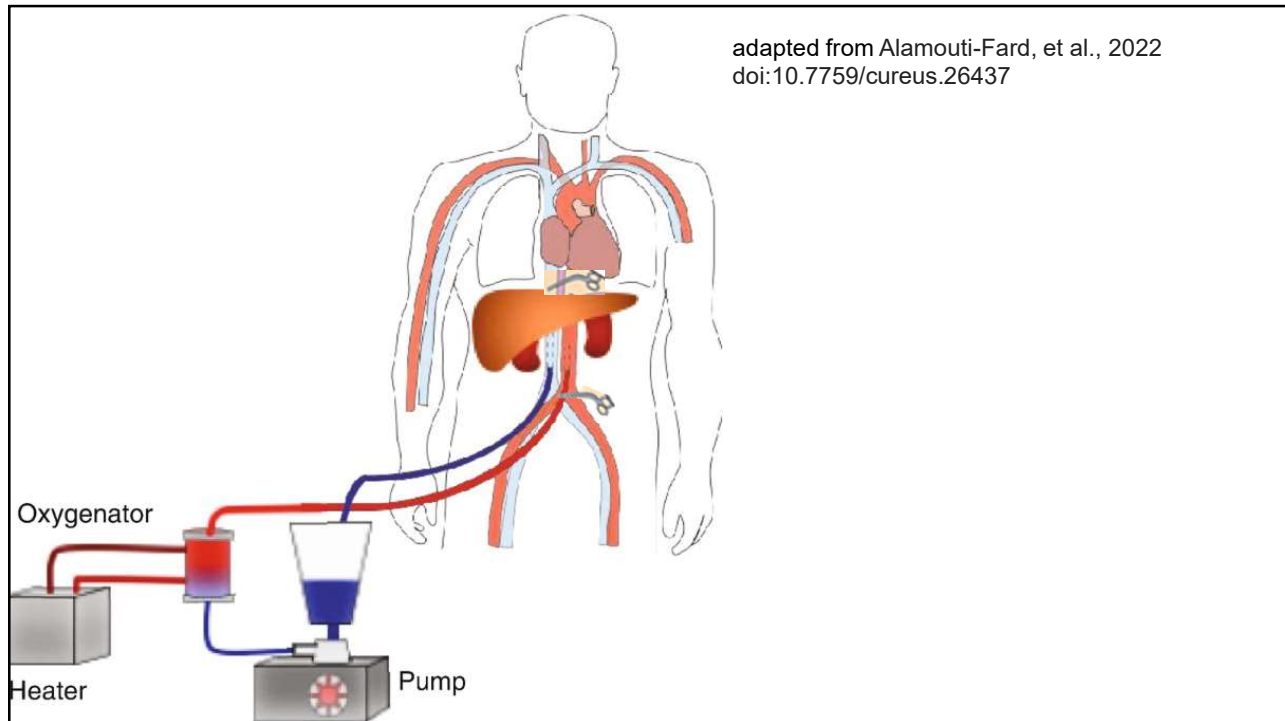
NRP can be...

- Thoracoabdominal (TA-NRP)
 - Cannulation of aorta in the chest
 - Venous cannulation in the chest
 - This is the way heart teams do it
 - Can be done for non-heart donors
 - Occasionally this is the ONLY feasible option
- Abdominal (A-NRP) technique that
 - Cannulation of aorta in the abdomen
 - Venous cannulation in either the abdomen or chest
 - Occasionally this is the ONLY feasible option

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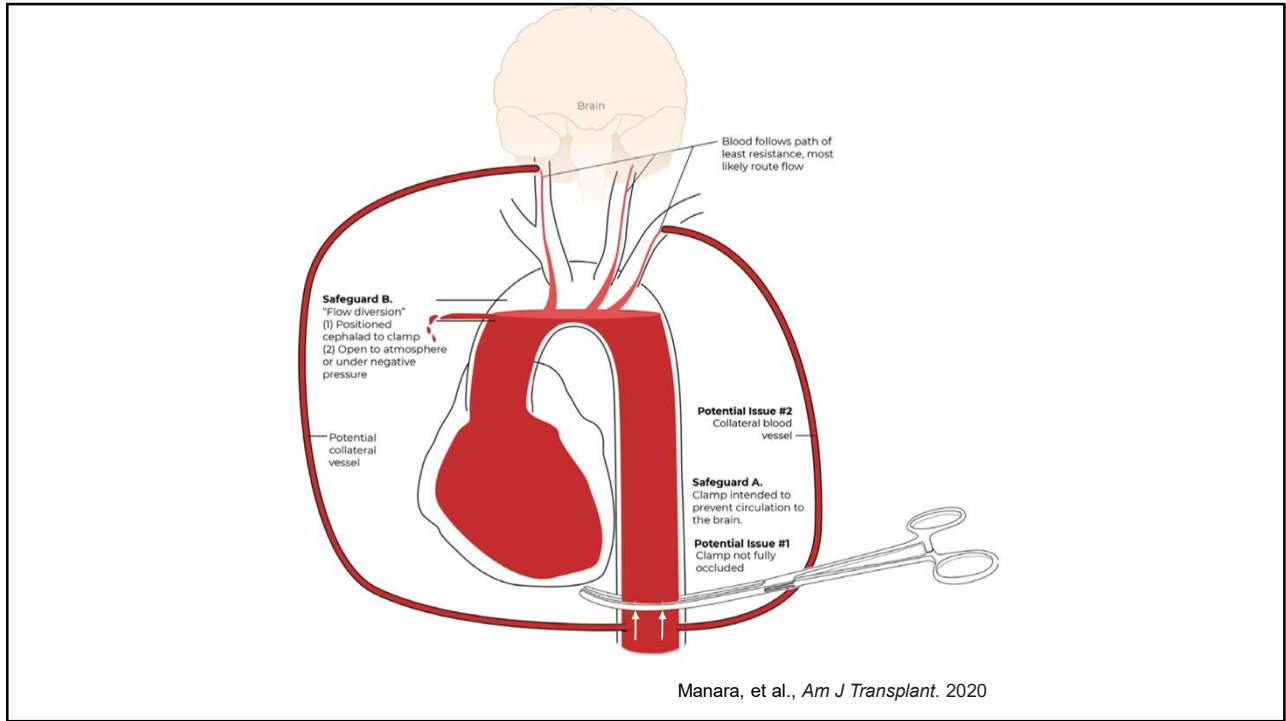


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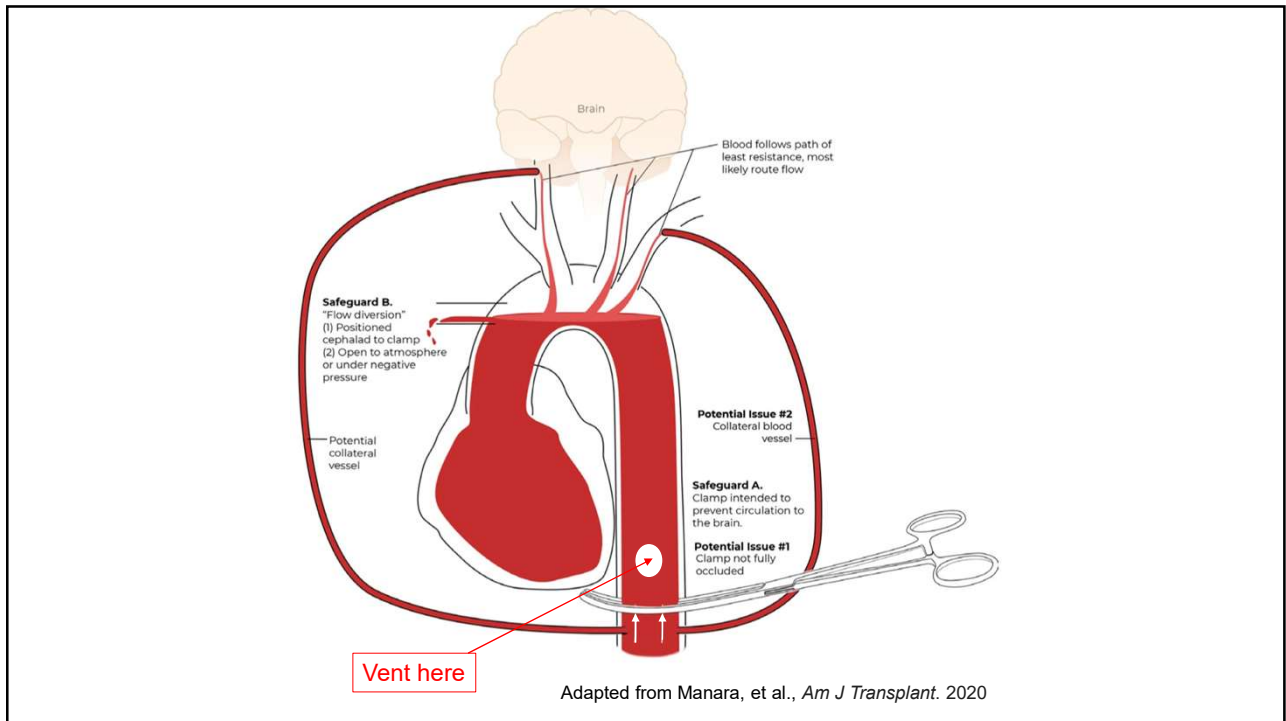
NRP re-establishes blood flow...

- ...to the organs
- ...NOT to the brain
 - Intentional act
 - Consistent with DNR
 - Not doing CPR is an intentional act
- Collateral circulation
 - Must be prevented, which we do EVERY time

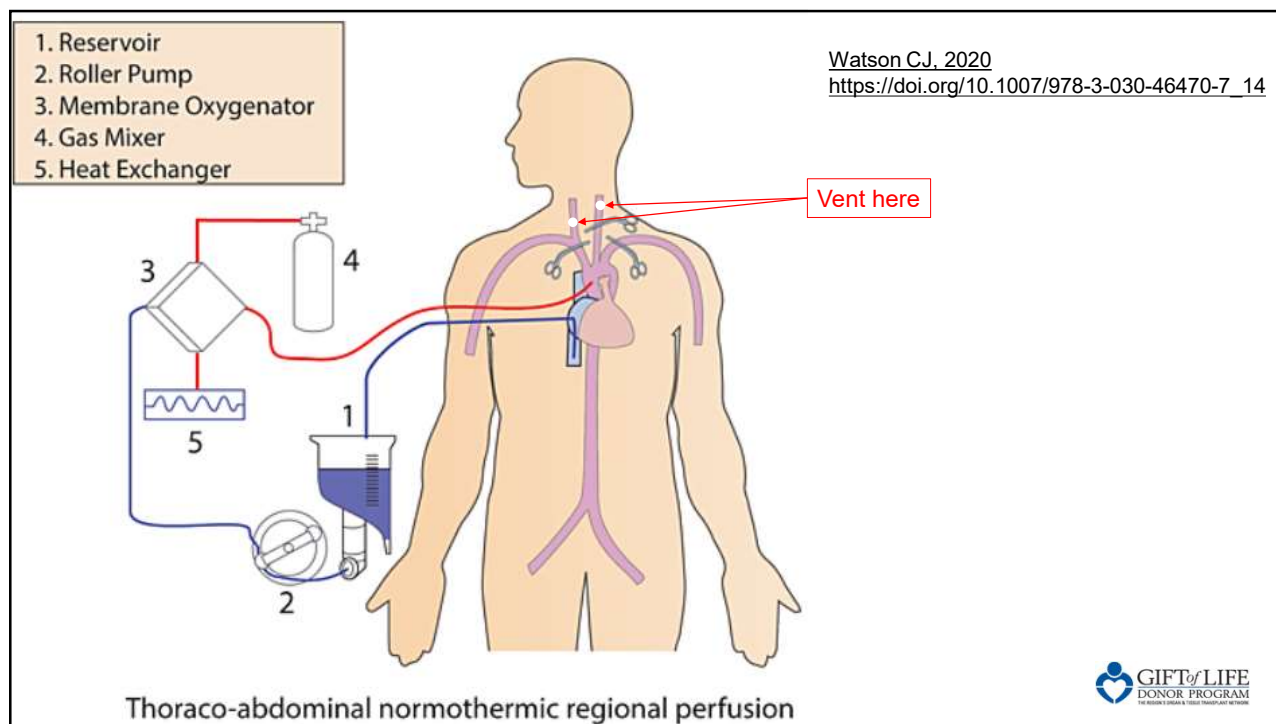
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NRP re-establishes blood flow...

- ...TO THE ORGANS
 - They “breathe” again
 - Recover from the lack of oxygen
 - Restores energy molecules
 - Removes antioxidants
 - Cellular damage is reversed
- Since they’ve recovered (even partially)
 - Better able to tolerate oxygen deprivation

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Thus, NRP...(from Europe)

- Increases organs available for transplant
- Better liver outcomes
 - Less ischemic cholangiopathy (IC)
 - Fewer biliary anastomotic strictures
- Better kidney outcomes
 - Less DGF (saves \$)
 - Better 1-year graft survival

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NRP in the US...

- US data evolving
- First reported liver data (n=13) showed excellent results, including in 3 SLK
 - Low ALT/AST
 - No ischemic cholangiopathy
 - No DGF in SLKs

Sellers, et al., *Clinical Transplantation* 2022

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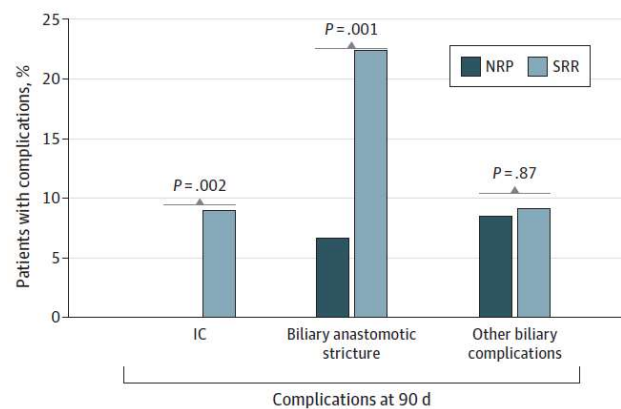
NRP in the US...

- Comparison to old-fashioned DCD
 - No ischemic cholangiopathy in 106 patients
 - 9% IC in 136 old-fashioned DCDs
 - Highly statistically significant
 - Also statistically significant:
 - Less “early allograft dysfunction”
 - Shorter length of stay
 - Fewer anastomotic strictures

Brubaker/Sellers, et al., *JAMA Surgery* 2024

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Figure 1. Ischemic Cholangiopathy and Biliary Complications in Normothermic Regional Perfusion (NRP) Compared With Standard Super Rapid Recovery (SRR) Groups



Brubaker/Sellers, et al., *JAMA Surgery* 2024

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NRP experience...

Liver

- 90 donors
 - 62 livers transplanted
 - 69% utilization rate
- 73 donors with liver intent
 - 55 (75%) livers transplanted
- 17 donors with no liver intent
 - 7 (41%) livers transplanted
- 5 donors with liver-only intent
 - Median age = 61 yr
 - 4 transplanted
 - 80% utilization rate

Sellers, et al., *Am J Transplant* 2025

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NRP experience...

Comparison to old-fashioned DCD

- Since October 1, 2023
 - 85 NRP donors
 - 62 (73%) livers transplanted
- January 1, 2022 – September 30, 2023
 - 219 DCD donors
 - 25 (11%) tDCD livers transplanted
 - $P < 0.001$ compared to NRP

Sellers, et al., *Am J Transplant* 2025

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NRP experience...

Comparison to old-fashioned DCD

- Donor age
 - NRP mean = 51.2
 - tDCD mean = 38.2
 - P < 0.001
- January 1, 2022 – September 30, 2023
 - 9 tDCD livers from > 50 y.o.
- Since October 1, 2023
 - 42 NRP livers from > 50 y.o.
 - 74% utilization rate

Sellers, et al., *Am J Transplant* 2025

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Experience by era...

	Era 1 (n=30)	Era 2 (n=30)	Era 3 (n=30)
Age (median, years)	52.5	53	53
Liver utilization (%)	53	70	83
Liver allocation failure (%)*	30	17	13
NRP duration (median, minutes)	99.5	87	79
PRBC given (%)	33	30	13

Sellers, et al., *Am J Transplant* 2025

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Now, the possibilities in the US

Liver surplus (based on 2023 data)

	NRP utilization (%)	National DCD utilization (2023, %)	National DND utilization (2023, %)	FGM	Additional livers*
Overall	69	28.8	79.5	→	2305
Era 3	83	28.8	79.5	→	3504

*Waitlist removals in 2023

- Died 954
- Too sick 989
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That would be a surplus of **362** or **1561** livers.

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NRP kidney recovery...

Comparison to old-fashioned DCD

- Since October 1, 2023
 - 90 NRP donors
 - 170 kidneys recovered
 - 121 (71%) kidneys transplanted
- January 1, 2022 – September 30, 2023
 - 270 DCD donors
 - 531 kidneys recovered
 - 319 (60%) tDCD kidneys transplanted
 - P = 0.02

Sellers, et al. *Am J Transplant* 2025



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Table 1

Descriptive data, donation outcomes, and kidney recipient DGF for 3 donation cohorts (NRP, DP, DBD).

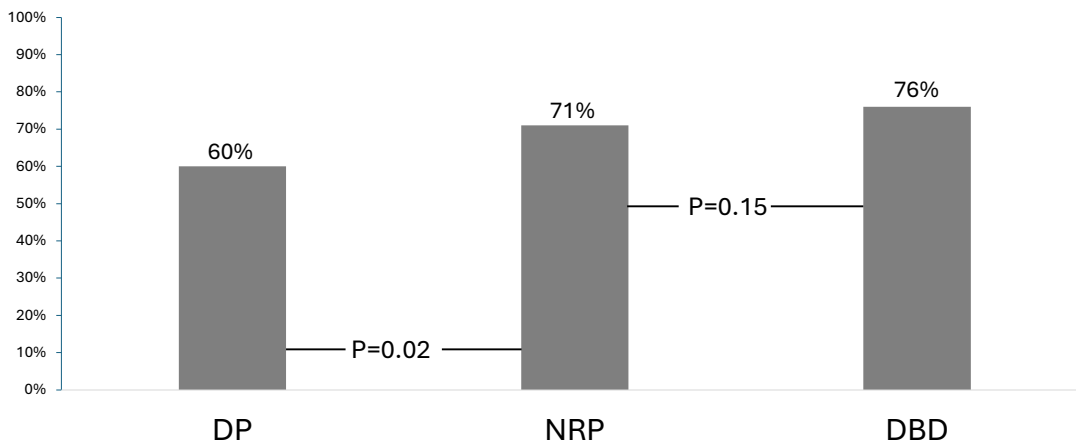
Variable	NRP (n = 90)	DP (n = 270)	DBD (n = 729)
Age (y)	53 (44-59)	48 (37-57)	44 (32-54)
		$P = .004^a$	$P < .001^a$
Female (%)	47	35	39
		$P = .06^a$	$P = .17^a$
BMI (kg/m ²)	30.85 (25.7-38.3)	29.05 (24.0-35.9)	27.7 (23.7-32.9)
		$P = .09^a$	$P < .001^a$
Liver utilization (%)	69	17	79
		$P < .001^b$	$P = .27^b$
Match KDPI (%) ^c	70 (57-85)	67 (46-82)	53 (30-77)
		$P = .11^a$	$<.001^a$
Kidney use (%) ^c	71	60	76
		$P = .02^a$	$P = .15^a$
DGF (%)	29	47	32
		$P = .001^a$	$P = .53^a$

Sellers, et al. *Am J Transplant* 2025



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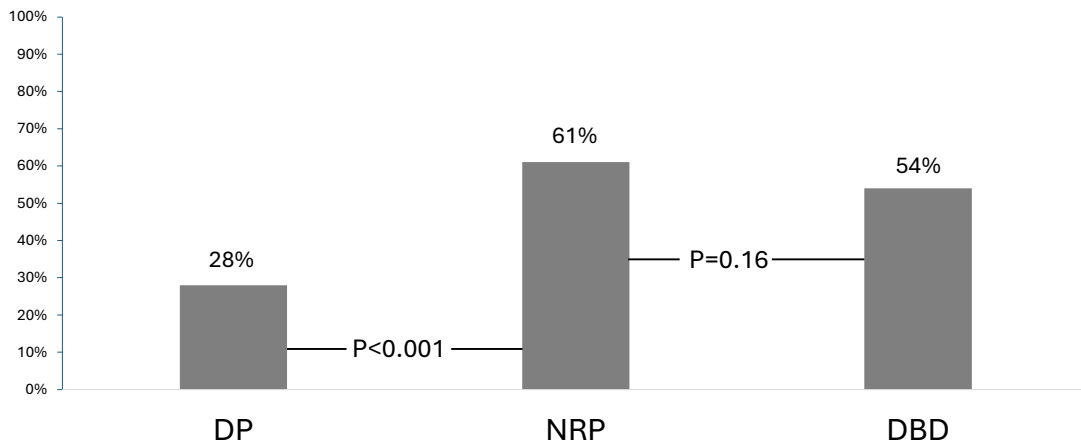
Kidney use rates (all age donors)



Sellers, et al. *Am J Transplant* 2025

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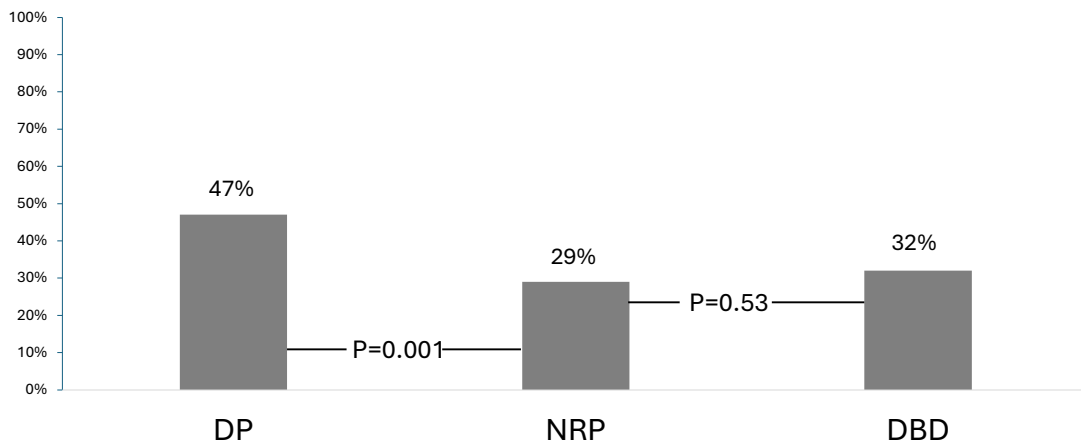
Kidney use rates (> 50 y.o. donors)



Sellers, et al. *Am J Transplant* 2025

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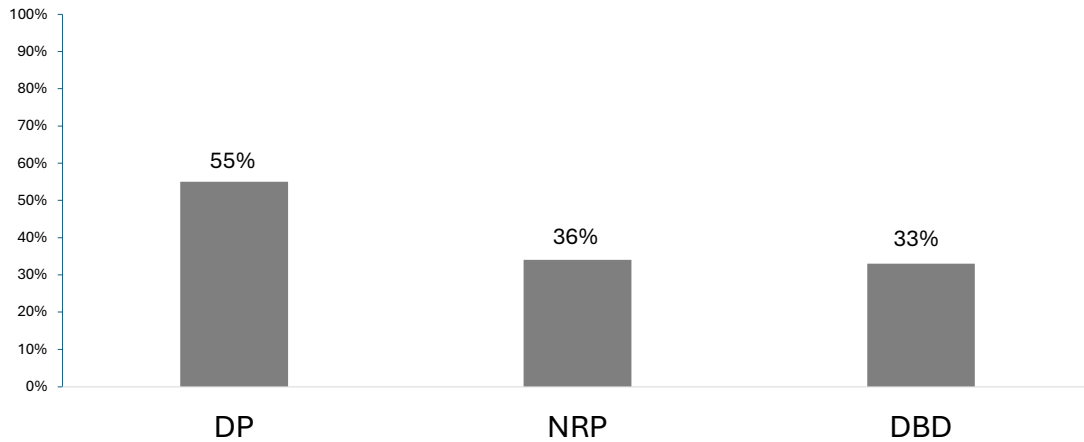
DGF rates



Sellers, et al. *Am J Transplant* 2025

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DGF rates (Gift of Life)



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Kidney recovery

	NRP (n=85)	SRR (n=266)	P value
Surgical damage (%)	0	3.8	0.006

Sellers, et al. *Am J Transplant* 2025



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In the literature...

	DGF rate	et al.
Sellers, Am J Transplant 2025	Lower	Reduced discard rate
Salguero, Minerva Urol Nephrol 2024	Lower	Shorter LOS
Merani, J Am Coll Surg 2024*	Lower	Shorter LOS
Motter, Clin Transplant 2024	Lower	--
Nulend, Transplantation 2024	Lower	--
Zhou, Transplantation 2024	Lower	--
Ghoneima, J Clin Med 2023	Lower	--
Oniscu, Transplantation 2023*	Lower	Higher 12-mo GFR
Wall, Am J Transplant 2023	Lower	--
Medina, Transl Androl Urol, 2021	Lower	--
Padilla, Am J Transplant 2021*	Lower	Lower 12-mo graft loss
Pearson, Clin Transplant 2021*	Lower	Reduced DGF duration
Ramirez, Transplant Direct 2021	Lower	--
Demiselle, Transpl Int 2016*	Lower	Higher 24-mo GFR
Valero, Transpl Int 2000*	Lower	--



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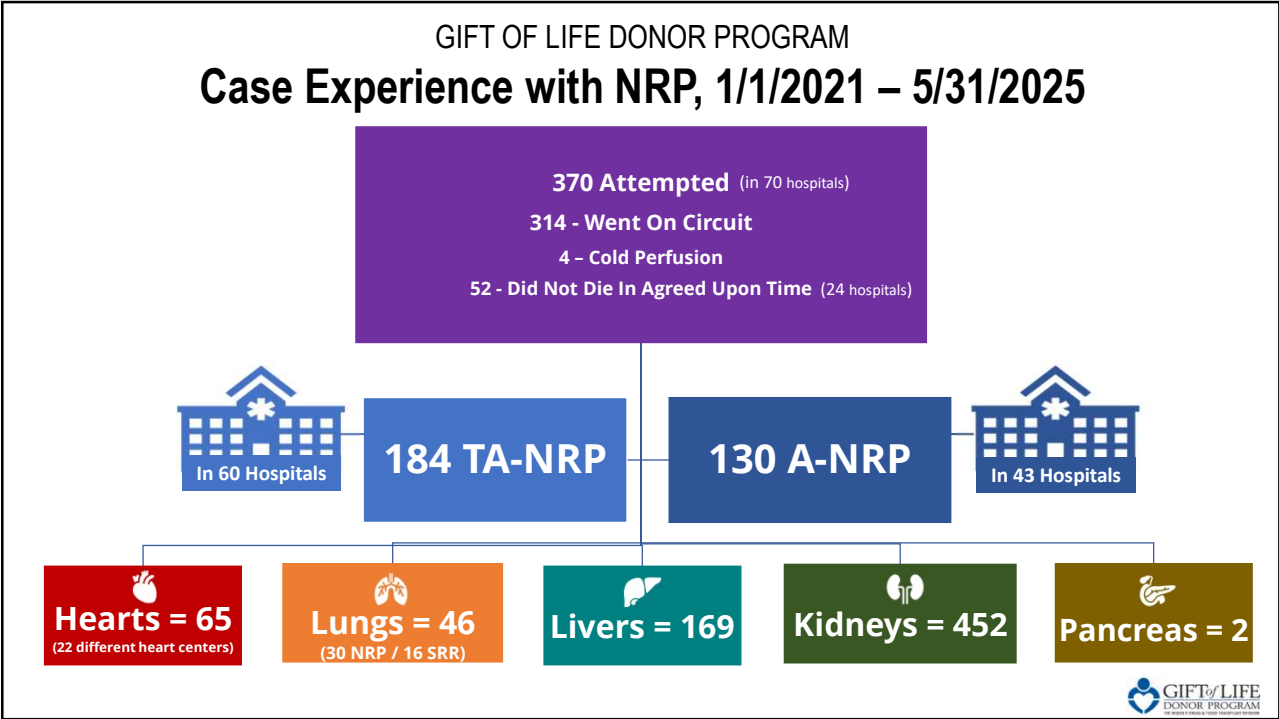
Now, the possibilities in the US

Additional kidneys (based on 2023 data)

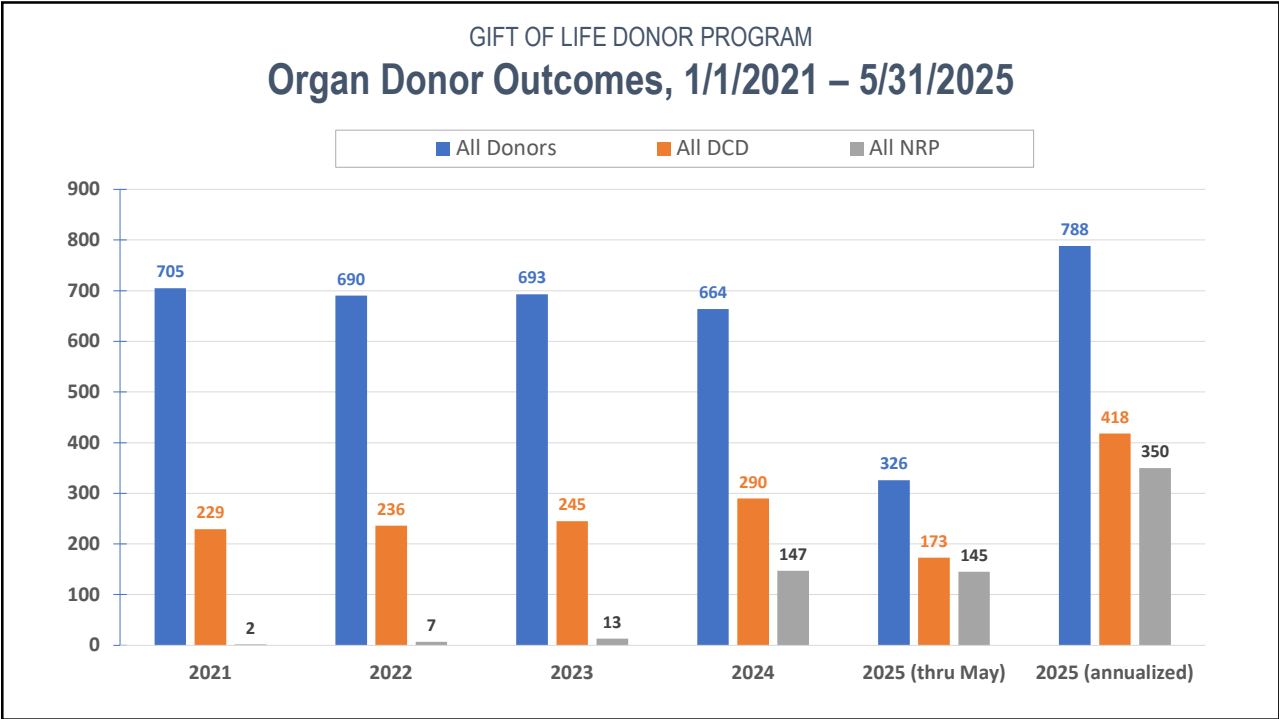
KDPI	NRP utilization (%)	National DCD utilization (2023, %)	National DND utilization (2023, %)
Overall	71.2	65.2	76.3
35-85	79.8	69.7	76.3
86-100	33.3	27.6	29.3

A 71% use rate in 2023 would have resulted in **1069** additional kidney transplants.

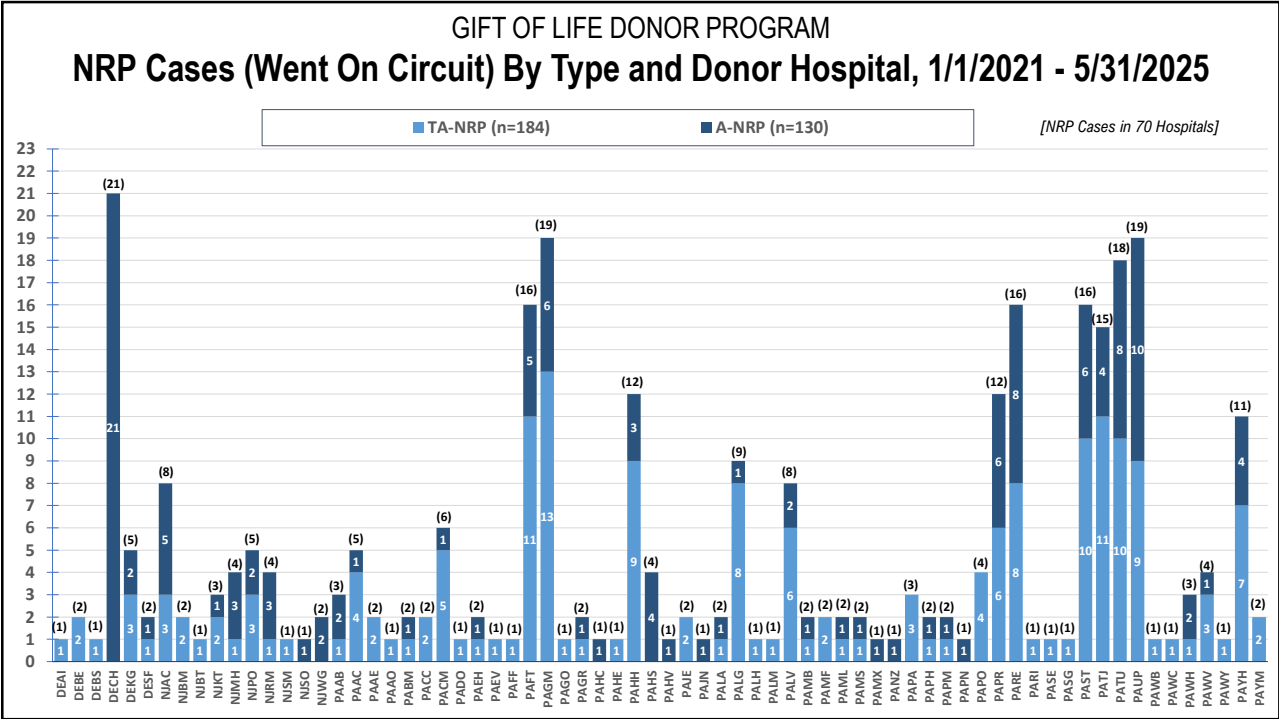
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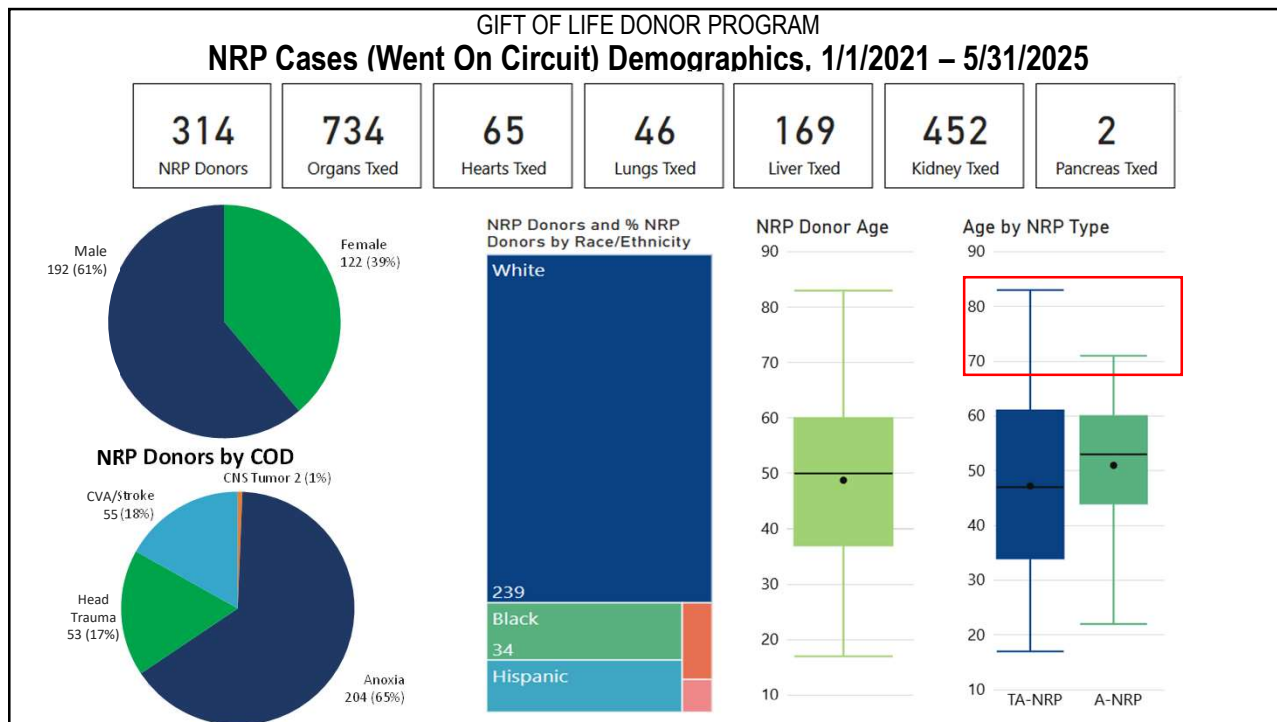


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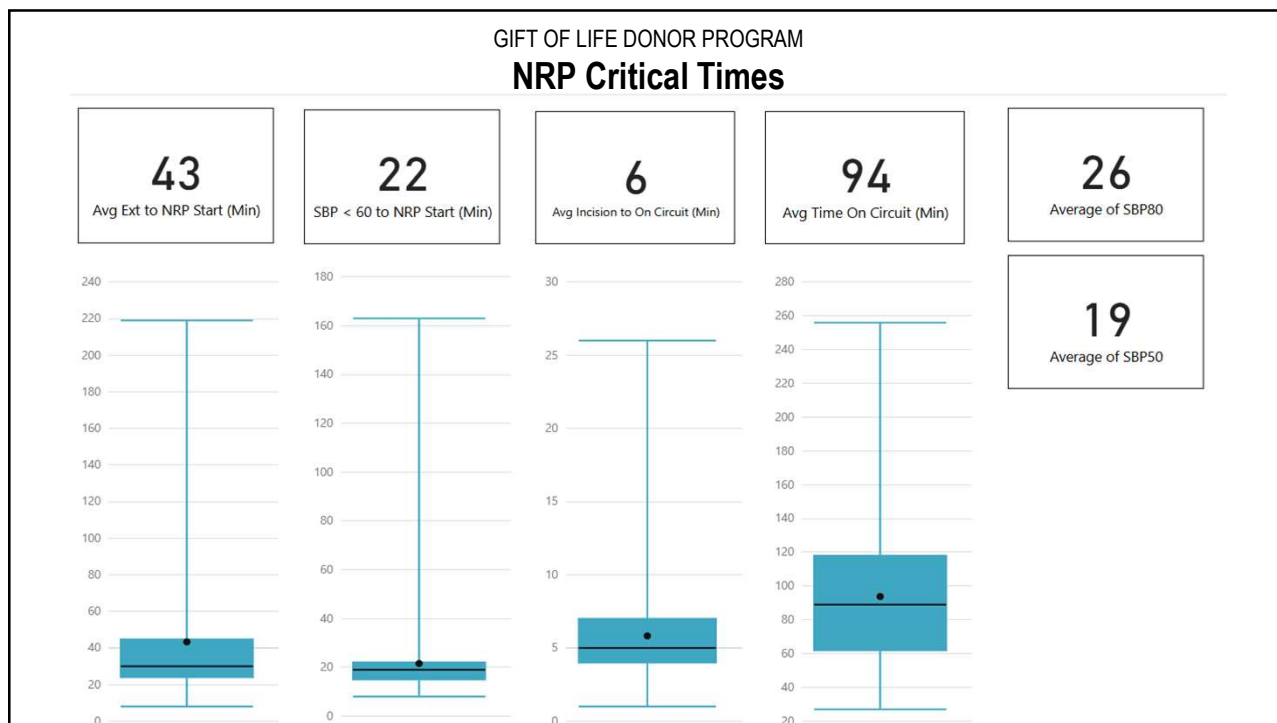


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Summary...

- Across multiple OPOs...
- NRP is associated with increased DCD liver **and** kidney utilization, particularly among older/high-KDPI donors.
- NRP is associated with better outcomes for
 - Livers - ischemic cholangiopathy, BAS, LOS
 - Kidneys – DGF
- Despite...
 - Older donors
 - Higher KDPI
- NRP has potential to significantly improve waitlist mortality.
 - Over 2000 additional organs

