Pediatric Risk to OHT (PRO) Score: Insights from UNOS Waitlist Mortality Findings

Stephanie-Grace Raymundo, MD,
Pediatric Cardiology
David Geffen School of Medicine at UCLA
Anila Chaudhary, MD, Juan Alejos, MD, Neeraj Srivastava, MD, FAAP, MHA

UCLA MATTEL Children's Hospital

Children's Discovery & Innovation Institute

Background

- Waitlisted pediatric heart transplant candidates have the highest mortality rate amongst solid organ transplants [1-2]
- A risk score has the potential to
    - Incorporate a candidate's unique risk factors
    - Predict mortality on the waitlist
    - Optimize organ allocation to the sickest awaiting transplantation

Objectives

We aimed to develop and validate a risk score that predicts waitlist mortality among children listed for heart transplant.

Methods

United Network for Organ Sharing (UNOS) database
- Inclusion criteria
    - 0-18 years old
    - Waitlisted for a single, first time, heart transplant
    - Time frame: January 2010-June 2019
- n= 4,696 patients

The patient set was divided into "derivation set" (2/3) and "validation set" (1/3)
1. Performed univariate analysis of clinical factors possibly associated with death or delisting within 1 year (Table 1)
2. Variables with a p value <0.2 underwent a multivariate analysis
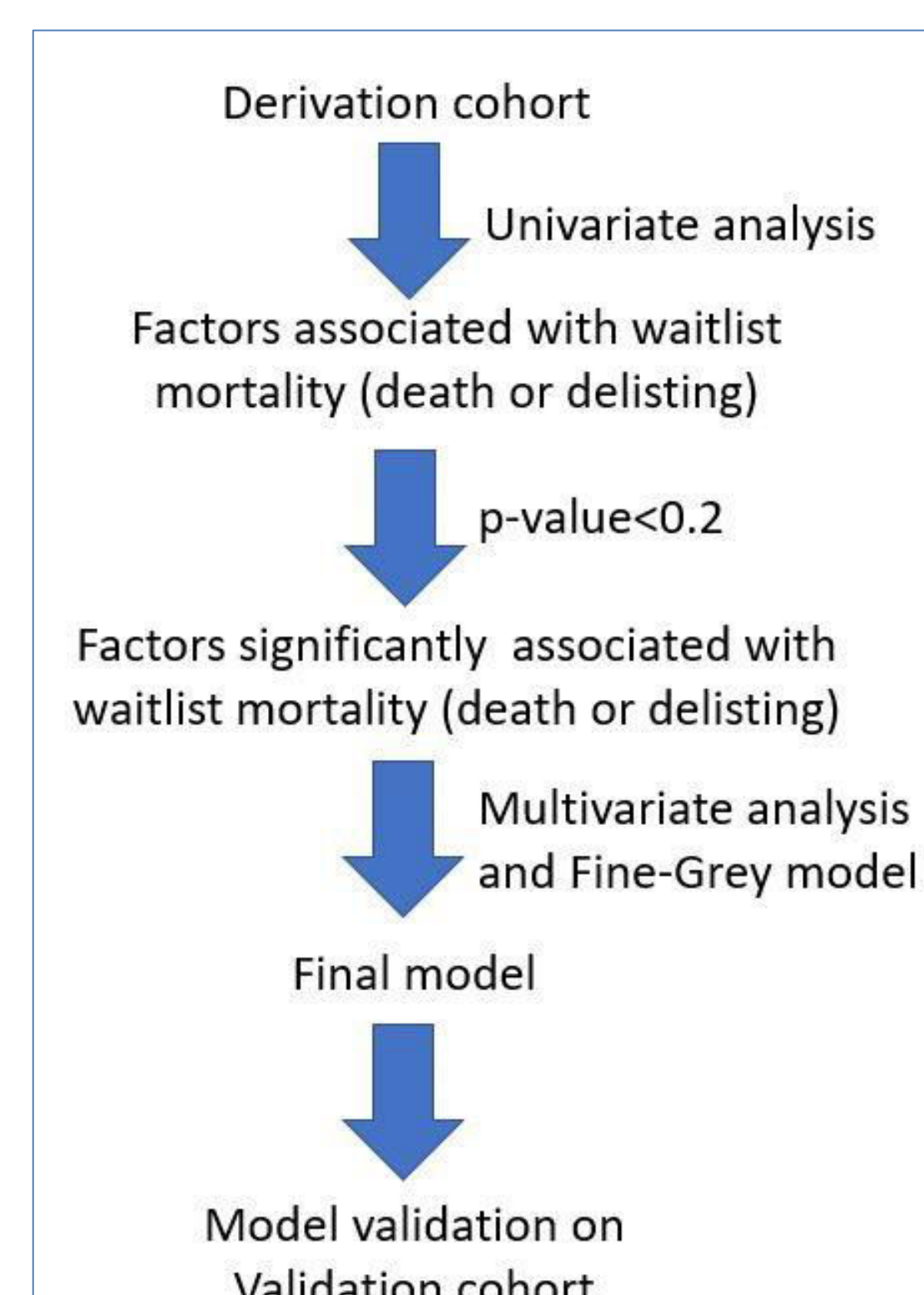3. Created a model by stepwise backwards procedure (Figure 1)

Figure 1: Flow chart demonstrating statistical approach

Methods (continued)

Table 1. Univariate analysis of predictors of 1-year waitlist mortality or delisting for worsening medical condition			
Variable/ Category	Hazard Ratio	95% CI	P Value
Age 1-4 (vs <1)	0.6	0.48 - 0.75	<.0001
Age 13-18 (vs <1)	0.2	0.15 - 0.27	.
Age 5-12 (vs <1)	0.37	0.29 - 0.48	.
Female (vs Male)	1.02	0.86 - 1.21	0.8226
Insurance - Other (vs Private)	0.89	0.49 - 1.61	0.3798
Insurance – Public (vs Private)	1.12	0.94 - 1.33	.
Race - Asian (vs White)	0.7	0.41 - 1.21	0.4202
Race - Black (vs White)	1.07	0.86 - 1.33	.
Race - Hispanic (vs White)	0.91	0.72 - 1.15	.
Race - Other (vs White)	1.2	0.8 - 1.81	.

Variable	Hazard Ratio	95% CI	P Value
Blood Type - A (vs O)	0.85	0.7 - 1.03	0.1057
Blood Type - AB (vs O)	0.59	0.33 - 1.07	.
Blood Type - B (vs O)	0.82	0.62 - 1.07	.
Status - Inactive (vs 2)	1.35	0.52 - 3.46	<.0001
Status - 1A (vs 2)	3	2.11 - 4.28	.
Status - 1B (vs 2)	1.43	0.93 - 2.2	.
Diagnosis - Congenital (vs Other)	2.22	1.85 - 2.66	<.0001
Weight - 10-19kg (vs >=60)	3.19	1.92 - 5.29	<.0001
Weight - 20-39kg (vs >=60)	2.28	1.34 - 3.9	.
Weight - 40-59kg (vs >=60)	1.3	0.72 - 2.34	.
Weight - <10kg (vs >=60)	6.05	3.78 - 9.69	.
Vad at list - LVAD (vs none)	0.62	0.43 - 0.88	0.0145
Vad at list - Other (vs none)	1.29	0.81 - 2.03	.

Variable	Hazard Ratio	95% CI	P Value
Inotropes (1-unit in Ventilator (Vent vs None)	1.37 / 3.06	1.16 - 1.63 / 2.57 - 3.64	0.0003 / <.0001
Defib (Defib vs None)	0.43	0.28 - 0.66	0.0001
Ecmo (Yes vs No)	4.46	3.57 - 5.58	<.0001
Dialysis (Yes vs No)	1.69	1.12 - 2.56	0.0121
Any Cancer (Yes vs No)	0.64	0.27 - 1.51	0.3124
Creatinine (1-unit in	1.06	0.99 - 1.13	0.0939
Albumin (1-unit incr	0.63	0.57 - 0.7	<.0001
Region 1 (vs 3)	1.01	0.59 - 1.72	<.0001
Region 2 (vs 3)	1.03	0.71 - 1.49	.
Region 4 (vs 3)	0.89	0.61 - 1.29	.
Region 5 (vs 3)	0.81	0.59 - 1.12	.
Region 6 (vs 3)	0.77	0.43 - 1.36	.
Region 7 (vs 3)	0.75	0.51 - 1.09	.
Region 8 (vs 3)	1.21	0.88 - 1.68	.
Region 9 (vs 3)	0.54	0.33 - 0.88	.
Region 10 (vs 3)	1.33	0.95 - 1.86	.
Region 11 (vs 3)	1.58	1.18 - 2.13	.

Results

Based on factors chosen for both clinical and statistical significance, we developed the following model:

Final Pediatric Risk to OHT (PRO) scoring model (Figure 2)
- Blood type
- Diagnosis of congenital heart disease
- Weight
- Ventilator support
- Inotropic support
- Extracorporeal membrane oxygenation (ECMO) status
- Creatinine level
- UNOS Region

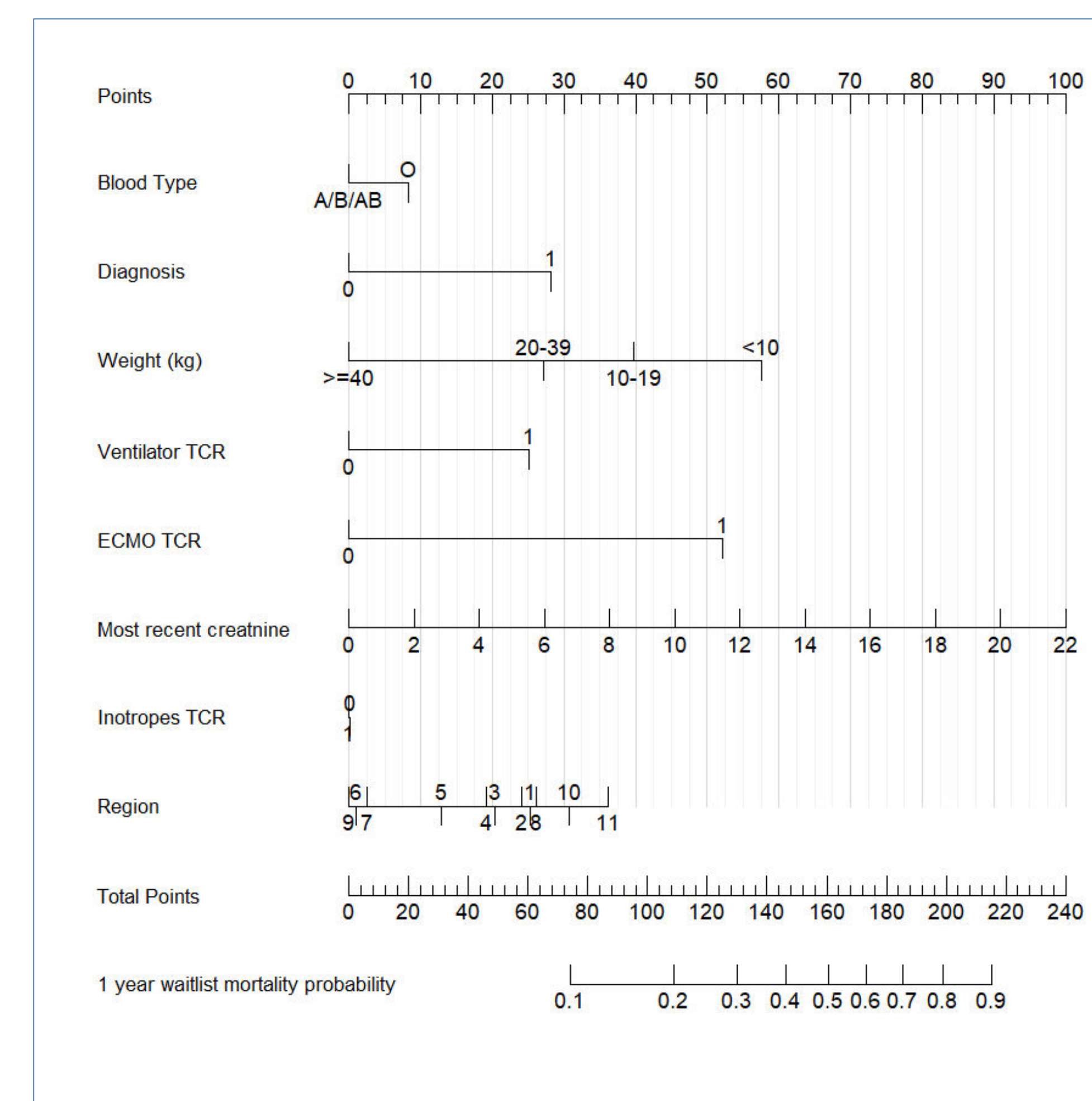The predictive strength was 0.745 as measured by Area Under the ROC curve at 1 year (Figure 3)

Figure 2: A higher score indicates an increased risk of mortality
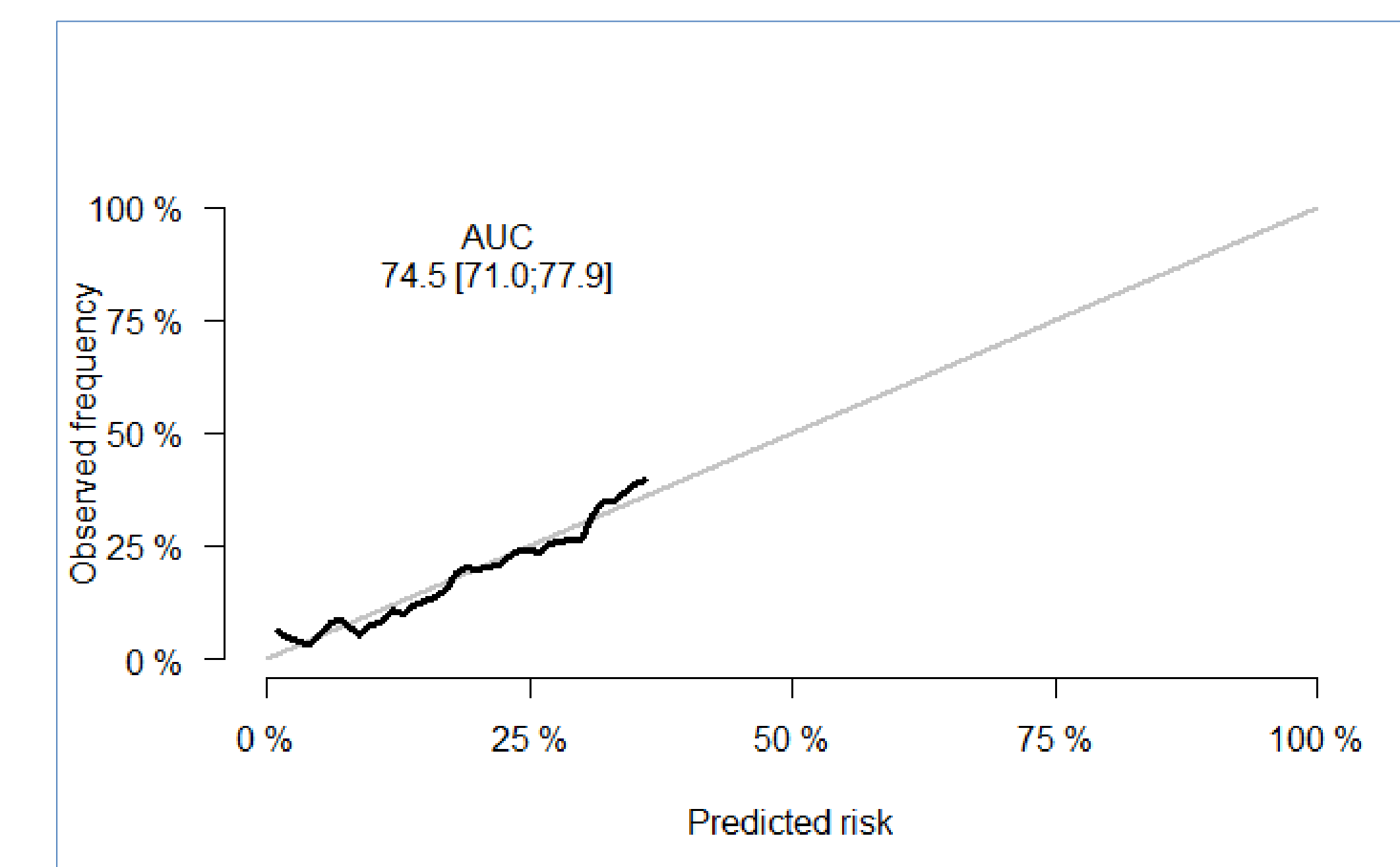
Results (continued)

Figure 3: Graphical presentation of PRO score predictive strength by AUC.

Conclusions

The PRO score is an improved predictive model to better assess the mortality for patients awaiting heart transplant.

Limitations

- Subject to database entry errors
- Reliance on available information in the database
- Use of the same cohort for both derivation and validation
- Generalizability

Future Directions

- Prospective application with external validation
- Personalized care
- Alternative listing strategy

References

1. Almond CSD, Thiagarajan RR, Piercey GE, et al. Waiting list mortality among children listed for heart transplantation in the United States. *Circulation*. 2009;119(5):717-727.
2. Denfield SW, Azeka E, Das B, et al. Pediatric cardiac waitlist mortality-Still too high. *Pediatr Transplant*. March 2020:e13671.

Acknowledgements

David Geffen School of Medicine