ITU KALEIDOSCOPE
ATLANTA 2019

A Health Care Cost Calculator for Older Patients over the First Year after Renal Transplantation

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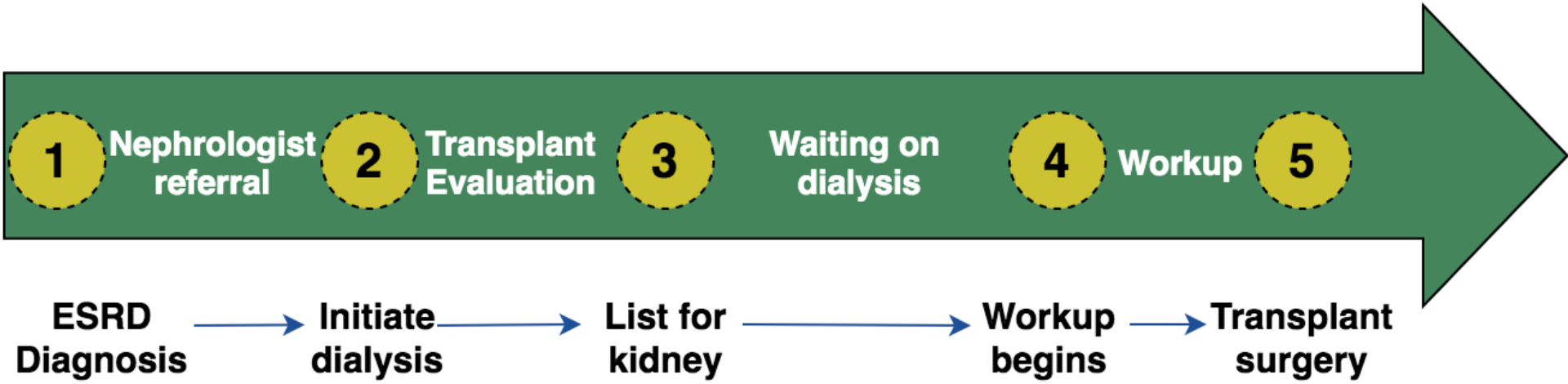
4-6 December
Atlanta, Georgia, USA

Background: Kidney Transplantation

- End-stage renal disease (ESRD) patients require dialysis or transplantation
- Older patients (age 60+) are increasingly transplanted in North America
  - Expanded Criteria Donor (ECD) kidneys
- The health care cost of transplanting older patients is very high
  - Canada: universal health care coverage for residents
  - First year after transplant: high risk, intensive use of health care



ESRD Diagnosis → Initiate dialysis → List for kidney → Workup begins → Transplant surgery

Background: Gaps in Knowledge

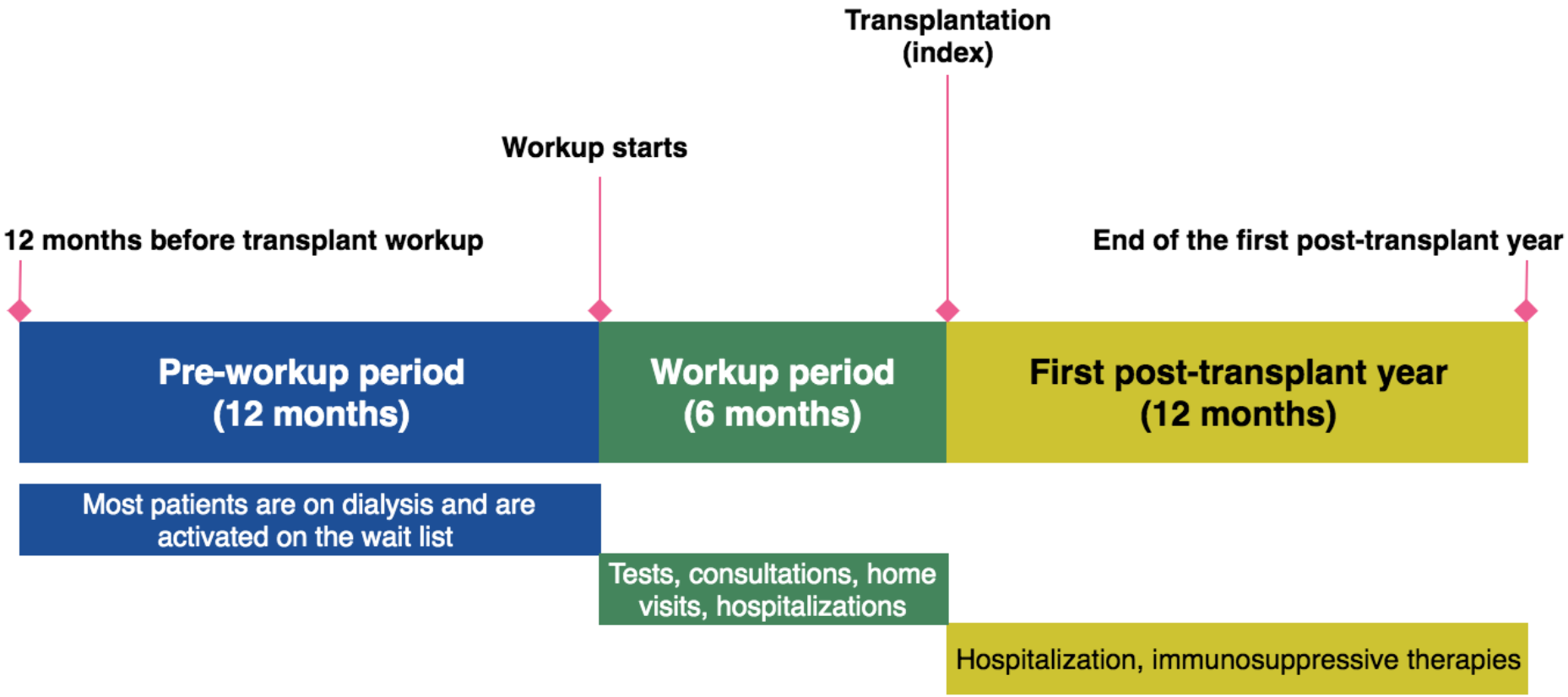
- ICT tools that target patients with kidney disease are very scarce
  - iChoose Kidney http://ichoosekidney.emory.edu/
  - Acute Kidney Injury Predictor http://www.akipredictor.com/en/
- Machine learning may be useful to predict kidney transplant outcomes
  - Patient survival
  - Transplant (graft) survival
  - Health care use
    - Classes of users: high-cost user status
    - Continuous cost outcomes

Objective

To develop and validate a machine learning-based health care cost calculator for older recipients (aged 60+) of a deceased-donor, kidney-only transplantation over the first year following transplantation.

Methods: Patient Cohort and Data

- All cases of kidney-only transplantation from a deceased donor performed in Ontario, Canada for 60+ recipients between March 31, 2002 and April 1, 2013 (N=1425)
- Patients were followed up from the year before transplant workup until death or to April 1, 2016
- Predictors were collected at/before transplant (index event)
- Outcome (total costs) was calculated over the first post-transplant year
  - Measured in CAD (2019 April value) where $1 CAD = $0.75 USD
- N=1328 survived for at least a year after transplant with complete health care use information


Transplantation
(index)
Workup starts
12 months before transplant workup
End of the first post-transplant year
Pre-workup period
(12 months)
Workup period
(6 months)
First post-transplant year
(12 months)
Most patients are on dialysis and are activated on the wait list
Tests, consultations, home visits, hospitalizations
Hospitalization, immunosuppressive therapies

Methods: Model training and testing

- Training set: testing set ~ 4:1
  - Training set: transplanted between 2002-2012 (N=1034, 78%)
  - Testing set: transplanted between 2012-2014 (N=294, 22%)
- Predictors were standardized
- Cost variables were log-transformed

- Regularized regression (lasso, ridge, elastic net) and regression tree
- Root mean-square-error (RMSE)
- R-square value

Results: Baseline characteristics

Amongst 1328 older transplant recipients:

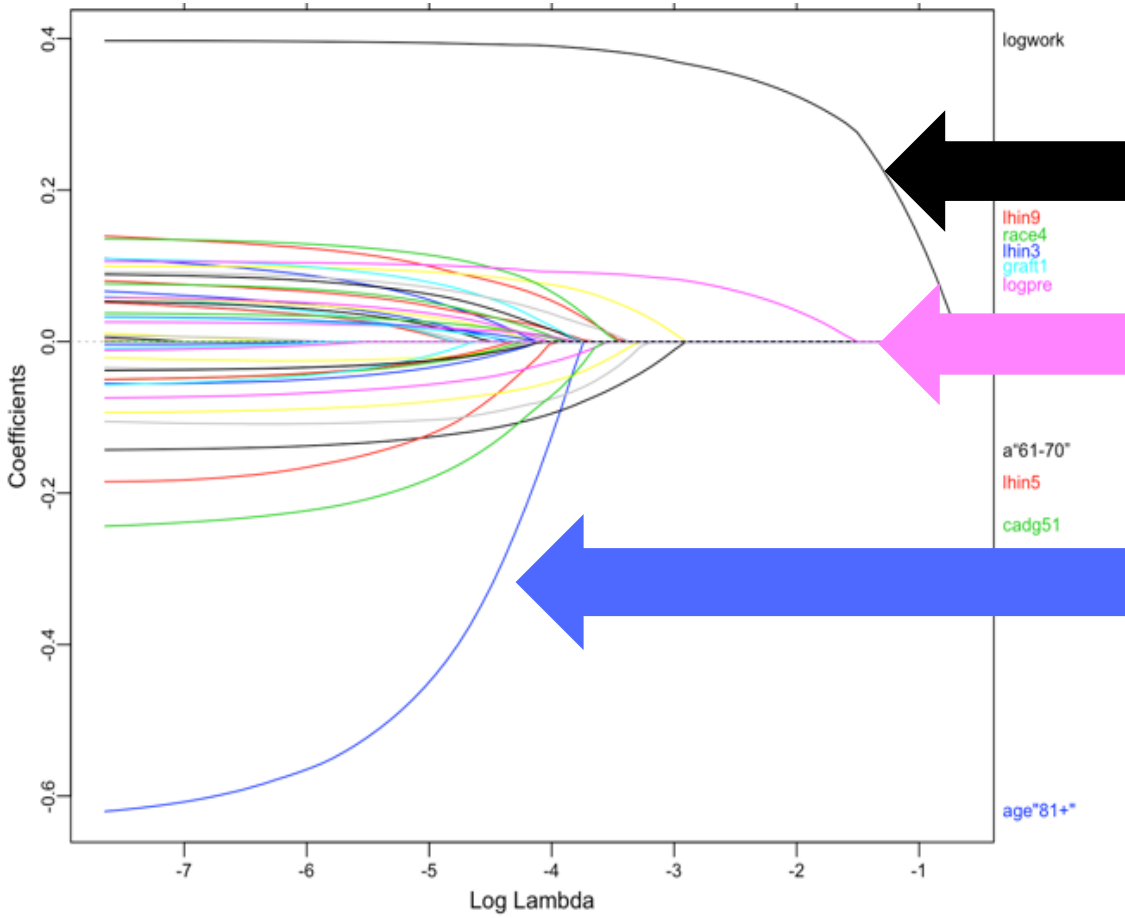
- 81%, 18%, and 1% were transplanted at ages 61-70, 71-80 and 81+
- 75% are Caucasian, 67% are male
- 5% were re-transplantation, 0.8% were pre-emptive transplantation
- 89.3% waited for > 12 months before transplantation
- Total health care costs during (mean ± SD) :
  - Pre-workup (12 months): 75608 ± 71855 CAD
  - Workup (6 months): 45460 ± 31271 CAD
  - First post-transplant year (12 months): 72723 ± 63256 CAD

Results: Model testing

Models	RMSE	R^2
Ridge regression	0.618	0.255
Lasso regression	0.604	0.258
Elastic net regression	0.610	0.251
Regression tree	0.630	0.0101

Best model – Lasso

Results: Model training (Lasso)



Optimal λ: 0.0317323

Workup costs
1% increase -> 0.38% increase

Pre-workup costs
1% increase -> 0.09% increase

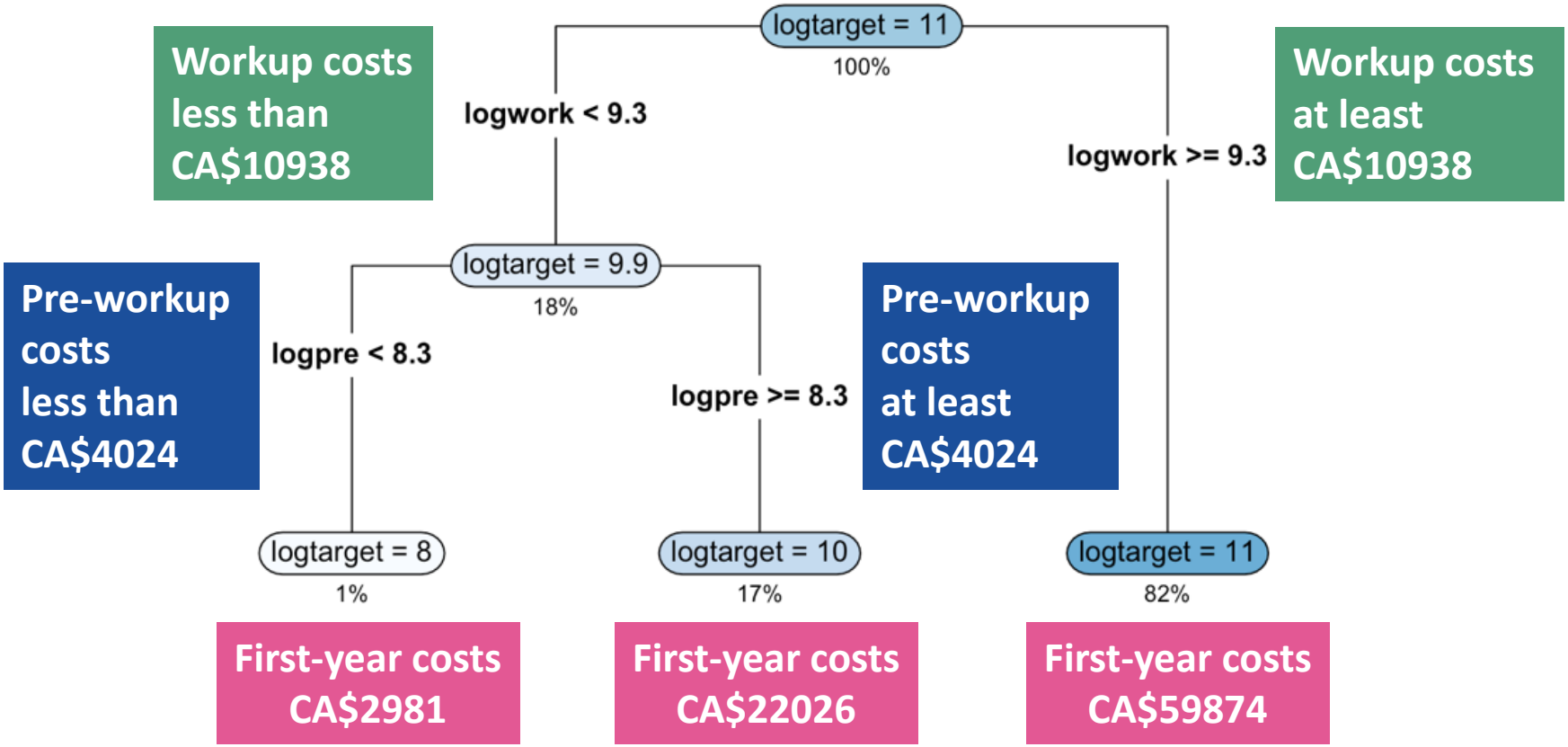
Age 81+ at transplantation
29.9% less costly compared with younger recipients (71-80)

Results: Model training (Lasso)

- Age 81+ or between 61-70
- LHIN K
- Having blood type B (vs. type O)

- LHIN J
- Sensitized (peak PRA>0%)
- Diabetic
- Higher costs before transplantation

Results: Model training (tree)



Discussion & Next Step

- Basic machine learning methods are promising tools for forecasting health care costs
- Previous health care use strongly predicts upcoming use
  - Consistent pattern of use among older, chronically ill patients
  - Continuous monitoring of health care use -> continuous cost prediction

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Thank you