Allocation of deceased donor kidneys

Phil Clayton
NSW Renal Group
14 June 2012
Outline

• Why study kidney allocation?
• Equity vs utility
• Current Australian model
• Previous work in Australia
• US allocation research
• Allocation simulations
  – Current model
  – A utility-based model
• Future directions
Demand vs supply

Australian dialysis patients vs transplants performed

Dialysis patients

Transplants performed
Equity vs utility trade-off

• Equity
  – Everyone has opportunity to benefit from transplantation

• Utility
  – Get most out of precious resource
  – Patient survival
  – Graft survival
  – QALYs?
  – Cost effectiveness??

• Whose perspective?
  – Patient / Donor / System / Society
Current Australian model

THE TRANSPLANTATION SOCIETY OF AUSTRALIA AND NEW ZEALAND

ORGAN TRANSPLANTATION FROM DECEASED DONORS:

CONSENSUS STATEMENT ON
ELIGIBILITY CRITERIA AND ALLOCATION PROTOCOLS

Version 1.2 — 16 May 2012
Current Australian model

• Major listing criteria:
  – ESKD on dialysis
  – 80% likelihood of surviving for at least 5 years after transplantation

• Major allocation criteria:
  – Blood group
  – Waiting time
  – HLA match
  – Highly sensitised
  – Childhood
### National formula

<table>
<thead>
<tr>
<th>Base score</th>
<th>Description</th>
<th>Level</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 HLA mismatches, Peak PRA not &lt; 50%</td>
<td>{Level 1}</td>
<td>60 000 000</td>
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</tr>
<tr>
<td>1 HLA mismatch, Peak PRA &gt; 80%</td>
<td>{Level 2}</td>
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<tr>
<td>2 HLA mismatches, Peak PRA &gt; 80%</td>
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<tr>
<td>0 mismatches at HLA-DR, 1 mismatch at HLA-A or HLA-B, Peak PRA not &gt; 80% and Centre Credit Difference &lt;= -3</td>
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<td>0 mismatches at HLA-DR, 2 mismatches at HLA-A or HLA-B, Peak PRA not &gt; 80% and Centre Credit Difference &lt;= -6</td>
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<td>When score is Null and Centre Credit Difference &lt;= -20</td>
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- **Paediatric bonus**: if age < 18, first dialysis before age 17 and on dialysis for > 1 yr + 30 000
- **Recipient at same centre as donor**: + 50 000

**Centre credit balance**: 1000 + patient centre credit

**Patient waiting period > 0**: + Wait in months * 1

If Score is < 54 000 000, go to relevant state-based algorithm
NSW formula

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<tr>
<td>Base score</td>
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<tr>
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<td>For each mismatch at HLA-A</td>
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<td>For each mismatch at HLA-B</td>
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<tr>
<td>Paediatric bonus</td>
<td>if age &lt; 18, first dialysis before age 17 and on dialysis for &gt; 1 yr</td>
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<tr>
<td>Patient dialysis waiting period&gt; 0</td>
<td>+ Wait in months * 100</td>
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<tr>
<td><strong>If score is &lt; 48 000 000, go to state waiting algorithm</strong></td>
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| State waiting          |          |
| Base score             |          |
|                        |          |
| Paediatric bonus       | if age < 18, first dialysis before age 17 and on dialysis for > 1 yr | + 100 000 |
| Patient dialysis waiting period> 0 | + Wait in months * 100 |
Other states

- VIC – HLA-B, -DR, waiting time
- SA – HLA-A, -B, -DR, waiting time
- QLD – HLA-A, -B, -DR, waiting time, paediatric status
- WA – HLA-A, -B, -DR; HLA-DR homozygous; waiting time
## ABO rules

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## ABO rules

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Death-censored graft survival
Australian DD grafts 1995-2009

Years

0.00
0.25
0.50
0.75
1.00

0 1 2 3 4 5 6

HLA mismatch

0
1
2
3
4
5
6
Death-censored graft survival

Australian DD grafts 1995-2009

Peak PRA
- 0-19
- 20-39
- 40-59
- 60-79
- 80-100
Patient survival
Australian DD grafts 1995-2009

Age
- 0-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+

Years
0-24
25-34
35-44
45-54
55-64
65+
Age difference (donor minus recipient age)

Australian DD grafts 1995-2009

Frequency

Young donors
Old patients

Old donors
Young patients

-100  -50  0  50  100  150  200  250  300  350  400
Donor–recipient age matching improves years of graft function in deceased-donor kidney transplantation

Wai H. Lim¹,², Sean Chang², Steve Chadban²,³, Scott Campbell²,⁴, Hannah Dent²,⁷, Graeme R. Russ²,⁵,⁶ and Stephen P. McDonald²,⁵,⁶

<table>
<thead>
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<th></th>
<th>Current</th>
<th>Best</th>
<th>Graft years gain (% gain)</th>
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<td><strong>13% old donors</strong></td>
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<td>YR/YD</td>
<td>60.9</td>
<td>70</td>
<td>6.4 (0.6%)</td>
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<tr>
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<td>9.1</td>
<td>0</td>
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</tr>
<tr>
<td>OR/YD</td>
<td>26.1</td>
<td>17</td>
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<tr>
<td>OR/OD</td>
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<tr>
<td>Graft years</td>
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<td><strong>25% old donors</strong></td>
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<tr>
<td>YR/YD</td>
<td>52.5</td>
<td>70</td>
<td>12.3 (1.2%)</td>
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<tr>
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<td>22.5</td>
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<td>Graft years</td>
<td>1027.0</td>
<td>1039.3</td>
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<td><strong>30% old donors</strong></td>
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<tr>
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<tr>
<td>Graft years</td>
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</table>

More benefit from age matching if higher proportion of older donors

doi: 10.1093/ndt/gfq127
Patient survival
Australian DD grafts 1995-2009

Primary disease
- Other
- Diabetic nepropathy

Years
0 5 10 15

Survival probability
Deceased kidney donor age
Australia 1990-2010
Donor co-morbidities

Australian deceased kidney donors 1993-2010

3-year moving average

- History of smoking
- Hypertension
- Diabetes
US allocation research

• Extensive modelling and simulations
• Proposed algorithm:
  – Scores for kidney donors and wait-listed patients
  – Top 20% kidneys -> top 20% recipients
  – Other 80% kidneys -> recipients aged within 15 years of donor
Allocation simulations

- Waiting list
- Donor pool

Simulation software

Allocation algorithms

Outcomes
- Equity of access
- Utility
  - Patient survival
  - Graft survival
  - ? others
NOMS-ANZDATA link

• NOMS
  – National database of kidney allocation
  – Since 2000 (Y2K)
  – Detailed waiting list data since 28 June 2006
  – Data extract 2001-2010
  – Demographics, serology, antibodies, crossmatch results, organ match results
  – Probabilistic linkage with ANZDATA
Simulation modelling

- Visit to Ann Arbor, Michigan
  - Great people
  - Spring snow (new jacket)
  - Bad coffee
- Simulation software
  - Developed for US
  - Adapted for ANZDATA/ANZOD/NOMS data
  - Australia allocation rules
  - Validation against actual allocation
## State balance

<table>
<thead>
<tr>
<th>State</th>
<th>Actual Out</th>
<th>Actual In</th>
<th>Actual Balance</th>
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<td>QLD</td>
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<td>44</td>
<td>-10</td>
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<tr>
<td>WA</td>
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<td>30</td>
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<th>Simulated Balance</th>
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Utility-based allocation

• Factors affecting transplant benefit
  – Age
  – Sex
  – Race
  – Primary disease
  – Co-morbidities
    • Diabetes
    • Coronary disease
    • Peripheral vascular disease
    • Cerebrovascular disease
    • Chronic lung disease
    • Smoking history
  – Body mass index
  – Time on RRT
  – Waiting time
  – Donor age
  – Ischaemic time
  – HLA mismatch
  – Peak PRA
Projected survival after deceased donor transplant

Age 65, male, white, diabetic nephropathy, overweight

Median 12.0 years
Projected survival on waiting list
Age 65, male, white, diabetic nephropathy, overweight

Median 5.5 years
Projected benefit from deceased donor transplant

Age 65, male, white, diabetic nephropathy, overweight

Median benefit 6.5 years

Patient survival

Years

Deceased donor transplant
Waiting list
Projected benefit from deceased donor transplant

Age 20, male, white, GN, normal weight

Median benefit 21.0 years

Patient survival

Yrs

0 5 10 15 20 25 30 35 40

0

0.25

0.5

0.75

1

Deceased donor transplant

Waiting list
Projected benefit from deceased donor transplant

Age 30, male, white, GN, normal weight

Median benefit 17.6 years

Patient survival

Deceased donor transplant

Waiting list
Projected benefit from deceased donor transplant

Age 40, male, white, GN, normal weight

Median benefit 14.3 years

Deceased donor transplant
Waiting list
Projected benefit from deceased donor transplant

Age 50, male, white, GN, normal weight

Median benefit 11.2 years

Patient survival

Years

Deceased donor transplant
Waiting list
Projected benefit from deceased donor transplant

Age 60, male, white, GN, normal weight

Median benefit 8.4 years
Projected benefit from deceased donor transplant

Age 70, male, white, GN, normal weight

Median benefit 6.1 years

Patient survival

Deceased donor transplant
Waiting list

Years

Patient survival
Projected benefit from deceased donor transplant

Age 80, male, white, GN, normal weight

Median benefit 3.9 years
Utility-based allocation

Factors affecting transplant benefit

- **Age**
- **Sex**
- **Race**
- **Primary disease**
- **Co-morbidities**
  - Diabetes
  - Coronary disease
  - Peripheral vascular disease
  - Cerebrovascular disease
  - Chronic lung disease
  - Smoking history

- **Body mass index**
- **Time on RRT**
- **Waiting time**
- **Donor age**
- **Ischaemic time**
- **HLA mismatch**
- **Peak PRA**

\[
\text{Benefit} = 26 - \frac{\text{age}}{4} - \frac{\text{donor age}}{20} - \frac{\text{HLA mismatch}}{3} - \frac{\text{peak PRA}}{20}
\]
Life expectancy by age

Current vs utility-based DD allocation

Utility-based

Current

Age

Life expectancy

0 20 40 60 80

0 10 20 30 40
Life expectancy by age
Current vs utility-based DD allocation

Current

Utility-based

Waiting list age distribution
Observed Simulated

Current deceased donor kidney allocation system

Utility-based deceased donor kidney allocation system

Living donor transplantation rate
Australia 2002-2010

Year

Living donor transplants

Observed
Simulated

## State balance

<table>
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<tr>
<th>Current</th>
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Future directions

• More sophisticated allocation models
• Sensitivity analyses
  – Changes in waiting list
  – Changes in donor pool
• QALYs
• Economic analyses
Acknowledgements

• ANZDATA
  – Blair Grace
  – Stephen McDonald
  – Steve Chadban
• NOMS
  – Jeremy Chapman
  – Jenni Wright
  – Paul Slater
• Arbor Research Collaborative for Health
  – Keith McCullough
  – Bob Merion
  – Alan Leichtman
• Australian and New Zealand patients and staff for their cooperation and contributions to ANZDATA and ANZOD