Is simultaneous pancreas kidney transplant the most cost-effective treatment for Type 1 diabetes patients with renal failure? A cost-utility analysis

Ong SC, Lee VTW, Chow WL, Lim J, Tong SC, Kee TYS, Madhavan K
Analyst
SingHealth
Centre for Health Services Research
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Introduction

Pancreas transplant for type I diabetes mellitus:

- improve quality of life
- cost-effective
- prolong survival
- induce an insulin-independent normoglycemic state

Most widely applied in Type 1 diabetes with renal failure (IDDM-RF)

- simultaneous pancreas kidney transplant (SPK).

Introduction

- Established & available in US & European centres
  - not available in Singapore

- Singapore has a national liver and kidney transplant programme
  - SPK is the next natural progression

- Overseas studies\(^1-2\) had proven that SPK is a cost-effective strategy
  - no analysis done in the region.

Objective

to assess cost-effectiveness of SPK compared with other treatment strategies for IDDM-RF prior to establishment of a pancreas transplant programme in Singapore.
Methods
Methods

Model structure and assumptions

➢ A decision analysis model was used.

➢ Treatment strategies for IDDM-RF:
  ✓ Cadaveric kidney transplant (Ktx-CAD),
  ✓ Living donor kidney transplant (Ktx-LD),
  ✓ Simultaneous pancreas kidney transplant (SPK),
  ✓ Dialysis.
Methods

➢ Assumptions:

✓ all options are available to patients,
✓ transplantations are performed and managed according to standard techniques and immunosuppressive regimens.

➢ The time horizon: 5 years

➢ Perspective: healthcare provider.

➢ Analyzed using TreeAge Pro software
Methods

Probabilities

- All patients and graft survival probabilities - 5-year survival analyses

- Exception: “Dies from operation or complication” -- survival probability of 1 year.

- All survival values -- Singapore Renal Registry data

- Exception: All SPK survival variables
  - American data from the United Network for Organ Sharing and Scientific Registry of Transplant Recipients (OPTN/SRTR)
  - No local data available
Methods

Health Outcomes

➢ Outcomes: Quality adjusted life year (QALY).

➢ QALY: a measure of disease burden, including both the quality and the quantity of life lived.

➢ QALY for each treatment option were obtained from a overseas study*
  ➢ Standard Gamble method
  ➢ based on a 5-year model

Methods

Cost analysis

- Only direct medical costs were considered in this study.

- Adjusted to 2010 values
  - health care component of the Singapore Consumer Price Index.

- We adopted a 3% annual discount rate for all future costs
  - which converted values that would occur in the future to their present values.
All cost components were based on the actual patients’ data locally.

Exception: All SPK related costs were based on expert opinion of a local surgical team

- 1st year SPK transplant cost -- 40%
- Annual follow-up cost -- 15%

higher than the cadaveric kidney transplant
Methods

Cost-utility analysis

- Cost-effectiveness: Cost-utility ratio (CUR, i.e., Cost per QALY gained)

- Incremental cost-utility ratio (ICUR) was also calculated versus the least costly strategy.

\[
\text{ICUR}_{A \text{ vs. } B} = \frac{\text{Cost A} - \text{Cost B}}{\text{QALY gained for A} - \text{QALY gained for B}}
\]

- WHO guidelines:
  - ICUR below 1 GDP per capita - highly cost-effective
  - < 3 times GDP per capita - cost-effective

*GDP per capita for Singapore 2010= SGD59,813 (USD48,382)
Methods

Sensitivity analysis

- Sensitivity analyses were performed to evaluate the impact of uncertainties around key variables.

- Survival variables
  - Variations: 95% CI (Singapore Renal Registry)

- SPK survival variables,
  - Variations: ±15% of the baseline values (the OPTN data)
  - higher level of uncertainty as no local data available.
Sensitivity analysis

- **Cost variables**
  - Variations: ± 20% of baseline values.

- **QALY:**
  - Variations: ± 1 Standard deviation
  - Previous study*

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Results
## Results

### Baseline analysis

<table>
<thead>
<tr>
<th>Treatment option</th>
<th>Cost, SGD</th>
<th>QALY</th>
<th>Cost-utility ratio, SGD</th>
<th>ICUR (vs dialysis), SGD</th>
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<tbody>
<tr>
<td>Dialysis</td>
<td>116,777</td>
<td>0.68</td>
<td>171,227</td>
<td>NA</td>
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<tr>
<td>Cadaveric kidney transplant, Ktx-CAD</td>
<td>192,602</td>
<td>2.21</td>
<td>87,203</td>
<td>Dominated</td>
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<tr>
<td>Living donor kidney transplant, KD-LD</td>
<td>201,900</td>
<td>2.78</td>
<td>72,702</td>
<td>40,630</td>
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<tr>
<td>Simultaneous pancreas kidney transplant, SPK</td>
<td>251,099</td>
<td>3.21</td>
<td>78,335</td>
<td>53,091</td>
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1 USD = SGD1.24
Figure 1: Cost-utility analysis for IDDM-RF treatment strategies

- **Dominated strategy**

Extended Dominance:

- $0.109 \leq k \leq 0.271$
### Results

#### Baseline analysis

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Results

The SPK would be the most cost-effective strategy:

- 10% increase in SPK kidney graft survival
- i.e., 86.8% versus 78.9% used in the baseline
Results

The SPK would be the most cost-effective strategy.

- 12% increase in patient survival for SPK strategy
- i.e., 97.2% vs 86.6% used in the baseline
Results

Sensitivity Analysis on QALY (dialysis free, insulin dependent state)

The SPK would be the most cost-effective strategy.

- QALY for the dialysis-free, insulin dependent state falls < 2.7
- vs 3.0 used in the baseline
Results

1\textsuperscript{st} year SPK transplant cost is only 20\% higher than the KA-CAD cost vs 40\% higher than the Ktx-CAD used in the baseline

as cost-effective as KA-LD strategy

Sensitivity Analysis on SPK Transplant 1\textsuperscript{st} year cost

Cost/Eff

Dialysis
Ktx-CAD
Ktx-LD
SPK

104K
117K
130K
143K
156K

$180K$
$170K$
$160K$
$150K$
$140K$
$130K$
$120K$
$110K$
$100K$
$90K$
$80K$
$70K$

SPK Transplant 1\textsuperscript{st} year cost
Conclusions
Conclusions

- Both Ktx-LD and SPK are highly cost-effective strategies in the treatment of IDDM-RF.

- Ktx-LD is the most cost-effective strategy in the baseline analysis.

- SPK is potentially the most cost-effective strategy in the sensitivity analyses:
  - 10% increase in SPK kidney graft survival
  - 12% increase in SPK patient survival
  - QALY for the dialysis-free, insulin dependent state falls <10%

  Reasonable within the sensitivity analyses ranges and achievable
Thank you

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