The Efficiency of Evaluating Candidates for Living Kidney Donation: A Scoping Review

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Introduction. The process of evaluating candidates for living kidney donation can be inefficient. A structured review of existing information on this topic can provide a necessary foundation for quality improvement. Methods. We conducted a scoping review to map the published literature to different themes related to an efficient donor candidate evaluation. We reviewed the websites of living donor programs to describe information provided to candidates about the nature and length of the evaluation process. Results. We reviewed of 273 published articles and 296 websites. Surveys of living donor programs show variability in donor evaluation protocols. Computed tomography (a routinely done test for all successful candidates) may be used to assess split renal volume instead of nuclear renography when the 2 kidneys differ in size. Depending on the candidate’s estimated glomerular filtration rate, a nuclear medicine scan for measured glomerular filtration rate may not be needed. When reported, the time to complete the evaluation varied from 3 months to over a year. The potential for undesirable outcomes was reported in 23 studies, including missed opportunities for living donation and/or preemptive transplants. According to living donor websites, programs generally evaluate 1 candidate at a time when multiple come forward for assessment, and few programs describe completing most of the evaluation in a single in-person visit. Conclusions. Data on the efficiency of the living donor evaluation are limited. Future efforts can better define, collect, and report indicators of an efficient living donor evaluation to promote quality improvement and better patient outcomes.

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the donor. Finally, there may also be missed opportunities for living donor transplants if the intended recipient receives a deceased donor kidney transplant while their donor is being actively evaluated.

A need to improve the efficiency of the living kidney donor candidate evaluation is featured in reports from patient advocacy groups, a recent consensus conference in the United States, the 2017 Kidney Disease Improving Global Outcomes international practice guideline, and a report from the National Health Services in the United Kingdom targeting an 18-week evaluation, where possible. However, although advocating for efficiency, these reports do not provide any recommendations on how efficiency can be achieved.

A review that summarizes existing information on the efficiency of the donor candidate evaluation can provide a necessary foundation for quality improvement. As a multidimensional construct (including the time to complete the evaluation, patient outcomes, and resource use), an efficient evaluation process may not easily be summarized in a single systematic review of a focused question. Instead, we undertook a scoping review to map the available literature to themes related to an efficient living kidney donor candidate evaluation. We also reviewed the websites of living donor programs from 4 countries to describe the information provided to candidates about the nature and length of the evaluation process.

METHODS

Literature Review

We followed the recommendations of the Joanna Briggs Institute for conducting and reporting scoping reviews. On September 12, 2017, 1 author (S.H.) searched bibliographic databases using the search terms “living AND kidney AND donor AND (assessment OR evaluation OR practice OR screening OR selection OR efficient OR efficiency)” [Medline (n = 2801 citations via PubMed), PsychInfo (n = 58), EMBASE (n = 2899 via OVID), and ABI Inform Collection (n = 5)]. Search terms were chosen based on terms associated with known articles of interest. Articles were restricted to human studies published in English from 2000 onward. Conference abstracts were excluded. Studies were not restricted by age or country. Google searches and reference lists of relevant articles were screened and manually added if appropriate, regardless of publication date. The title, abstract, or full-text of an article was used to sort the literature into themes related to the efficiency of living kidney donor evaluations. We then summarized the findings within each theme, focusing on how they could be used to guide future efficiency improvements. Articles only considering how accepting donors with certain characteristics influenced their postdonation outcomes were excluded.

Living Donor Program Websites

From May to August 2017, we searched the websites of living donor programs in Canada, United States, United Kingdom, and Australia for information related to an efficient evaluation process.

Statistical Methods

Meta analysis was performed using the metaprop package in STATA v13.0 using a random-effects model. Confidence intervals were calculated using exact methods.

RESULTS

A total of 4706 articles were available for screening after duplicates were deleted. After applying the exclusion criteria, 273 articles were available for mapping (Figure 1). Five relevant themes emerged through the mapping process: (1) surveys of living donor program practices (8 studies), (2) renal imaging for the living donor assessment (159 studies), (3) kidney function assessment (56 studies), (4) the flow of living donor candidates through the evaluation process (38 studies), and (5) the living donor experience with the evaluation process (12 studies).

Studies Surveying Living Donor Programs

Eight surveys of multiple transplant programs were conducted in the United States, United Kingdom, France, and Europe (Table 1). These surveys revealed not only some similarities in the evaluation and selection of living donor candidates but also some notable differences in donor eligibility criteria and tests preformed to evaluate a candidate. Evaluating the efficiency of the living donor evaluation process was not an objective of any of the surveys.

Number of Candidates Evaluated Simultaneously

Several donor candidates may come forward at the same time for the same recipient. This may increase to dozens of candidates when recipients share their need for a living donor on social media, which is often public. One survey from the United Kingdom reported that 50% of centers evaluate 1
donor candidate at a time, whereas 20% evaluate 2 or more simultaneously (although it was not reported what the policy is among the remaining 30%).16 Detail on the relative rigor of the evaluations was not reported (eg, 1 candidate evaluated quicker; full versus partial evaluation for 1 or all candidates). Further research is needed on the optimal use of resources in evaluating multiple donor candidates simultaneously versus sequentially.

Removal From the Deceased Donor Waitlist

Some intended recipients are on a waitlist for a deceased donor kidney while the evaluation of their living donor candidate is underway. In such cases, a prolonged living donor evaluation may result in a deceased donor transplant and the loss of a kidney from a potential living donor at that time. A recent survey of 44 transplant centers from the United Kingdom reported that recipients are removed from the deceased donor waitlist when the living donor transplant date is scheduled (16 centers), when the candidate is approved for donation (8 centers), when the final crossmatch is complete (5 centers), or on the actual day of the living donor transplant (1 center).16 The US Organ Procurement and Transplantation Network policy now requires potential recipients of all organ types (living or deceased) to be registered on the waiting list prior to their transplant, although listing status may be inactive to prevent offers of a deceased donor (policy 3 in reference).22 We are unaware of whether these policies impacted the efficiency of the living donor work-up.

Time for Smoking Cessation or Abstinence

The requirements related to smoking have become less stringent over time. Most centers do not routinely exclude active smokers (36% of French centers exclude only heavy smokers; only 2% of US centers require documentation of cessation), but instead urge donors to stop (or reduce) smoking for some period of time before donation.13,17

Time to Complete Evaluation

The time to complete the donor evaluation was mentioned briefly in 2 surveys from the United Kingdom. Twenty programs did not have a targeted time period, but 3 to 6 months was seen as an appropriate window by 9 programs (although the start and end dates of the evaluation were not defined).15,16

Renal Imaging Studies

A total of 159 studies reported on renal imaging modalities in the candidate evaluation. Most of these studies considered the accuracy of computed tomography (CT) and magnetic resonance (MR) angiography to define the renal vasculature compared with the actual vascular findings observed during surgery (CT was more common than MR).16,23 Correctly charting the vascular network and characterizing any abnormalities as benign (ie, cysts, lesions, small excisable tumors, or stones) is a critical function of CT or MR imaging in the living donor evaluation and is necessary to ensure donor and recipient safety.24 Regarding efficiency, CT or MR imaging is generally performed later in the evaluation because these tests are costly and expose donor candidates to mild risks related to contrast media or ionizing radiation.12,16,23,26 In some centers, there may be a waiting time to receive such testing.

If a clinically important size discrepancy between the left and right kidney is observed (ie, >1 cm or >10% difference from prior imaging), then a nuclear renogram may be performed to assess the relative function of each kidney, called the “split renal function” (if significantly different then the donor may be left with the higher-functioning kidney). All living donors complete a CT or MR scan as part of the evaluation (Figure 2A). Because of the expected relationship between kidney size and function (larger kidney = more nephrons = higher function), 18 studies assessed whether the relative kidney volume determined by CT can be used as a surrogate for relative function as determined by nuclear renography (Figure 2B). Most authors concluded that CT...
Volumetry could replace split renal function measurement, eliminating this test from the evaluation process for some candidates. Given such consistent reporting, a systematic review and meta-analysis was conducted separately (including these studies and more), which reported a moderate correlation between split renal volume by CT scan and split renal volume by nuclear renogram (Pearson’s $r = 0.74$, beta $= 0.76$ by linear regression). For predicting a clinically significant size difference between the 2 kidneys, CT had a specificity of 88% and negative predictive value of 86% (sensitivity 35%; positive predictive value 40%).

**Studies Measuring Predonation Kidney Function**

Acceptable living donor candidates must have sufficient predonation kidney function to minimize the risks associated with living with 1 kidney. Glomerular filtration rate (GFR) measured using a radionuclide (mGFR) is the current gold standard, but is a resource-intensive test, is not always readily available, exposes donor candidates to potentially harmful radioisotopes, and may be subject to systematic bias and measurement error. Because of this, GFR is estimated (eGFR) early in the evaluation using serum creatinine (a biomarker that can be measured from a simple blood test). For predicting a clinically significant size difference between the 2 kidneys, CT had a specificity of 88% and negative predictive value of 86% (sensitivity 35%; positive predictive value 40%).

**FIGURE 2.** Improving the efficiency of the evaluation: The use of split renal volume measured by CT to replace split renal function measurement by nuclear renogram. A, The current renal imaging protocol at many transplant centers, where the CT scan and nuclear renogram are both performed for donor candidates. Both examinations may be conducted on the same day, but this is not necessary. B, The proposed renal imaging protocol, where the nuclear renogram is replaced by CT scan for some donor candidates.

Studies measuring GFR by radionuclide for some donor candidates. Threshold is an arbitrary cut-point generated by the data to permit 100% sensitivity. Algorithm described by Huang et al estimated that at least 53% of donors in the United States from 2009 to 2015 would not have required a mGFR based on an eGFR high enough to assure a mGFR of 90 mL/min per 1.73 m² or greater. In 1 validation study, 27% of mGFR could have been avoided, but a posttest probability cutpoint greater than 98% (rather than 95% in the original study) was required to achieve 100% sensitivity. In a second validation study, 14% of mGFR could have been avoided, but a posttest probability cutpoint greater than 99.98% was required to achieve 100% sensitivity. More work is needed to advance this prediction tool to clinical practice.
Studies Describing The Flow Of Living Donors Through The Evaluation Process

A total of 38 studies reported on the number of donor candidates evaluated by their programs. We summarized these results, tabulating the proportion who donated, the number of potential donors lost because the intended recipient either received a transplant from a deceased donor or died or became too ill to receive a transplant, and the time required to evaluate candidates.

The proportion of living donor candidates who ultimately donated ranged from 8% to 86%, averaging 37% across studies (Figure 4). Although the definition of the numerator and denominator varied, no difference was observed when we excluded any study.

Twenty-four (63%) studies reported a loss of intended recipients due to illness or death (range 1-7%) or receipt of a deceased donor kidney (1-21%) (Table 2). Although these recipients had a potential living donor, none of these studies evaluated whether a living donor transplant was feasible (i.e., the donor candidate may have come forward only a few weeks before, which was not enough time to complete a thorough evaluation). It is possible that up to 21% of potential recipients could have received a living donor transplant if the evaluation was quicker. This is, however, an upper theoretical limit and the true loss of potential living donor transplants remains unknown without more data. A recent study projected that a more efficient living donor evaluation process (i.e., donor evaluation completed 3 months sooner) may result in a 26% increase in the total number living donor kidney transplants performed, translating to substantial healthcare system cost savings through avoided dialysis. These findings are supported by a recent quality improvement project that reduced the time to complete the living donor assessment using a 1-day donor assessment model.

Seventeen studies (45%) reported evaluation times using various metrics, estimated using data or stated anecdotally. Common evaluation times included the time until approval to donate, donation, or rejection, although the definition of the starting point varied (Table 3). The time until donation ranged from 4 to 14 months across studies and transplant programs. One report described a single recipient who received a kidney from her father (before) and her mother (after) the living donor evaluation process was redesigned to be completed in 1 day. The results of this

### Proportion of candidates who donated

| Study                  | ES (95% CI) | country          | note                                                                 |
|-----------------------|-------------|------------------|----------------------------------------------------------------------|
| Saunders (2000)       | 13.0 (9.2, 17.6) | United Kingdom  | unclear how many came forward                                        |
| Trevitt (2001)        | 56.9 (42.2, 70.7) | United Kingdom  |                                                                       |
| Weisser (2004)        | 49.3 (38.6, 61.8) | Germany          | all presented for psychosocial evaluation                             |
| Calder (2004)         | 51.0 (48.6, 53.4) | Egypt            | accepted (no indication of how many donated)                         |
| McCullough (2005)     | 18.0 (12.8, 24.2) | United Kingdom  |                                                                       |
| Kayler (2005)         | 17.1 (10.8, 25.2) | South Africa     |                                                                       |
| Jenkyns (2006)        | 7.9 (5.3, 10.7) | United States    |                                                                       |
| Tushy (2006)          | 1.1 (0.8, 2.0)  | United States    | NOAD only, combined liver and kidney donor candidates                 |
| Akoh (2008)           | 22.7 (19.1, 26.6) | United States    |                                                                       |
| Larsen (2009)         | 17.9 (14.1, 22.2) | United Kingdom  |                                                                       |
| Reese (2009)          | 15.7 (9.7, 23.4) | United States    |                                                                       |
| Roodeval (2009)       | 51.9 (43.1, 60.6) | Denmark          | accepted (no indication of how many donated)                         |
| Lin (2010)            | 64.9 (51.8, 79.9) | United Kingdom  |                                                                       |
| Zhao (2010)           | 46.6 (40.5, 52.8) | Taiwan           | all listed and had a donor                                           |
| Lapasa (2010)         | 66.1 (57.1, 74.4) | China            |                                                                       |
| Mohsin (2010)         | 8.1 (5.8, 10.9)  | United States    |                                                                       |
| Norman (2011)         | 50.7 (38.4, 63.0) | Oman             | recipients transplanted (number of candidates who donated not stated) |
| Moore (2012)          | 45.8 (42.2, 49.6) | United States    | accepted (no indication of how many donated)                         |
| Weng (2012)           | 38.3 (35.6, 41.2) | United States    |                                                                       |
| Sackova (2013)        | 37.5 (28.2, 47.5) | United States    |                                                                       |
| Gonzales (2013)       | 39.5 (30.9, 48.7) | Poland           |                                                                       |
| Romagnoli (2013)      | 30.4 (20.5, 41.3) | Italy            |                                                                       |
| Magle (2015)          | 38.1 (28.5, 48.6) | Turkey           | accepted (no indication of how many donated)                         |
| Connaughton (2016)    | 18.4 (16.0, 21.0) | Ireland          |                                                                       |
| Atsulman (2016)       | 40.1 (32.5, 46.8) | New Zealand      |                                                                       |
| Guthoff (2016)        | 48.9 (40.1, 57.7) | Germany          |                                                                       |
| Mulit (2017)          | 85.8 (77.9, 91.4) | Kenya            |                                                                       |
| Ali-Khati (2017)      | 59.6 (55.9, 62.9) | Jordan           |                                                                       |
| Bailey (2017)         | 13.1 (10.9, 15.5) | England and Wales|                                                                       |
| Graham (2017)         | 68.9 (61.2, 75.4) | Ireland          |                                                                       |
| Knight (2018)         | 37.8 (23.2, 53.5) | United Kingdom   |                                                                       |
| Habbous (2018)        | 18.6 (15.3, 22.2) | Canada           | all candidates returned screening questionnaire                       |
| Overall               | 36.8 (28.7, 44.5) |                   |                                                                       |

**FIGURE 4.** Forest plot with proportion of donor candidates who donated. Studies were pooled using a random effects model. There was significant variability (I² = 99.5%, P < 0.0001). ES, effect size (a proportion); CI, confidence interval.
## Table 2

Summary of studies reporting on the loss of potential donor candidates due to recipient illness or death or competition from deceased donor transplantation

| Reference            | Transplant center                                                                 | Period                              | From recipient illness or death | From deceased donor transplant |
|----------------------|------------------------------------------------------------------------------------|-------------------------------------|---------------------------------|-------------------------------|
| Saunders 2000⁴⁵      | Leicester General Hospital, Leicester UK                                           | 1994-1998                           | 1 no longer eligible after surgeon consult (recipient cancer), but no indication of recipient death or loss before surgeon consult | 25 (9%)                      |
| Schweitzer 2004⁴⁶    | University of Heidelberg Hospital, Germany                                        | 1997-2002                           | NR                             | 3 (7%) (in subset of 45 candidates) |
| Calder 2004⁴⁷        | St. George’s Hospital, UK                                                          | 1997-2001                           | 2 (1%) (death only)            | 13 (7%)                       |
| McQuaid 2005⁴¹       | University of Cape Town and Groote Schuur Hospital, South Africa                   | January 2000 to March 2003          | 4 (3%)                         | 25 (21%)                      |
| Kayler 2005⁴²         | Thomas Jefferson University Hospital, PA                                        | January 2000 to April 2003          | 12 donors were approved but recipient too sick or died or received a transplant (unsure of donor source); for donors who did not initiate medical work-up (definition of this is unclear, n = 120), 18 recipients died/too sick and 84 already transplanted (unsure of donor source) | NR                           |
| Tuohy 2006⁴⁴         | Beth Israel Deaconess Medical Center, NY                                          | 2000-2003                           | 7 (2%) (death only)            | 34 (9%)                       |
| Akoh 2008⁴⁶          | South West Transplant Centre, UK                                                  | January 2003 to February 2008       | NR                             | 20 (17%) (but unclear if all had a live donor) |
| Larsen 2009⁴⁶        | Rigshospitalet, Denmark                                                          | January 2002 to December 2006       | 59 (6%) recipient reasons including death, malignancy, cardiovascular disease (grouped) | 15 (1%)                       |
| Reese 2009⁴⁹         | Hospital of the University of Pennsylvania                                       | December 2006 to March 2008         | 5 (2%) (illness only, no indication of death) | 5 (2%)                       |
| Roobnai 2009⁵⁰       | Erasmus Medical Center, University Hospital Rotterdam                             | January 2000 to December 2007       | 55 (28%) (deaths)              | NR                           |
| Lin 2010⁵¹           | National Taiwan University Hospital, Taiwan                                       | January 2005 to December 2008       | 14-20% of those excluded donors (death only) | 28 (6%)                       |
| Lapasie 2010⁵²       | Stanford, CA                                                                     | October 2007 to March 2009          | 35 (11%) (combined death, illness or incompatible) | 23-28% of those excluded      |
| Sanner 2011⁵⁵        | Karolinska University Hospital, Stockholm Sweden                                   | January 2004 to July 2008           | 35 (11%) (combined death, illness or incompatible) | 36 (3%)                       |
| Norman 2011⁵⁶        | University of Michigan Transplant Center                                         | January 1995 to June 2006           | NR (assume zero deaths)         | 17 (14%)                      |
| Moore 2012⁵⁷         | Vanderbilt University Medical Center, TN, USA                                     | January 2004 to July 1, 2009         | 4/84 (5%) deaths (records available for only 84) | 0 (no cadaveric donation in Kenya) |
| Wang 2012⁵⁹          | Saint Barnabas Medical Center, Livingston, N.J., USA                              | January 2000 to December 2005       | NR                             | 13 (4%) with a donor in the evaluation |
| Gozdowska 2013⁵²      | Poland                                                                            | 2007-2011                           | NR                             | 13 (4%) with a donor in the evaluation |
| Romagnoli 2013⁵⁷      | Catholic University, Rome, Italy                                                 | January 2005 to March 2012          | NR                             | 13 (4%) with a donor in the evaluation |
| Connaughton 2016⁶⁶    | Ireland                                                                           | January 2000 to March 2014          | NR                             | 13 (4%) with a donor in the evaluation |
| Alsulaiman 2016⁶⁶     | Christchurch Hospital, New Zealand                                               | January 2004 to June 2008           | NR                             | 13 (4%) with a donor in the evaluation |
| Muturi 2017⁶⁹        | Kenyatta University Hospital, Kenya                                               | 2010-2014                           | NR                             | 13 (4%) with a donor in the evaluation |
| Al-Rabadi 2017⁷⁰     | King Hussein Medical Center, Jordan                                               | January 2008 to June 2016           | NR                             | 13 (4%) with a donor in the evaluation |
| Bailey 2017⁷¹        | Multiple centers in England and Wales                                            | August 8, 2014 to January 31, 2016  | NR                             | 13 (4%) with a donor in the evaluation |
| Knight 2018⁷³        | Oxford Transplant Centre                                                          | January 2013 to December 2016       | NR                             | 13 (4%) with a donor in the evaluation |
| Habbour 2018 (unpublished data) | London Health Sciences Centre, London, Ontario Canada                        |                                    | NR                             | 13 (4%) with a donor in the evaluation |

*These were studies primarily mapped to the living donor experience with the living donor evaluation.

NR, not reported; N/A, not applicable.
redesign were highly positive, showing a reduction in the evaluation time from 2 years to 3 months, an increase in the number of preemptive transplants from less than 10% to greater than 50%, a rise in the number of living donor kidney transplants per million population from less than 5 to greater than 32, and a reduction in the prevalence of patients on dialysis.2

**Studies Describing the Living Donor Experience**

Eleven studies asked prior donors about their experience with donation.3,4,5,5,7,4,8,2 One of the most common comments related to the evaluation process was that the evaluation was lengthy, and a prolonged evaluation was a source of strain on both the donor and the recipient:

> “It just has to be soon as possible because we are not able to do anything right now. X (the recipient) is so bad that we never know in advance if we can carry out the plans we’ve made but have to wait and see on the day.”75

> “… it actually disrupted our whole life … I had to keep taking time off work … like each time we went for tests … when … they were going to have the first operation, I took holidays and then it was cancelled and then I tried to ring my boss and get back to work again so I could save my holidays. It was pretty hard … you sort of have to try and switch off your family life to get on with the job.”45 (mother donating to her child)

> “At the first appointment, we were told that the process takes approximately 9 or 10 months, and all I could think of was whether we had this amount of time, as our daughter’s

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**TABLE 3.**

| References | Transplant center | Period | Evaluation time |
|------------|-------------------|--------|-----------------|
| Saunders 200035 | Leicester General Hospital, Leicester UK | 1994-1998 | Time until donation: mean, 9.3 mo (SD, 6.5 mo) |
| Trevitt 200137 | Barts and The London NHS Trust, London, UK | 1997-1999 | ~4 mo from the time of initial crossmatch until donation (estimated from graph) |
| Calder 200440 | St. George’s Hospital, UK | 1997-2001 | Process designed to take a minimum of 3 mo (some with <3 mo if coming from abroad and had testing done elsewhere) |
| "Williams 200745 | Edith Cowan University and Sir Charles Gairdner Hospital | Not reported | Most cases between 1 and 2 y, shortest was 6 mo |
| Ferriman 200847 | Royal Free Hospital, London UK | ~2007-2008 | 116 d |
| Larsen 200948 | Rigshospitalet, Denmark | January 2002 to December 2006 | Median, 4 (IQR, 1-24) months time until approval; median, 3 mo (IQR, 0-9 mo) from approval to donation; median, 3 (IQR, 0-48) time until rejection |
| "Sanner 201155 | Karolinska University Hospital, Stockholm Sweden | January 2004 to July 2008 | Median, 11.0 (SD, 8.6); range, 1-48 mo |
| Romagnoli 201353 | Catholic University, Rome, Italy | January 2005 to March 2012 | Not reported (but acknowledged it is time consuming and resource intensive) |
| Weng 201655 | Saint Barnabas Medical Center in Livingston, N.J., USA | 2007-2010 | 163 d (time from referral to donation, but unclear what referral means) |
| Alsulaiman 201656 | Christchurch Hospital, New Zealand | January 2004 to June 2008 | 3-9 mo |
| "Bailey 20163 | Belfast City Hospital, UK | Not reported | 9-10 mo, down to <3 mo for a healthy willing donor at the time of writing |
| Al-Rabadi 201770 | King Hussein Medical Center, Jordan | January 2008 to June 2016 | Process designed to take a minimum of 2 mo, but not measured |
| Bailey 201771 | Multiple centers in England and Wales | August 8, 2014 to January 31, 2016 | Median, 308 d for donors; median, 61 d for nondonors |
| Graham 201772 | Ireland | 2010-2015 | 2.3 mo for work-up |
| Habbous 201872 | Multiple centers in Canada and Australia | September 2009 to January 2015 | Median, 10.3 mo (total evaluation time), 7.9 mo (time until approval), 0.7 mo from approval until donation, 4.8 mo from CT angiogram until donation, and 3.0 mo for time between consents |
| Knight 201873 | Oxford Transplant Centre | January to March 2016 | Median, 132 d from first contact until decision; median, 204 d from first contact until donation |
| Habbous 2018 | London Health Sciences Centre, London, Ontario Canada | January 2013 to December 2016 | Time from evaluation start until donation was a median 9.2 (6.1-14.0) months; time until withdrawal or decline was a median 4.3 (1.4-9.1) months |

*These were studies primarily mapped to the living donor experience with the living donor evaluation. IQR, interquartile range (25th-75th percentile); SD, standard deviation.
United Kingdom Leeds, England Leeds St James
United States Hershey, Pennsylvania Penn State Milton S Hershey
Canada Vancouver, British Columbia St. Paul
Canada Toronto, Ontario Toronto General Hospital 2-3 mo, (3-6 mo before surgery can be scheduled) Low
and it shouldn’t take so long to get checked out as a donor.

The length of time needed to reconsider the act of donation (the ‘cooling off’ period) varies by donor, but 3 months may be sufficient for most. Some donors have expressed wanting less time to think about the decision to donate because of the additional anxiety it produces: “the longer you wait, the longer you worry about it”. Once the decision is made, donors often want the surgical procedure as quickly as possible. Several donors blamed the healthcare system for conducting an inefficient and poorly executed evaluation process (concerning an evaluation time of 6 months or longer). Moreover, the time between donor approval and donor surgery was prolonged for several donors, which injected an additional source of anxiety for both the donor and recipient.

Some donors reported being frustrated that a prolonged evaluation resulted in their intended recipient spending an unnecessarily longer time on dialysis. One study reported donor responses in favor of preemptive transplant (ie, better for recipient health), whereas others favored transplant after some time on dialysis (ie, more likely for the recipient to be compliant with medications and to better understand the value of a kidney).

Information on Living Donor Program Websites

We reviewed the websites for 296 living donor programs in Canada, United States, United Kingdom, and Australia (SDC, Materials and Methods, http://links.lww.com/TXD/A151), focusing on issues related to an efficient living donor evaluation.

Time to Complete the Evaluation

9/296 (3%) of the websites provided information on the duration of the donor evaluation process, time until results

are obtained, and the time to complete the evaluation (ie, number of days of testing at the hospital). Most websites only provided a low level of information, stating either the number of days of testing required or the total evaluation time. Some representative examples are listed in Table 4. Twenty-one programs acknowledged the evaluation may take up to 6 months, sometimes providing very broad ranges (eg, 6-12 months; 1-6 months; 3-18 months; up to 6 months). Others described evaluations less than 4 months. Although some of these may accurately represent the efficiency of the program, we are only aware of published data from 1 center (2-3 months in Belfast City Hospital, Ireland, UK). One website stated a time of 2 months from donor approval to surgery (Ohio State University Medical Center).

Ten transplant programs indicated that evaluation testing is completed in 1 day for most candidates (depending on the candidates’ age; older candidates may require additional testing). Eleven programs indicated up to 2 days were required, and 6 programs indicated at least 3 days were required.

Medical History Form Online

Seventy-two websites provided their medical history intake form online (71 from the United States). Of these, 49 (68%) could be completed and submitted directly to the program coordinators online. Twenty-two of these used the same third-party system (Breeze Transplant) to facilitate collection of the online health history questionnaire.

Number of Candidates Evaluated Simultaneously

Twenty-five websites stated their general procedure for assessing candidates when more than 1 comes forward at the same time. Most stated the preferred candidate is the one who is a better match (although the definition of “match” was not described), and few programs involve a joint decision by the healthcare team and the intended

**TABLE 4.** Representative information from the websites of living kidney donor programs on the time to complete the evaluation process

| Country     | City, province     | Hospital                                      | Example                                      | Quality |
|-------------|--------------------|-----------------------------------------------|----------------------------------------------|---------|
| Canada      | London, Ontario    | London Health Science Centre                  | 2-3 d for tests; 3-6 mo for results; 6+ mo total from start to surgery date | Moderate |
| United States | Portland, Oregon | Oregon Health and Science University         | 1 d for evaluation, 2-3 mo plus a few weeks to schedule surgery | Moderate |
| United Kingdom | Belfast, Ireland | Belfast City Hospital                        | 1 d (1 full day, starts at 8:00 AM; the day’s schedule provided); most results reported within a few days. While our priority is always make sure donation make possible for the donor, we can actually complete all of this within 2-3 mo if necessary. There may be an appropriate delay before you have the local assessment process if we need additional information or blood tests. Other times it may be too early for you to have other investigations depending on the person that you are hope to give a kidney to | Moderate |
| Canada      | Toronto, Ontario  | Toronto General Hospital                     | 2-3 mo, (3-6 mo before surgery can be scheduled) | Low     |
| United States | Columbus, Ohio   | Ohio State University Medical Center         | 1 d for evaluation, 2 mo from donor approval to surgery | Low     |
| Canada      | Vancouver, British Columbia | St. Paul’s Hospital                        | 3+ mo                                           | Very low |
| United States | Hershey, Pennsylvania | Penn State Milton S Hershey Medical Center | 4-6 mo                                           | Very low |
| United Kingdom | Leeds, England   | Leeds St James’s University Hospital         | 3-6 mo                                           | Very low |

The quality of reporting was subjective, based on the relative detail of information provided.
DISCUSSION

There are limited data on the efficiency of the living donor evaluation in the literature and the websites of living donor programs. Based on available information, we summarized several areas that have the potential to improve the living donor evaluation process, which may promote better recipient outcomes, improve donor satisfaction, and reduce costs to the healthcare system.

A prolonged living donor evaluation may cause anxiety for donor candidates who want to minimize the dialysis time for the intended recipient (including avoiding dialysis altogether).55,76 There is a paucity of information on the duration of the living donor evaluation, but existing studies report evaluation times that are often long, used different definitions of the evaluation start and end date, and rarely report more than 1 indicator. For example, the time between donor approval and actual donation can take weeks in some programs and months in others.48,72 Together with the time until approval, this can explain some of the differences between the total time until donation between different programs or can reveal hidden differences between programs who have similar total evaluation times.72 Thus, more accurate estimates of the time to complete an evaluation (using multiple metrics) are needed to facilitate quality improvement. Moreover, the potential implications of a prolonged evaluation on recipient outcomes were infrequently reported or were reported with insufficient detail to draw conclusions or use as a reliable indicator for benchmarking. As a result, it remains only speculative whether the loss of potential living donor kidney transplants due to recipient illness or death, due to receipt of a deceased donor kidney transplant, or due to donor candidate withdrawal could have been avoided if the evaluation was completed earlier.6 In the case where a radionuclide is used to measure the GFR, which may be unnecessary if the candidate has an eGFR associated with a high posttest probability of having a level of GFR that permits or precludes donation.32 In the case where a radionuclide is used to measure the total renal function, the split renal function can be measured with little additional effort and cost. However, for programs that use different contrast media for these 2 related tests, this may provide one strategy for improvement.83,84 Better prediction of postdonation kidney function from predonation eGFR is needed, which may be enhanced by incorporating variables like predonation kidney volume.85,86

In conclusion, there are promising opportunities to improve the efficiency of the living donor evaluation process. Better efforts are needed to define, collect, and report indicators of an efficient living donor evaluation for accountability, benchmarking, quality improvement, and research. Individual programs can learn from the processes used by other programs to improve their own practices (eg, enable a 1-day evaluation), but this requires individual programs to be more transparent on their evaluation procedures. The evaluation should continue to focus on ensuring donor safety, including completing tests that are costly or time-consuming if they are necessary to complete a thorough evaluation for donor candidacy.

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