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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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An efficient living donor candidate evaluation is completed in as little time as possible and meets the needs of the donor candidate, the intended recipient, and the healthcare system. An inefficient evaluation process can result in missed opportunities for preemptive transplants if the intended recipient's kidney disease progresses.[1,2] If an intended recipient is approved for transplant but the evaluation of their living donor is delayed because of an inefficient healthcare process, this may cause anxiety and frustration for the recipient and

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the donor.[3] 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.[4]

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.[5-8] 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.[9] 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.[10] 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,[11-14] United Kingdom,[15,16] France,[17] and Europe[18] (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.[12,19,20] 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.[21] One survey from the United Kingdom reported that 50% of centers evaluate 1

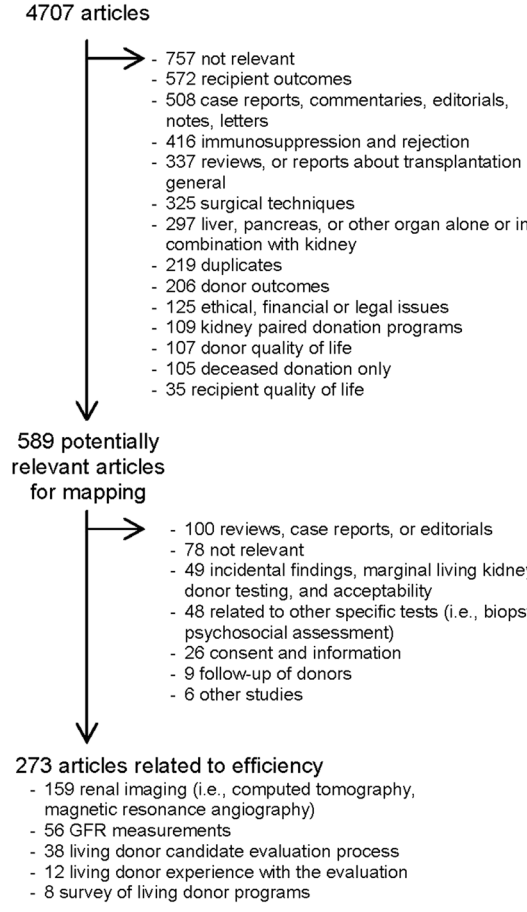

FIGURE 1. Study selection and inclusion.

TABLE 1.

Survey of living donor programs

References	Countries	No. centers responding	Average number of living donor transplants per center each year
Bia 1995[11]	United States	173/231 (75%)	13
Lumsdaine 1999[15]	United Kingdom	29/31 (94%)	4.7
Gabolde 2001[17]	France	36/46 (78%)	1.6
Mandelbrot 2007[12] or Rodrigue 2007[13]	United States	132/205 (64%)	39
Lennerling 2012[18]	Europe	113 programs over 40 countries	Median < 50
Brar 2012[14]	United States	72/181 (40%)	Median, ~80
Arunachalam 2013[16]	United Kingdom	44/74 (59%) includes transplant and nontransplant centers	69

Studies surveying living donor programs.

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 kidney 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]

Receipt of a Formal Psychosocial Evaluation

Survey responses suggest a formal psychosocial evaluation is required for all donor candidates by 74% of programs in the United States (survey from 2007), 60% in Europe (survey from 2001), and 53% in France (survey from 2013).[13,17,18] Whether these assessments were conducted by a psychiatrist, psychologist, or social worker varied. Programs that do not routinely conduct a formal psychosocial evaluation may do so if underlying problems were identified or suspected during the evaluation, or if the donor was unrelated to the intended recipient. The 2017 Kidney Disease Improving Global Outcomes guideline recommends that all candidates receive an in-person psychosocial evaluation (an ungraded recommendation due to insufficient evidence).[7] As of 2013, a psychosocial evaluation is required during the assessment of *donors* (rather than *candidates*) in the United States, which can be conducted by any of the 3 aforementioned professionals (policy 14 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.[12,16,25,26] 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

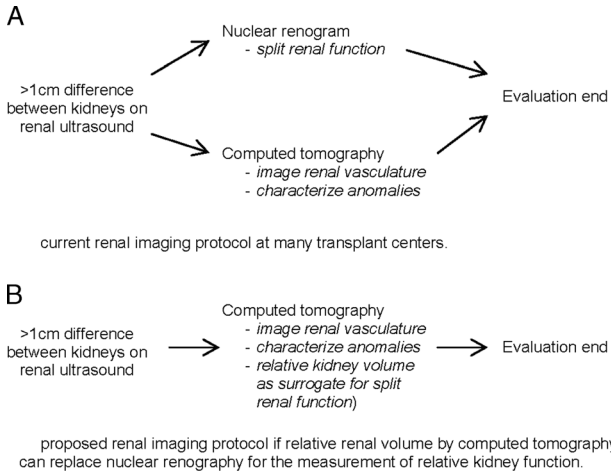

FIGURE 2. Improving the efficiency of the evaluation: The use of split renal volume measured by CT to replace split renal function measurement by nuclear renogram. A, The current renal imaging protocol at many transplant centers, where the CT scan and nuclear renogram are both performed for donor candidates. 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.

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).[27] 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%).[27]

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.[28] 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).[7,29,30] Confirmation using another test can be performed later, including a second eGFR from creatinine with/without cystatin-c (Cys), measured creatinine clearance, or mGFR.[7,31]

Fifty-six studies focused on measuring or estimating GFR in kidney donor candidates. Most studies compared the accuracy of various equations to estimate kidney function or predict postdonation kidney function. In contrast, 2 studies were identified that directly addressed the role of GFR in an efficient living donor evaluation.[32,33] In the presence of imprecision and biases among existing methods, Huang et al[32] developed an algorithm to determine whether mGFR could be unnecessary for some candidates based on high predictive value of eGFR, age, sex, and race for measuring kidney function. The rationale behind this algorithm is presented in Figure 3. The authors recommend that the second eGFR (the first confirmatory test, or "posttest probability 2" in Figure 3) be performed using both serum creatinine and Cys. However, 2 validation studies used a second eGFR based only on serum creatinine since Cys is not routinely available.[33,34] 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 m^2 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.[33] 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.[34] More work is needed to advance this prediction tool to clinical practice.

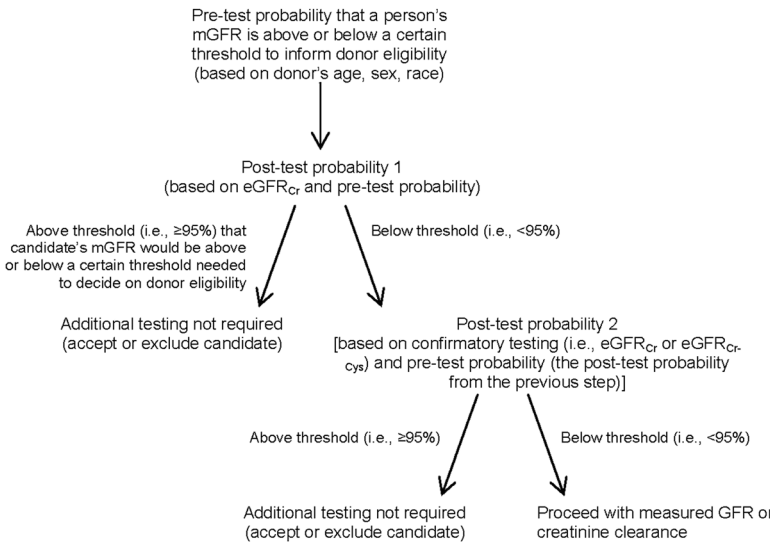

FIGURE 3. Algorithm to remove measured GFR by radionuclide for some donor candidates. Threshold is an arbitrary cut-point generated by the data to permit 100% sensitivity. Algorithm described by Huang et al[32] mGFR, measured GFR; $eGFR_{Cr}$, eGFR using serum creatinine; $eGFR_{Cr\text{-}Cys}$, eGFR serum creatinine and Cys. $eGFR_{Cr}$, eGFR estimated using serum creatinine only; $eGFR_{Cr\text{-}Cys}$, eGFR estimated using both serum creatinine and cystatin C.

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.[2,3,35-73] 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 (ie, 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 (ie, 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.[4] 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.[2]

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).[35,47,48,65,72] 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.[3] The results of this

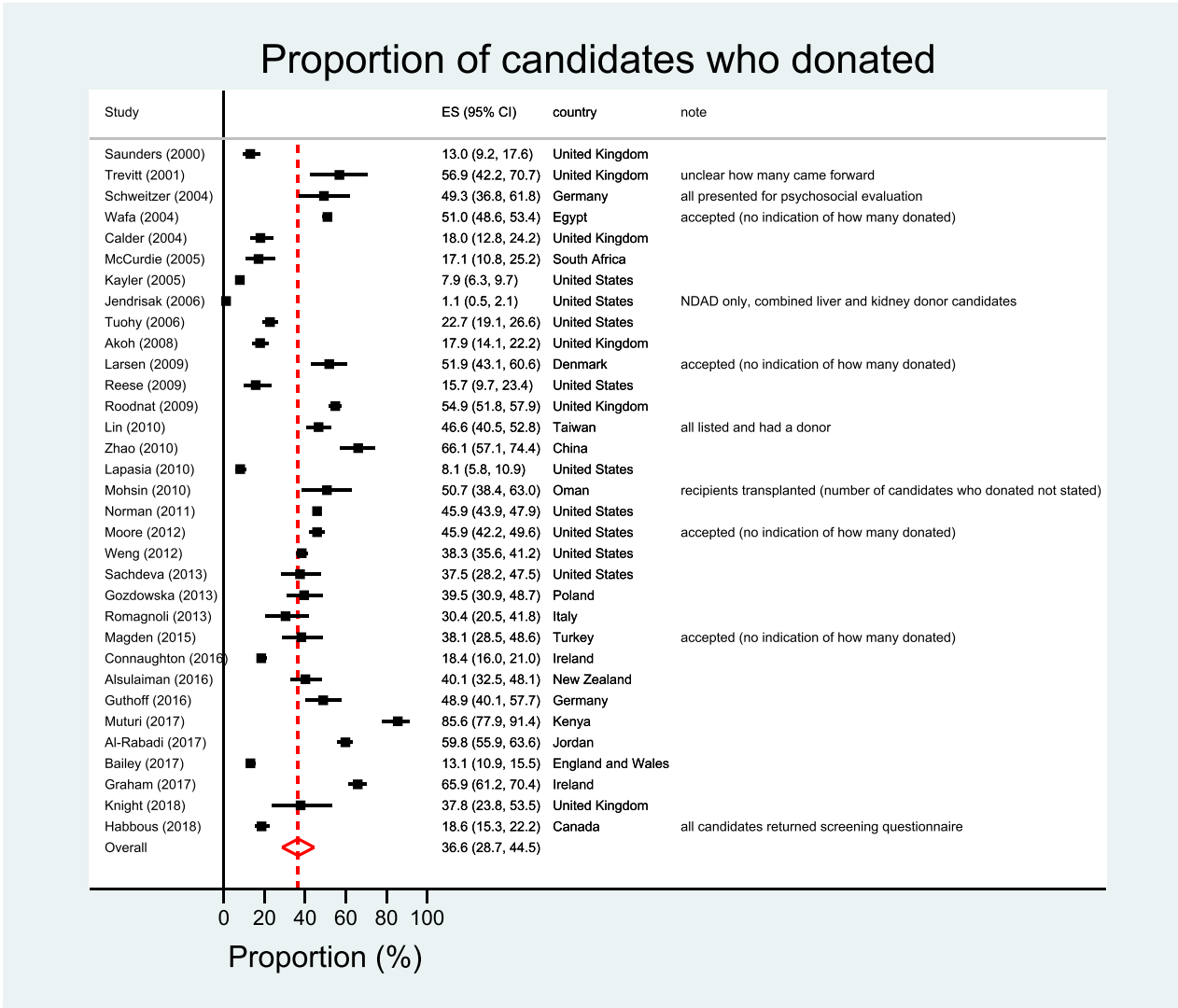

FIGURE 4. Forest plot with proportion of donor candidates who donated. Studies were pooled using a random effects model. There was significant variability (I^2 = 99.5%, P < 0.0001). ES, effect size (a proportion); CI, confidence interval.

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	Loss of potential donor candidates	
			Due to recipient illness or death	Due to deceased donor transplant
Saunders 2000[35]	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 2004[38]	University of Heidelberg Hospital, Germany	1997-2002	NR	3 (7%) (in subset of 45 candidates)
Calder 2004[40]	St. George's Hospital, UK	1997-2001	2 (1%) (death only)	13 (7%)
McCurdie 2005[41]	University of Cape Town and Groote Shuur Hospital, South Africa	January 2000 to March 2003	4 (3%)	25 (21%)
Kayler 2005[42]	Thomas Jefferson University Hospital, PA	January 2000 to April 2003	NR	64 (6%) (estimated)
Tuohy 2006[44]	Beth Israel Deaconess Medical Center, NY	2000-2003	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)	
Akoh 2008[46]	South West Transplant Centre, UK	January 2003 to February 2008	7 (2%) (death only)	34 (9%)
Larsen 2009[48]	Rigshospitalet, Denmark	January 2002 to December 2006	NR (recipient unfit for transplant in 5 (4%), but no indication of deaths or loss due to illness)	NR
Reese 2009[49]	Hospital of the University of Pennsylvania	December 2006 to March 2008	NR	20 (17%) (but unclear if all had a live donor)
Roodnat 2009[50]	Erasmus Medical Center, University Hospital Rotterdam	January 2000 to December 2007	59 (6%) recipient reasons including death, malignancy, cardiovascular disease (grouped)	15 (1%)
Lin 2010[51]	National Taiwan University Hospital, Taiwan	January 2005 to December 2008	5 (2%) [illness only, no indication of death]	5 (2%)
Lapasia 2010[53]	Stanford, CA	October 2007 to March 2009	28 (6%) (deaths)	not clear
[a]Sanner 2011[55]	Karolinska University Hospital, Stockholm Sweden	January 2004 to July 2008	6/135 recipients	N/A (recipients only)
Norman 2011[56]	University of Michigan Transplant Center	January 1995 to June 2006	14-20% of those excluded donors (death only)	23-28% of those excluded
Moore 2012[57]	Vanderbilt University Medical Center, TN, USA	January 2004 to July 1, 2009	35 (11%) (combined death, illness or incompatible)	NR
Weng 2012[59]	Saint Barnabas Medical Center in Livingston, N.J., USA	January 2000 to December 2005	56 (5%)	36 (3%)
Gozdowska 2013[62]	Poland	2007-2011	NR (assume zero deaths)	17 (14%)
Romagnoli 2013[63]	Catholic University, Rome, Italy	January 2005 to March 2012	5 (6%)	6 (8%)
Connaughton 2016[66]	Ireland	January 2000 to March 2014	33 (3%)	75 (8%)
Alsulaiman 2016[67]	Christchurch Hospital, New Zealand	January 2004 to June 2008	17 (10%) combined	
Muturi 2017[69]	Kenyatta National Hospital, Kenya	2010-2014	4/84 (5%) deaths (records available for only 84)	0 (no cadaveric donation in Kenya)
Al-Rabadi 2017[70]	King Hussein Medical Center, Jordan	January 2008 to June 2016	42 (7%)	NR
Bailey 2017[71]	Multiple centers in England and Wales	August 8, 2014 to January 31, 2016	32 (4%)	34 (4%)
Knight 2018[73]	Oxford Transplant Centre	January to March 2016	NR	2 (4%)
Habbous 2018 (unpublished data)	London Health Sciences Centre, London, Ontario Canada	January 2013 to December 2016	4 (1%) with a donor in the evaluation	13 (4%) with a donor in the evaluation

[a]These were studies primarily mapped to the living donor experience with the living donor evaluation.

NR, not reported; N/A, not applicable.

TABLE 3.

Summary of studies reporting on the duration of the living donor evaluation

References	Transplant center	Period	Evaluation time
Saunders 2000[35]	Leicester General Hospital, Leicester UK	1994-1998	Time until donation: mean, 9.3 mo (SD, 6.5 mo)
Trevitt 2001[37]	Barts and The London NHS Trust, London, UK	1997-1999	~4 mo from the time of initial crossmatch until donation (estimated from graph)
Calder 2004[40]	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 already)
[a]Williams 2007[45]	Edith Cowan University and Sir Charles Gairdner Hospital	Not reported	Most cases between 1 and 2 y, shortest was 6 mo
Ferriman 2008[47]	Royal Free Hospital, London UK	~2007-2008	116 d
Larsen 2009[48]	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
[a]Sanner 2011[55]	Karolinska University Hospital, Stockholm Sweden	January 2004 to July 2008	11.0 (SD, 8.6); range, 1-48 mo
Romagnoli 2013[63]	Catholic University, Rome, Italy	January 2005 to March 2012	Not reported (but acknowledged it is time consuming and resource intensive)
Weng 2016[65]	Saint Barnabas Medical Center in Livingston, N.J., USA	2007-2010	163 d (time from referral to donation, but unclear what referral means)
Alsulaiman 2016[67]	Christchurch Hospital, New Zealand	January 2004 to June 2008	3-9 mo
[a]Bailey 2016[3]	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 2017[70]	King Hussein Medical Center, Jordan	January 2008 to June 2016	Process designed to take a minimum of 2 mo, but not measured
Bailey 2017[71]	Multiple centers in England and Wales	August 8, 2014 to January 31, 2016	Median, 308 d for donors; median, 61 d for nondonors
Graham 2017[2]	Ireland	2010-2015	2-3 mo for work-up
Habbous 2018[72]	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 consults
Knight 2018[73]	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 (unpublished data)	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

[a] These were studies primarily mapped to the living donor experience with the living donor evaluation.

IQR, interquartile range (25th-75th percentile); SD, standard deviation.

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.[3,45,55,74-82] 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

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[a]
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 to make sure donation is as safe as 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 1-d 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

[a] The quality of reporting was subjective, based on the relative detail of information provided.

kidney was failing and she was determined not to have dialysis if she could avoid it."[3]

"I wish the process could be quicker, there are people dying and it shouldn't take so long to get checked out as a donor."[82]

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.[76] 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".[76] 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).[55,74] 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.[45,74]

Some donors reported being frustrated that a prolonged evaluation resulted in their intended recipient spending an unnecessarily longer time on dialysis.[55] 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).[76]

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).[2] 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

recipient. Most programs stated only evaluating 1 candidate at a time, but screened up to 10 candidates at the outset.

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.[4] According to the websites of living donor programs, many programs can conduct the evaluation in a single visit to the transplant center. However, whether they *can* do so and whether they *actually* do so is uncertain.

The necessity of measuring GFR in donor candidates with a radionuclide has been debated. By eliminating unnecessary tests, the burden on candidates, the cost to the healthcare system, and the timeliness of the evaluation process can all be improved. Nuclear renography is useful to measure the split (left vs right) renal function. However, CT volumetry can conceivably replace nuclear renography to measure the relative function.[27] Moreover, nuclear renography can be 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]

This scoping review has 2 main strengths. First, it highlights gaps in knowledge that require further research, including the potential implications of an inefficient evaluation process on health and cost outcomes. Second, it identifies areas for potential improvement that warrant additional testing. However, there are a few limitations that must be recognized. First, given the difficulty in performing a targeted search on this topic, we may have missed relevant studies that were not captured by the search terms chosen, or excluded some efficiency indicators. Future work is needed to establish important and actionable metrics for quality improvement. Second, we did not assess the quality of the included studies, as few studies had the primary objective of evaluating the efficiency of the living donor evaluation. Third, we were unable to estimate the true cost of an inefficient living donor evaluation on transplant activity. Although we found an upper limit of 21% lost opportunities for transplant, this represents an upper limit because we could never know if donor candidates: (1) would have completed their evaluation, (2) would have been deemed eligible for donation, and (3) would have donated. Finally, the cost of a more efficient living donor evaluation was unavailable. One study projected the cost savings associated with a shorter time until living donor kidney transplantation, but was based on hypothetical scenarios and only the costs due to recipient dialysis were modeled.[4] A second study used regression-based models to estimate the true cost of living kidney donation to the healthcare system for donors and potential candidates.[87] However, the cost of the living donor evaluation due to real-world efficiency improvements remains to be estimated.

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.[9] 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.

REFERENCES

1. Habbous S, McArthur E, Begen MA, et al. Initiating maintenance dialysis prior to living kidney donor transplantation when a donor candidate evaluation is well underway. *Transplantation*. 2018;102:e345–e353.
2. Graham JM, Courtney AE. The adoption of a One-Day Donor Assessment Model in a Living Kidney Donor Transplant Program: a quality improvement project. *Am J Kidney Dis*. 2017;71:209–215.
3. Bailey P, Edwards A, Courtney AE. Living kidney donation. *BMJ*. 2016; 354:i4746.
4. Habbous S, McArthur E, Sarma S, et al. Potential implications of a more timely living kidney donor evaluation. *Am J Transplant*. 2018;25: DOI:10.1111/ajt.14732.
5. Moore DR, Serur D, Rudow DL, et al. Living donor kidney transplantation: improving efficiencies in live kidney donor evaluation—recommendations from a consensus conference. *Clin J Am Soc Nephrol*. 2015;10: 1678–1686.
6. Getchell LE, McKenzie SQ, Sontrop JM, et al. Increasing the rate of living donor kidney transplantation in ontario: donor- and recipient-identified barriers and solutions. *Can J kidney Heal Dis*. 2017;4:2054358117698666.
7. Lentine KL, Kasiske BL, Levey AS, et al. KDIGO clinical practice guideline on the evaluation and care of living kidney donors. *Transplantation*. 2017; 101(8S Suppl 1):S1–S109.
8. Living Donor Kidney Transplantation. A UK Strategy. *NHS*. 2020; odt.nhs.uk/pdf/ldkt_2020_strategy.pdf. Accessed November 30, 2017.

9. Solberg LI, Mosser G, McDonald S. The three faces of performance measurement: improvement, accountability, and research. *Jt Comm J Qual Improv*. 1997;23:135–147.
10. The Joanna Briggs Institute. *The Joanna Briggs Institute Reviewers' Manual 2015: Methodology for JBI Scoping Reviews*. South Australia: The Joanna Briggs Institute; 2015.
11. Bia MJ, Ramos EL, Danovitch GM, et al. Evaluation of living renal donors. The current practice of US transplant centers. *Transplantation*. 1995;60: 322–327.
12. Mandelbrot DA, Pavlakis M, Danovitch GM, et al. The medical evaluation of living kidney donors: a survey of US transplant centers. *Am J Transplant*. 2007;7:2333–2343.
13. Rodrigue JR, Pavlakis M, Danovitch GM, et al. Evaluating living kidney donors: relationship types, psychosocial criteria, and consent processes at US transplant programs. *Am J Transplant*. 2007;7: 2326–2332.
14. Brar A, Jindal RM, Abbott KC, et al. Practice patterns in evaluation of living kidney donors in United Network for Organ Sharing-approved kidney transplant centers. *Am J Nephrol*. 2012;35:466–473.
15. Lumsdaine JA, Wigmore SJ, Forsythe JL. Live kidney donor assessment in the UK and Ireland. *Br J Surg*. 1999;86:877–881.
16. Arunachalam C, Garrues M, Biggins F, et al. Assessment of living kidney donors and adherence to national live donor guidelines in the UK. *Nephrol Dial Transplant*. 2013;28:1952–1960.
17. Gabolde M, Hervé C, Moulin AM. Evaluation, selection, and follow-up of live kidney donors: a review of current practice in French renal transplant centres. *Nephrol Dial Transplant*. 2001;16:2048–2052.
18. Lennerling A, Lovén C, Dor FJ, et al. Living organ donation practices in Europe—results from an online survey. *Transpl Int*. 2013;26:145–153.
19. Kocot A, Giessing M. Increasing the donor and recipient pool-expanded criteria in living kidney donors. *Transplant Proc*. 2013;45:1245–1247.
20. Tong A, Chapman JR, Wong G, et al. Screening and follow-up of living kidney donors: a systematic review of clinical practice guidelines. *Transplantation*. 2011;92:962–972.
21. Kazley AS, Hamidi B, Balliet W, et al. Social media use among living kidney donors and recipients: survey on current practice and potential. *J Med Internet Res*. 2016;18:e328.
22. Organ Procurement and Transplantation Network Policies. https://optn.transplant.hrsa.gov/media/1200/optn_policies.pdf. Accessed April 16, 2018.
23. Ghonge NP, Gadanayak S, Rajakumari V. MDCT evaluation of potential living renal donor, prior to laparoscopic donor nephrectomy: what the transplant surgeon wants to know? *Indian J Radiol Imaging*. 2014;24: 367–378.
24. Tonyali S, Erdem Y, Yilmaz SR, et al. Urologic disorders in living renal donors and outcomes of their recipients. *Transplant Proc*. 2015;47:1306–1308.
25. Nguyen KN, Patel AM, Weng FL. Ionizing radiation exposure among kidney transplant recipients due to medical imaging during the pretransplant evaluation. *Clin J Am Soc Nephrol*. 2013;8:833–839.
26. Bazeed MF, Fooshang FF, Ahmed MA. Low-radiation-dose dual-phase MDCT protocol with split contrast media dose and time optimization: protocol design for renal donors evaluation. *Acta Radiol*. 2011;52:927–932.
27. Habbous S, Garcia-Ochoa C, Brahm G, et al. Can split renal volume by computed tomography replace nuclear split renal function in living kidney donor evaluations? *A systematic review and meta analysis*. 2018; (under review).
28. Soveri I, Berg UB, Björk J, et al. Measuring GFR: a systematic review. *Am J Kidney Dis*. 2014;64:411–424.
29. Levey AS, Stevens LA, Schmid CH, et al. A new equation to estimate glomerular filtration rate. *Ann Intern Med*. 2009;150:604–612.
30. Lujan PR, Chiurchiu C, Douthat W, et al. CKD-EPI instead of MDRD for candidates to kidney donation. *Transplantation*. 2012;94:637–641.
31. Levey AS, Inker LA. GFR evaluation in living kidney donor candidates. *J Am Soc Nephrol*. 2017;28:1062–1071.
32. Huang N, Foster MC, Lentine KL, et al. Estimated GFR for living kidney donor evaluation. *Am J Transplant*. 2016;16:171–180.
33. Gaillard F, Flamant M, Lemoine S, et al. Estimated or measured GFR in living kidney donors work-up? *Am J Transplant*. 2016;16:3024–3032.
34. Habbous S, Garg AX. The role of the glomerular filtration rate on the selection and evaluation of living kidney donor candidates: validation of risk prediction tools. 2018:(unpublished).
35. Saunders RN, Elwell R, Murphy GJ, et al. Workload generated by a living donor programme for renal transplantation. *Nephrol Dial Transplant*. 2000;15:1667–1672.
36. Naqvi SA. Donor selection in a living related renal transplant program—an analysis of donor exclusion. *Transplant Proc*. 2000;32:120.
37. Trevitt R, Whittaker C, Ball EA, et al. Drop-out rate during living donor selection. *EDTNA ERCA J*. 2001;27:88–91.
38. Schweitzer J, Seidel-Wiesel M, Verres R. Donor-recipient interaction: the Heidelberg model of evaluation and consultation. *Nephrol Dial Transplant*. 2004;(19 Suppl 4):iv75–iv78.
39. Wafa EW, Donia AF, Ali-El-Dein B, et al. Evaluation and selection of potential live kidney donors. *J Urol*. 2004;171:1424–1427.
40. Calder FR, Chang RW. Panning for gold: screening for potential live kidney donors. *Nephrol Dial Transplant*. 2004;19:1276–1280.
41. McCurdie FJ, Pascoe MD, Broomberg CJ, et al. Outcome of assessment of potential donors for live donor kidney transplants. *Transplant Proc*. 2005;37:605–606.
42. Kayler LK, Armenti VT, Dafoe DC, et al. Patterns of volunteerism, testing, and exclusion among potential living kidney donors. *Health Care Women Int*. 2005;26:285–294.
43. Jendrisak MD, Hong B, Shenoy S, et al. Altruistic living donors: evaluation for nondirected kidney or liver donation. *Am J Transplant*. 2006;6: 115–120.
44. Tuohy KA, Johnson S, Khwaja K, et al. Gender disparities in the live kidney donor evaluation process. *Transplantation*. 2006;82:1402–1407.
45. Williams AM, Broderick D, O'Driscoll C, et al. Development of a donor driven assessment protocol in Western Australia based on experiences of living renal donors. *Nephrol Nurs J*. 2007;34:66–70.
46. Akoh JA, Stacey S. Assessment of potential living kidney donors: options for increasing donation. *Dial Transplant*. 2008;37:352–359.
47. Ferriman A. Becoming a live kidney donor. *BMJ*. 2008;336:1374–1376.
48. Larsen J, Sørensen SS, Feldt-Rasmussen B. Can value for money be improved by changing the sequence of our donor work-up in the living kidney donor programme? *Transpl Int*. 2009;22:814–820.
49. Reese PP, Shea JA, Bloom RD, et al. Predictors of having a potential live donor: a prospective cohort study of kidney transplant candidates. *Am J Transplant*. 2009;9:2792–2799.
50. Roodnat JI, Kal-van Gestel JA, Zuidema W, et al. Successful expansion of the living donor pool by alternative living donation programs. *Am J Transplant*. 2009;9:2150–2156.
51. Lin MH, Tasi MK, Lin HY, et al. Analysis of the factors influencing living kidney donation: the experience in National Taiwan University Hospital. *Transplant Proc*. 2010;42:689–691.
52. Zhao W-Y, Zhang L, Han S, et al. Evaluation of living related kidney donors in China: policies and practices in a transplant center. *Clin Transplant*. 2010;24:E158–E162.
53. Lapasia JB, Kong S, Busque S, et al. Living donor evaluation and exclusion: the Stanford experience. *Clin Transplant*. 2011;25:697–704.
54. Mohsin NB, Metry A. Reasons of preclusion of living-related donor renal transplants in Oman. *Exp Clin Transplant*. 2010;8:303–306.
55. Sanner MA, Lagging E, Tibell A. The kidney recipient's path to transplantation: a comparison between living and deceased kidney donor recipients in Stockholm, Sweden. *Nephrol Dial Transplant*. 2011;26: 1053–1057.
56. Norman SP, Song PX, Hu Y, et al. Transition from donor candidates to live kidney donors: the impact of race and undiagnosed medical disease states. *Clin Transplant*. 2011;25:136–145.
57. Moore DR, Feurer ID, Zaydfudim V, et al. Evaluation of living kidney donors: variables that affect donation. *Prog Transplant*. 2012;22:385–392.
58. Pavlakis M, Hanto DW. Clinical pathways in transplantation: a review and examples from Beth Israel Deaconess Medical Center. *Clin Transplant*. 2012;26:382–386.
59. Weng FL, Dhillon N, Lin Y, et al. Racial differences in outcomes of the evaluation of potential live kidney donors: a retrospective cohort study. *Am J Nephrol*. 2012;35:409–415.
60. Sachdeva M, Sunday S, Israel E, et al. Obesity as a barrier to living kidney donation: a center-based analysis. *Clin Transplant*. 2013;27:882–887.
61. Perlis N, Connelly M, D'A Honey JR, et al. Evaluating potential live-renal donors: Causes for rejection, deferral and planned procedure type, a single-centre experience. *Can Urol Assoc J*. 2013;7:41–45.
62. Gozdowska J, Jankowski K, Bieniasz M, et al. Characteristics of potential living kidney donors and recipients: donor disqualification reasons—experience of a Polish center. *Transplant Proc*. 2013;45: 1347–1350.
63. Romagnoli J, Salerno MP, Calia R, et al. Expanding the living donor pool, "1st Act": analysis of the causes of exclusion of potential kidney donors. *Transplant Proc*. 2013;45:2632–2634.
64. Mağden K, Ucar FB, Velioğlu A, et al. Donor contraindications to living kidney donation: a single-center experience. *Transplant Proc*. 2015;47: 1299–1301.
65. Weng FL, Lee DC, Dhillon N, et al. Characteristics and evaluation of geographically distant vs geographically nearby living kidney donors. *Transplant Proc*. 2016;48:1934–1939.

66. Connaughton DM, Harmon G, Cooney A, et al. The Irish living kidney donor program—why potential donors do not proceed to live kidney donation? *Clin Transplant*. 2016;30:17–25.
67. Alsulaiman T, Mark S, Armstrong S, et al. Assessment of potential live kidney donors and computed tomographic renal angiograms at Christchurch Hospital. 2016;2016:4924320.
68. Guthoff M, Nadalin S, Fritsche A, et al. The medically complex living kidney donor: glucose metabolism as principal cause of donor declination. *Ann Transplant*. 2016;21:39–45.
69. Muturi A, Kotecha V, Kanyi S. A retrospective study to assess the evaluation of living related kidney donors and their outcomes following nephrectomy at Kenyatta National Hospital. *BMC Nephrol*. 2017;18:171.
70. Al-Rabadi K, Almardini RI, Hajeer M, et al. Living kidney donor cancellation at King Hussein Medical Center. *Exp Clin Transplant*. 2017;15(Suppl 1): 116–120.
71. Bailey PK, Tomson CRV, MacNeill S, et al. A multicenter cohort study of potential living kidney donors provides predictors of living kidney donation and non-donation. *Kidney Int*. 2017;92:1249–1260.
72. Habbous S, Arnold J, Begen MA, et al. Duration of Living Kidney Transplant Donor Evaluations: Findings From 2 Multicenter Cohort Studies. *Am J Kidney Dis*. 2018;S0272-6386:30126–30124. DOI:10.1053/j.ajkd.2018.01.036.
73. Knight SR, Cao KN, South M, et al. Development of a clinical decision support system for living kidney donor assessment based on national guidelines. *Transplantation*. 2018; Accepted for publication.
74. Sanner MA. The donation process of living kidney donors. *Nephrol Dial Transplant*. 2005;20:1707–1713.
75. Agerskov H, Ludvigsen MS, Bistrup C, et al. Living kidney donors' experiences while undergoing evaluation for donation: a qualitative study. *J Clin Nurs*. 2015;24:2258–2267.
76. Mazaris EM, Crane JS, Warrens AN, et al. Live donor kidney transplantation: attitudes of patients and health care professionals concerning the pre-surgical pathway and post-surgical follow-up. *Int Urol Nephrol*. 2012;44:157–165.
77. Shaw RM, Bell LJ. "Because you can"t live on love': living kidney donors' perspectives on compensation and payment for organ donation. *Health Expect*. 2015;18:3201–3212.
78. Taylor LA, McMullen P. Living kidney organ donation: experiences of spousal support of donors. *J Clin Nurs*. 2008;17:232–241.
79. Walton-Moss B, Boulware LE, Cooper M, et al. Prospective pilot study of living kidney donor decision-making and outcomes. *Clin Transplant*. 2007;21:86–93.
80. Cabrer C, Oppenhaimer F, Manyalich M, et al. The living kidney donation process: the donor perspective. *Transplant Proc*. 2003;35:1631–1632.
81. Li T, Dokus MK, Kelly KN, et al. Survey of living organ donors' experience and directions for process improvement. *Prog Transplant*. 2017;27: 232–239.
82. Dorflinger LM, Kulkarni S, Thiessen C, et al. Assessing living donor priorities through nominal group technique. *Prog Transplant*. 2018;28:29–35.
83. Patankar K, Low RS-T, Blakeway D, et al. Comparison of computer tomographic volumetry versus nuclear split renal function to determine residual renal function after living kidney donation. *Acta Radiol*. 2014;55:753–760.
84. Gaillard F, Pavlov P, Tissier A-M, et al. Use of computed tomography assessed kidney length to predict split renal GFR in living kidney donors. *Eur Radiol*. 2017;27:651–659.
85. Herts BR, Sharma N, Lieber M, et al. Estimating glomerular filtration rate in kidney donors: a model constructed with renal volume measurements from donor CT scans. *Radiology*. 2009;252:109–116.
86. Choi DK, Choi SM, Park BH, et al. Measurement of renal function in a kidney donor: a comparison of creatinine-based and volume-based GFRs. *Eur Radiol*. 2015;25:3143–3150.
87. Habbous S, Sarma S, Barnieh L, et al. Health care costs for the evaluation, surgery, and follow-up care of living kidney donors. *Transplantation*. 2018; 19: DOI:10.1097/TP.0000000000002222.