Feature

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Application of the 2017 KDIGO Guideline for the Evaluation and Care of Living Kidney Donors to Clinical Practice

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Abstract

The Kidney Disease: Improving Global Outcomes (KDIGO) 2017 "Clinical Practice Guideline on the Evaluation and Care of Living Kidney Donors" was developed to assist medical professionals who evaluate living kidney donor candidates and provide care before, during, and after donation. This guideline Work Group concluded that a comprehensive approach to donor candidate risk assessment should replace eligibility decisions on the basis of assessments of single risk factors in isolation. To address all issues important to living donors in a pragmatic and comprehensive guideline, many of the guideline recommendations were on the basis of expert consensus opinion even when no direct evidence was available. To advance available evidence, original data analyses were also undertaken to produce a "proof-of-concept" risk projection model for kidney failure. This was done to illustrate how the community can advance a new quantitative framework of risk that considers each candidate's profile of demographic and health characteristics. A public review by stakeholders and subject matter experts as well as industry and professional organizations informed the final formulation of the guideline. This review highlights the guideline framework, key concepts, and recommendations, and uses five patient scenarios and 12 guideline statements to illustrate how the guideline can be applied to support living donor evaluation and care in clinical practice.

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Introduction

For patients with kidney failure (approximately 5 million worldwide), transplantation offers a longer, better quality life at a fraction of the cost of dialysis (1,2). Unfortunately, the number of patients in need of a transplant continues to rise, and there are too few deceased donors to meet the demand. The alternative, a living donor transplant, offers many advantages, including superior graft and patient survival, shorter wait times, and lower health care costs (3,4). We estimate that over half a million people worldwide have donated a kidney, with 260,000 candidates now undergoing an evaluation each year (resulting in 30,000 persons donating a kidney each year) (5,6). Concern for the health and welfare of the living donor is paramount, and a lack of evidence and inconsistent guidance from expert groups underscore a critical need to strengthen the rigor, safety, and defensibility of donor selection and follow-up (7). In response, Kidney Disease: Improving Global Outcomes (KDIGO), a global nonprofit organization dedicated to developing and implementing evidence-based clinical practice guidelines in kidney disease, convened both an international Work Group and Evidence Review Team (8). The organization's first "Clinical Practice Guideline on the Evaluation and Care of Living Kidney Donors," published in 2017, helps inform donor candidate evaluation and care before, during, and after donation, with information organized across 19 chapters (8).

The guideline emphasizes shared decision making among donor candidates and providers. In this synopsis, we review the framework and key concepts advanced through the guideline related to assessing donor risk. We also provide a checklist of items for the evaluation, care, and follow-up of living kidney donors (Table 1). Finally, we use five patient scenarios to illustrate the use of consensus-based guideline recommendations in clinical care, which includes topics that warrant future research.

A Framework to Quantify Postdonation Risk and Its Application to Decision Making

The practice of living kidney donation occurs in a complex medical, ethical, and social context, which the Work Group considered in developing its recommendations. A key consideration is that donation may increase the risk to donors for some adverse outcomes compared with if they had not donated a kidney. A poor outcome can negatively affect the donor, the recipient, and public opinions about donation. Details on different perspectives of risk are described elsewhere (9,10), and the approach used by KDIGO to compile relevant evidence is presented in the Supplemental Appendix.

Table 1. Checklist for the evaluation, care, and follow-up of living kidney donors

Chapter	Topic	Checklist Item
1	Evaluation goals, decision-making framework, roles and responsibilities	✓ Provide the donor candidate individualized estimates of short- and long-term risks ✓ Evaluate medical risks with respect to predetermined transplant program acceptance threshold
2	Informed consent	✓ Obtain consent from the donor candidate for evaluation and donation
3	Compatibility testing, incompatible transplantation, paired donation	✓ Determine ABO blood type and human leukocyte antigen compatibility ✓ Inform incompatible donors about exchange programs and incompatible living donor transplantation options
4	Preoperative evaluation and management	✓ Conduct a preoperative assessment as per local guidelines to minimize risk
5	Predonation kidney function	✓ Estimate GFR using serum creatinine–based estimating equations and confirm with one or more of the following according to availability: measured GFR using an exogenous filtration marker, measured creatinine clearance, eGFR from the combination of serum creatinine and cystatin C, or repeat eGFR with serum creatinine
6	Predonation albuminuria	✓ Assess albuminuria using albumin-to-creatinine ratio in an untimed urine specimen and confirm albuminuria with albumin excretion rate in a timed urine specimen or by repeating albumin-to-creatinine ratio if albumin excretion rate cannot be obtained
7	Predonation hematuria	✓ Perform testing to identify cause of microscopic hematuria that is not reversible
8	Kidney stones	✓ Assess history and kidney imaging for nephrolithiasis
9	Hyperuricemia, gout, and mineral and bone disease	✓ Assess history of gout
10	Predonation BP	✓ Measure BP prior to donation on at least two occasions
11	Predonation metabolic and lifestyle factors	✓ Assess metabolic and lifestyle risk for CKD and/or cardiovascular disease by obtaining the following prior to donation: ● Body mass index measurement ● History of diabetes mellitus and gestational diabetes and family history of diabetes ● Fasting blood glucose and/or glycated hemoglobin (hemoglobin A_{1c}) ● Fasting lipid profile, including total cholesterol, LDL-cholesterol, HDL-cholesterol, and triglycerides ● Present and past use of tobacco products
12	Preventing infection transmission	✓ Screen for the following infections before donation: ● HIV ● Hepatitis B virus ● Hepatitis C virus ● Cytomegalovirus ● Epstein–Barr virus ● *Treponema pallidum* (syphilis) ● Urinary tract infection ● Other potential infections on the basis of geography and environmental exposures
13	Cancer screening	✓ Perform cancer screening as per local guidelines
14	Evaluation of genetic kidney disease	✓ Assess family history of kidney disease
15	Pregnancy	✓ Confirm a negative quantitative human chorionic gonadotropin pregnancy test immediately before donation in women of childbearing potential
16	Psychosocial evaluation	✓ Perform face-to-face psychosocial evaluation, education, and planning session with one or more trained, experienced health professionals
17	Acceptable surgical approaches for donor nephrectomy	✓ Select optimal surgical technique by an experienced surgeon
18	Ethical, legal, and policy considerations	✓ Respect donor autonomy during all phases of evaluation and donation
19	Postdonation follow-up care	✓ Perform annual postdonation follow-up care that includes the following: ● BP measurement ● Body mass index measurement ● Serum creatinine measurement with GFR estimation ● Albuminuria measurement ● Review and promotion of healthy lifestyle practices, including exercise, diet, and abstinence from tobacco ● Review and support of psychologic health and well-being

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A central goal of the 2017 KDIGO guideline is to advance a framework to evaluate and select donor candidates on the basis of the predicted long-term risk for adverse outcomes from simultaneous consideration of predonation demographic and health characteristics. An example of a tool that enables such projected risk estimation is presented in Table 2. This tool focuses on the postdonation outcome of permanent kidney failure treated with dialysis or transplantation

Table 2. Example of a projection tool to estimate kidney failure risk in donor candidates (32) and a method for communicating such risks (9,33)

Suggested Steps and Considerations
(*1*) An online tool (http://www.transplantmodels.com/esrdrisk/) estimates the projected lifetime risk of permanent kidney failure treated by dialysis or transplantation in the absence of donation according to baseline demographic and clinical characteristics included in the online tool
(*2*) This projected predonation risk can be multiplied by the best available estimate for donation-attributable risk to obtain the projected postdonation risk; for example, Grams *et al.* (34) report a relative risk of 3.5–5.3 for 15-yr kidney failure risk according to sex and race
(*3*) The projected risk estimate can be compared with the program's postdonation threshold of acceptable risk
(*4*) Use the tool cautiously when there is concern that the individual has risk factors not captured in the tool (*e.g.*, familial or genetic risk) and for younger candidates
(*5*) When communicating kidney failure risk to donor candidates:
Use plain language to make written and verbal materials more understandable
Present data using absolute risks
Present information in pictographs if graphs are included
Present data using frequencies
Use an incremental risk format to highlight how postdonation risks change from preexisting baseline levels
Be aware that the order in which risks and benefits are presented can affect risk perceptions
Consider using summary tables that include all risks and benefits associated with donation
Consider presenting only the information that is most critical to the patients' decision making, even at the expense of completeness
Repeatedly draw patients' attention to the time interval over which a risk occurs
A model was developed to project the estimated 15-year and lifetime risk of kidney failure in the absence of donation ("baseline risk") on the basis of simultaneous consideration of each candidate's profile of demographic and health characteristics. In brief, cohort studies on kidney failure risk are only available for approximately 150,000 living donors, but they are available for millions of healthy persons in the general population. To leverage the information available in general population cohorts, the Kidney Disease: Improving Global Outcomes Clinical Practice Guideline on the Evaluation and Care of Living Kidney Donors Work Group collaborated with the CKD Prognosis Consortium to model the long-term risk of kidney failure in the absence of donation on the basis of ten candidate predonation demographic and health characteristics. The multistep modeling process was complex and independently published (34), and the risk projection tool is available online at http://www.transplantmodels.com/esrdrisk/. For clinical application, estimates provided for the predicted incidence of kidney failure in the absence of donation are then multiplied by the donation-attributable relative risk of kidney failure (which in the analysis was 3.5–5.3 according to sex and race).

because it is a central outcome of a donor candidate's long-term risk that may at least in part result from donation. Decision making is then guided by comparing the donor candidate's projected risk of an adverse outcome with the transplant program's acceptable risk threshold, where the latter is defined as the upper limit of acceptable risk established by a program for donor candidate selection. Under such a framework, when a candidate's estimated risk is above the acceptable threshold, the transplant program is justified in declining the candidate and can ground its decision in a quantitative framework. When a donor candidate's estimated risk is below the acceptable risk threshold, the transplant program should accept a donor candidate, and it should be the candidate's decision whether to proceed with living kidney donation after understanding the risks (Figure 1).

1.10. All donor candidates should be evaluated using the same criteria, regardless of whether donation is directed toward a designated recipient.

1.11. Each transplant program should establish policies describing medical criteria that are acceptable for donation, addressing when possible, numeric thresholds for short-term and long-term postdonation risks above which the transplant program will not proceed with donation. Risks should be expressed as absolute rather than relative risks.

This approach differs from prior living kidney donor guidelines that describe postdonation risk in relation to single predonation characteristics assessed in isolation. Prior guidelines also differ on the recommended specific thresholds for a characteristic that should be used to accept or decline living kidney donor candidates (7). For example, historically, most programs excluded donors with a body mass index exceeding a predetermined threshold, usually between 30 and 35 kg/m^2, without considering additional donor characteristics or risk factors. By comparison, the KDIGO guideline endorses individualizing the decision to approve donation in obese candidates on the basis of their predicted long-term risk in relation to the transplant program's acceptance threshold.

The example risk tool in Table 2 is a proof of concept, and the Work Group strongly endorses continued efforts to improve the precision and generalizability of predonation risk estimation, including consideration of additional factors such as genetic and familial traits, and to incorporate tailored prediction of the risk effect of donation (11). Since publication of the guideline, investigators have continued to make important contributions to this estimation (11,12).

The guideline also provides recommendations on the framework for decision making as well as the roles and responsibilities of various stakeholders. If a donor candidate is not accepted, the transplant program should explain the reason for nonacceptance to the donor candidate. The program should formulate a plan for any needed care and support for a declined donor candidate. Such support may include alternative ways of helping the intended recipient and the possibility of referral to another program for a second opinion if the donor candidate does not accept the noneligibility decision. Finally, transplant programs should conduct as efficient a donor evaluation as possible, meeting

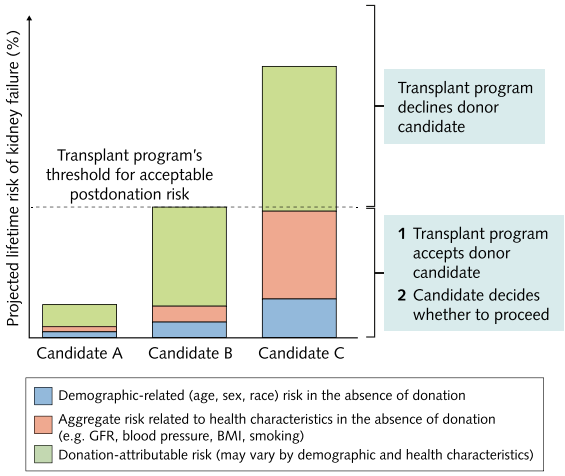

Figure 1. | The Kidney Disease: Improving Global Outcomes framework to accept or decline donor candidates on the basis of a transplant program's threshold of acceptable projected lifetime risk of kidney failure, quantified as the aggregate of risk related to demographic and health profile and donation-attributable risks. The decision by a transplant program to accept or decline a donor candidate is grounded on whether an individual's estimated projected postdonation lifetime risk is above or below the threshold set (dotted line) by the transplant program. Lifetime risk is composed of estimated risk in the absence of donation (*i.e.*, related to donor demographic and health characteristics as denoted in blue and pink, respectively) and estimated risk attributable to donation (green). The threshold may vary across transplant programs, but the same threshold should apply to all donor candidates at each program. For example, candidate A would be acceptable because the estimated projected postdonation risk is far below the threshold. Candidate B could be accepted with caution because the estimated projected postdonation risk is close to the threshold, and candidate C would be unacceptable because the estimated postdonation projected risk is far above the threshold. BMI, body mass index. Reprinted from ref. 8, with permission.

the needs of donor candidates, intended recipients, and transplant programs.

Applying Guideline Recommendations in Clinical Care: Patient Scenario Examples

We use five patient scenario examples to demonstrate how care can be informed by the guideline recommendations (Figure 2). These examples illustrate common scenarios, including consideration of multiple donor candidates for a given recipient and how a candidate's age, race, and genetic factors inform risk (scenario 1); evaluation of a donor candidate with a family history of autosomal dominant polycystic kidney disease (ADPKD; scenario 2); evaluation of a donor candidate with microscopic hematuria (scenario 3); and support for long-term donor health and well-being (scenario 4), including a donor candidate with an interest in future pregnancy (scenario 5). In many cases, it is difficult (and sometimes impossible) to formulate an issue into an answerable focused question that, in turn, can be supported by a rigorous evidence base. In such cases, information in the guideline provides context on how an experienced group of peers thinks about a clinical situation.

Patient Scenario 1. Black Donor Candidates, Predonation Kidney Function Evaluation, and *APOL1* Genotyping

Guideline Chapter 5 discusses the assessment of predonation kidney function (as GFR) and the use of GFR in risk estimation in combination with age, sex, and race (Figure 3). After adjustment for age and level of GFR, black persons have a higher projected risk of kidney failure than whites, and men have a higher projected risk than women. For each sex and race combination, older age is generally associated with a higher 15-year projected risk of kidney failure but always associated with lower projected lifetime risk, and for each age, a higher predonation GFR is associated with lower projected risk (Supplemental Figure 1). Provided in this chapter is the rationale for why donor kidney function should be expressed as GFR and not as serum creatinine concentration, why GFR should be expressed in milliliters per minute per 1.73 m^2 rather than milliliters per minute, how to assess GFR, and the rationale for the use of predonation GFR in combination with other characteristics for risk prediction rather than a comparison with a single GFR threshold value for donor acceptability.

> 5.6. GFR of 90 ml/min per 1.73 m^2 or greater should be considered an acceptable level of kidney function for donation.
> 5.7. The decision to approve donor candidates with GFR 60–89 ml/min per 1.73 m^2 should be individualized on the basis of demographic and health profile in relation to the transplant program's acceptable risk threshold.
> 5.8. Donor candidates with GFR<60 ml/min per 1.73 m^2 should not donate.

For example, a transplant program may decide to approve donation when the projected lifetime risk of kidney failure after donation is <5%. In the case of scenario 1, the example risk tool featured in the guideline would suggest that the intended recipient's husband as a donor candidate would have a 0.35% 15-year projected risk of kidney failure in the absence of donation and a 2.92% lifetime risk. Corresponding numbers for the recipient's mother are 0.28% and 0.33%, respectively. Assuming that donation increases the relative risk of kidney failure by fourfold, the postdonation projected lifetime risk of kidney failure might be 11.7% for the husband and 1.3% for the mother, with some uncertainty in long-term outcomes on the basis of existing literature. This would suggest that the mother but not the husband would be an acceptable donor at this time. This approach also has the potential benefit of the husband becoming a donor in the future if the transplant from the mother fails.

Chapter 14 includes recommendations related to *APO* L1 (*APOL1*) genotyping, where *APOL1* genotyping may be offered to donor candidates with sub-Saharan African ancestors. Donor candidates can be informed that having two *APOL1* allele risk variants increases the lifetime risk of kidney failure but that the precise kidney failure risk for an affected individual after donation cannot currently be quantified. The guideline also emphasizes the need for ongoing research to define the role of *APOL1* genotyping in the living donor candidate evaluation, a topic being addressed in new initiatives like the National

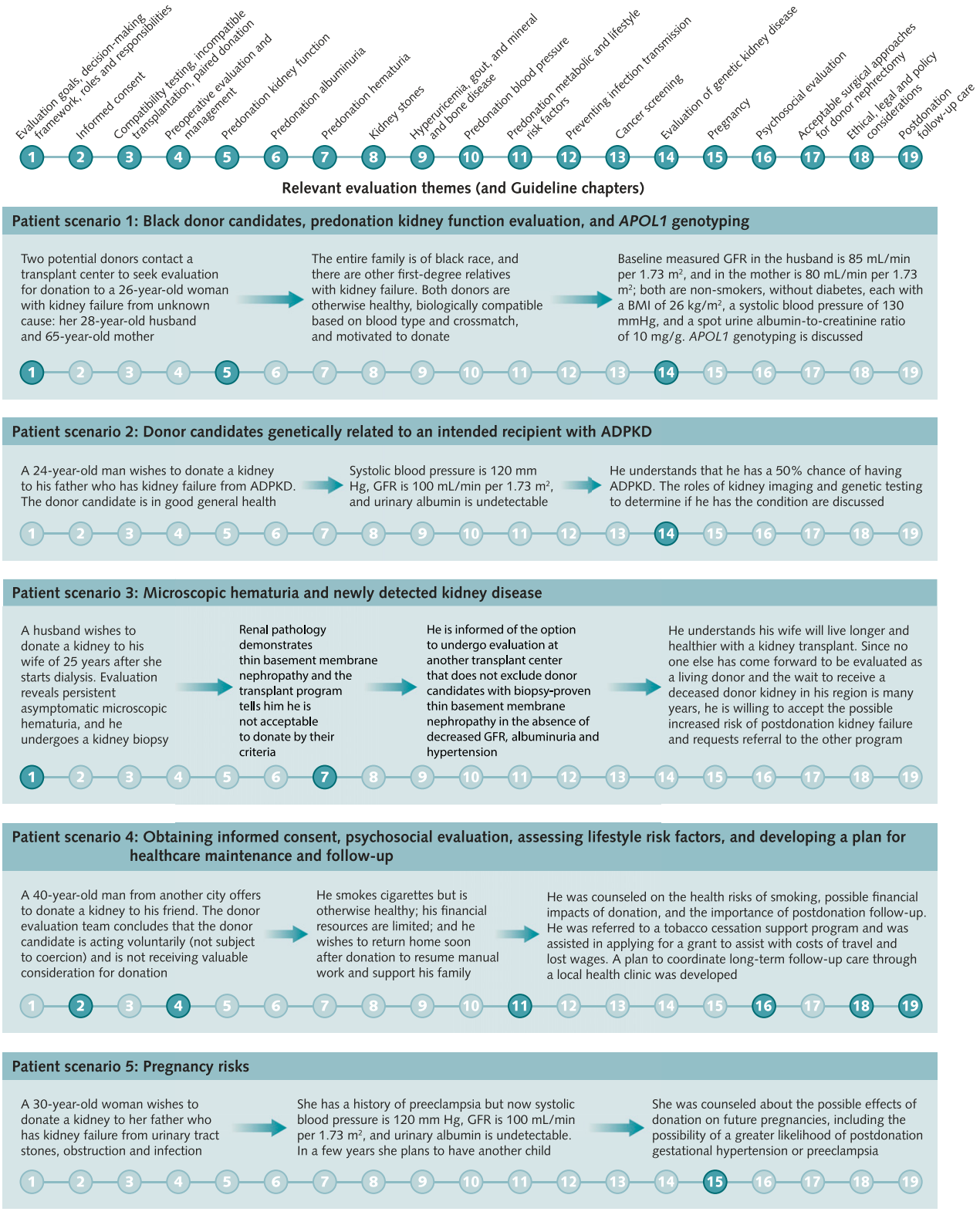

Figure 2. | Five patient scenarios illustrate application of the KDIGO evaluation framework and guideline recommendations. These case scenarios illustrate use of a sample of recommendations from 19 guideline chapters. ADPKD, autosomal dominant polycystic kidney disease; BMI, body mass index.

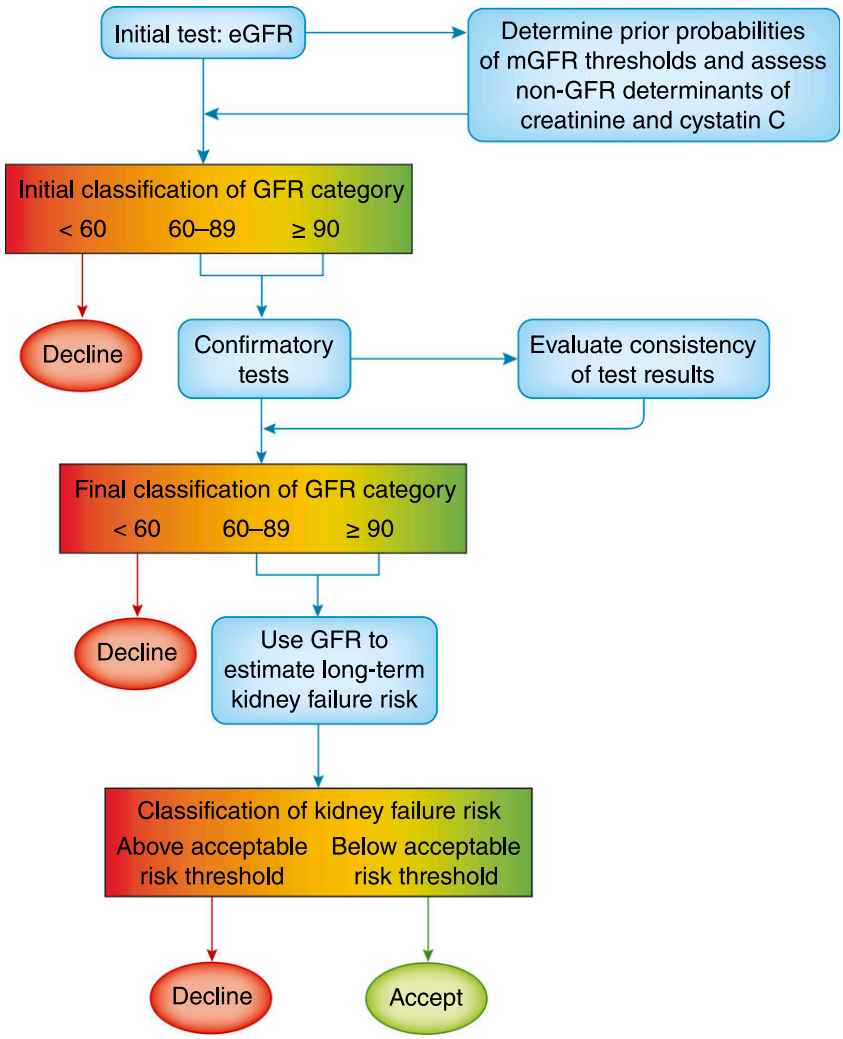

Figure 3. | **Following a stepwise approach in assessment of GFR and application to donor candidate selection facilitates efficiency.** eGFRcr is the initial test in most donor candidates. eGFRcys may be the preferred initial test for candidates with variations in non-GFR determinants of eGFRcr: for example, variation in muscle mass or diet. Interpretation of eGFR should include consideration of the probability that measured GFR (mGFR) is above or below thresholds for decision making (http://ckdepi.org/equations/donor-candidate-gfr-calculator). Very high likelihood that mGFR is <60 ml/min per 1.73 m^2 is justification to decline without further evaluation. Confirmatory tests are as follows: mGFR or mCrCl is required in the United States. Elsewhere, eGFRcr-cys can be acceptable if mGFR or mCrCl is not available and if eGFRcys was not used as the initial test. Repeat eGFRcr can be acceptable if none of the others confirmatory tests are available but is not preferred. Inconsistent test results suggest inaccuracy of one or more tests, which should be discarded or repeated. To use GFR to estimate long-term kidney failure risk, long-term estimated projected risk of kidney failure is compared with the transplant program's threshold for acceptable risk. Long-term risk in the absence of donation can be estimated from demographic and health characteristics, including GFR (http://www.transplantmodels.com/esrdrisk). Additional risk attributable to donation is currently thought to be approximately 3.5–5.3 times higher than risk in the absence of donation, but there is substantial uncertainty, especially in younger donor candidates, and we suggest caution in decision making. Postdonation kidney failure risk above the program's acceptance threshold is justification to decline the candidate. Candidates with risk below the threshold are acceptable to the program and they make their own decision whether to proceed with donation. Colors are blended together to signify the thresholds for decision making that are imprecise. Modified from ref. 30, with permission. eGFRcr, eGFR using serum creatinine; eGFRcys, eGFR using serum cystatin C; eGFRcr-cys, eGFR using both serum creatinine and serum cystatin C; mCrCl, measured creatinine clearance; mGFR, measured glomerular filtration rate.

Institutes of Health–sponsored *APOL1*-Long Term Outcomes study and the Living Donor Extended Time Outcomes study (13).

Patient Scenario 2. Donor Candidates Genetically Related to an Intended Recipient with ADPKD

Guideline Chapter 14 outlines considerations related to genetic kidney disease, including ADPKD. The guideline recommends that, when an intended recipient is genetically related to the donor candidate, efforts should be made to determine the cause of the intended recipient's kidney failure, whether the cause is genetic, and whether the disease can cause kidney failure.

14.3. Donor candidates found to have a genetic kidney disease that can cause kidney failure should not donate.

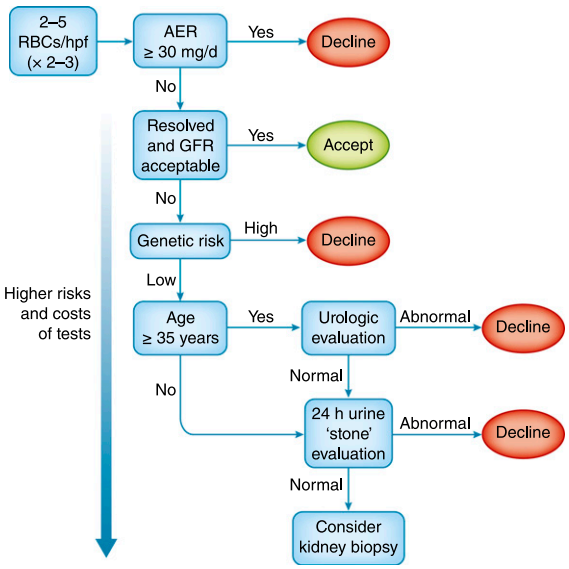

Figure 4. | Following a stepwise approach in the evaluation of microscopic hematuria in living kidney donor candidates facilitates efficiency. AER, albumin excretion rate; hpf, high-power field; RBC, red blood cell. Reprinted from ref. 8, with permission.

14.5. In cases where it remains uncertain whether the donor candidate has a genetic kidney disease and whether the disease can cause kidney failure, donation should proceed only after informing the donor candidate of the risks of donation if the disease manifests later in life.

The guideline recommends that donor candidates with ADPKD should not donate but that donor candidates with a family history of ADPKD in a first-degree relative may be acceptable for donation if they meet age-specific imaging or genetic testing criteria that reliably exclude ADPKD. The rationale refers to recent studies and a KDIGO Controversies Conference, which summarized diagnostic criteria for ADPKD (14,15). Age-dependent imaging criteria for diagnosis and ADPKD exclusion have been established for adults with a family history of ADPKD of unknown gene type (PKD1 or PKD2). Although the finding of an ultrasound with both kidneys together showing no cysts or one cyst reliably rules out the presence of ADPKD in candidates 40 years old or older, the utility of ultrasound in younger donor candidates is more limited. In such patients, an absent or limited number of cysts seen on kidney computed tomography or magnetic resonance imaging may be considered to rule out ADPKD (15). DNA testing can also sometimes help diagnose or exclude the condition (16). Linkage-based genetic diagnoses of ADPKD using polymorphic markers flanking of two disease genes is now rarely performed. Rather, direct mutation screening (by Sanger or next generation sequencing) is now commonly used for molecular diagnosis of ADPKD (17,18). Up to 15% of patients with suspected ADPKD have a negative comprehensive mutation screen. If the first-degree relative with ADPKD undergoes PKD1 and PKD2 mutation screening (using an acceptable technique), and if a pathogenic mutation is successfully identified, the donor candidate can be tested for this same mutation. However, when mutation screening in the first-degree relative with ADPKD is negative, DNA testing, including molecular diagnostics, is unhelpful in determining whether the donor candidate does or does not have ADPKD.

Patient Scenario 3. Microscopic Hematuria and Newly Detected Kidney Disease

Guideline Chapter 7 describes how donor candidates can be assessed for microscopic hematuria and recommends how those with persistent microscopic hematuria undergo testing for possible causes. Appropriate testing may include urinalysis and urine culture to assess for infection, cystoscopy and imaging to assess for urinary tract malignancy, 24-hour urine stone panel to assess for nephrolithiasis and/or microlithiasis, and a kidney biopsy to assess glomerular disease. An algorithm that serves as one example on how to undertake such testing is presented in Figure 4.

7.3. Donor candidates with hematuria from a reversible cause that resolves (*e.g.*, a treated infection) may be acceptable for donation.

Referenced in the guideline are epidemiologic studies of asymptomatic kidney diseases that can present with microscopic hematuria, including IgA nephropathy, Alport syndrome, and thin basement membrane nephropathy. All three conditions are associated with increased risks of developing hypertension and proteinuria compared with the general population over time, but unlike IgA nephropathy and Alport syndrome, thin basement membrane nephropathy rarely progresses to kidney failure (19). The guideline summarizes postdonation data showing no harm for donors with thin basement membrane nephropathy, recognizing that the information is limited to small series with short-term follow-up (20,21). The guideline offers an ungraded recommendation that donor candidates with IgA nephropathy should not donate, and in the text, also discourages women who are carriers of X-linked Alport syndrome (*i.e.*, COL4A5 mutation) from donation.

Patient Scenario 4. Obtaining Informed Consent, Psychosocial Evaluation, Assessing Lifestyle Risk Factors, and Developing a Plan for Health Care Maintenance and Follow-Up

Obtaining informed consent and evaluating the relationship between the donor candidate and the recipient are critical aspects of the donor evaluation. Guideline Chapter 2 describes the process of informed consent in living donation, which includes ascertaining voluntarism and disclosing that it may be a crime to receive valuable consideration (money or property) for donation. Guideline Chapter 16 discusses the importance of understanding the donor-recipient relationship in the psychosocial assessment of donor candidates.

16.2. To ensure voluntariness, at least a portion of the psychosocial evaluation of the donor candidate should be performed in the absence of the intended recipient, family members, and other persons who could influence the donation decision.

In addition to determining whether a candidate is eligible to become a kidney donor, the donor evaluation team has an opportunity to develop a strategy to minimize each donor's risk of postdonation complications. Specific to the importance of tobacco abstinence, Guideline Chapter 4 on perioperative evaluation and management recommends that donor candidates who smoke be advised to quit at least 4 weeks before donation to reduce their risk of perioperative complications. Guideline Chapter 11 on lifestyle risk factors suggests that donor candidates who use tobacco products be counseled on the risks of cancer, cardiopulmonary disease, and kidney failure, that they should be advised to abstain from use of tobacco products, and that they should be referred to a tobacco cessation support program if possible. Although tobacco use is not an absolute contraindication to donation, the guideline recommends that the decision to approve a donor candidate who is an active tobacco user should be individualized on the basis of their demographic and health profile in relation to the transplant program's acceptable risk threshold (scenario 1).

Guideline Chapter 19 of the guideline recommends that each donor be provided a personalized postdonation follow-up care plan before donation, which clearly describes what follow-up is needed, who will provide the care, and how often. In the case of a non-local donor or donor with limited financial resources, the donor evaluation team has a responsibility to assess whether there is a reliable way for the donor to receive this care after donation.

19.2. The following measurements and procedures should be performed at least annually postdonation:
- BP; body mass index; serum creatinine measurement with GFR estimation; albuminuria; review and promotion of a healthy lifestyle, including regular exercise, healthy diet, and abstinence from tobacco; and review and support of psychosocial health and wellbeing.

19.3. Donors should be monitored for CKD, and those meeting criteria for CKD should be managed according to the 2012 KDIGO CKD Guideline.

19.4. Donors should receive age-appropriate health care maintenance and management of clinical conditions and health risk factors according to clinical practice guidelines for the regional population.

As described in Guideline Chapter 16, the donor team can plan to provide psychosocial support at a distance, which includes support in the uncommon case where the recipient has a poor outcome in the early years after transplantation (in approximately 3%–5% of living kidney donor transplants, the recipient or their graft does not survive the first year). The team can also counsel and prepare the donor candidate for the possible financial effect of donation. Chapter 18 on the ethical, legal, and policy considerations in living donation recommends that donor candidates should be informed of the availability of legitimate financial assistance for expenses from evaluation and donation. Initiatives to remove financial disincentives for kidney donation (*i.e.*, replacement of costs incurred by the donation, such as loss of income, travel, and accommodations for the evaluation and donation) are acceptable as an issue of justice (22). Governmental and other programs to reimburse living organ donors for the nonmedical expenses that they incur have been implemented in many jurisdictions (23,25).

Patient Scenario 5. Pregnancy Risks

Guideline Chapter 15 of the guideline considers pregnancy in the context of living donation. The guideline recommends that women candidates should be asked about future childbearing plans, that they should not be excluded from donation solely because they desire to become pregnant after donation, and that women with childbearing potential be counseled about the effects that donation may have on future pregnancies (25,26), including the possibility of a greater likelihood of being diagnosed with gestational hypertension or preeclampsia. The guideline also recommends that women with childbearing potential who proceed with donation should be counseled on how to reduce the risk of complications in future pregnancies (*e.g.*, maintain a healthy pre-pregnancy weight).

15.5. Women should not be excluded from donation solely because they desire to conceive children after donation.

15.6. Women with a prior hypertensive disorder of pregnancy may be acceptable for donation if their long-term postdonation risks are acceptable.

To strengthen informed choice in living kidney donation and the safety, protection, and care of all donor candidates, robust commitment and collaboration across researchers, clinicians, and policy makers are needed to measure and present risks and benefits and to support donor candidates in informed decision making. The more that we understand risk and disclose it transparently, the more we can help support public trust and advance living kidney donation within a defensible system of practice. The 2017 KDIGO guideline marks an important step in advancing a new framework for consistent, transparent decision making in the evaluation and selection of living donor candidates which can and should be updated with evolving evidence. Ongoing empirical studies, including formal evaluations of education, removal of disincentives, practice efficiency, and risk evaluation and communication, are necessary to advance the evidence base grounding the practice (9,27–29).

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Supplemental Material

This article contains the following supplemental material online at http://cjasn.asnjournals.org/lookup/suppl/doi:10.2215/CJN.12141019/-/DCSupplemental.

Supplemental Appendix. Guideline development principles and methods.

Supplemental Figure 1. The effect of age, sex, race, and predonation GFR on 15-year and predicted lifetime risk of kidney failure.

References

1. Liyanage T, Ninomiya T, Jha V, Neal B, Patrice HM, Okpechi I, Zhao MH, Lv J, Garg AX, Knight J, Rodgers A, Gallagher M, Kotwal S, Cass A, Perkovic V: Worldwide access to treatment for end-stage kidney disease: A systematic review. *Lancet* 385: 1975–1982, 2015
2. Tonelli M, Wiebe N, Knoll G, Bello A, Browne S, Jadhav D, Klarenbach S, Gill J: Systematic review: Kidney transplantation compared with dialysis in clinically relevant outcomes. *Am J Transplant* 11: 2093–2109, 2011
3. Axelrod DA, Schnitzler MA, Xiao H, Irish W, Tuttle-Newhall E, Chang SH, Kasiske BL, Alhamad T, Lentine KL: An economic assessment of contemporary kidney transplant practice. *Am J Transplant* 18: 1168–1176, 2018
4. Klarenbach S, Barnieh L, Gill J: Is living kidney donation the answer to the economic problem of end-stage renal disease? *Semin Nephrol* 29: 533–538, 2009
5. Mahillo B, Carmona M, Álvarez M, White S, Noel L, Matesanz R: 2009 Global data in organ donation and transplantation: Activities, laws, and organization. *Transplantation* 92: 1069–1074, 2011
6. Horvat LD, Shariff SZ, Garg AX; Donor Nephrectomy Outcomes Research (DONOR) Network: Global trends in the rates of living kidney donation. *Kidney Int* 75: 1088–1098, 2009
7. Tong A, Chapman JR, Wong G, de Bruijn J, Craig JC: Screening and follow-up of living kidney donors: A systematic review of clinical practice guidelines. *Transplantation* 92: 962–972, 2011
8. Lentine KL, Kasiske BL, Levey AS, Adams PL, Alberú J, Bakr MA, Gallon L, Garvey CA, Guleria S, Li PK, Segev DL, Taler SJ, Tanabe K, Wright L, Zeier MG, Cheung M, Garg AX: KDIGO clinical practice guideline on the evaluation and care of living kidney donors. *Transplantation* 101[Suppl 1]: S1–S109, 2017
9. Lentine KL, Segev DL: Understanding and communicating medical risks for living kidney donors: A matter of perspective. *J Am Soc Nephrol* 28: 12–24, 2017
10. Lentine KL, Lam NN, Segev DL: Risks of living kidney donation: Current state of knowledge on outcomes important to donors. *Clin J Am Soc Nephrol* 14: 597–608, 2019
11. Massie AB, Muzaale AD, Luo X, Chow EKH, Locke JE, Nguyen AQ, Henderson ML, Snyder JJ, Segev DL: Quantifying postdonation risk of ESRD in living kidney donors. *J Am Soc Nephrol* 28: 2749–2755, 2017
12. Ibrahim HN, Foley RN, Reule SA, Spong R, Kukla A, Issa N, Berglund DM, Sieger GK, Matas AJ: Renal function profile in white kidney donors: The first 4 decades. *J Am Soc Nephrol* 27: 2885–2893, 2016
13. Freedman BI, Moxey-Mims M, Alexander A, Astor BC, Birdwell KC, Bowden DW, Bowen G, Bromberg J, Craven TE, Darshana DM, Divers J, Doshi MD, Eidbo E, Fornoni A, Gautreaux MD, Gbadegesin RA, Gee PO, Guerra G, Hsu CY, Iltis AS, Jefferson N, Julian BA, Klassen DK, Koty PP, Langefeld CD, Lentine KL, Ma L, Mannon RB, Menon MC, Mohan S, Moore JB, Murphy B, Newell KA, Odim J, Ortigosa-Goggins M, Palmer ND, Park M, Parsa A, Pastan SO, Poggio ED, Rajapakse N, Reeves-Daniel AM, Rosas SE, Russell LP, Sawinski D, Smith SC, Spainhour M, Stratta RJ, Weir MR, Reboussin DM, Kimmel PL, Brennan DC: APOL1 long-term kidney transplantation outcomes network (APOLLO): Design and rationale. *Kidney Int Rep* 5: 278–288, 2020
14. Chapman AB, Devuyst O, Eckardt KU, Gansevoort RT, Harris T, Horie S, Kasiske BL, Odland D, Pei Y, Perrone RD, Pirson Y, Schrier RW, Torra R, Torres VE, Watnick T, Wheeler DC; Conference Participants: Autosomal-dominant polycystic kidney disease (ADPKD): Executive summary from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney Int* 88: 17–27, 2015
15. Pei Y, Hwang YH, Conklin J, Sundsbak JL, Heyer CM, Chan W, Wang K, He N, Rattansingh A, Atri M, Harris PC, Haider MA: Imaging-based diagnosis of autosomal dominant polycystic kidney disease. *J Am Soc Nephrol* 26: 746–753, 2015
16. Simms RJ, Travis DL, Durkie M, Wilson G, Dalton A, Ong AC: Genetic testing in the assessment of living related kidney donors at risk of autosomal dominant polycystic kidney disease. *Transplantation* 99: 1023–1029, 2015
17. Audrézet MP, Cornec-Le Gall E, Chen JM, Redon S, Quéré I, Creff J, Bénech C, Maestri S, Le Meur Y, Férec C: Autosomal dominant polycystic kidney disease: Comprehensive mutation analysis of PKD1 and PKD2 in 700 unrelated patients. *Hum Mutat* 33: 1239–1250, 2012
18. Rossetti S, Consugar MB, Chapman AB, Torres VE, Guay-Woodford LM, Grantham JJ, Bennett WM, Meyers CM, Walker DL, Bae K, Zhang QJ, Thompson PA, Miller JP, Harris PC; CRISP Consortium: Comprehensive molecular diagnostics in autosomal dominant polycystic kidney disease. *J Am Soc Nephrol* 18: 2143–2160, 2007
19. Savige J, Rana K, Tonna S, Buzza M, Dagher H, Wang YY: Thin basement membrane nephropathy. *Kidney Int* 64: 1169–1178, 2003
20. Koushik R, Garvey C, Manivel JC, Matas AJ, Kasiske BL: Persistent, asymptomatic, microscopic hematuria in prospective kidney donors. *Transplantation* 80: 1425–1429, 2005
21. Choi SR, Sun IO, Hong YA, Kim HG, Park HS, Chung BH, Choi BS, Park CW, Kim YS, Yang CW: The role of kidney biopsy to determine donation from prospective kidney donors with asymptomatic urinary abnormalities. *Transplant Proc* 44: 11–13, 2012
22. Delmonico FL, Martin D, Domínguez-Gil B, Muller E, Jha V, Levin A, Danovitch GM, Capron AM: Living and deceased organ donation should be financially neutral acts. *Am J Transplant* 15: 1187–1191, 2015
23. Sickand M, Cuerden MS, Klarenbach SW, Ojo AO, Parikh CR, Boudville N, Garg AX; Donor Nephrectomy Outcomes Research Network: Reimbursing live organ donors for incurred non-medical expenses: A global perspective on policies and programs. *Am J Transplant* 9: 2825–2836, 2009
24. Garg AX, Nevis IF, McArthur E, Sontrop JM, Koval JJ, Lam NN, Hildebrand AM, Reese PP, Storsley L, Gill JS, Segev DL, Habbous S, Bugeja A, Knoll GA, Dipchand C, Monroy-Cuadros M, Lentine KL; DONOR Network: Gestational hypertension and preeclampsia in living kidney donors. *N Engl J Med* 372: 124–133, 2015
25. US Department of Health and Human Services: Advancing American kidney health: Available at: https://aspe.hhs.gov/system/files/pdf/262046/AdvancingAmericanKidneyHealth.pdf. Accessed November March 1, 2020
26. Ibrahim HN, Akkina SK, Leister E, Gillingham K, Cordner G, Guo H, Bailey R, Rogers T, Matas AJ: Pregnancy outcomes after kidney donation. *Am J Transplant* 9: 825–834, 2009
27. Lentine KL, Mandelbrot D: Moving from intuition to data: Building the evidence to support and increase living donor kidney transplantation. *Clin J Am Soc Nephrol* 12: 1383–1385, 2017

28. Garg AX: Helping more patients receive a living donor kidney transplant. *Clin J Am Soc Nephrol* 13: 1918–1923, 2018
29. O'Keeffe LM, Ramond A, Oliver-Williams C, Willeit P, Paige E, Trotter P, Evans J, Wadström J, Nicholson M, Collett D, Di Angelantonio E: Mid- and long-term health risks in living kidney donors: A systematic review and meta-analysis. *Ann Intern Med* 168: 276–284, 2018
30. Levey AS, Inker LA: GFR evaluation in living kidney donor candidates. *J Am Soc Nephrol* 28: 1062–1071, 2017
31. Lentine KL, Kasiske BL, Levey AS, Adams PL, Alberú J, Bakr MA, Gallon L, Garvey CA, Guleria S, Li PK, Segev DL, Taler SJ, Tanabe K, Wright L, Zeier MG, Cheung M, Garg AX: Summary of kidney disease: Improving global outcomes (KDIGO) clinical practice guideline on the evaluation and care of living kidney donors. *Transplantation* 101: 1783–1792, 2017
32. Inker LA, Koraishy FM, Goyal N, Lentine KL: Assessment of glomerular filtration rate and end-stage kidney disease risk in living kidney donor candidates: A paradigm for evaluation, selection, and counseling. *Adv Chronic Kidney Dis* 25: 21–30, 2018
33. Fagerlin A, Zikmund-Fisher BJ, Ubel PA: Helping patients decide: Ten steps to better risk communication. *J Natl Cancer Inst* 103: 1436–1443, 2011
34. Grams ME, Sang Y, Levey AS, Matsushita K, Ballew S, Chang AR, Chow EK, Kasiske BL, Kovesdy CP, Nadkarni GN, Shalev V, Segev DL, Coresh J, Lentine KL, Garg AX; Chronic Kidney Disease Prognosis Consortium: Kidney-failure risk projection for the living kidney-donor candidate. *N Engl J Med* 374: 411–421, 2016

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