





## CKJ REVIEW

# The evaluation of kidney transplant candidates prior to waitlisting: a scoping review

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## ABSTRACT

Before patients with kidney failure can undergo kidney transplantation, their suitability is assessed through a transplantation work-up. Variation in the transplantation work-up could contribute to inefficiency and inequality in accessing the transplant waiting list and kidney transplantation. We conducted a scoping review on the evaluation of kidney transplant candidates prior to waitlisting, investigating: (i) content of the transplantation work-up; (ii) contraindications to waitlisting; and (iii) organization of the transplantation work-up. A systematic search was conducted in Ovid Medline and Ovid EMBASE in collaboration with a medical information specialist. Studies investigating practice patterns since 2013 related to the evaluation of adults receiving their first kidney graft from a deceased donor were included. Results from 20 studies showed substantial variation in the evaluation of kidney transplant candidates. The content of the transplantation work-up differed between studied centers, yet common domains included screening for infections, heart disease, peripheral artery disease, and malignancy. Commonly reported contraindications to waitlisting were obesity and age-related factors. However, strict cut-off for BMI and age were used less. The organization of the transplantation work-up differed across studied centers with regard to referral and waitlisting decisions, screening and prioritization, and the setting of the transplantation work-up. Literature on the evaluation of kidney transplant candidates is limited, but our findings suggest substantial variation in pre-waitlisting practices among centers. This may contribute to differences in kidney transplantation access and

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outcomes between countries. Further research on pre-transplantation practices, specifically regarding the standardization of the transplantation work-up, is needed.

**Keywords:** cardiovascular, guidelines, kidney transplantation, obesity, systematic review



## INTRODUCTION

For patients with kidney failure, kidney transplantation is often the best kidney replacement therapy (KRT), offering a better quality of life and increased life expectancy compared with dialysis [1–3]. Access to kidney transplantation is partly influenced by patient comorbidity, as conditions such as (cardio)vascular disease and obesity may make transplantation riskier and can potentially impact long-term prognosis [4, 5]. To facilitate optimal outcomes, kidney transplant candidates receive a transplantation work-up assessing their suitability for kidney transplantation.

Several international guidelines have outlined the most important factors in determining patient suitability for kidney transplantation [6–11], but there is little universal agreement among them (Supplementary information 1) and it is unclear whether the recommendations described in guidelines are adopted in clinical practice. Variation in the evaluation of kidney transplant candidates could be a contributing factor to inefficiency and inequality in accessing the transplant waiting list and kidney transplantation. Therefore, the standardization of pre-waitlisting practice patterns is desirable and in line with recommendations from a strategic action plan in the USA [12], and a joint statement in Europe [13].

An overview of publications on pre-waitlisting practices for kidney transplantation is needed to increase the transparency of kidney transplant candidacy evaluation, and is a first step towards the standardization of pre-waitlisting procedures. To date, such an overview has not been performed. Therefore, we conducted a scoping review on the evaluation of kidney transplant candidates prior to waitlisting worldwide, investigating: (i) content of the transplantation work-up; (ii) contraindications to waitlisting; and (iii) organization of the transplantation work-up.

## METHODS

Given the emergent state of evidence on kidney transplant candidacy evaluation, a scoping review was performed to examine the extent of current evidence and identify gaps in research [14]. The scope of this review is limited to what takes place prior to waitlisting. Therefore, the term ‘pre-waitlisting’ refers to practices that take place in the process of waitlisting for transplantation and does not include practices that take place once the patient has been listed. For this reason, practice patterns related to waiting list management (e.g. delisting, inactive status, or periodical screening of patients on the transplant waiting list) or kidney allocation (human leukocyte antigen type or antibody testing) were not investigated.

## Protocol and registration

This review adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [15]. A protocol of this study was registered with Open Science Framework (<https://doi.org/10.17605/OSF.IO/46AXJ>).

## Search strategy

A systematic search was conducted in the electronic databases Ovid Medline and Ovid EMBASE from inception until 20 January 2023 in collaboration with a medical information specialist (J.D.). A preliminary search of relevant articles, reference tracking, and similarity tracking yielded several key articles, which were used to create a search strategy using the following concepts:

[kidney transplantation] AND [candidacy evaluation/contraindications] AND [waiting list OR practice patterns] AND [evaluation design].

The search string for Ovid Medline (Supplementary information 2) was developed first using MeSH and free-text terms, and was later translated to EMBASE. Attempts were made to contact the authors of studies for which a full-text article was not available.

## Study selection

Study selection consisted of two stages of screening: (i) initial screening on title and abstract using the online review tool Rayyan [16]; and (ii) full-text review. Both stages of screening were performed independently by two reviewers (B.A.B. in collaboration with V.S.S., A.K., K.J.J., R.H., M.P., or M.D.) with scheduled meetings to reach consensus.

## Eligibility criteria

Studies investigating practice patterns since 2013 related to the evaluation of adults receiving their first kidney graft from a deceased donor were included. Practice patterns needed to be reported from the perspective of a healthcare professional (e.g. nephrologist, transplant surgeon, transplant center coordinator). There were no limits imposed with regards to location.

Studies were excluded if they only contained results for pediatric patients (<18 years of age), simultaneous kidney-pancreas or kidney-liver transplantation, re-transplantation, or living donor kidney donation. However, studies that made no distinction between pre-transplantation practices for deceased or living donor donation were included. Any practice patterns reported from the perspective of the patient were excluded, as were any practices that were performed once the patient was waitlisted. Studies that investigated any COVID-19-related changes to kidney transplantation procedures or any experimental screenings for evaluating kidney transplant candidates without evidence that this screening was also used in clinical

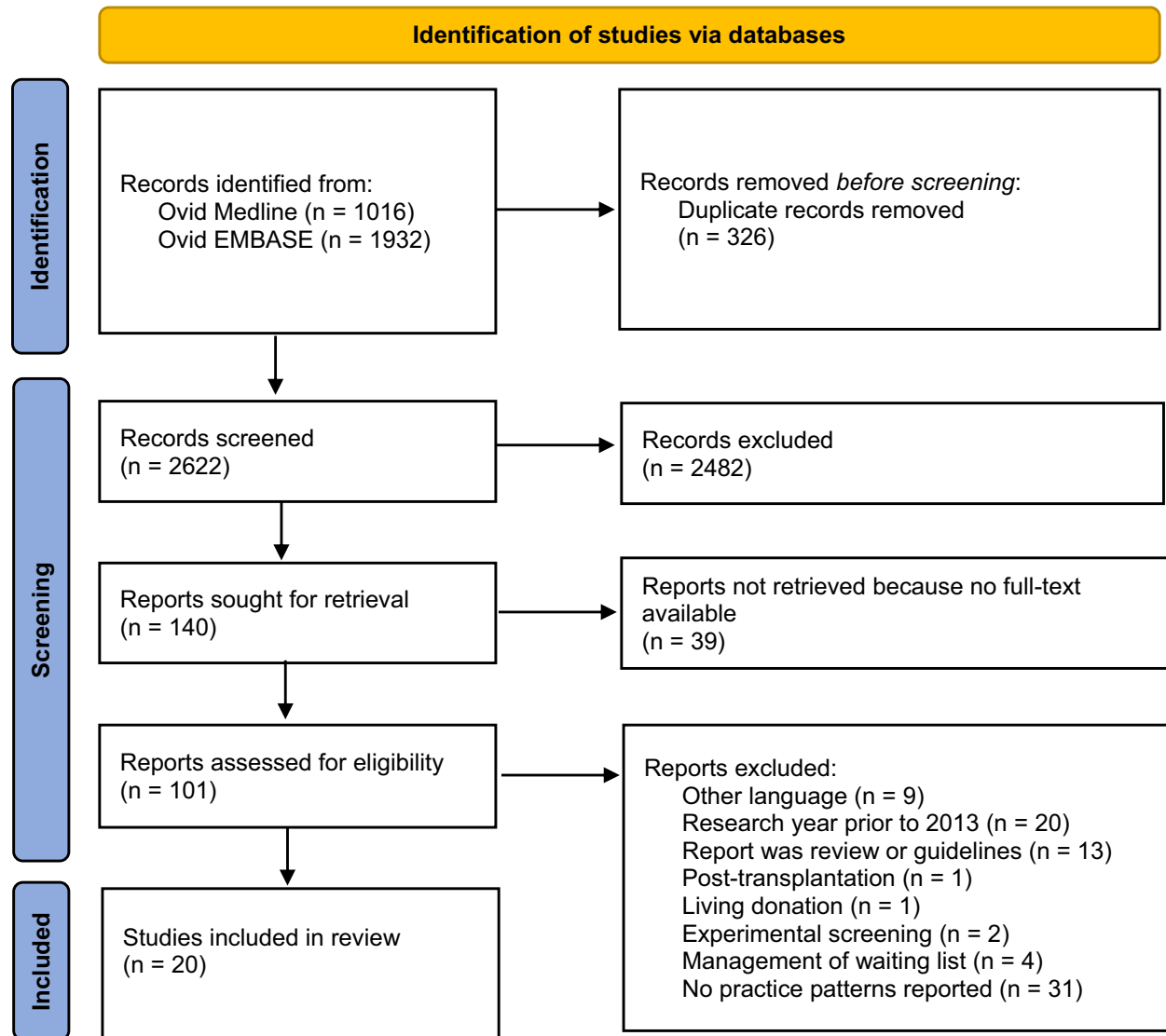


Figure 1: Modified PRISMA 2020 flow diagram.

practice were excluded. Lastly, studies were also excluded if they researched practice patterns prior to 2013, or if they were not written in the English language.

### Data charting and synthesis

Relevant information was extracted from the included studies and summarized in Excel tables by a single reviewer (B.A.B.). Relevant variables included: author name, year of publication, location, research year(s), study design, publishing journal, and any practice patterns related to the research question. For surveys, the role of the respondent, how respondents were considered, and response rate were also collected.

Results were separated for studies that contained a survey versus studies that did not contain a survey, and summarized according to the following sub-categories: (i) content of the transplantation work-up; (ii) contraindications to waitlisting; and (iii) organization of the transplantation work-up. The percentages reported in the results section reflect the findings from the orig-

inal articles and are based only on studies that reported pre-waitlisting practice patterns.

## RESULTS

### Study selection and study characteristics

Study selection is summarized using a modified PRISMA 2020 flow diagram in Fig. 1. The search in Ovid Medline and Ovid EMBASE yielded 1016 and 1932 articles, respectively. Following the removal of duplicates, 2622 articles were screened on title and abstract. Of the 140 abstracts that met eligibility criteria, 39 did not have a full text available and were excluded, leaving 101 articles that were read in entirety. A total of 20 studies were included, of which 14 studies contained surveys on practice patterns. The majority of studies were conducted in the USA (n = 12), followed by studies conducted in Europe (n = 3), global studies (n = 2), and studies conducted in Australia (n = 2) and Canada (n = 1). Characteristics of the included studies are summarized in Table 1.

Table 1: Characteristics of included studies.

Study information	Reference number	Study design	If study design was a survey:				Results in table:
			Respondents	How were respondents considered?	Response rate	Publishing journal	
Al-Obaidi (2019) Location: USA Research years: 2012–17	47	Retrospective observational	N/A	N/A	N/A	<i>Open Forum Infectious Diseases</i>	Suppl. 3
Basu (2018) Location: USA Research years: 2013–14	48	Randomized controlled trial	N/A	N/A	N/A	<i>Clinical Journal of American Society of Nephrology</i>	Suppl. 3
Beksac (2017) Location: USA Research year: 2016	22	Survey	Medical doctors or doctors of osteopathic medicine working at US transplant centers (n = 62)	A list of recipients was obtained from ASTS.	53/213 (25%) transplant centers	<i>Urologic Oncology</i>	2a, Suppl. 4
Brar (2014) Location: USA Research years: 2012–13	23	Survey	Transplantation professionals, including nephrologists, surgeons, nurses, and social workers (n = 79)	A list of UNOS-approved transplant programs was obtained from the website and respondents were identified through transplant program websites or phone calls to the institution.	79/181 (44%) transplant centers	<i>Transplantation Proceedings</i>	2a, Suppl. 4
Burns (2019) Location: Australia Research years: 2013–18	49	Prospective yearly audit	N/A	N/A	N/A	<i>Journal of Renal Care</i>	Suppl. 3
Chakker (2018) Location: USA Research year: 2011–14	50	Retrospective observational	N/A	N/A	N/A	<i>Journal of American Heart Association</i>	Suppl. 3
Chan (2016) Location: Canada Research year: 2013	26	Survey	35 nephrologists, 10 transplant surgeons, and 2 collective responses (n = 47)	The survey was sent to members of the Adult Kidney Group of the Canadian Society of Transplantation and the Comité de Rein-Pancréas of Transplant Québec.	17/18 (94%) transplant centers	<i>Canadian Journal of Kidney Health and Disease</i>	2b, Suppl. 6
Cheng (2020) Location: USA Research year: N.R.	21	Survey	55 transplant nephrologists and 9 transplant surgeons (n = 64)	The survey was distributed via the America Society of Transplant's Kidney-Pancreas Community of Practice email distribution group and also posted online.	78/188 (42%) for members that opened the email and 78/477 (16%) for members who received the email	<i>Kidney Medicine</i>	Suppl. 5

Table 1: Continued

Study information	Reference number	Study design	If study design was a survey:				Results in table:
			Respondents	How were respondents considered?	Response rate	Publishing journal	
Dziódzio (2022) Location: Germany Research year: N.R.	27	Survey	23 head of nephrology and 28 head of surgical department (n = 51)	The survey was sent to surgical and nephrological heads of all 39 German kidney transplant centers.	39/39 (100%) transplant centers	<i>Obesity Surgery</i>	2b, Suppl. 6
Gin (2016) Location: USA Research year: 2014	51	Survey	90 US renal transplant surgeons	The survey was via email to a list obtained with permission from ASTS.	65/195 (33%) transplant centers	<i>Urologic Oncology</i>	2b, Suppl. 3, Suppl. 6
Maggiore (2019) Location: Europe Research year: N.R.	18	Survey	52 nephrologists and 28 transplant surgeons (n = 80)	Respondents were approached by DESCARTES Working Group members and were colleagues in academic transplant centers with > 5 years of experience.	31/37 (84%) respondents for survey 1; and 49/57 (86%) respondents for survey 2	<i>Nephrology Dialysis Transplantation</i>	2a, Suppl. 4
Mandelbrot (2017) Location: USA Research year: 2013	25	Survey	30 nephrologists, 25 surgeons, and 4 others (n = 59)	A list of medical and surgical directors of all 222 kidney transplant programs was purchased from UNOS.	59/190 (31%) transplant centers	<i>Clinical Transplantation</i>	2b, Suppl. 5, Suppl. 6, Suppl. 7
McAdams-DeMarco (2020) Location: USA Research years: 2017–18	24	Survey	81 nephrologists, 37 transplant surgeons, and 15 others (n = 133)	Transplant programs were identified using data from OSRTR external release.	133/206 (66%) transplant centers	<i>Transplantation</i>	2a, 2b, Suppl. 4, Suppl. 5, Suppl. 6
Montarello (2020) Location: Australia Research years: 2015–19	52	Retrospective observational	N/A	N/A	N/A	<i>Kidney International</i>	Suppl. 3
Omar (2013) Location: Sweden Research year: N.R.	31	Interviews	7 nephrologists, 6 surgeons, and 2 transplant coordinators (n = 15)	Sampling techniques purposefully included key decision-makers at transplant centers and nephrology units.	4/4 (100%) transplant centers	<i>Scandinavian Journal of Public Health</i>	2c, Suppl. 6, Suppl. 7
Pruthi (2018) Location: UK Research year: 2018	17	Survey	35 consultant nephrologists, 30 clinical directors, 2 consultant transplant surgeons, and 4 others (n = 71)	The survey was sent to the lead physicians and surgeons of all 71 adult renal centers in the UK.	71/71 (100%) transplant centers	<i>Transplantation</i>	2a, 2b, 2c, Suppl. 4, Suppl. 5, Suppl. 6, Suppl. 7

Table 1: Continued

Study information	Reference number	Study design	If study design was a survey:			Publishing journal	Results in table:
			Respondents	How were respondents considered?	Response rate		
Rijkse (2022) Location: global Research year: 2019	19	Survey	Transplant surgeons and urologists from Europe (n = 122), North America (n = 12), South America (n = 4), Africa (n = 3), Asia (n = 18), and Oceania (n = 2) (n = 161)	A list of participants from previous surveys was supplemented with additional participants received from department heads of Euro transplant region and participants of the Living Donor Nephrectomy course.	161/939 (17%) respondents	<i>European Surgical Research</i>	Suppl. 5, Suppl. 6
Stenvinkel (2013) Location: worldwide Research year: 2012–2013	28	Survey	Nephrologists from Europe (n = 227), South and Central America (n = 48), Middle East (n = 40), Asia (n = 36), North America (n = 20), Oceania (n = 20), and Africa (n = 8) (total n = 399)	The survey was posted on the NDT-E website.	N.R.	<i>Nephrology Dialysis Transplantation</i>	2b
Urbanski (2020) Location: USA Research year: 2016	29	Interviews	29 transplant nephrologists, 11 transplant surgeons, 7 nurse coordinators, 14 pharmacists, 4 administrators, and 29 other program staff (n = 94)	Spontaneous and brief interviews conducted on-site at 2016 American Transplant Congress.	94/277 (34%) respondents	<i>CommonHealth</i>	2b, Suppl. 6
Wall (2019) Location: USA Research year: 2016	30	Survey	173 physicians, 39 surgeons, 8 social workers, and 8 nurse coordinators (n = 228)	Eligible transplant programs were identified using databases and annual reports provided on the websites of the Organ Procurement and Transplant Network and the SRTN.	228/468 (49%) respondents	<i>World Journal of Surgery</i>	2b, Suppl. 6
Whelan (2022) Location: USA Research year: 2020	20	Survey	41 medical directors, 43 transplant nephrologists, and 6 others (n = 90)	Medical directors were invited first, and if there was no response, a nephrologist or transplant surgeon, from a list of adult kidney transplant programs obtained using data from SRTN.	90/172 (52%) transplant centers	<i>American Journal of Transplantation</i>	2a, 2b, 2c, Suppl. 4, Suppl. 5, Suppl. 6, Suppl. 7

N/A, not applicable; N.R., not reported; ASTS, American Society of Transplant Surgeons; UNOS, United Network for Organ Sharing; DESCARTES, Developing Education Science and Care for Renal Transplantation in European States; SRTN, Scientific Registry of Transplant Recipients; NDT-E, Nephrology Dialysis Transplantation–Educational.



## Content of the transplantation work-up

A total of 11 studies reported practice patterns related to the content of the transplantation work-up. Results for the content of the transplantation work-up from studies containing a survey are summarized in Table 2a and results from studies not containing a survey are reported in [Supplementary information 3](#). Study-specific results are reported in [Supplementary information 4](#) and results related to the content of the transplantation work-up for patients with specific indications are reported in [Supplementary information 5](#).

### Infections

Results from two European surveys indicated that 99%–100% of centers routinely screened for human immunodeficiency virus (HIV) and hepatitis B and C virus (HBV and HCV, respectively), 95%–100% of centers screened for cytomegalovirus (CMV), and 94%–95% of centers screened for Epstein–Barr virus (EBV) [17, 18]. The following infections were screened for less often: varicella zoster virus (VZV, 76% of centers) [18], syphilis (40% of centers) [18], herpes simplex virus (HSV, 72% of centers) [17], tuberculosis (TB, 25% of centers) [18], and toxoplasmosis (19% of centers) [18]. Practices related to the screening of infectious disease were not available for other regions.

### Heart disease

A majority of surveyed centers (58%–88%) stratified patients by risk to determine which cardiac investigations to perform [17, 19, 20], with common risk factors being age (88%), diabetes (97%), history of cardiovascular disease (91%), and abnormal electrocardiogram (ECG, 89%) [17]. The following investigations were reported most often as part of the standard transplantation work-up in all patients: ECG (100% of surveyed centers) [17], echocardiogram (45%–63% of surveyed centers) [17, 18], and ‘cardiac stress testing’ (44% of surveyed centers) [17], such as stress echocardiography (1–20% of surveyed centers) [17, 20] and nuclear medicine perfusions studied (19% of surveyed centers) [20]. Coronary angiography, the only form of invasive screening reported, was performed more frequently in dialysis patients (41% of surveyed centers) [21] and diabetic patients (1%–20% of surveyed centers) [20, 21] compared with its standard use in all patients (1%–3% of surveyed centers) [17, 20]. A UK survey reported the following cardiac investigations in ‘high-risk’ patients: thallium stress testing (34% of centers), exercise tolerance test (21% of centers), stress echocardiography, and dobutamine stress Tc scan (both 13% of centers) [17].

### Peripheral artery disease

Two surveys reported practices for screening for peripheral artery disease (PAD) prior to waitlisting [17, 18]. A European survey found that 31% of centers performed Doppler ultrasonography of the iliac arteries in all patients [18], while in the UK this was routinely performed by only 7% of surveyed centers [17]. Doppler ultrasonography of the carotid arteries (14% of surveyed European centers) [18] and Doppler sonography of the lower extremity arteries (7% of surveyed UK centers) [17] were also used. The included studies did not contain any information on invasive screening for PAD.

### Malignancy

Three surveys contained information on screening for malignancy prior to waitlisting [17, 18, 22]. A US survey indicated that

86% of centers screened all patients for renal masses by performing an ultrasound of the kidneys (66% of surveyed centers) or computed tomography (34% of centers [22]). In the UK, a survey reported in 83% of centers screening for breast, prostate, bladder, and colorectal cancer was a part of the standard transplantation work-up for all patients [17]. Non-invasive screening methods, such as an abdominal ultrasound (performed in 30%–54% of surveyed European centers), were more common than invasive screening methods, such as gastroscopy and colonoscopy (each performed in 3% of surveyed European centers) [17, 18]. In women, a gynecological consultation was part of the standard work-up in 33% of surveyed European centers [18], and in men a prostate-specific antigen (PSA) test was routinely performed in 23% of surveyed European centers [17].

### Other investigations

Five surveys described a variety of other investigations that were performed in the evaluation of kidney transplant candidates prior to waitlisting [17, 18, 23–25]. A European survey reported the following basic laboratory tests performed in all patients: full blood count (100% of centers), liver enzymes (96% of centers), international normalized ratio/activated partial thromboplastin time (INR/APTT, 95% of centers), parathyroid hormone (PTH, 90% of centers), and a urine culture (83% of centers) [18]. The chest x-ray was routinely performed in 95% of surveyed European centers [18] and 85% of surveyed UK centers [17]. In the USA, a single survey reported that adherence was assessed in 51% of centers [23], while two surveys reported that frailty was assessed in 17%–25% of centers [24, 25]. Practices related to the evaluation of adherence and frailty in other regions were not available. The following investigations were performed less often among surveyed European centers: urological consultation (21%) [18], psychological consultation (7%–16%) [17, 18], orthopantomogram (15%) [18], lung function test (7%–8%) [17, 18], and a voiding cystourethrogram (3%–8%) [17, 18].

### Contraindications to waitlisting

In total, 12 studies reported contraindications to waitlisting for kidney transplantation. Results from studies containing a survey are summarized in Table 2b and results from studies not containing a survey are reported in [Supplementary information 3](#). Study-specific results are summarized in [Supplementary information 6](#).

### Obesity

Six surveys reported that extreme obesity was considered a potential contraindication to waitlisting [17, 20, 26–29]. Between 67% and 81% of surveyed centers had an official policy on obesity as a contraindication [26, 27], with BMI cut-off points being the most common assessment criteria (82%) [17]. The following BMI thresholds were reported: between 30 and 34 kg/m<sup>2</sup> (2%–24% of surveyed centers) [17, 27–29], between 35 and 39 kg/m<sup>2</sup> (12%–51% of surveyed centers) [17, 20, 26–29], and >40 kg/m<sup>2</sup> (6%–62% of surveyed centers) [17, 20, 26–28]. In general, surveyed European centers adhered to lower BMI cut-off points compared with surveyed centers in North America. Results from two surveys show that only 2%–7% of surveyed European centers adhered to a BMI cut-off of 40 kg/m<sup>2</sup> [17, 27], while this was 54% of surveyed centers in the USA [20] and 62% of surveyed centers in Canada [26]. Between 6% and 55% of surveyed centers reported that they did not exclude patients based on BMI [20, 27–29], but used other criteria to evaluate obesity, such as abdominal circumference, fat

Table 2a: Summary of survey results related to the content of the transplantation work-up.

Domain	Screening or investigation	Percentage of respondents	Reference number
Infections	HIV	99–100	17, 18
	HBV	99–100	17, 18
	HCV	99–100	17, 18
	CMV	95–100	17, 18
	EBV	94–95	17, 18
	VZV	76	18
	HSV	72	17
	Syphilis	40	18
	TB	25	18
	Toxoplasmosis	19	18
Heart disease	Resting ECG	100	17
	Echocardiography	45–63	17, 18
	‘Cardiac stress testing’	44	17
	Stress echocardiography	1–20	17, 20
	Nuclear medicine perfusion studies	19	20
	Cardiological consultation	16	18
	Dopamine stress Tc scan	13	17
	Exercise ECG	13	18
	Cardiopulmonary exercise (CPEX) testing	10	17
	Exercise tolerance test	7	17
	Myocardial scintigraphy	3	18
	Coronary angiography	1–3	17, 20
Peripheral artery disease	Doppler ultrasonography of iliac arteries	7–31	17, 18
	Doppler ultrasonography of carotid arteries	14	18
	Pelvic x-ray	7	17
	Doppler ultrasonography of lower extremity arteries	7	17
	Abdominal CT scan <sup>a</sup>	3	17
Malignancy	Screening for renal masses	86	22
	Ultrasound of kidneys	66–84	18, 22
	Screening for breast, prostate, bladder, and colorectal cancer	83	17
	Abdominal ultrasound	30–54	17, 18
	Abdominal CT scan	34	22
	Gynecological consultation (in women)	33	18
	PSA (in men)	23	17
	Abdominal CT scan <sup>a</sup>	3	17
	Gastroscopy	3	17
	Colonoscopy	3	18
	Sigmoidoscopy/baroscopy	1	17
Other	Full blood count	100	18
	Liver enzymes	96	18
	INR/APTT	95	18
	Chest x-ray	85–95	17, 18
	PTH	90	18
	Urine culture	83	18
	Adherence	51	23
	Liver enzymes	96	18
	Frailty	17–25	24, 25
	Urological consultation	21	18
	Psychological consultation	7–16	17, 18
	Orthopantomogram	15	18
	Lung function test	7–8	17, 18
	Voiding cystourethrogram	3–8	17, 18
	Urodynamic test	5	18
	Psychiatric consultation	1	18

Percentages reflect findings from the original articles.

<sup>a</sup>Abdominal CT scan could be used to evaluate peripheral vasculature and/or malignancy in abdominal organs.

HIV, human immunodeficiency virus; HBV, hepatitis B; HCV, hepatitis C; CMV, cytomegalovirus; VZV, varicella zoster virus; EBV, Epstein-Barr virus; TB, tuberculosis; HSV, herpes simplex virus; ECG, electrocardiogram; CT, computed tomography; PSA, prostate-specific antigen; PTH, parathyroid hormone; INR/APTT, international normalized ratio/activated partial thromboplastin clotting time (blood tests).



Table 2b: Summary of survey results related to contraindications to waitlisting.

Domain	Criteria	Percentage of respondents	Reference number
Obesity practices	Presence of BMI cut-offs	82	17
	Presence of official policy on obesity	67–81	26, 27
	No BMI cut-off point present	6–55	20, 27–29
Obesity contraindications	BMI 40 kg/m <sup>2</sup>	6–62	11, 20, 26–28
	BMI 35–39 kg/m <sup>2</sup>	12–51	17, 20, 26–29
	BMI 30–34 kg/m <sup>2</sup>	2–24	17, 27–29
Age-related practices	No age cut-off point present	96	17
Age-related contraindications	Frailty	75	24
	Cognitive impairment without support	73	25
	Recipient is aged 75–79 years <sup>a</sup>	8–66	30
	Functional impairment without support	61	25
	Recipient is aged 70–74 years <sup>b</sup>	2–57	17, 30
	Recipient is aged 80+ years <sup>c</sup>	30–52	30
	Nursing home residency <sup>d</sup>	7–41	25
	(Progressive) cognitive impairment	34–36	25
	(Progressive) functional impairment	14–32	25
	Age cut-off 70–90 years	22	25
Other contraindications	Recipient is aged 65–69 years <sup>e</sup>	0–18	30
	Life expectancy following transplantation remains the same	25	25
	Untreated prostate cancer <sup>f</sup>	45	51

Percentages reflect findings from the original articles.

<sup>a</sup>8% of studied centers consider this an absolute contraindication and 66% a relative contraindication.

<sup>b</sup>2% of studied centers consider this an absolute contraindication and 57% a relative contraindication.

<sup>c</sup>30% of studied centers consider this an absolute contraindication and 52% a relative contraindication.

<sup>d</sup>41% of studied centers consider this an absolute contraindication, 16% considered this a contraindication if candidate is in nursing home purely for cognitive/social reasons, and 7% considered this a contraindication if candidate is in nursing home purely for physical reasons.

<sup>e</sup>0% of studied centers consider this an absolute contraindication and 18% a relative contraindication.

<sup>f</sup>The remaining respondents (55%) reported that whether patients with prostate cancer were eligible for kidney transplantation depended on the risk of disease. Of these respondents, 31% allowed active surveillance (in the absence of a definitive treatment), 33% did not, and 36% reported this depended on patient age.

distribution, waist-to-hip ratio, exercise tolerance, comorbidities, or muscle mass [26].

### Age-related factors

Four surveys reported age-related contraindications to waitlisting [17, 24, 25, 30]. Various cut-off points for age were reported but not frequently enforced [17, 30]. In the USA, a single survey reported that frailty was considered a contraindication in 75% of centers, which was assessed using the timed walk test (19% of centers), low BMI (15% of centers), functional status (12% of centers), the timed up-and-go or stair climb test (11% of centers), the number of hospitalizations (10% of centers), or by assessment of sarcopenia, the Montreal Cognitive Assessment (MoCA), or Fried frailty phenotype (8% of centers) [24]. Additional age-related contraindications included cognitive or functional impairment and nursing home residency [25].

### Other contraindications

One survey reported a minimal median life expectancy ranging between 2 and 10 years, wherein 25% of centers would not list a candidate that was only expected to benefit from kidney transplantation in terms of quality of life, as opposed to length of life [25].

### Organization of the transplantation work-up

A total of three surveys provided information related to the organization of the transplantation work-up [17, 20, 31]. Results

from studies containing a survey are summarized in Table 2c and results from studies not containing a survey are reported in [Supplementary information 3](#). Study-specific results are summarized in [Supplementary information 7](#).

Prior to initiating the transplantation work-up, patient suitability for kidney transplantation was discussed by their health-care provider(s). Among studied European centers, the decision to discuss kidney transplantation as an option was made using a multidisciplinary team approach (20%–55% of centers) or solely by consultant nephrologist (20%–40% of centers) [17, 31]. In the USA, a survey found that 59% of centers screened referrals prior to scheduling an in-person evaluation, while the remaining 40% of centers only evaluated patients at the scheduled visit [20]. This same survey also reported that 26% of centers prioritized the transplantation work-up of patients with a living donor, whilst 22% of centers prioritized the transplantation work-up of patients with a living donor if there was a chance of pre-emptive transplantation [20].

In the UK, a single survey reported that the most frequent setting of the transplantation work-up was a low clearance clinic (LCC, 36% of centers), followed by the usual CKD clinic (21% of centers), or a dedicated transplantation work-up clinic (20% of centers) [17]. Following completion of the transplantation work-up, waitlisting decisions were reached most often using a multidisciplinary team approach (76% of surveyed UK centers) [17]. The same survey stated that 88% of centers required all patients to be seen by a transplant surgeon before being wait-listed. Of the remaining centers, 6% of centers reported that all patients were discussed with a transplant surgeon and 6% of

Table 2c: Summary of survey results related to the organization of the transplantation work-up.

Domain	Practice	Percentage of respondents	Reference number
Screening & prioritization of candidates prior to the transplantation work-up	Screening of patients prior to in-person evaluation	59	20
	Patients were screened by a multidisciplinary team	20–55	17, 31
	Patients were screened by consultant nephrologist	40	17
	Prioritization of patients with a living donor	26	20
	Prioritization of patients with living donor if there is a chance of pre-emptive transplantation	22	20
Setting of the transplantation work-up	Dedicated low clearance clinic	36	17
	Usual chronic kidney disease clinic	21	17
	Dedicated transplantation work-up clinic	20	17
Waitlisting decisions	All patients must be seen by transplant surgeon prior to waitlisting	88	17
	Waitlisting decisions were reached by a multidisciplinary team	76	17

Percentages reflect findings from original articles.

centers reported no surgical involvement in reaching the waitlisting decision [17].

## DISCUSSION

This scoping review summarized recent practice patterns related to the evaluation of kidney transplant candidates prior to waitlisting from 20 studies. The content of the transplantation work-up varied between studied centers, but common domains included screening for infections, heart disease, PAD, and malignancy. Obesity and age-related factors were the most commonly reported contraindications to waitlisting. However, strict cut-offs for BMI and age were used less. The organization of the transplantation work-up differed across studied centers with regard to referral and waitlisting decisions, screening and prioritization, and the setting of the transplantation work-up.

### Content of the transplantation work-up

The content of the transplantation work-up varied between the studied centers. Within the infections domain, screening for HIV, HBV, HCV, CMV, and EBV was common and similar between studied centers, while within domains for heart disease, PAD, and malignancy, screening varied in the type of investigations used and the frequency of their use. The greatest amount of variation was observed in screening for heart disease, suggesting a lack of cohesiveness in this field. Pre-transplantation screening for (cardio)vascular disease aims to reduce peri- and post-operative cardiac events. However, findings from recently published studies suggest that screening for asymptomatic coronary artery disease (CAD) and coronary revascularization do not improve outcomes following kidney transplantation [32, 33], and guidelines and practices related to cardiovascular assessment need to be reviewed [34]. Further research is needed to determine best practices for cardiovascular screening in kidney transplant candidates. One such study, the Canadian–Australasian Randomised Trial of Screening Kidney Transplant Candidates for Coronary Artery Disease (CARSK) [35], is currently under way.

Variation in the content of the transplantation work-up may contribute to differences in transplantation access and outcomes between countries. To improve this, several organizations developed strategies to promote equitable access to kidney

transplantation. In the USA, the Organ Transplantation Affinity Group (OTAG) called for increasing the transparency of referral and pre-transplantation practices as part of their 2023–28 action plan [12], and in Europe the European Kidney Health Alliance (EKHA) recommended studying barriers to transplantation to help bridge the gap in transplantation activity between European countries [13]. In doing so, it is important to also take the subset of relatively young and healthy individuals with kidney failure into account, who would benefit from a shorter transplantation work-up containing less (invasive) screening methods compared with normal- or high-risk patients [18, 36]. Further research investigating and comparing the content of the transplantation work-up within and between countries is needed.

### Contraindications to waitlisting

The most commonly reported contraindications to waitlisting for kidney transplantation were obesity and age-related factors. However, strict cut-offs for age and BMI were less often used as sole determining factors for kidney transplant recipient candidacy. This is in accordance with studies suggesting that older and obese patients also experience a better quality of life and improved survival following kidney transplantation compared with dialysis [37–39]. Surprisingly, there was no mention of heart disease or PAD-related contraindications, despite the common practice of screening for heart disease and PAD during the transplantation work-up to assess the technical aspects and risks of the surgical procedure [40]. Likewise, accepted contraindications, such as active malignancy, non-adherence, or substance abuse, were also not mentioned by the included studies [10, 11]. However, these factors may still be used in the evaluation of kidney transplant candidates.

In practice, it is often a combination of contraindications that prevent a patient from entering the waiting list rather than a single condition barring access to kidney transplantation. While kidney transplantation is often the best KRT for most patients with kidney failure, contraindications serve as a balancing act between the improved quality and length of life offered by kidney transplantation and the increased risk of peri- and post-operative complications. Recent guidelines recommend weighing patient comorbidities in the context of other risk factors when evaluating kidney transplant candidates [41], but the practice of considering a combination of contraindications in the

evaluation of kidney transplant candidates was not captured by this review. Additionally, the rate of kidney transplantation can vary widely between countries [42], making it possible that in some countries the shortage of transplantable kidneys may have influenced the presence of some contraindications. In centers with strict contraindications, access to the transplant waiting list may be limited to the 'healthiest' patients who are deemed to benefit most from a kidney transplant.

### Organization of the transplantation work-up

The organization of the transplantation work-up was comparable between studied centers in terms of the order of events from referral to waitlisting; however, the manner in which the transplantation work-up was carried out differed between studied centers. Kidney transplant candidates were worked up in a variety of different clinical settings and waitlisting decisions were made individually by nephrologists or transplant surgeons, or by reaching a group consensus during multidisciplinary meetings. The organization of the transplantation work-up could contribute to inefficiency in the referral process and delay access to the transplant waiting list and kidney transplantation if referring centers are not well-informed of the transplant center's evaluation criteria and waitlisting procedures. A longer duration of the transplantation work-up likely results in prolonged dialysis and reduces the chance of pre-emptive kidney transplantation, both of which may negatively impact graft and patient survival [43–46].

### Strengths and limitations

Most notably, this review provides a comprehensive overview of practice patterns related to the evaluation of kidney transplant candidates prior to waitlisting. To increase the clinical relevance of this study, only practice patterns investigated in the last decade were included.

This review's main limitation is that results only reflect reported practice patterns of studied centers, and therefore the conclusions may not be generalizable to other centers. Thus, we were only able to comment on the variation of these reported practices. Despite the inclusion of 20 studies, results related to the content and organization of the transplantation work-up were based on a small number of studies. From the included studies, we were unable to draw conclusions with regard to practice patterns within countries or regions, or trends over time. The systematic search was restricted to published articles, and it is possible that additional information on the evaluation of kidney transplant candidates could be available via other sources (e.g. transplant center websites). To simplify the search, we omitted living donor kidney transplantation from our search strategy and focused on deceased donor kidney transplantation, despite the high prevalence of living donor transplantation in some countries. Furthermore, it is possible that some of the reported practices are outdated and may not reflect current clinical practice. Further research is needed to investigate current practice patterns in evaluating kidney transplant candidates, also how the evaluation of different subgroups may differ (e.g. dialysis patients, diabetic patients, older patients). The lack of studies comparing different evaluation strategies, especially how these strategies relate to kidney transplantation outcomes, is one of the remaining gaps in knowledge.

It is important to note that while standardization of pre-waitlisting practices patterns is considered desirable, this is only one aspect of a more holistic approach to improving equity and access to kidney transplantation. Variation in practice patterns

may also reflect nuanced approaches, which in some instances or circumstances may in fact be more efficient or more suitable.

## CONCLUSION

This scoping review, based on 20 studies, found global variation in the evaluation of kidney transplant candidates. Results show that the content of the transplantation work-up varied between studied centers, even within common screening domains. Within the infections domain, screening for HIV, HBV, HCV, CMV, and EBV was similar between studied centers, whilst domains for heart disease, PAD, and malignancy varied in the type of investigations used and the frequency of their use. The most commonly reported contraindications to waitlisting were obesity and age-related factors. The order of events in the organization of the transplantation work-up was comparable across studied centers, yet the manner in which the transplantation work-up was carried out differed.

Overall, literature on kidney transplant candidacy evaluation is lacking and further studies investigating pre-transplantation practices are needed. This review is a first step to increasing the transparency of pre-waitlisting practice patterns, as was endorsed by EU and US recommendations. In turn, this may aid in standardizing the criteria used to evaluate kidney transplant candidates prior to waitlisting, which could improve kidney transplantation access and outcomes.

## SUPPLEMENTARY DATA

Supplementary data are available at [Clinical Kidney Journal](#) online.

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## AUTHORS' CONTRIBUTIONS

B.A.B.: conceptualization, methodology, formal analysis, investigation, writing—original draft, visualization, project administration; M.P.: conceptualization, investigation, writing—review and editing; A.K.: conceptualization, investigation, writing—review and editing; M.D.: investigation; J.D.: methodology; K.J.J.: conceptualization, investigation, writing—review and editing; R.H.: conceptualization, investigation, writing—review and editing; V.S.S.: conceptualization, methodology, investigation, writing—review and editing, supervision.

## DATA AVAILABILITY STATEMENT

No new data were generated or analyzed in support of this research.

## CONFLICT OF INTEREST STATEMENT

None declared.

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