

OPINION

ISOT Position Statement on Immunological Evaluation in Kidney Transplantation

Manish R. Balwani^{1,2} | Anil Kumar³ | Vivek B. Kute⁴ | Khushboo Saxena⁵ | Pranjal Kashiv² | Jigar Shrimali⁶ | Subho Banerjee⁵ | Divyesh P. Engineer⁵ | Sanjay Kumar Agarwal⁷ | Sanjay Kolte⁸ | Amit Pasari¹ | Feroz Aziz^{9,10} | Pratik Das¹¹ | Umapati Hegde¹² | Deepak S. Ray¹¹ | Dhananjai Agarwal¹³ | Sourabh Sharma¹⁴ | Amol Bhawane¹⁵ | Narayan Prasad¹⁶ | Arpita Ray Chaudhury¹⁷ | Sreebhushan Raju¹⁸ | Shruti Tapiawala¹⁹ | Vikas Jain²⁰ | Debasis Das²¹ | Vrushali Deshpande²² | Vishal Ramteke²³ | Ashish Sharma²⁴ | Anil K. Bhalla²⁵ | Sandeep Guleria²⁶ | Georgi Abraham²⁷ | Vishal Parmar⁵ | Sakthi Selvakumar²⁸ | Suraj M. Godara²⁹ | Kapil Gothwal²⁴ | Sanshriti Chauhan³⁰ | Hari Shankar Meshram³¹

¹Department of Nephrology, Saraswati Kidney Care Center, Nagpur, Maharashtra, India | ²Department of Nephrology, Jawaharlal Nehru Medical College, DMIHER, Wardha, Maharashtra, India | ³National Organ and Tissue Transplant Organization (NOTTO), Ministry of Health and Family Welfare, Government of India, New Delhi, India | ⁴Treasurer, Indian Society of Organ Transplantation, Ahmedabad, Gujarat, India | ⁵Department of Nephrology, Institute of Kidney Diseases and Research Center and Institute of Transplantation Sciences (IKDRC-ITS), Ahmedabad, Gujarat, India | ⁶Department of Nephrology, Renu Kidney Hospital, Ahmedabad, Gujarat, India | ⁷Department of Nephrology, AIIMS, New Delhi, India | ⁸Department of Urology, Max Super Speciality Hospital / Sparsh Urology and Kidney Hospital, Nagpur, India | ⁹Department of Nephrology, Aster MIMS Hospital, Kozhikode, Kerala, India | ¹⁰Department of Nephrology, IQRAA International Hospital and Research Centre, Kozhikode, Kerala, India | ¹¹Department of Nephrology, Rabindranath Tagore International Institute of Cardiac Sciences, Kolkata, West Bengal, India | ¹²Department of Nephrology, Muljibhai Patel Urological Hospital, Nadiad, Gujarat, India | ¹³Department of Nephrology, SMS Medical College, Jaipur, Rajasthan, India | ¹⁴Department of Nephrology, VMMC & Safdarjung Hospital, New Delhi, India | ¹⁵Department of Nephrology, AIIMS, Nagpur, India | ¹⁶Department of Nephrology, SGPGI, Lucknow, Uttar Pradesh, India | ¹⁷Department of Nephrology, North Bengal Medical College, Siliguri, West Bengal, India | ¹⁸Department of Nephrology, NIMS, Hyderabad, Telangana, India | ¹⁹Department of Nephrology, Institute of Renal Sciences, Global Hospital, Mumbai, Maharashtra, India | ²⁰Department of Urology, Manipal Hospital, Dwarka, New Delhi, India | ²¹Department of Cardiac Surgery, Narayana Super-Speciality Hospital, Howrah, Kolkata, India | ²²Department of Pathology, Institute of Surgical Pathology, Nagpur, Maharashtra, India | ²³Department of Nephrology, Max Super Speciality Hospital, Nagpur, Maharashtra, India | ²⁴Department of Renal Transplant Surgery, PGIMER, Chandigarh, India | ²⁵Department of Nephrology, Sir Ganga Ram Hospital, New Delhi, India | ²⁶Department of Nephrology, Indraprastha Apollo Hospitals, New Delhi, India | ²⁷Department of Nephrology, Madras Medical Mission and Tanker Foundation, Chennai, India | ²⁸Department of Nephrology, Kauvery Hospital, Trichy, Tamil Nadu, India | ²⁹Department of Nephrology, Mahatma Gandhi Medical College & Hospital, Jaipur, Rajasthan, India | ³⁰Department of Nephrology, Fortis, New Delhi, India | ³¹Department of Nephrology, ILBS, New Delhi, India

Correspondence: Vivek B. Kute (drvivekkute@rediffmail.com)

Received: 7 April 2026 | **Revised:** 11 July 2026 | **Accepted:** 17 July 2026

Keywords: antibodies | blood group incompatibility | crossmatching | desensitization | histocompatibility testing | HLA | immunologic | kidney transplantation

ABSTRACT

Background: Immunological evaluation plays a central role in kidney transplantation, guiding donor selection, risk assessment, and graft outcomes. Although international guidelines are comprehensive, applying them in a real-world low resource setting can be challenging where laboratory capacity varies and access to advanced testing is limited. There is therefore a need for implementable guidelines that reflect local realities while maintaining clinical rigor.

Methods: The Indian Society of Organ Transplantation (ISOT) brought together a multidisciplinary panel of transplant nephrologists, surgeons, clinical immunologists, and histocompatibility laboratory scientists from centers across India. A focused review of international guidelines, systematic reviews, and key studies was undertaken. Draft recommendations were developed

and shared ahead of a structured consensus meeting. These were discussed, refined, and finalized through iterative expert deliberation. Recommendations were classified as “Recommended” or “Suggested” based on consensus, and their evidentiary basis was clearly defined.

Results: A total of 48 consensus recommendations were developed across 13 thematic areas covering key aspects of immunological evaluation. These included immunological risk assessment, antibody screening and crossmatch testing including virtual crossmatch, sensitization assessment, serum sampling and waitlist monitoring, HLA typing, post-transplant monitoring, laboratory governance and immunological assessment in ABO-incompatible transplantation. Of these, 23 were “Recommended” and 25 “Suggested.” Additional guidance focused on resource-adapted and cost-conscious approaches suited to the Indian context.

Conclusions: These recommendations offer a practical and standardized framework for immunological evaluation in kidney transplantation within low- and middle-income settings. Their adoption has the potential to improve patient safety and optimize graft outcomes.

1 | Introduction

Kidney transplantation remains the optimal treatment for end-stage kidney disease (ESKD), offering superior survival and quality of life compared with long-term dialysis. Immunological compatibility between donor and recipient plays a critical role in determining patient and graft outcomes, and advances in transplant immunology assessment have significantly improved risk stratification, donor selection, and post-transplant monitoring. Over the past decades, the introduction of sensitive antibody detection techniques, including flow cytometric crossmatch (FxCm), solid-phase assays, and donor-specific antibody (DSA) testing, has enhanced the ability to identify immunological risk and prevent antibody-mediated rejection (ABMR). However, the application of these technologies varies widely across transplant centers, particularly in resource-limited healthcare systems.

India performs a large number of kidney transplants annually, but transplant programs operate within a heterogeneous healthcare environment characterized by variability in laboratory infrastructure, access to advanced immunological testing, and financial constraints. Although international guidelines from Kidney Disease: Improving Global Outcomes (KDIGO), the American Society of Transplantation (AST), and the European Society for Organ Transplantation (ESOT) provide comprehensive recommendations, their direct implementation may not always be feasible across all transplant settings in India. Consequently, there is a need for context-specific guidance that integrates international evidence with practical considerations relevant to the Indian healthcare ecosystem.

To address this gap, the Indian Society of Organ Transplantation (ISOT) convened a multidisciplinary expert panel to develop consensus recommendations on immunological evaluation in kidney transplantation. The objective of this consensus statement is to provide a pragmatic framework for immunological risk assessment, antibody screening, compatibility testing, and post-transplant monitoring, while acknowledging differences in laboratory capability and resource availability across transplant centers.

2 | Methods

Development of the Expert Consensus Statement: This expert consensus statement was developed under the aegis of Indian Society of Organ Transplantation (ISOT) to provide practical guidance on immunological evaluation in kidney transplantation in the Indian healthcare setting. The methodological framework for development and reporting of this document was informed by the ACCORD (Guideline for Reporting Consensus-Based Methods in Biomedical Research) recommendations. The goal of this consensus process was to synthesize available international evidence together with national clinical expertise to generate contextually relevant recommendations for transplant programs operating within heterogeneous healthcare environments.

Expert Panel Composition: The consensus panel comprised multidisciplinary specialists involved in kidney transplantation across India, including: transplant nephrologists ($n = 8$); transplant surgeons ($n = 4$); clinical immunologists ($n = 3$); histocompatibility laboratory specialists ($n = 3$). Panel members were invited by the ISOT organizing committee based on: recognized expertise in kidney transplantation; active involvement in transplant immunology practice; academic contributions in the field and representation of transplant programs with varying laboratory infrastructure and clinical resources. The panel was intended to reflect the multidisciplinary structure of transplant programs and the diverse practice environments across India.

Scope of the Consensus: This document focuses on immunological evaluation in kidney transplantation. The scope includes recommendations related to: immunological risk assessment; anti-HLA antibody screening; sensitization assessment; serum sampling and waitlist monitoring; HLA typing strategies; crossmatch testing and interpretation; donor-specific antibody (DSA) interpretation; virtual crossmatch strategies; desensitization approaches; ABO-incompatible transplantation; post-transplant immunological monitoring; management considerations for highly sensitized candidates; laboratory standards and governance.

Literature Review and Evidence Identification: A focused narrative literature review was conducted to inform development of the recommendation statements. Evidence sources included: international clinical practice guidelines, consensus statements from transplant societies, systematic reviews and meta-analyses, large cohort and observational studies in transplant immunology.

Electronic searches were performed in PubMed, Embase, and Google Scholar, supplemented by manual review of reference lists from key publications. Key reference guideline documents included those from: Kidney Disease: Improving Global Outcomes (KDIGO), American Society of Transplantation (AST) and European Society for Organ Transplantation (ESOT). Evidence was interpreted with particular consideration for clinical applicability within the Indian transplant ecosystem, including variation in laboratory resources, institutional practices, and access to advanced testing.

Development of Recommendation Statements: An initial set of recommendation statements was drafted by the writing group based on synthesis of the literature review and current clinical practices in transplant immunology. The statements were structured into thematic domains corresponding to key steps in immunological evaluation for kidney transplantation. These domains formed the 13 sections presented in the recommendation tables. Draft statements were circulated among panel members prior to the consensus meeting to allow preliminary review and feedback.

Consensus Development Process: Consensus was achieved through a structured expert panel meeting convened by ISOT. During the meeting: (1) Each draft statement was presented by the writing group. (2) Panel members discussed the scientific rationale, clinical applicability, and feasibility of each statement. (3) Statements were revised where necessary to reflect panel input. (4) Final wording was agreed upon through iterative group discussion. Panel members were encouraged to consider: strength of supporting evidence, relevance to current transplant practice, feasibility across different healthcare settings and laboratory resource variability. No formal Delphi methodology or anonymous voting process was employed. Instead, recommendations were finalized when no substantive objections were raised following discussion. This approach mirrors structured expert panel consensus, commonly used in clinical fields where high-quality randomized evidence is limited.

Definition of Consensus: Two recommendation terminologies were used in this document.

Recommended: Statements designated as Recommended represent recommendations for which unanimous agreement was achieved among panel members during the consensus meeting. These recommendations reflect practices considered appropriate for most transplant centers.

Suggested: Statements designated as Suggested represent recommendations for which the panel agreed on the general direction of the recommendation but acknowledged greater uncertainty, variability in institutional practice, or dependence on available resources. These recommendations may require adaptation based on local expertise and infrastructure.

Classification of Evidence Basis: The evidentiary basis supporting each recommendation was classified into one of the following categories to provide transparent context regarding the source of supporting information.

- Adopted from International Guidelines: Recommendations derived directly from established international clinical practice guidelines issued by major transplant organizations.
- Adapted from International Guidelines: Recommendations based on international guidelines but modified to reflect the Indian clinical context, resource availability, or national regulatory considerations.
- Observational Evidence: Recommendations supported primarily by observational studies, registry data, or cohort studies rather than randomized controlled trials.
- Expert Opinion: Recommendations based primarily on collective expert experience in transplant immunology when high-quality published evidence was limited or unavailable.
- Legal Requirement: Recommendations that derive from a binding statutory or regulatory mandate governing organ transplantation in India, specifically the Transplantation of Human Organs and Tissues Act (THOTA) and its associated Rules, rather than from a graded body of clinical evidence. Such recommendations are incorporated as mandatory practice points applicable to all transplant programs operating within the Indian regulatory framework, irrespective of the strength of the underlying scientific evidence.

This classification system was used for transparency and does not represent a formal GRADE evidence assessment; where a recommendation reflected a statutory mandate, it was classified under Legal Requirement to signal that its inclusion is driven by national regulatory obligation rather than by graded evidence.

3 | Results

Final consensus statements were organized into 13 thematic sections covering the full pathway of immunological evaluation in kidney transplantation: (1) Immunological Risk Assessment, (2) Antibody Screening and Sensitization Assessment, (3) Serum Sampling and Waitlist Monitoring, (4) HLA Typing Strategy, (5) Pre-Transplant Crossmatch Testing including Virtual Crossmatch, (6) Interpretation of Crossmatch and Donor-Specific Antibodies, (7) Desensitization and Alternative Transplant Strategies, (8) ABO-Incompatible Transplantation, (9) Post-Transplant Immunological Monitoring, (10) Emerging and Adjunct Immunological Tools, (11) Laboratory Standards and Governance, (12) Practical Immunological Testing Algorithm, and (13) Recommendation in resource restricted setting

A total of 48 recommendation statements were developed across 13 thematic sections addressing the immunological evaluation of kidney transplant candidates and recipients. Of these, 23 statements were classified as "Recommended" and 25 as "Suggested", reflecting varying levels of consensus strength and applicability across transplant settings (Table 1). A structured approach to interpreting DSA and associated clinical decisions is summarized in Table 2. A practical stepwise immunological evaluation pathway is provided in Table 3 and Figure 1.

TABLE 1 | Immunological evaluation in kidney transplantation.

S. No.	Statements	Strength	Evidence
Section 1. Immunological Risk Assessment			
1.1	We recommend all potential kidney transplant recipients and donors undergo baseline immunological risk stratification prior to donor selection and transplant planning.	1	Adopted from International Guidelines [1, 2, 3, 4, 5]
1.2	We recommend including risk stratification assessment of prior transplantation including graft outcome, blood transfusions, pregnancy, and other history of HLA sensitization.	1	Adopted from International Guidelines [1, 3, 4, 6]
1.3	We suggest kidney transplant candidates be categorized as low or high immunological risk based on sensitization history, PRA/cPRA level, DSA status, and crossmatch results.	2	Observational Evidence [3, 7, 8, 9, 10, 11]
Section 2. Antibody Screening and Sensitization Assessment			
2.1	We recommend all kidney transplant candidates undergo anti-HLA antibody screening as part of routine pre-transplant immunological evaluation.	1	Adopted from International Guidelines [1, 3, 12]
2.2	We recommend assessment of PRA or calculated PRA (cPRA) to estimate the presence and degree of sensitization in a patient while listing in deceased donor kidney transplantation program	1	Adopted from International Guidelines [3, 5, 13, 14]
2.3	We recommend solid-phase antibody testing using Luminex-based assays be performed, where available, in sensitized candidates	1	Adopted from International Guidelines [3, 15, 16, 12]
2.4	We suggest single-antigen bead (SAB) assays be used in sensitized or high immunologic-risk candidates to identify DSA and support crossmatch interpretation.	2	Observational Evidence [15, 17, 18, 19, 20, 21]
2.5	We recommend interpretation of SAB assay results based on clinical context, sensitization history, cross match findings, antibody strength, target HLA loci, assay limitations, prozone effect, CREG pattern and inter-laboratory variability, rather than relying solely on MFI values.	1	Expert Opinion [15, 17, 18, 22]
Section 3. Serum Sampling and Waitlist Monitoring			
3.1	We suggest pre-transplant crossmatch testing use the most recent recipient serum sample, preferably obtained within 48 h and not exceeding 72 h prior to transplantation, where feasible	2	Adapted from International Guidelines [1, 3, 23]
3.2	We recommend candidates on a deceased donor waiting list undergo periodic antibody screening, with repeat testing following any sensitizing event	1	Adopted from International Guidelines [1, 3, 4]
3.3	We suggest storage of historical serum samples to be encouraged to facilitate retrospective antibody analysis in cases of unexpected rejection	2	Expert Opinion ¹
Section 4. HLA Typing Strategy			
4.1	We recommend minimum HLA typing for kidney transplantation to include HLA-A, HLA-B, HLA-DR loci for all recipients and donors; and HLA-DQ loci typing, wherever feasible	1	Adopted from International Guidelines [3, 4]
4.2	We suggest additional typing for HLA-C and HLA-DP be considered, particularly in sensitized recipients and retransplant candidates.	2	Observational Evidence [3, 24, 25, 26, 27]
4.3	We suggest HLA typing be performed by reverse-SSOP or NGS (2-field or Medium-High resolution) especially when virtual crossmatch, detailed antibody interpretation, or epitope analysis is required.	2	Expert Opinion [24, 25, 26, 28, 29]
4.4	We suggest establishing biological relationship in living related donation by DNA profiling, as required under the Transplantation of Human Organs and Tissues Act (THOTA)	2	Legal Requirement [30]

(Continues)

TABLE 1 | (Continued)

Section 4. HLA Typing Strategy			
Section 5. Pre-Transplant Crossmatch Testing			
5.1	We recommend performing a physical crossmatch prior to living donor kidney transplantation	1	Expert Opinion [1, 3, 34]
5.2	We suggest either CDC crossmatch or flow cytometric crossmatch be used depending on laboratory capability, in low immunological-risk candidates.	2	Adapted from International Guidelines ^{31,32,3}
5.3	We suggest flow cytometric crossmatch to be preferred where available because of its greater sensitivity, particularly in sensitized recipients and retransplant candidates.	2	Adapted from International Guidelines [3, 32]
5.4	We recommend crossmatch results to be interpreted with distinction between T-cell and B-cell reactivity and in conjunction with DSA testing and clinical risk assessment.	1	Adapted from International Guidelines ^{3,33,19}
5.5	We suggest deceased donor kidney allocation to be based on virtual crossmatch where reliable antibody data and validated laboratory systems are available.	2	Observational Evidence [3, 34, 35]
Section 6. Interpretation of Crossmatch and Donor-Specific Antibodies (Table 3)			
6.1	We recommend all immunological testing to be appropriately planned and interpreted in the context of clinical history to ensure accurate risk assessment and optimal transplant decision-making.	1	Observational Evidence [3, 33, 17, 40]
6.2	We recommend that while a positive CDC crossmatch is generally considered a contraindication to kidney transplantation, any decision to reject a particular donor be mandatorily preceded by a more detailed evaluation and not be based on a single CDC crossmatch alone.	1	Adopted from International Guidelines [31, 1, 3]
6.3	We recommend that an isolated positive flow cytometric crossmatch with negative CDC crossmatch be interpreted cautiously with individual assessment of DSA strength and clinical context.	1	Observational Evidence [3, 33, 15, 9, 36]
6.4	We recommend clinicians and transplant centers defining center-specific cutoffs based on clinical expertise and context	1	Observational Evidence [17, 18, 22]
6.5	We suggest complement-binding assays such as C1q or C3d to be considered in selected high-risk recipients to assess antibody pathogenicity.	2	Expert Opinion [37, 22]
Section 7. Desensitization and Alternative Transplant Strategies			
7.1	We suggest evaluating highly sensitized candidates for kidney paired exchange, deceased donor priority allocation where available, or desensitization in experienced centers.	2	Observational Evidence [38, 39, 40, 41]
7.2	We suggest kidney paired exchange to be considered before desensitization in candidates with positive flow crossmatch or clinically significant DSA.	2	Expert Opinion [38, 39, 40, 42]
7.3	We suggest desensitization to be considered in selected candidates when alternative donors are unavailable and the anticipated benefit outweighs immunological risk.	2	Adapted from International Guidelines [39, 40, 41, 43]
7.4	We suggest desensitization protocols include plasmapheresis, IVIG, rituximab, or other adjunctive therapies, according to institutional expertise and resource availability.	2	Observational Evidence [40, 44, 41]
Section 8. ABO Incompatible Transplantation (ABOiKT): Antibody Testing, Titer Cutoff, and Post-Transplant Monitoring			
8.1	We suggest ABOiKT be performed in centers with established desensitization protocols, transfusion medicine support and monitoring capability.	2	Adapted from International Guidelines [44, 45, 46]

(Continues)

TABLE 1 | (Continued)

Section 8. ABO Incompatible Transplantation (ABOiKT): Antibody Testing, Titer Cutoff, and Post-Transplant Monitoring			
8.2	We recommend baseline anti-A/anti-B isoagglutinin titers to be measured before planning ABOiKT and IgG titers guide clinical decision-making	1	Adopted from International Guidelines [44, 45, 47, 48]
8.3	We recommend candidates who are both ABO-incompatible and HLA-sensitized to be considered at particularly high immunological risk.	1	Adopted from International Guidelines [39, 45, 49]
8.4	We suggest ABO isoagglutinin titers to be measured using the column agglutination technique, following a standardized center-specific SOP, with all serial measurements performed using the same method.	2	Adapted from International Guidelines [44, 45]
8.5	We suggest centers to aim for a low pre-transplant titer, typically $\leq 1:8$ to $\leq 1:32$, based on local protocols and desensitization capability.	2	Adapted from International Guidelines [44, 45]
8.6	We suggest monitoring ABO antibody titers in the first 1–2 weeks post-transplant and management be guided by clinical and graft function parameters, and not by titer rise alone.	2	Adapted from International Guidelines [44, 45]
Section 9. Post-Transplant Immunological Monitoring			
9.1	We suggest not monitoring DSA routinely in low immunological-risk kidney transplant recipients, particularly in resource-limited settings. Post-transplant serum may be stored for testing if needed.	2	Observational Evidence [50]
9.2	We suggest routine DSA monitoring be considered in high immunological-risk recipients	2	Adapted from International Guidelines [24, 9, 51]
9.3	We recommend DSA monitoring be performed at 3, 6, and 12 months after transplantation and annually thereafter, where resources permit.	1	Observational Evidence [24]
9.4	We suggest DSA testing be performed in cases of unexplained decline in graft function.	2	Adapted from International Guidelines ^{24,52,53,54,55}
Section 10. Emerging and Adjunct Immunological Tools			
10.1	We suggest Donor-derived cell-free DNA (dd-cfDNA) be used as a non-invasive adjunctive biomarker for early detection of allograft injury but should not replace histopathological diagnosis.	2	Expert Opinion [56, 57, 58, 59, 60]
10.2	We recommend not using eplet mismatch analysis and non-HLA antibody testing for routine clinical use due to limited standardization and availability.	1	Adapted from International Guidelines [3, 44, 58, 59]
Section 11. Laboratory Standards and Governance			
11.1	We suggest Histocompatibility testing be performed in laboratories accredited under national standards such as National Accreditation Board for Testing and Calibration Laboratories (NABL)	2	Expert Opinion [3, 15]
11.2	We recommend laboratories should maintain standard operating procedures, internal quality control systems, and documented personnel competency assessment. Participation in external quality assurance programs is encouraged.	1	Expert Opinion [3, 15]
11.3	We suggest close collaboration between transplant physicians, surgeons, coordinators, and histocompatibility laboratories for appropriate interpretation of immunological testing.	2	Expert Opinion [1]
Section 12. Recommended Immunological Testing According to Resource Availability			
12.1	We recommend all transplant centers ensure access to minimum essential immunological testing either locally or through referral laboratories.	1	Expert Opinion [3, 15]

(Continues)

TABLE 1 | (Continued)

Section 12. Recommended Immunological Testing According to Resource Availability			
12.2	We recommend centers without advanced immunological testing capability should establish collaborative networks with regional histocompatibility laboratories to enable access to specialized testing when clinically required.	1	Expert Opinion [3, 15]
Section 13. Cost-Conscious Testing Strategies in the Indian Context			
13.1	We recommend immunological testing strategies in India consider cost constraints, insurance coverage, and variability in laboratory access, while maintaining patient safety.	1	Expert Opinion [61, 62]
13.2	We recommend advanced immunological testing be considered for sensitized patients, retransplants, ABO-incompatible transplantation, and cases with prior rejection.	1	Expert Opinion [4, 39, 40, 41, 58]
Recommend: 1; suggest: 2			

Abbreviations: ABO, ABO blood group system; ABOiKT, ABO-incompatible kidney transplantation; C1q, complement component 1q; C3d, complement component 3d; CDC, complement-dependent cytotoxicity; cPRA, calculated panel reactive antibody; CREG, cross-reactive group; DNA, deoxyribonucleic acid; DSA, donor-specific antibody; HLA, human leukocyte antigen (HLA-A, -B, -C, -DP, -DQ, -DR); IgG, immunoglobulin G; IVIG, intravenous immunoglobulin; MFI, mean fluorescence intensity; NGS, next-generation sequencing; PRA, panel reactive antibody; SAB, single antigen bead; SOP, standard operating procedure; SSOP, sequence-specific oligonucleotide probe; THOTA, Transplantation of Human Organs and Tissues Act.

TABLE 2 | A structured approach to interpreting donor-specific antibodies and associated clinical decisions is summarised.

Scenario	Suggested approach
Negative CDC and Flow crossmatch, no DSA	Proceed with transplantation
Negative CDC, positive Flow crossmatch or DSA	Individualized risk assessment
Positive CDC crossmatch and/or Flow crossmatch with documented DSA	Avoid transplantation
Significant DSA with ABO compatible donor	Consider kidney paired exchange or desensitization

Abbreviations: CDC, complement-dependent cytotoxicity; CREG, cross-reactive group; DSA, donor-specific antibody; HLA, human leukocyte antigen; MFI, mean fluorescence intensity; SAB, single antigen bead.

TABLE 3 | A practical stepwise broad immunological evaluation pathway.

DSA strength (SAB MFI) ^a	immunological risk	Suggested clinical approach
<1000	Minimal	Usually clinically insignificant
1000–5000	Low-moderate	A. Increased rejection risk; evaluate carefully B. Consider clinical context and crossmatch results C. Individualize case-by case threshold for desensitization. D. KT with induction with informed consent E. Consider paired exchange or desensitization
>5000	High	A. Consider paired exchange or desensitization B. Transplantation usually avoided unless desensitization successful

Abbreviations: ABO, ABO blood group system; CDC, complement-dependent cytotoxicity; DSA, donor-specific antibody; HLA, human leukocyte antigen; PRA, panel reactive antibody; SAB, single antigen bead.

^aHLA-A, HLA-B, HLA-DR, HLA-DQ: Same cutoffs may not be applicable to antibodies against all loci.

4 | Discussion

Kidney transplantation in India occurs within a heterogeneous healthcare system, with significant variability in laboratory infrastructure, financial resources, and access to advanced

immunological testing. Approximately 80% of kidney transplants are performed in private hospitals, while 20% occur in government institutions [63]. Many patients bear a substantial proportion of medical costs out-of-pocket due to limited universal health insurance coverage and public funding. These

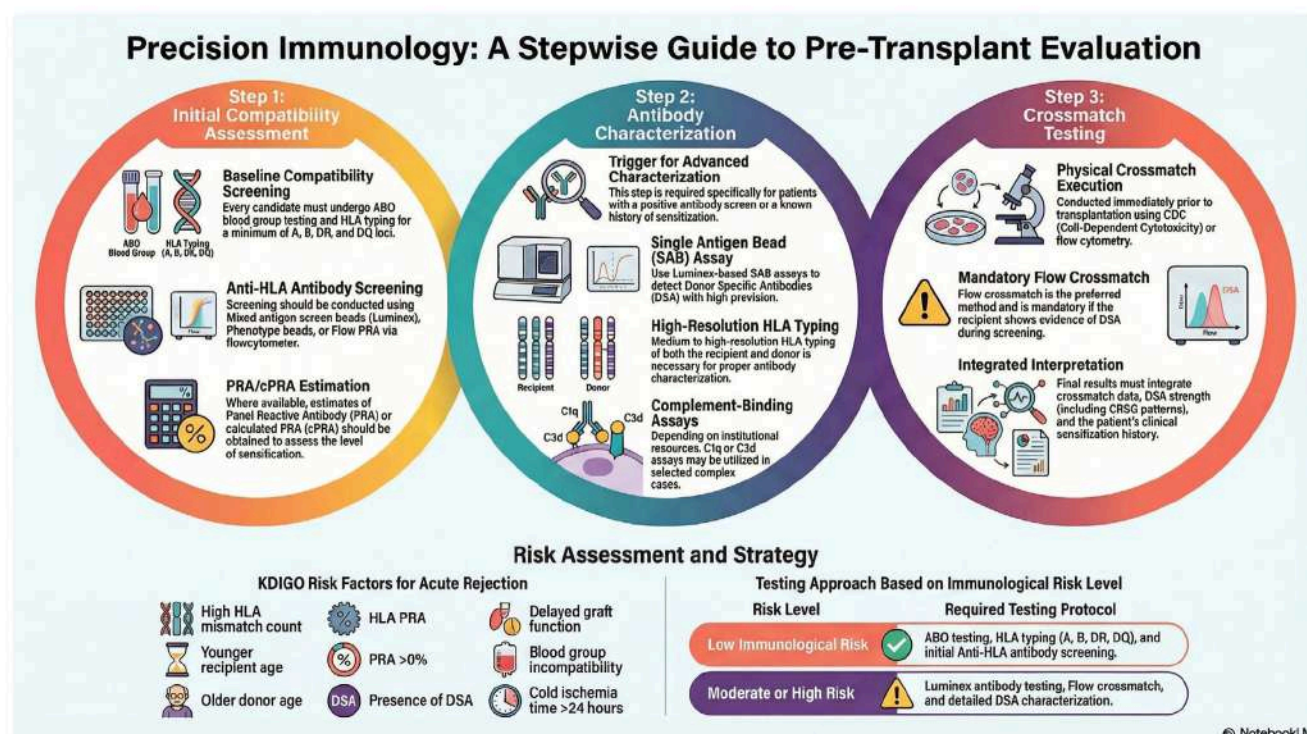


FIGURE 1 | Stepwise immunological evaluation before kidney transplantation. Sequential workup through HLA and ABO typing, anti-HLA antibody screening with donor-specific antibody detection, and physical crossmatch, integrated to define recipient immunological risk. Figure created using Google NotebookLM. ABO, ABO blood group; DSA, donor-specific antibody; HLA, human leukocyte antigen.

factors influence the availability and utilization of advanced immunological testing such as: Luminex single antigen bead (SAB) assays, Complement-binding antibody testing and Donor-derived cell-free DNA (dd-cfDNA) monitoring. In addition, there is significant variability in histocompatibility laboratory capacity across transplant centers.

To address these challenges, the expert panel recommends:

- Adoption of a stepwise testing approach, prioritizing essential immunological evaluation.
- Development of regional transplant immunology laboratories to support smaller centers and reduce costs.
- Standardization of laboratory quality assurance and accreditation through NABL.
- Close collaboration between physicians, transplant surgeons, and histocompatibility laboratories.

Future priorities for transplant immunology in India include:

- Expansion of kidney paired exchange programs
- Establishment of national transplant laboratory networks
- Development of cost-effective immunological testing strategies

These measures may help optimize patient and graft outcomes across diverse healthcare settings in India.

5 | Conclusions

These recommendations offer a practical and standardized framework for immunological evaluation in kidney transplantation within low- and middle-income settings. Their adoption has the potential to improve patient safety and optimize graft outcomes.

Funding

The authors have nothing to report

Author Contributions

Manish R. Balwani, Vivek B. Kute, Khushboo Saxena, Pranjal Kashiv Subho Banerjee, Divyesh P Engineer and Hari Shankar Meshram: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing, Supervision and all other authors: Investigation, Expert consultation, Writing – review & editing, Validation, and final approval of the manuscript. Anil Kumar, Jigar Shrimali, Divyesh P. Engineer, Sanjay Kumar Agarwal, Sanjay Kolte, Amit Pasari, Feroz Aziz, Pratik Das, Umapati Hegde, Deepak S. Ray, Dhananjai Agarwal, Sourabh Sharma, Amol Bhawane, Narayan Prasad, Arpita Ray Chaudhury, Sreebhushan Raju, Shruti Tapiawala, Vikas Jain, Debasis Das, Vrushali Deshpande, Vishal Ramteke, Ashish Sharma, Anil K. Bhalla, Sandeep Guleria, Georgi Abraham, Vishal Parmar, Sakthi Selvakumar, Suraj M. Godara, Kapil Gothwal, and Sanshriti Chauhan have contributed.

Ethics Statement

This manuscript is an expert consensus statement by the Indian Society of Organ Transplantation (ISOT) based on published literature and clinical

expertise. It does not involve primary data, human participants, or identifiable patient information. In accordance with ICMJE guidelines, ethical approval and informed consent were not required. All authors contributed to the recommendations and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. Kidney Disease: Improving Global Outcomes (KDIGO) Transplant Work Group, "KDIGO Clinical Practice Guideline for the Care of Kidney Transplant Recipients," *American Journal of Transplantation* 9, no. 3 (2009): S1–S155, <https://doi.org/10.1111/j.1600-6143.2009.02834.x>.
2. S. J. Chadban, C. Ahn, D. A. Axelrod, et al., "KDIGO Clinical Practice Guideline on the Evaluation and Management of Candidates for Kidney Transplantation," *Transplantation* 104, no. 4S1 Suppl 1 (2020): S11–S103, <https://doi.org/10.1097/TP.0000000000003136>.
3. B. D. Tait, C. Süsal, H. M. Gebel, et al., "Consensus Guidelines on the Testing and Clinical Management Issues Associated With HLA and Non-HLA Antibodies in Transplantation," *Transplantation* 95, no. 1 (2013): 19–47, <https://doi.org/10.1097/TP.0b013e31827a19cc>.
4. A. R. Tambur, P. Campbell, F. H. Claas, et al., "Sensitization in Transplantation: Assessment of Risk (STAR) 2017 Working Group Meeting Report," *American Journal of Transplantation* 18, no. 7 (2018): 1604–1614, <https://doi.org/10.1111/ajt.14752>.
5. N. Mamode, O. Bestard, F. Claas, et al., "European Guideline for the Management of Kidney Transplant Patients With HLA Antibodies: By the European Society for Organ Transplantation Working Group," *Transplant International* 35 (2022): 10511, <https://doi.org/10.3389/ti.2022.10511>.
6. S. S. Wan, S. J. Chadban, N. Watson, and K. Wyburn, "Development and Outcomes of De Novo Donor-Specific Antibodies in Low, Moderate, and High Immunological Risk Kidney Transplant Recipients," *American Journal of Transplantation* 20, no. 5 (2020): 1351–1364, <https://doi.org/10.1111/ajt.15754>.
7. J. M. Cecka, "Calculated PRA (CPRA): The New Measure of Sensitization for Transplant Candidates," *American Journal of Transplantation* 10, no. 1 (2010): 26–29, <https://doi.org/10.1111/j.1600-6143.2009.02927.x>.
8. Z. Y. Kang, X. Y. Han, C. Liu, W. Liu, and D. H. Li, "Association of Donor-Specific Antibodies With Adverse Outcomes in Solid Organ Transplantation: A Systematic Review and Meta-Analysis of 69 Studies," *Frontiers in Immunology* 16 (2025): 1633853, <https://doi.org/10.3389/fimmu.2025.1633853>.
9. C. Süsal and G. Opelz, "Current Role of Human Leukocyte Antigen Matching in Kidney Transplantation," *Current Opinion in Organ Transplantation* 18, no. 4 (2013): 438–444, <https://doi.org/10.1097/MOT.0b013e3283636ddf>.
10. O. Bestard, O. Thaunat, M. I. Bellini, et al., "Alloimmune Risk Stratification for Kidney Transplant Rejection," *Transplant International* 35 (2022): 10138, <https://doi.org/10.3389/ti.2022.10138>.
11. O. Bestard, L. Couzi, M. Crespo, N. Kassarir, and O. Thaunat, "Stratifying the Humoral Risk of Candidates to a Solid Organ Transplantation: A Proposal of the ENGAGE Working Group," *Transplant International* 34, no. 6 (2021): 1005–1018, <https://doi.org/10.1111/tri.13874>.
12. R. A. Bray and H. M. Gebel, "Strategies for Human Leukocyte Antigen Antibody Detection," *Current Opinion in Organ Transplantation* 14, no. 4 (2009): 392–397, <https://doi.org/10.1097/MOT.0b013e32832c294c>.
13. M. P. Sypek, J. Y. Kausman, N. Watson, et al., "The Introduction of cPRA and Its Impact on Access to Deceased Donor Kidney Transplantation for Highly Sensitized Patients in Australia," *Transplantation* 105, no. 6 (2021): 1317–1325, <https://doi.org/10.1097/TP.0000000000003410>.
14. E. P. Kransdorf and M. J. Pando, "Calculated Panel Reactive Antibody With Decimals: A Refined Metric of Access to Transplantation for Highly Sensitized Candidates," *Human Immunology* 78, no. 3 (2017): 252–256, <https://doi.org/10.1016/j.humimm.2016.12.009>.
15. E. F. Reed, P. Rao, Z. Zhang, et al., "Comprehensive Assessment and Standardization of Solid Phase Multiplex-Bead Arrays for the Detection of Antibodies to HLA," *American Journal of Transplantation* 13, no. 7 (2013): 1859–1870, <https://doi.org/10.1111/ajt.12287>.
16. R. Battle, D. Pritchard, S. Peacock, et al., "BSHI and BTS UK Guideline on the Detection of Alloantibodies in Solid Organ (and Islet) Transplantation," *International Journal of Immunogenetics* 50, no. 2 (2023): 3–63, <https://doi.org/10.1111/iji.12641>.
17. H. C. Sullivan, H. M. Gebel, and R. A. Bray, "Understanding Solid-Phase HLA Antibody Assays and the Value of MFI," *Human Immunology* 78, no. 7–8 (2017): 471–480, <https://doi.org/10.1016/j.humimm.2017.05.007>.
18. A. R. Tambur and W. C. H. L. A. Diagnostics, "Evaluating DSA Strength by Titration," *Transplantation* 102, no. 1S Suppl 1 (2018): S23–S30, <https://doi.org/10.1097/TP.0000000000001817>.
19. L. Frischknecht, Y. Deng, C. Wehmeier, et al., "The Impact of Pre-Transplant Donor Specific Antibodies on the Outcome of Kidney Transplantation—Data From the Swiss Transplant Cohort Study," *Frontiers in Immunology* 13, (2022): 1005790. Published 2022 Sep 21, <https://doi.org/10.3389/fimmu.2022.1005790>.
20. C. Wiebe, I. W. Gibson, T. D. Blydt-Hansen, et al., "Evolution and Clinical Pathologic Correlations of De Novo Donor-Specific HLA Antibody Post Kidney Transplant," *American Journal of Transplantation* 12, no. 5 (2012): 1157–1167, <https://doi.org/10.1111/j.1600-6143.2012.04013.x>.
21. J. Buttigieg, H. Ali, A. Sharma, and A. Halawa, "Positive Luminex and Negative Flow Cytometry in Kidney Transplantation: A Systematic Review and Meta-Analysis," *Nephrology Dialysis Transplantation* 34, no. 11 (2019): 1950–1960, <https://doi.org/10.1093/ndt/gfy349>.
22. A. R. Tambur, N. D. Herrera, K. M. K. Haarberg, et al., "Assessing Antibody Strength: Comparison of MFI, CIq, and Titer Information," *American Journal of Transplantation* 15, no. 9 (2015): 2421–2430, <https://doi.org/10.1111/ajt.13295>.
23. S. Peacock, D. Briggs, M. Barnardo, et al., "BSHI/BTS Guidance on Crossmatching Before Deceased Donor Kidney Transplantation," *International Journal of Immunogenetics* 49 (2022): 22–29, <https://doi.org/10.1111/iji.12558>.
24. C. Wiebe, D. Pochinco, T. D. Blydt-Hansen, et al., "Class II HLA Epitope Matching—A Strategy to Minimize De Novo Donor-Specific Antibody Development and Improve Outcomes," *American Journal of Transplantation* 13, no. 12 (2013): 3114–3122, <https://doi.org/10.1111/ajt.12478>.
25. R. J. Duquesnoy, "A Structurally Based Approach to Determine HLA Compatibility at the Humoral Immune Level," *Human Immunology* 67 no. 11 (2006): 847–862, <https://doi.org/10.1016/j.humimm.2006.08.001>.
26. M. Sypek, J. Kausman, S. Holt, and P. Hughes, "HLA Epitope Matching in Kidney Transplantation: An Overview for the General Nephrologist," *American Journal of Kidney Diseases* 71, no. 5 (2018): 720–731, <https://doi.org/10.1053/j.ajkd.2017.09.021>.
27. D. Viglietti, A. Loupy, D. Vernerey, et al., "Value of Donor-Specific Anti-HLA Antibody Monitoring and Characterization for Risk Stratification of Kidney Allograft Loss," *Journal of the American Society of Nephrology* 28, no. 2 (2017): 702–715, <https://doi.org/10.1681/ASN.2016030368>.
28. R. J. Duquesnoy, "Reflections on HLA Epitope-Based Matching for Transplantation," *Frontiers in Immunology* 7, (2016): 469, <https://doi.org/10.3389/fimmu.2016.00469>.
29. C. Wiebe, V. Kosmoliaptis, D. Pochinco, C. J. Taylor, and P. Nickerson, "A Comparison of HLA Molecular Mismatch Methods to Determine HLA

- Immunogenicity," *Transplantation* 102, no. 8 (2018): 1338–1343, <https://doi.org/10.1097/TP.0000000000002117>.
30. National Organ and Tissue Transplant Organisation (NOTTO), "Ministry of Health and Family Welfare, Government of India. Transplantation of Human Organs and Tissues Rules," 2014. Government of India; 2014. https://www.notto.mohfw.gov.in/WriteReadData/Portal/News/899_1_1_Transplantation_of_Human_Organs_and_Tissues_Rules_2014.pdf.
31. R. Patel and P. I. Terasaki, "Significance of the Positive Crossmatch Test in Kidney Transplantation," *New England Journal of Medicine* 280, no. 14 (1969): 735–739, <https://doi.org/10.1056/NEJM196904032801401>.
32. M. R. Garovoy, M. A. Rheinschmidt, M. Bigos, et al., "Flow Cytometry Analysis: A High Technology Crossmatch Technique Facilitating Transplantation," *Transplantation Proceedings* 15, no. 3 (1983): 1939–1944.
33. C. Lefaucheur, A. Loupy, G. S. Hill, et al., "Preexisting Donor-Specific HLA Antibodies Predict Outcome in Kidney Transplantation," *Journal of the American Society of Nephrology* 21, no. 8 (2010): 1398–1406, <https://doi.org/10.1681/ASN.2009101065>.
34. P. Amico, G. Hönger, J. Steiger, and S. Schaub, "Utility of the Virtual Crossmatch in Solid Organ Transplantation," *Current Opinion in Organ Transplantation* 13, no. 6 (2009): 656–661, <https://doi.org/10.1097/MOT.0b013e328331c169>.
35. M. C. Bhaskaran, S. Heidt, and T. Muthukumar, "Principles of Virtual Crossmatch Testing for Kidney Transplantation," *Kidney International Reports* 7, no. 6 (2022): 1179–1188. Published 2022 Mar 15, <https://doi.org/10.1016/j.ekir.2022.03.006>.
36. L. Amrouche, O. Aubert, C. Suberbielle, et al., "Long-Term Outcomes of Kidney Transplantation in Patients With High Levels of Preformed DSA," *Transplantation* 101, no. 10(2017): 2440–2448, <https://doi.org/10.1097/TP.0000000000001650>.
37. A. Loupy, C. Lefaucheur, D. Vernerey, et al., "Complement-Binding Anti-HLA Antibodies and Kidney-Allograft Survival," *New England Journal of Medicine* 2013;369(13):1215–1226, <https://doi.org/10.1056/NEJMoa1302506>.
38. F. H. J. Claas, M. D. Witvliet, R. J. Duquesnoy, G. G. Persijn, and I. I. Doxiadis, "The Acceptable Mismatch Program as a Fast Tool for Highly Sensitized Patients Awaiting a Cadaveric Kidney Transplantation: Short Waiting Time and Excellent Graft Outcome," *Transplantation* 78, no. 2 (2004): 190–193, <https://doi.org/10.1097/01.TP.0000129260.86766.67>.
39. B. J. Orandi, X. Luo, A. B. Massie, et al., "Survival Benefit With Kidney Transplants From HLA-Incompatible Live Donors," *New England Journal of Medicine* 374, no. 10 (2016): 940–950, <https://doi.org/10.1056/NEJMoa1508380>.
40. S. C. Jordan, J. Choi, and A. Vo, "Kidney Transplantation in Highly Sensitized Patients," *British Medical Bulletin* 114, no. 1 (2015): 113–125, <https://doi.org/10.1093/bmb/ldv013>.
41. A. A. Zachary and M. S. Leffell, "Desensitization for Solid Organ and Hematopoietic Stem Cell Transplantation," *Immunological Reviews* 258, no.1 (2014): 183–207, <https://doi.org/10.1111/imr.12150>.
42. V. Kute, S. Agarwal, M. Sahay, et al., "Kidney-Paired Donation to Increase Living Donor Kidney Transplantation in India: Guidelines of Indian Society of Organ Transplantation – 2017," *Indian Journal of Nephrology* 28, no. 1 (2018): 1, https://doi.org/10.4103/ijn.IJN_365_17.
43. C. A. Schinstock, R. B. Mannon, K. Budde, et al., "Recommended Treatment for Antibody-Mediated Rejection After Kidney Transplantation: The 2019 Expert Consensus From the Transplantation Society Working Group," *Transplantation* 104, no. 5 (2020): 911–922, <https://doi.org/10.1097/TP.0000000000003095>.
44. A. N. R. Barnett, M. Manook, M. Nagendran, et al., "Tailored Desensitization Strategies in ABO Blood Group Antibody Incompatible Renal Transplantation," *Transplant International* 27, no. 2. (2014): 187–196, <https://doi.org/10.1111/tri.12234>.
45. J. R. Montgomery, J. C. Berger, D. S. Warren, N. T. James, R. A. Montgomery, and D. L. Segev, "Outcomes of ABO-Incompatible Kidney Transplantation in the United States," *Transplantation* 93, no. 6 (2012): 603–609, <https://doi.org/10.1097/TP.0b013e318245b2af>.
46. K. Takahashi and K. Saito, "ABO-Incompatible Kidney Transplantation," *Transplantation Reviews* 27, no. 7 (2013): 1–8, <https://doi.org/10.1016/j.trre.2012.07.003>.
47. H. Naciri Bennani, K. M. Bobo Barry, J. Noble, P. Malvezzi, T. Jouve, and L. Rostaing, "Outcomes of ABO-Incompatible Kidney Transplants With Very High Isoagglutinin Titers: A Single-Center Experience and Literature Review," *Frontiers in Immunology* 15, (2024): 1504495. Published 2024 Dec 2, <https://doi.org/10.3389/fimmu.2024.1504495>.
48. A. A. R. Tobian, R. S. Shirey, R. A. Montgomery, et al., "ABO Antibody Titer and Risk of Antibody-Mediated Rejection in ABO-Incompatible Renal Transplantation," *American Journal of Transplantation* 10, no. 5 (2010): 1247–1253, <https://doi.org/10.1111/j.1600-6143.2010.03103.x>.
49. Y. Ko, J. Y. Kim, S.-H. Kim, et al., "Acute Rejection and Infectious Complications in ABO- and HLA-Incompatible Kidney Transplantations," *Annals of Transplantation* 25, (2020): e927420. Published 2020 Oct 6, <https://doi.org/10.12659/AOT.927420>.
50. D. A. J. van den Broek, S. Meziyerh, K. Budde, et al., "The Clinical Utility of Post-Transplant Monitoring of Donor-Specific Antibodies in Stable Renal Transplant Recipients: A Consensus Report With Guideline Statements for Clinical Practice," *Transplant International* 36, (2023): 11321. Published 2023 Jul 25, <https://doi.org/10.3389/ti.2023.11321>.
51. C. Lefaucheur, K. Louis, A. B. Morris, et al., "Clinical Recommendations for Posttransplant Assessment of Anti-HLA (Human Leukocyte Antigen) Donor-Specific Antibodies: A Sensitization in Transplantation: Assessment of Risk Consensus Document," *American Journal of Transplantation* 23, no. 1 (2023): 115–132, <https://doi.org/10.1016/j.ajt.2022.11.013>.
52. A. Loupy and C. Lefaucheur, "Antibody-Mediated Rejection of Solid-Organ Allografts," *New England Journal of Medicine* 379, no. 12 (2018): 1150–1160, <https://doi.org/10.1056/NEJMra1802677>.
53. M. Haas, A. Loupy, C. Lefaucheur, et al., "The Banff 2017 Kidney Meeting Report: Revised Diagnostic Criteria for Chronic Active T Cell-Mediated Rejection, Antibody-Mediated Rejection, and Prospects for Integrative Endpoints for Next-Generation Clinical Trials," *American Journal of Transplantation* 18, no. 2 (2018): 293–307, <https://doi.org/10.1111/ajt.14625>.
54. C. Roufosse, N. Simmonds, M. Clahsen-Van Groningen, et al., "A 2018 Reference Guide to the Banff Classification of Renal Allograft Pathology," *Transplantation* 102, no. 11 (2018): 1795–1814, <https://doi.org/10.1097/TP.0000000000002366>.
55. A. Loupy, M. Haas, C. Roufosse, et al., "The Banff 2019 Kidney Meeting Report (I): Updates on and Clarification of Criteria for T Cell- and Antibody-Mediated Rejection," *American Journal of Transplantation* 20, no. 9 (2020): 2318–2331, <https://doi.org/10.1111/ajt.15898>.
56. O. Aubert, C. Ursule-Dufait, R. Brousse, et al., "Cell-Free DNA for the Detection of Kidney Allograft Rejection," *Nature Medicine* 30, no. 8 (2024): 2320–2327, <https://doi.org/10.1038/s41591-024-03087-3>.
57. R. D. Bloom, J. S. Bromberg, E. D. Poggio, et al., "Cell-Free DNA and Active Rejection in Kidney Allografts," *Journal of the American Society of Nephrology* 28, no. 7 (2017): 2221–2232, <https://doi.org/10.1681/ASN.2016091034>.
58. T. Sigdel, F. Archila, T. Constantin, et al., "Optimizing Detection of Kidney Transplant Injury by Assessment of Donor-Derived Cell-Free DNA via Massively Multiplex PCR," *Journal of Clinical Medicine* 8, no. 1 (2019): 19, <https://doi.org/10.3390/jcm8010019>.
59. T. Abdulhadi, L. Alrata, C. Dubrawka, et al., "Donor-Derived Cell Free DNA as a Biomarker in Kidney Transplantation," *Pharmacogenomics* 24, no. 14 (2023): 771–780, <https://doi.org/10.2217/pgs-2023-0138>.
60. Y. Xing, Q. Guo, C. Wang, et al., "Donor-Derived Cell-Free DNA as a Diagnostic Marker for Kidney-Allograft Rejection: A Systematic Review

and Meta-Analysis," *Biomolecules and Biomedicine* 24, no. 4 (2024): 731–740. Published 2024, <https://doi.org/10.17305/bb.2024.10049>.

61. V. Jha, G. Garcia-Garcia, K. Iseki, et al., "Chronic Kidney Disease: Global Dimension and Perspectives," *Lancet* 382, no. 9888 (2013): 260–272, [https://doi.org/10.1016/S0140-6736\(13\)60687-X](https://doi.org/10.1016/S0140-6736(13)60687-X).

62. C. Wiebe, R. Balshaw, I. W. Gibson, et al., "A Rational Approach to Guide Cost-Effective De Novo Donor-Specific Antibody Surveillance With Tacrolimus Immunosuppression," *American Journal of Transplantation* 23, no. 12 (2023): 1882–1892, <https://doi.org/10.1016/j.ajt.2023.07.025>.

63. V. B. Kute, H. V. Patel, S. Banerjee, et al., "Analysis of Kidney and Liver Exchange Transplantation in India (2000–2025): A Multicentre, Retrospective Cohort Study," *Lancet Regional Health—Southeast Asia* 37 (2025): 100597, <https://doi.org/10.1016/j.lansea.2025.100597>.