OPTN

Briefing to the OPTN Board of Directors on

Standardize Kidney Biopsy Reporting and Data Collection

OPTN Kidney Transplantation Committee

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Standardize Kidney Biopsy Reporting and Data Collection

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Executive Summary

Renal procurement biopsy reporting currently lacks standardization, with both variation in the parameters reported and how this information is shared with transplant programs. A renal procurement biopsy is a diagnostic examination of tissue sample taken from a deceased donor kidney during procurement. An Organ Procurement Organization (OPO) performs procurement biopsies to identify chronic or acute organ damage and estimate potential risk to graft function.[1] Procurement biopsies are increasingly prevalent, and more than half of all deceased donor kidneys procured for transplant are biopsied.[2] Variation in biopsy reporting results in significant allocation inefficiency, for both Organ Procurement Organizations (OPOs) reporting results and evaluating transplant programs.

Standardizing kidney biopsy data collection that identifies characteristics and data points that are most useful to inform offer acceptance, and thereby increase allocation efficiency, can reduce inconsistencies in quality and comprehensiveness and improve efficiency.[3]

This proposal aims to standardize biopsy reporting and data collection by establishing a required set of biopsy parameters to be reported when a procurement kidney biopsy is performed. These data are critical to inform offer acceptance as measures of acute and chronic damage, and balance the granularity of information required by organ offer-evaluating surgeons and the level of detail that pathologists of varying levels of expertise are able to provide.[4] This will reduce inconsistencies in comprehensiveness and improve reproducibility and reliability, and therefore increase allocation efficiency. To implement this proposal, new, discrete data fields will be added to the OPTN Donor Data and Matching System. This proposal was developed in conjunction with the *Establish Minimum Kidney Donor Criteria to Require Biopsy* proposal.

[1] 1 Lentine et al. "Procurement Biopsies in Kidney Transplantation," *Journal of the American Society of Nephrology*, 32 (2021): 1835-1837.
[2] Carpenter et al. "Procurement Biopsies in the Evaluation of Deceased Donor Kidneys," Clinical Journal of the American Society of Nephrology, 13 (2018): 1876-1885.
[3] OPTN Policy Oversight Committee Biopsy Standards Workgroup Meeting Summary. July 22, 2020. https://optn.transplant.hrsa.gov/media/3934/20200722_poc_biopsywg_summary.pdf
[4] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, August 3, 2021. https://optn.transplant.hrsa.gov/media/hydnvomr/20210803-biopsy-best-practices-meeting-summary.pdf

Purpose

The purpose of this proposal is to improve biopsy reporting and data collection by establishing a standard set of biopsy parameters for OPOs to provide to transplant programs and the OPTN. Standardization of reporting will be operationalized in the OPTN Donor Data and Matching System, with discrete data fields for each parameter. This proposal will require OPOs to provide these specific biopsy characteristics, which are critical to inform offer evaluation and appropriate acceptance practices for individual potential transplant recipients to transplant programs evaluating those offers. This proposal manages and maintains information about organ donors by standardizing and streamlining the reporting of biopsy results, which provide key kidney donor information used in kidney allocation and offer evaluation. Standardization of biopsy reporting will reduce inconsistencies in quality and comprehensiveness of biopsy analysis among OPOs, minimize the need for transplant hospitals that accept deceased donor kidney offers to perform their own biopsy analysis, and streamline reporting of biopsy results, and thus improve allocation efficiency. This proposal was developed and released in conjunction with the *Establish Minimum Kidney Donor Criteria to Require Biopsy*, which aims to standardize when a biopsy is performed, streamline communication between OPOs and transplant centers, and increase allocation and offer acceptance efficiency.

Background

Current OPTN policy requires[5] that recovering OPOs (also known as "host" OPOs) provide kidney biopsy information in deceased donor kidney offers if a biopsy is performed, but otherwise does not prescribe what parameters or types of biopsy information should be reported. The *OPTN Guidance on Requested Deceased Donor Information* recommends that a biopsy sample capture a minimum of 25 glomeruli, and suggests sending the biopsy material along with a kidney when transported.[6] This proposal standardizes the data that must be reported by the OPO if a biopsy is performed, but does not change the policy requirements for when a biopsy must be performed.

More than 50 percent of all deceased donor kidneys are biopsied upon procurement, though recent literature has shown that the quality and reliability of procurement biopsy varies considerably. With biopsies reported as the main reason for non-utilization for 37 percent of non-utilized deceased donor kidneys, many point to procurement biopsies as a possible driver of the nearly 20 percent rate of kidney graft non-utilization in the United States. [7,8] Many others believe these procurement biopsies provide information critical to understanding organ quality and appropriate placement of the organ.[9] The literature itself faces a number of limitations, including selection bias, limited data, and lack of consistency and standardization in histological assessment. [10,11] In particular, it can be difficult to point

[5] OPTN Policy 2.11.A *Required Information for Deceased Kidney Donors*
[6] OPTN Organ Procurement Organization Committee: Guidance on Requested Deceased Donor Information, (2018). https://optn.transplant.hrsa.gov/media/2504/opo_guidance_201806.pdf
[7] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, May 24, 2021. https://optn.transplant.hrsa.gov/media/4685/20210524_kidney_biopsy_best_practices_-wg_summary.pdf
[8] Kasiske et al. "The Role of Procurement Biopsies in Acceptance Decisions for Kidneys Retried for Transplant," *Clinician Journal of the American Society of Nephrology*, 9 (2014): 562-571.
[9] Angeletti et al. "Making Procurement Biopsies Important Again for Kidney Transplant Allocation," *Nephron*, 142 (2019). https://www.karger.com/Article/Pdf/499452
[10] Leninte et al. "Procurement Biopsies in Kidney Transplantation: More Information May Not Lead to Better Decisions," *Journal of the American Society of Nephrology*, 32 (2021). https://jasn.asnjournals.org/content/32/8/1835
[11] Wang et al. "The Donor Kidney Biopsy and Its Implications in Predicting Graft Outcomes: A Systematic Review," *American Journal of Transplantation*, 15 (2015): 1903-1914.

to biopsy itself as the main cause of non-utilization, as many donors from whom biopsies are requested have a number of risk factors that could lead to increased odds of offer decline.[12] However, wide variation in biopsy practices, the absence of accessible, large-scale biopsy data, and resulting limitations of the literature have led to calls for increased standardization. The *2018 Consensus Conference to Decrease Kidney Discards* report from the National Kidney Foundation recommended increased standardization of deceased donor biopsies.[13] Carpenter et al. challenge the utility of procurement biopsies "in absence of greater standardization of the process across organ procurement organizations," encouraging "standardization of evaluation of procurement biopsies and subsequent reporting."[14]

In 2020, the OPTN Policy Oversight Committee (POC) established their Biopsy Standards and Practices Workgroup to evaluate biopsy practices, their use and efficiency in the current system, and the potential need for rules or guidance regarding biopsy practices.[15] Through literature and data review, the Policy Oversight Committee's Biopsy Standards and Practices Workgroup identified inconsistencies in biopsy practices and the quality of biopsy analysis as a major hurdle to greater allocation efficiency. This Workgroup found that the quality and comprehensiveness of analysis of biopsy results vary significantly based on geography and pathologist experience, resulting in transplant hospitals that accept deceased donor kidney offers performing their own biopsy reading, ultimately slowing allocation efficiency. Furthermore, there is variation in the reporting of the results themselves, with inconsistencies in the parameters and response options reported and the format in which the results are recorded.

The POC provided the Kidney Transplantation Committee (the Committee) with several directives, including the development of a standard pathology form, with the rationale that the form could "identify those characteristics and data points that are most useful to inform offer acceptance and thereby increase allocation efficiency." This standardized reporting would also reduce inconsistencies in comprehensiveness of pathology reports based on geography and pathologist experience.[16]

The Kidney Committee's Biopsy Best Practices Workgroup (the Workgroup) was formed with multidisciplinary representation from the following OPTN committees and a subject matter expert in renal pathology:

- Kidney Transplantation
- Organ Procurement Organization
- Liver and Intestinal Organ Transplantation
- Data Advisory

Proposal for Board Consideration

The OPTN Kidney Committee proposes the required reporting of several biopsy parameters when reporting biopsy results, which will include modifications to the OPTN Donor Data and Matching System donor data collection, the Deceased Donor Registration (DDR) in the Data System for the Organ Procurement and Transplantation Network, and related data definitions.

[12] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, May 24, 2021.
[13] National Kidney Foundation, "Report of the National Foundation Consensus Conference to Decrease Kidney Discards," (2018). https://www.kidney.org/news/report-national-kidney-foundation-consensus-conference-to-decrease-kidney-discards
[14] Carpenter et al. "Procurement Biopsies in the Evaluation of Deceased Donor Kidneys," *Clinical Journal of the American Society of Nephrology*, 13 (2018): 1876-1885.
[15] OPTN Policy Oversight Committee Meeting Summary, June 3, 2020. https://optn.transplant.hrsa.gov/media/3871/20200603_poc_biopsywg_summary_final.pdf
[16] OPTN Policy Oversight Committee Project Recommendations Memo: Local Recovery and Biopsy Standards & Practices Workgroups. September 9, 2020.

Standardized Pathology Report

Table 1 outlines the proposed standardized pathology report, which includes the addition of eight new data elements, with the proposed biopsy parameters and their respective response options.

Table 1: Proposed Standardized Pathology Report Data Fields

Data Element	Response Options				
Biopsy Type	Wedge			Core Needle	
Tissue Preparation Technique	Frozen			Formalin-Fixed Paraffin Embedded	
Number of Glomeruli	_____				
Number of Globally Sclerotic Glomeruli	_____				
Percent Globally Sclerotic Glomeruli	_____%				
Nodular Mesangial Glomerulosclerosis	Absent		Present		Unknown
Interstitial Fibrosis and Tubular Atrophy (IFTA)	<5%	6-25%	26-50%	50%	Unknown
Vascular Disease	None: <10%	Mild: 10-25%	Moderate: 26-50%	Severe: >50%	Unknown
Arteriolar Hyalinosis	None	Mild to Moderate (1 arteriole)	Moderate to Severe (>1 arteriole)	Severe – multiple or circumferential	Unknown
Cortical Necrosis	Absent		Present: _____%		Unknown
Fibrin Thrombi	Absent		Present: _____%		Unknown
Other Comments:					

This proposed Standardized Pathology Report was developed with critical input from subject matter experts in both renal and general pathology, clinical expertise of transplant physicians and surgeons who evaluate these reports, OPO personnel who complete and share the reports, and extensive literature and data review. Workgroup members also consulted their renal and general pathologist colleagues in the development of this proposal.

The proposed data collection includes measures of chronic and acute damage, and captures biopsy sample characteristics. Chronic damage indicators, such as global glomerulosclerosis and vascular disease, can provide insight on potential risks to graft function.[17, 18] Acute damage measures indicate both degree of acute or necrotic damage, as well as the potential reversibility of this damage.[19] Sample characteristics, such as biopsy type and tissue preparation technique, provide valuable context to

[17] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[18] Sethi et al. "Proposal for Standardized Grading" (2017): 787-789.
[19] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.

evaluating clinicians on external factors potentially influencing the biopsy reading.[20] Similarly, the number of glomeruli visualized indicates sample adequacy, providing valuable context to the reliability and reproducibility of the biopsy.[21] Data elements and definitions were developed from three published consensus statements, defined in peer review publication, and are industry standard. [22,23,24] **Appendix C: Proposed Data Elements and Definitions** can be found in the Proposed Changes to Biopsy Data Collection section below.

The Committee identified and organized the elements and the detail represented in the respective response options to balance the provision of clinically useful information to organ offer-evaluating clinicians and the usability to pathologists with and without renal-specific training, focusing on reproducibility, reliability, and clarity.[25,26] Those elements requiring a greater degree of interpretation, such as interstitial fibrosis and tubular atrophy (IFTA) and vascular disease, have less granular, categorical response options to improve reproducibility and reliability.[27,28] For those elements that are more objective and quantitative, such as number of glomeruli, numeric field response options are given.[29]

In reviewing current biopsy data collection, the Workgroup identified misalignment between biopsy data collection in the OPTN Donor Data and Matching System and the DDR,[30] which reduces efficiency and could potentially lead to inaccurate or incomplete data collection.[31,32] Acknowledging this, the Committee decided to incorporate the collection of this data into the standardization of reporting in the OPTN Donor Data and Matching System and the Data System for the Organ Procurement and Transplantation Network.[33] Therefore the Committee proposes several modifications in the DDR that will align biopsy data collection for future use. All post-comment changes incorporated by the Committee will apply to both the proposed OPTN Donor Data and Matching System data collection and the proposed DDR data collection. **Appendix A: Proposed Changes Modifications to Biopsy Data in The OPTN Donor Data and Matching System** and **Appendix B: Proposed Modifications to Biopsy Data in the Deceased Donor Record (DDR)** can be found in the Proposed Changes to Biopsy Data Collection section at the end of this document.

[20] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, March 22, 2021.
[21] Ibid.
[22] Sethi et al.'s Mayo Clinic and Renal Pathology Society Consensus Report on Pathologic Classification, Diagnosis, and Reporting of Glomerulonephritis.
[23] Sethi et al.'s Proposal for Standardized Grading of Chronic Changes in Native Kidney Biopsy Specimens.
[24] Haas's Towards Harmony in Defining and Reporting Glomerular Disease on Kidney Biopsy.
[25] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, March 22, 2021. https://optn.transplant.hrsa.gov/media/4541/20210322_kidney_biopsy_best_practices_-wg_summary.pdf
[26] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, August 3, 2021. https://optn.transplant.hrsa.gov/media/hydnvomr/20210803-biopsy-best-practices-meeting-summary.pdf
[27] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021. https://optn.transplant.hrsa.gov/media/4768/20210628_kidney_biopsy_best_practices_-wg_summary.pdf
[28] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, March 22, 2021.
[29] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[30] The Deceased Donor Resignation (DDR) form is part of the Data System for the Organ Procurement and Transplantation Network, which is part of the OPTN Computer System. The DDR is a data collection tool for OPOs to electronically submit deceased donor data, providing a record of donor information for all deceased donors. The deceased donor data includes information about donor OPO, donor demographics, organ recovery and preservation, donor serology, intended recipients, and other information. The donor information is utilized to evaluate post-transplant outcomes, monitor potential disease transmission, and evaluate metrics for research and reporting purposes.
[31] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, April 20, 2021. https://optn.transplant.hrsa.gov/media/4608/20210420_kidney_biopsy_best_practices_-wg_summary.pdf
[32] OPTN Kidney Committee Meeting Summary, November 15, 2021.
[33] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, October 25, 2021.

Glomerulosclerosis and Chronic Kidney Damage

Glomeruli are clusters of capillary veins and nerves that work to filter waste products from the bloodstream, while retaining blood cells and protein in the bloodstream.[34] Glomerulosclerosis is scarring (or sclerosis) of the glomeruli, which impacts the ability of the kidney to successfully filter waste and retain protein and blood cells.[35] Glomerulosclerosis, measured as percent globally sclerotic glomeruli, is the most commonly reported and referenced biopsy finding, with most offer-evaluating clinicians evaluating this parameter as the first indicator of chronic damage to kidney function.[36] Global sclerosis of glomeruli can be caused by a number of diseases, such as hypertension and diabetes, and leads to poor glomerular filtering and reduced kidney function.[37] Glomerulosclerosis as a finding is generally presented with the number of glomeruli and the number of globally sclerotic glomeruli, as this allows the percent calculation to be checked for accuracy and provides additional context to the sample quality.[38] These are objective, measurable, and commonly reported biopsy parameters that the Workgroup recognized as good indicators of graft function and survival.[39]

Nodular Mesangial Glomerulosclerosis

Nodular Mesangial Glomerulosclerosis is another pathway of chronic injury, related to long durations of hyperglycemia and diabetic kidney disease.[40] This parameter can indicate potential issues with glomerular filtering and potentially reduced kidney graft function in a recipient, often specifically related to damage caused by advanced diabetes in the donor. [41] The Workgroup recognized that this information is most useful in the evaluation of donors with unknown or relatively recent diabetes histories, as disease onset can significantly precede diagnosis.[42] In considering response options, the Workgroup acknowledged that nodular mesangial sclerosis is less commonly reported on procurement biopsies, and may be difficult for general pathologists to identify and quantify.[43] The Workgroup determined that “absent,” “present,” and “unknown” response options were most appropriate, allowing pathologists to indicate nodular mesangial glomerulosclerosis without requiring quantification.[44]

Feedback gathered in public comment was mostly supportive of the inclusion of nodular mesangial sclerosis, though some commenters noted that early mesangial changes can be hard to identify on frozen section biopsies. The AST supported the limited granularity of this element, and recommended requiring pathologists to provide a reason if nodular sclerosis cannot be indicated. The AST also encouraged review of the utility of the parameter in any future revisions to this data collection are considered. There was limited opposition to the inclusion of this element as overly specific and potentially difficult to identify. The Committee considered this feedback and ultimately decided to maintain nodular mesangial glomerulosclerosis as proposed.

[34] National Institute of Diabetes and Digestive and Kidney Diseases, “Glomerular Disease,” April 2014. https://www.niddk.nih.gov/health-information/kidney-disease/glomerular-diseases
[35] Ibid.
[36] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[37] Ibid.
[38] Ibid.
[39] Ibid.
[40] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary August 3, 2021.
[41] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[42] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary August 3, 2021.
[43] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, October 25.
[44] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, August 3.

Interstitial Fibrosis and Tubular Atrophy, Vascular Disease, and Arteriolar Hyalinosis

Interstitial fibrosis (IF), tubular atrophy (TA), and vascular disease are also terminal pathways of chronic damage to a kidney. Interstitial fibrosis and tubular atrophy (IFTA) typically occur together, and are indicators of general wear and tear chronic damage.[45] Vascular disease, defined as the percent luminal narrowing of the most severely involved vessel, can inform a general sense of the risk of further scarring.[46] Chronic changes narrow lumen, and narrowed vessels lead to poor kidney perfusion.[47] The Workgroup determined that IFTA and Vascular Disease are essential to holistic understanding of chronic damage to a kidney graft and potential graft function.[48] The Workgroup initially chose to increase granularity at the lower end of the related response options as this is where critical differences can be detected and most clinical decision making occurs.[49] These categories also balance the level of detail pathologists of varying renal-specific experience can reliably achieve with frozen sections[50, 51]

The AST expressed concern for poor inter-observer agreement at the lowest end of the scoring scale for IFTA, and referenced literature noting assessment of IFTA to the nearest 5 percent can be difficult in frozen sections. The AST recommended aligning the response options for IFTA with the Banff classification scoring system for interstitial fibrosis.[52] The Committee agreed with this feedback, and opted to reduce the granularity of lower-end response options for the IFTA parameter. The original proposed response options delineated 5-10 percent and 11-25 percent; after public comment considerations, the Committee combined these options to 6-25 percent.

Feedback from public comment reflected significant support for the inclusion of a separate arteriolar hyalinosis element, which was originally grouped with arterial damage in the definition for vascular disease. Commenters noted that chronic diseases typically cause greater arteriole changes than arterial changes, and so arteriolar hyalinosis can be a more common finding. Furthermore, though minimal arteriolar hyalinosis is difficult to identify, more severe disease can be recognized. Public comments referenced literature evidencing the correlation and impacts of arteriolar hyalinosis on graft and recipient outcomes.[53] One commenter emphasized the need to separate the arterial and arteriolar damage parameters, noting that non-renal pathologists can inaccurately indicate no vascular disease if a large vessel with intimal fibrosis is not identified, despite significant or advanced arteriolar hyalinosis upon re-read of the biopsy slide. After reviewing this feedback, the Committee decided to separate the arterial and arteriolar damage elements. The Committee opted to include a unique field for arteriolar hyalinosis, utilizing the Banff Classification scoring system and definition.[54] The definition for vascular disease was updated accordingly to specify arterial damage, and is in alignment with the standard definition for vascular disease as given in the Banff Classification scoring system.[55]

[45] Sethi et al. “Proposal for Standardized Grading” (2017): 787-789.
[46] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[47] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[48] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[49] Ibid.
[50] Ibid.
[51] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, August 3, 2021.
[52] Roufosse et al. “2018 Reference Guide to the Banff Classification of Renal Allograft Pathology” (2018): 1795-1814.
[53] Gilbert A et al, Mod Path. 2022; 35(1):128-134.
[54] Roufosse et al. “2018 Reference Guide to the Banff Classification of Renal Allograft Pathology” (2018): 1795-1814.
[55] Ibid.

Acute Damage Indicators: Cortical Necrosis and Fibrin Thrombi

Cortical necrosis and fibrin thrombi are measures of acute and irreversible damage to the kidney. Cortical necrosis is the presence of necrotic material in the cortex, and can indicate acute damage with no expectation of recovery.[56] Cortical necrosis can also indicate the damage sustained by the kidney through the death and procurement processes.[57] Both cortical necrosis and fibrin thrombi can signal potential worsening of kidney function upon reperfusion.[58] These two parameters were recognized by the Workgroup as essential to evaluating irreversible, acute damage to the kidney and related impacts to potential graft function.[59] The Workgroup determined the percentage field response option was appropriate for both parameters, as fibrin thrombi can be counted and cortical necrosis is a typically conspicuous finding that can be easily estimated.[60]

There was general public comment support for the inclusion of fibrin thrombi and cortical necrosis, particularly for the evaluation of potential acute kidney injury, as well as some concern for visualization of fibrin thrombi on frozen slides, particularly for non-renal pathologists.

Biopsy in Organ Offer Evaluation and Placement

The Committee believes that a biopsy should be considered in context with other donor and organ information as part of a holistic review and evaluation of an organ offer.[61] As such, biopsies alone should not be utilized to determine an organ's viability, but instead to help determine whether a patient will receive the most benefit from that organ.[62] Feedback gathered in public comment for both this proposal and its sister proposal, *Establish Minimum Kidney Donor Criteria to Require Biopsy*, revealed agreement with this principle, as well as concern about the role of biopsy results in organ offer review. Committee considered this feedback, and maintains that standardization of biopsy performance and reporting will support this practice, as indication of external influencing factors provide context to reliability and the results themselves are more reported in a more reproducible manner.

In keeping with the principle of biopsy results as part of a holistic review, the Workgroup originally opted not to include any kind of scoring system in the proposed data collection. While several studies have developed scoring systems to quantify organ viability based on biopsy results, the Committee reiterated that a biopsy should provide characteristic information, not determine organ quality.[63]

The AST and AOPO recommended alignment with the 2018 Banff Classification of Renal Allograft Pathology, particularly with respect to the inclusion of additional parameters and granularity of response options.[64] The Workgroup originally chose not to base the standardized report entirely on the Banff Histopathological Consensus criteria, as they determined these criteria were established to standardize histological assessment in terms of organ viability, not to provide baseline graft

[56] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[57] Ibid.
[58] Ibid.
[59] Ibid.
[60] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[61] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, September 14, 2021. https://optn.transplant.hrsa.gov/media/xyab1tvw/20210914_kidney_biopsy_best_practices_-wg_summary.pdf
[62] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, January 25, 2021. https://optn.transplant.hrsa.gov/media/4399/20210125_kidney_biopsy_best_practices_summary.pdf
[63] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, March 22, 2021.
[64] Roufosse et al. "2018 Reference Guide to the Banff Classification of Renal Allograft Pathology" (2018): 1795-1814.

characteristics.[65] However, the Workgroup did choose to include several parameters included in the Banff criteria, as these elements provide valuable pathological information. These elements include interstitial fibrosis, tubular atrophy, vascular disease, cortical necrosis, and fibrin thrombi.[66] In considering the AST and AOPO's feedback, the Committee decided to update several response options, including aligning the granularity of the IFTA element as discussed above. The Committee also decided to incorporate a specific arteriolar hyalinosis element, also mentioned previously.

Proposal Development and Other Considerations

The Workgroup collaborated with the OPTN Data Advisory Committee (DAC) in developing this proposal. The DAC is an operating committee of the OPTN and oversees all data-related functions, including collaboration with other OPTN committees on modifications, additions, and removals of data elements collected by the OPTN in order to improve the completeness, accuracy, and timeliness of the data.[67] Through discussion, the Workgroup evaluated each proposed data element against the Data Standardization Checklist to ensure the quality, usefulness, transparency and reliability of OPTN data. This checklist provides a tool to ensure a consistent and systematic approach to aid OPTN Committees in the assessment of data they seek to add, modify, or remove.

The Workgroup discussed extensively the advantages and disadvantages of core needle and wedge biopsy sampling. Wedge biopsy considerations included overestimation of sub-capsular scarring, relative ease to core needle biopsies, and conservative sampling effects on estimation.[68] In discussing core needle sampling, the Workgroup considered potential improvements in vessel sample size and estimations of vascular disease, as well as the relative risk of additional kidney damage, such as arterial ureteral fistula. Wedge sampling is a simpler and more accessible method for surgeons, while core needle sampling may need to be performed by a pathologist or clinician with appropriate training to ensure the needle is through the cortex, and reduce risk of damage.[69] The Workgroup determined that requiring one specific sampling method, such as core needle or wedge, would impede appropriate sampling variation, which could negatively impact access to reliable biopsy information overall.[70] The Workgroup determined that both core needle and wedge sampling methods were acceptable.[71]

The Workgroup identified that frozen sections are the most accessible and timely tissue preparation technique available for procurement kidney biopsies, though they are less reproducible and more difficult to evaluate accurately than formalin-fixed paraffin-embedded (FFPE) samples.[72,73] Frozen sections can distort certain characteristics; indication of preparation technique and sampling type can inform evaluating clinicians on biopsy quality.[74] The Workgroup determined that recommending the use of FFPE preparation was infeasible for procurement kidney biopsies, but decided to maintain the tissue

[65] Liapis et al. "Banff Histopathological Consensus Criteria for Preimplantation Kidney Biopsies," *American Journal of Transplantation*, 17 (2017): 140-150.
[66] Liapis et al. "Banff Histopathological Consensus Criteria for Preimplantation Kidney Biopsies," *American Journal of Transplantation*, 17 (2017): 140-150.
[67] OPTN Data Advisory Committee. https://optn.transplant.hrsa.gov/members/committees/data-advisory-committee/
[68] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[69] Ibid.
[70] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[71] Ibid.
[72] Ibid.
[73] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, October 25, 2021. https://optn.transplant.hrsa.gov/media/a0ubydx1/20211025_kidney_biopsy_best_practices_-wg_summary.pdf
[74] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, March 22, 2021.

preparation technique parameter in order to provide a holistic set of biopsy information and allow for differentiation if ever necessary.[75,76] However, the Workgroup recognized that the limitations of frozen samples can also be mitigated by creating clearly defined, categorized response options to allow pathologists to more easily and reliably define characteristics into data points.[77]

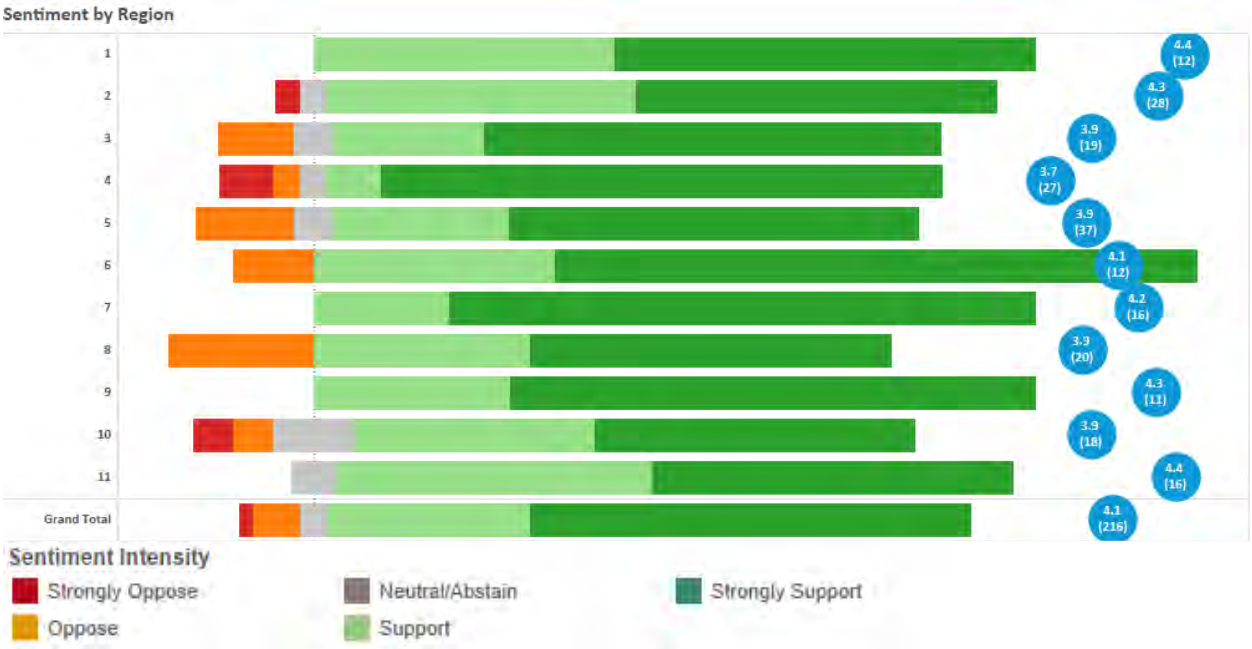
Though the Workgroup determined recommendations on biopsy type and tissue preparation technique were not appropriate, several surgeons and physicians felt that indicating these characteristics with the biopsy chronic and acute damage indicators will provide valuable context to evaluating clinicians on potential influences to biopsy results and reliability.[78]

Overall Sentiment from Public Comment

Overall sentiment in Public Comment and the Regional Meetings was supportive. There was some opposition across regions and member types, which was voiced both in Regional Meetings and through written, submitted comments.

The proposal was supported without opposition in Regions 1, 7, 9 and 11. Opposing sentiment was strongest in Regions 8 and 10. Public Comments encompassing sentiment voiced in the Regional Meetings have been submitted for each region.

Figure 1: Public Comment Sentiment by Region

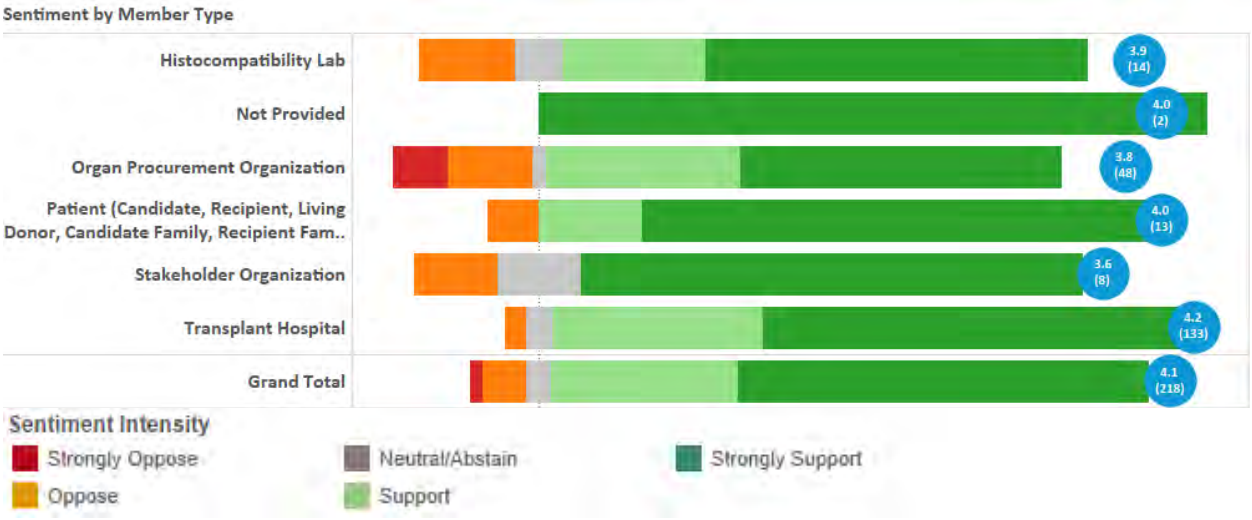


The proposal was generally supported across all member types. There was opposition from OPOs and stakeholder organizations. Several stakeholder organizations submitted written comment, including the American Society of Transplantation (AST), the Association of Organ Procurement Organizations (AOPO),

[75] Ibid.
[76] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, June 28, 2021.
[77] OPTN Kidney Committee Biopsy Best Practices Workgroup Meeting Summary, March 22, 2021.
[78] Ibid.

the National Kidney Foundation (NKF), the American Nephrology Nurses Association (ANNA), and the American Society of Transplant Surgeons (ASTS). NATCO, the AST, ANNA, and ASTS submitted comments supporting the proposed changes. OPTN Stakeholder Committees also reviewed this proposal and submitted public comment, including the OPO Committee, the Transplant Coordinators Committee, the Operations and Safety Committee, and the Data Advisory Committee.

Figure 2: Public Comment Sentiment by Member Type



In total, the proposal received 36 public comments submitted via the OPTN website.[79] The proposal was generally well supported, with several members emphasizing benefits to streamlined offer evaluation, improved and standardized information sharing, and increased allocation efficiency. Other comments covered many different topics, including the following themes:

- Biopsy Practices, Quality, and Reliability
- Operationalization
- Additional Elements

Biopsy Practices, Quality, and Reliability

Variation in the quality of biopsy sampling and related reliability of results was heavily discussed in public comment. In particular, appropriate sample size, standardization in sampling and tissue preparation methods, the limitations of frozen sections, and concerns for pathologist experience were highlighted throughout public comment and the regional meetings. These concerns were emphasized as underlying issues impacting reliability of biopsy findings and potential utilization of organs.

The OPTN Data Advisory Committee expressed concerns for sample adequacy, and recommended including an additional field for pathologists to indicate whether the biopsy was adequate per the 2018 Banff Classification of Renal Allograft Pathology Guidelines.[80] Other commenters echoed similar concerns, emphasizing a need to ensure biopsy samples are appropriately representative of overall organ quality. Several members, including the OPTN Operations and Safety Committee, recommended

[79] OPTN Public Comment, *Standardize Kidney Biopsy Reporting and Data Collection*, 2022. https://optn.transplant.hrsa.gov/policies-bylaws/public-comment/standardize-kidney-biopsy-reporting-and-data-collection/
[80] Roufosse et al, "A 2018 Reference Guide to the Banff Classification of Renal Allograft Pathology," (2018). https://journals.lww.com/transplantjournal/Fulltext/2018/11000/A_2018_Reference_Guide_to_the_Banff_Classification.14.aspx

including a guideline specifying a standard minimally acceptable number of glomeruli in order to ensure adequate sample size. Some commenters expressed the need to standardize sampling method and tissue preparation technique, emphasizing the importance of quality control in biopsy preparation and the limitations of frozen section biopsies. One member noted that frozen sections can distort the degree of damage and render certain characteristics difficult to identify, particularly for non-renal pathologists.

Throughout public comment, pathologist experience was identified as a major factor in the reliability of biopsy results. Commenters emphasized that non-renal or general pathologists not familiar with reading frozen kidney biopsies may not be able to provide reproducible or reliable results, which could negatively impact utilization. The AST and the OPTN Data Advisory Committee suggested the inclusion of a data field specifying the expertise of the reading pathologist, such as general experience versus renal pathology experience. Members of the OPTN Transplant Coordinators and OPO Committees recommended providing some kind of supplementary education on best practices as a resource to general pathologists with less renal experience. Some commenters supported requiring high resolution images of biopsy slides to be uploaded to the OPTN Donor Data and Matching System for transplant program review. There was also significant support for the use of centralized pathology services, for which OPOs could upload high resolution images of biopsy slides to be read by experienced renal pathologists. Several members noted that central digital pathology reading could greatly improve access to renal pathology services and further enhance standardization.

The Workgroup similarly recognized issues with variation in pathologist experience. To reduce the impact of variation in pathologist experience, the Workgroup delineated categorized response options, with levels of granularity specific to what a general, non-renal specific pathologist could reproducibly identify. After reviewing Public Comment feedback, the Committee reiterated this approach to variation in pathologist experience. The Committee agreed that centralized pathology services are an ideal solution, but noted that the costs related to high resolution slide imaging could render centralized pathology reading inaccessible to some OPOs.

Operationalization

Several OPO members and the OPTN OPO Committee expressed concerns about inconsistent access to pathology services, particularly at rural donor hospitals. Members noted that, in these cases, biopsy readings may not be able to be obtained without significant delays to allocation, as slides need to be shipped to an external pathologist to be read and results reported, before allocation can continue.

Commenters raised additional concerns that some pathologists, may not be willing or comfortable with identifying some of the proposed data elements, particularly on frozen sections, and requiring some estimation could impact relative accuracy of the results. Some commenters recommended including a “not available” response option for certain elements, to address these concerns for data quality and reliable reporting in such cases where pathologists are unable to identify specific biopsy characteristics. In consideration of this, the Committee decided to include an “unknown” response option for several of the proposed data elements, including nodular mesangial glomerulosclerosis, interstitial fibrosis and tubular atrophy, vascular disease, arteriolar hyalinosis, cortical necrosis, and fibrin thrombi. The Committee preferred the label “unknown,” as opposed to “not available,” as “unknown” provides a specific reason, and “not available” could indicate a number of circumstances, including not present, unable to visualize in sample, or unknown. Similarly, a few commenters noted that these elements should be readable for pathologists at various levels of expertise, and suggested reducing the granularity of some data elements to improve accuracy in reporting for pathologists without renal experience.

These commenters recommended further aligning the scoring scales for these elements with the Banff Classification of Renal Allograft Pathology. Committee discussions involving these elements are expanded upon above.

The OPTN OPO Committee and other OPO members recommended utilizing these data elements in offer screening tools, to improve allocation efficiency and encourage transplant program accountability in their use of biopsy results in review and acceptance practices.

The AST noted that the proposed data collection is understandable and sufficiently usable, and recommended providing a PDF sample form and education support for OPOs and transplant programs to ease operationalization and implementation of the proposed data collection. Several commenters noted that the proposed standardized reporting and data collection significantly supports its sister proposal, *Establish Minimum Kidney Donor Criteria to Require Biopsy*. The Committee acknowledged and appreciated this feedback as implementation considerations.

Additional Data Elements

Commenters recommended several additional fields for consideration by the Kidney Committee. These include time and date of biopsy reading, diabetic changes, number of arteries with elastic lamina, and as previously mentioned, a field to indicate pathologist expertise. The OPTN Operations and Safety Committee suggested including an additional field to indicate donor use of dialysis therapy during donor management, to align with the *Establish Minimum Kidney Donor Criteria to Require Biopsy* proposal.

Feedback collected in public comment highlighted significant support for the inclusion of arteriolar hyalinosis. In considering this feedback, the Committee felt this was an appropriate addition to the proposed data collection to create unique elements specifying arterial and arteriolar changes. Public comment feedback and Committee discussions regarding arteriolar hyalinosis are expanded upon in the proposal section above, along with public comment feedback related to specific data elements.

Compliance Analysis

NOTA and OPTN Final Rule

The OPTN Kidney Committee submits this project for consideration under the authority of NOTA 42 USC 247(b)(2)(E), which requires that the OPTN shall "adopt and use standards of quality for the acquisition and transportation of donated organs" as well as under the authority of OPTN Final Rule §121.6(a), which states that those OPTN members procuring organs are responsible for "laboratory tests and clinical examinations of potential organ donors… to determine any contraindications for donor acceptance, in accordance with policies established by the OPTN." This project sets a standard of quality for the acquisition of donated organs by standardizing information provided in biopsy results to include information regarding both biopsy sampling quality and pathologic organ characteristics. This project will also standardize reporting of biopsy data, which provide critical donor, organ, and offer evaluation information.

Furthermore, NOTA authorizes the OPTN to “collect, analyze, and publish data concerning organ donation and transplants,”[81] and the OPTN Final Rule, which states that the OPTN shall "(i) Maintain and operate an automated system for managing information about transplant candidates, transplant

[81] 42 U.S.C. §274(b)(2)(I)

recipients, and organ donors… "(ii) Maintain records of all transplant candidates, all organ donors and all transplant recipients; [and] (iii) Operate, maintain, receive, publish, and transmit such records and information electronically…"[82] The Final Rule also requires OPOs and transplant hospitals "as specified from time to time by the Secretary, to submit to the OPTN...information regarding transplantation candidates, transplant recipients, [and] donors of organs…"[83] "This project manages and maintains information about organ donors by standardizing and streamlining the reporting of biopsy results, which provide key kidney donor information used in kidney allocation and offer evaluation.

OPTN Strategic Plan

This proposal aligns with the following strategic goals:

- *Increase the number of transplants*
- *Promote the efficient management of the OPTN*

The primary strategic goals for this project are to promote the efficient management of the OPTN and increase the number of transplants through efficient donor and recipient matching. This proposal will standardize biopsy reporting, and therefore reduce inconsistencies in quality and comprehensiveness of biopsy analysis and improve reproducibility and reliability, increasing both allocation and offer acceptance efficiency. Improvements in donor and recipient matching efficiency and quality of offer information can improve placement of organs and potentially decrease organ discards. This proposal promotes the efficient management of the OPTN by reducing inconsistencies in analysis and reporting and aligning biopsy data collection across the OPTN Computer System.

OPTN Data Collection Principles

This proposal aligns with the following OPTN Data Collection Principles:

- Develop transplant, donation, and allocation policies
- Ensure patient safety when no alternative sources of data exist
- Determine member-specific performance

This proposal will standardize and formalize biopsy reporting to improve donor information used to inform offer evaluation and appropriate recipient placement, thereby aligning with the development of transplant, donation, and allocation policies. This proposal also addresses the current absence of centralized, uniform, and granular biopsy results reporting. This information can impact recipient placement and clinical care post-transplant, and can be critical to ensuring patient safety. This data will also be used to inform member-specific performance, as the Scientific Registry of Transplant Recipients adjusts OPO and transplant program outcomes for biopsy findings.

Implementation Considerations

Member and OPTN Operations

Operations affecting Organ Procurement Organizations

OPO staff will need to work with pathologists to ensure results are reported per the standardized report, through request or the provision of sample forms. There could be an increase in administrative burden

[82] 42 C.F.R. §121.11(a)(1)(i)-(iii)
[83] 42 C.F.R. §121.11(b)(2)

with additional data fields required on the DDR and in the OPTN Donor Data and Matching System. However, some of this administrative burden may be mitigated by the alignment of biopsy reporting on the DDR and in the OPTN Donor Data and Matching System, as OPO staff will not need to interpret the results of a biopsy read to determine which parameters and responses should be reported via the DDR biopsy fields. Implementation time may be necessary to train and educate staff.

Operations affecting the OPTN

This proposal will require implementation in the OPTN Computer System. Feedback received on the proposed data elements will be taken into consideration for final decisions on implementation.

This proposal requires the submission of official OPTN data that are not presently collected by the OPTN or collected in a different format. The OPTN Contractor has agreed that data collected pursuant to the OPTN's regulatory requirements in §121.11 of the OPTN Final Rule will be collected through OMB approved data collection forms. Therefore, after OPTN Board approval, the modifications to the OPTN Donor Data and Matching System data collection and DDR form will be submitted for OMB approval under the Paperwork Reduction Act of 1995. This will require a revision of the OMB-approved data collection instruments, which may impact the implementation timeline.

The OPTN plans to distribute educational materials, and is seeking to release a sample pathology report for OPO use and integration into current procurement kidney pathology practices.

Operations affecting Transplant Hospitals

Transplant hospitals and offer-evaluating clinicians and staff should review and understand the information provided in the standardized biopsy report. The proposed standardized data should improve efficiency in offer evaluation, as biopsy information is provided in a streamlined, more consistent fashion. Minimal implementation time is necessary to educate staff.

Operations affecting Histocompatibility Laboratories

This proposal is not anticipated to affect the operations of Histocompatibility Laboratories.

Projected Fiscal Impact

This proposal is projected to have a fiscal impact on the OPTN' transplant hospitals, and organ procurement organizations, but it is not anticipated to have any fiscal impact on histocompatibility laboratories.

Projected Impact on Organ Procurement Organizations

Many OPOs have biopsy reporting in donor electronic medical records (EMRs), and there could be IT implementation costs associated with reformatting donor EMRs. If an OPO chooses to align their EMR with the updated biopsy data collection, there may be implementation costs to re-program additional fields for data capture. The data fields are located directly in the OPTN Computer System, and some OPOs upload into the OPTN Computer System via API. If these OPOs choose to align with the updated biopsy data collection, they may need to work to reconfigure their system, including any APIs, and get the data captured properly in their primary system so it migrates directly for data capture.

This will have ongoing effects on work flow by requiring additional data entry into the OPTN Donor Data and Matching System and the DDR on biopsy results. OPOs will need to supplement communication with pathologists to provide the appropriate standardized form and/or include the required information. OPOs may need to rework received pathology reports that do not incorporate the standardized elements at initial release.

The OPTN Fiscal Impact Group believes incorporating the updated data collection into OPO EMRs will take approximately 6-12 months to implement depending on the donor EMR and interface utilized. It is challenging to approximate an ongoing annual cost impact with no standard or system-wide format, process, or EMR for reporting biopsies.

This proposal may produce standardized values that can prevent additional biopsies and potentially rework needed to obtain follow-up additional information, leading to potential long-term cost savings. This process may result in a long-term savings of staff time if data is consistent and easily readable with standardized documentation requirements.

Projected Impact on Transplant Hospitals

There will be implementation costs associated with educating transplant center staff on the standardized biopsy data elements, what they capture, and related education on biopsy in holistic review of donor kidney organ offer.

Standard documentation can improve offer evaluation efficiency by ensuring that all necessary and relevant information is conveyed to the transplant team.

Projected Impact on the OPTN

The OPTN Contractor estimates 1,547 hours for implementation. Implementation will involve updates to the OPTN Computer System, education and training on the changes, and communication efforts about the changes. The OPTN Contractor estimates 135 hours for ongoing support. Ongoing support will involve answering member questions and the production of monitoring reports at six months, one year and two years post-implementation.

Projected Impact on Histocompatibility Laboratories

There is no projected impact on Histocompatibility Laboratories.

Post-implementation Monitoring

Member Compliance

This proposal will not change current routine monitoring of OPTN members. Site surveyors will continue to review a sample of deceased donor medical records, and any material incorporated into the medical record by reference, to verify that data reported in the DDR are consistent with source documentation.

Data Collection Monitoring

The policy will be monitored six, 12, and 24 months post-implementation. The following metrics, and any subsequently requested by the Committee, will be evaluated as data become available. Appropriate

lags will be applied, per typical OPTN conventions, to account for time delay in institutions reporting data to the OPTN Computer System and compared to an appropriate pre-policy cohort to assess performance before and after implementation of this policy.

- Counts and percents of biopsied deceased donor kidneys by:
  - Biopsy type
  - Tissue preparation technique
  - Number of glomeruli observed
  - Percent glomerular sclerosis
  - Interstitial fibrosis and tubular atrophy
  - Vascular disease
  - Arterlior hyalinosis
  - Cortical necrosis
  - Fibrin thrombi

Conclusion

This proposal addresses one aspect of the Policy Oversight Committee's priority to improve allocation efficiency by standardizing biopsy reporting. This proposal will standardize biopsy reporting by establishing a standard set of biopsy parameters and appropriate responses required to be reported when a procurement kidney biopsy is performed. The Committee submits this proposal under the principle that procurement renal biopsies should be utilized to help determine whether a patient will receive the most benefit from an organ, in context with other donor and organ information. The Committee believes that standardization of biopsy practice and reporting will support this practice through reduced inconsistency, more reliable reporting methods, and improved efficiency.

The proposed biopsy parameters are critical to inform organ offer evaluation and appropriate placement, balancing the granularity required by evaluating clinicians and that which pathologists of varying renal-specific experience are able to provide, focusing on reproducibility, reliability, and clarity. The proposed standardization will reduce inconsistencies in comprehensiveness and reporting, and help improve reliability, and so help increase allocation efficiency.

After consideration of public comment feedback, the Kidney Committee opted to include an element for Arteriolar Hyalinosis, to allow specification of arteriolar damage. To address concern for data quality in cases where pathologists are unable to identify more specific biopsy characteristics, the Committee decided to include an "unknown" response option for several data elements, as well as reduce the granularity of response options.

This proposal will update the OPTN Donor Data and Matching System information collection and the DDR, to improve biopsy information reporting and biopsy data collection, respectively.

Appendix A: Proposed Modifications to Biopsy Data in the OPTN Donor Data and Matching System

Data Element	Current State	Proposed Changes
Biopsy Type	Biopsy type – Needle, Wedge	No proposed changes
Tissue Preparation Technique	Field not present in current state	Response options include Frozen Section, Formalin-Fixed Paraffin-Embedded Section (FFPE)
Number of Glomeruli	Glomeruli count – numeric field response	Number of Glomeruli – numeric field response
Number of Globally Sclerotic Glomeruli	Field not present in current state	Response options include a numeric field
Percent Globally Sclerotic Glomeruli	Percent Glomerulosclerosis – numeric percentage field	Percent Globally Sclerotic Glomeruli – numeric percentage field
Nodular Mesangial Glomerulosclerosis	Field not present in current state	Nodular Mesangial Glomerulosclerosis – absent, present, unknown
Interstitial Fibrosis and Tubular Atrophy (IFTA)	Field not present in current state	Interstitial Fibrosis and Tubular Atrophy – less than 5%, 5-25%, 26-50%, greater than 50%, unknown
Vascular Disease (Percent Luminal Narrowing of the Most Severely Involved Vessel)	Field not present in current state	Vascular Disease (Percent Luminal Narrowing of the Most Severely Involved Vessel) – None (<10%), Mild (10-25%), Moderate (26-50%), Severe (>50%), unknown
Arteriolar Hyalinosis	Field not present in current state	Arteriolar Hyalinosis – None, Mild to Moderate (1 arteriole), Moderate to Severe (>1 arteriole), Severe (Multiple or circumferential), unknown
Cortical Necrosis	Field not present in current state	Cortical Necrosis – absent, present with numeric percentage field, unknown
Fibrin Thrombi	Field not present in current state	Fibrin Thrombi – absent, present with numeric percentage field, unknown

Appendix B: Proposed Modifications to Biopsy Data in the Deceased Donor Record (DDR)

Data Element	Current State	Proposed Changes
Biopsy Type	Type of biopsy – Needle, Wedge, or Other Specify (open text field)	Biopsy Type – Needle, Wedge
Tissue Preparation Technique	Field not present in current state	Tissue Preparation Technique – Frozen Section, Formalin-Fixed Paraffin-Embedded Section (FFPE)
Number of Glomeruli	Number of Glomeruli Visualized – Numeric field response	Number of Glomeruli – numeric field response
Number of Globally Sclerotic Glomeruli	Field not present in current state	Number of Globally Sclerotic Glomeruli - Numeric field response
Percent Globally Sclerotic Glomeruli	Glomerulosclerosis percentage – 0-5%, 6-10%, 11-15%, 16-20%, greater than 20%, indeterminate	Percent Globally Sclerotic Glomeruli – percentage field response
Nodular Mesangial Glomerulosclerosis	Field not present in current state	Nodular Mesangial Glomerulosclerosis – absent, present, or unknown
Interstitial Fibrosis	Interstitial Fibrosis – absent, minimal, mild, mild-moderate, severe, unknown	Interstitial Fibrosis and Tubular Atrophy – less than 5%, 5-25%, 26-50%, greater than 50%, unknown
Vascular Disease (Percent Luminal Narrowing of the Most Severely Involved Vessel)	Vascular Changes – absent, minimal, mild, mild-moderate, severe, unknown	Vascular Disease (Percent Luminal Narrowing of Most Severely Involved Vessel – None (<10%), Mild (10-25%), Moderate (26-50%), Severe (>50%), unknown
Arteriolar Hyalinosis	Field not present in current state	Arteriolar Hyalinosis – None, Mild to Moderate (1 arteriole), Moderate to Severe (>1 arteriole), Severe (Multiple or circumferential), unknown
Cortical Necrosis	Field not present in current state	Cortical Necrosis – Absent, Present with numeric percentage field, unknown
Fibrin Thrombi	Field not present in current state	Fibrin Thrombi – Absent, Present with numeric percentage field, unknown

Appendix C: Proposed Data Elements and Definitions

Data Element	Current Definition	Proposed Changes
Biopsy	The process of removing tissue from patients for diagnostic examination	No proposed changes
Biopsy Type	No definition present in current state	The method by which tissue is removed from the patient for diagnostic examination
Tissue Preparation Technique	No definition present in current state	The method by which biopsy material is prepared for histologic examination
Number of Glomeruli	No definition present in current state	The total of all glomerular capillary tufts in the sample, include sclerotic and non-sclerotic tufts
Number of Globally Sclerotic Glomeruli	Field not present in current state	The number of glomeruli exhibiting global (complete) collapse of glomerular capillary walls and consolidation of the glomerular tuft by extracellular matrix, causing capillary luminal obliteration
Percent Globally Sclerotic Glomeruli (Percent Glomerulosclerosis)	The percentage of sclerosis (or hardening) of the glomeruli calculated on biopsy. This pathology usually commences in the juxtamedullary glomeruli and gradually spreads to involve other parts of the kidney, eventually causing kidney failure	The percentage of glomeruli exhibiting global (complete) collapse of glomerular capillary walls and consolidation of the glomerular tuft by extracellular matrix, causing capillary luminal obliteration
Nodular Mesangial Glomerulosclerosis	Field not present in current state	Rounded accumulation of collagenous matrix expanding one or more mesangial areas
Interstitial Fibrosis (IF)	No definition present in current state	The accumulation of fibrous tissue between the tubules
Tubular Atrophy (TA)	Field not present in current state	Shrinkage of tubules with variable thickening of the tubular basement membrane and flattening of the tubular epithelium
Vascular Disease	No definition present in current state	Fibrous thickening of the intima of arteries, measured by the percent luminal narrowing of the most severely involved vessel

Data Element	Current Definition	Proposed Changes
Percent Luminal Narrowing	Field not present in current state	The reduction in diameter of vessel lumens owing to vascular disease
Arteriolar Hyalinosis	Field not present in current state	Arteriolar hyaline thickening
Cortical Necrosis	Field not present in current state	Deaths of cortical cells, typically affecting all three tissue compartments
Fibrin Thrombi	Field not present in current state	Capillary lumen aggregate of coagulated blood containing fibrin and platelets, with or without entrapped cellular elements