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Nephropathology Education During Nephrology Fellowship Training in the United States



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The goals of nephrology fellowship programs are to develop the skills and knowledge of the fellows in order to be competent in the subspecialty and act as independent consultants. Nephrology fellowship training program directors are required to maintain an environment conducive to educating the fellows in each of the Accreditation Council for Graduate Medical Education (ACGME) competency areas.¹ Education in nephropathology is an important ACGME competency that needs to be achieved during fellowship training.¹ In 2009, Berns conducted a survey of practicing nephrologists to assess the adequacy of their fellowship training.² The majority (57.1%) of respondents in this survey felt

competent and well trained in interpreting kidney biopsy pathology. The other respondents reported either having no or little training in interpreting kidney biopsy pathology during their fellowship and, in any case, not enough to feel competent.²

Given the intimate relationship between structure and function of the kidney and the corresponding disease entities, it is understandable how valuable access to kidney biopsies is to nephropathology education. Kidney biopsy is an important diagnostic tool, making it integral to nephrology fellow education. The nephrology fellow not only has to master the biopsy technique but also to incorporate pathology information from light microscopy (LM), immunofluorescence (IF), and electron microscopy (EM) with clinical details to diagnose the kidney disease. Moreover, the emergence of various kidney disease-specific classification and reporting systems emphasize the need for continued update of knowledge in these areas.^{3–6} This is further enhanced by the

formulation of an etiopathogenetic basis of reporting glomerular diseases, aiding in a more personalized management of patients.⁵ A recent refinement in kidney biopsy reporting includes scoring of chronic kidney parenchymal parameters for prognostication,⁶ emphasizing the need for familiarity and awareness of kidney pathology terminology by the clinical nephrology community.

The interdisciplinary cooperation of nephrologists and nephropathologists is essential not only to obtain immediate kidney biopsy information, but also to accurately develop clinicopathological correlations, both in native and transplant kidney diseases. The diagnosis of most renal parenchymal diseases includes criteria such as morphology, immunopathology, and clinical features, but lacks an etiologic basis.⁷ To deliver accurate targeted therapy, there need to be continued advances in elucidation of pathogenesis of such glomerular diseases. Historically, fellows learned nephropathology through case discussions, kidney biopsy conferences, and close interactions with the nephropathologist.⁸ However, in the recent years, increasing numbers of kidney biopsy samples in the United States have been outsourced to commercial nephropathology groups for analysis. This may hinder or diminish some of the educational components of nephrology fellowship training.

Nephropathology education during nephrology fellowship training may vary across institutions in the United States. The factors for successful nephropathology education have not been well studied. To gain greater insight into fellows' experience regarding

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nephropathology education, we surveyed nephrology fellowship training program directors (N-TPD) in the United States.

Methods

The study was declared exempt by the institutional review board at Northwell Health. The survey was newly created with no prior known validation. Faculty input and validation were provided internally within the department at our institution. In May 2014, this online survey was distributed via e-mail to all US adult nephrology fellowship training

program directors. Each survey was identified by a unique respondent identification number generated by the survey creation software. This ensured the anonymity of all respondents. Follow-up reminders were sent via e-mail in June and July 2014.

Survey domains included characteristics of the programs such as location, size, number of fellows, and number of kidney biopsies evaluated each year (Table 1). Specific questions regarding nephropathology were addressed, including the presence of a division of nephropathology and

whether a nephropathologist was present at their institution. Characteristics of nephropathology education at the institution were also obtained to determine how involved the nephropathologist was with teaching, how often nephropathology conferences were offered, and what educational tools were used to teach kidney pathology, such as lectures or videoconferencing. N-TPDs were also asked about other opportunities to enhance the nephropathology education of fellows. The survey included open-ended questions to provide feedback on what a graduating nephrology fellow was expected to know regarding nephropathology. N-TPDs were also asked to rate their satisfaction with nephropathology education at their institution. Survey responses were tabulated as frequencies and percentages. To analyze the independent association of each variable in the survey with satisfaction, we used a generalized logit model. Satisfaction was analyzed as a binary variable by having “Yes” as 1 category and collapsing “No” and “Yes, but we can do better” together (reference category). A χ^2 test of independence was performed to examine the relationship between each survey question and the overall level of satisfaction. A Cramer V test was used to measure the strength of association between variables. A *P* value less than 0.05 was considered statistically significant.

All analyses assumed a 2-sided significance level of 0.05. Analysis was performed with R statistical software, version R 3.3.1 (R Foundation for Statistical Computing).

Results

A total of 63 U.S. N-TPDs responded (response rate 43%). Table 1 provides the characteristics of the programs (such as location, size,

Table 1. Baseline questions and results of all components of the survey

Variable	Geographic category	n (%)
Location of institution	Northeast	29 (48%)
	Central	8 (13%)
	Southern	16 (26%)
	Western	8 (13%)
Size of institution	Community hospital with no medical school	2 (3%)
	Community hospital with an affiliate medical school	6 (10%)
	Small-to-medium hospital system w/medical school	9 (15%)
	Large hospital health system w/medical school	44 (72%)
Number of fellows	<2	2 (3%)
	3	2 (3%)
	4	14 (23%)
	5–8	30 (49%)
	>8	13 (21%)
Number of kidney biopsies performed	<50/yr	14 (23%)
	51–100/yr	18 (30%)
	101–150/yr	13 (21%)
	>151/yr	16 (26%)
Division of nephropathology	No	24 (39%)
	Yes	61 (61%)
Nephropathologist at institution	No	11 (18%)
	Yes	50 (82%)
How involved is nephropathologist with teaching	Infrequently involved	1 (2%)
	Sometimes involved	3 (5%)
	Frequently involved	13 (21%)
	Very involved	44 (72%)
Frequency of nephropathology conferences	Biweekly	6 (13%)
	Weekly	2 (4%)
	Monthly	36 (75%)
	Every 3 mo	4 (8%)
Introductory nephropathology lectures	No	5 (8%)
	Yes	56 (92%)
Use of videoconferencing in reviewing nephropathology cases	No	54 (89%)
	Yes	7 (11%)
Satisfaction with nephropathology education	No	2 (3%)
	Yes but we can do better	22 (36%)
	Yes	37 (61%)

number of fellows) and number of kidney biopsies evaluated each year.

Resources for Nephropathology Education

Having a nephropathologist as part of the education team is critical during nephrology fellowship training. More than 60% of fellowship training programs had a division of nephropathology at their institution, and 82% had a nephropathologist on site. The remainder of the programs relied on an outside institution or a private pathology service for their kidney biopsy readings. Programs with a nephropathology section/division were more likely to be satisfied with their nephropathology education

(odds ratio = 2.79; 95% confidence interval = 1.1–8.35; $P = 0.05$).

There was some variation in the number of kidney biopsies performed at these institutions. Whereas 30% of the programs performed between 51 and 100 kidney biopsies per year, 26% performed more than 151 kidney biopsies per year. Another 21% performed 101 to 150 biopsies, whereas nearly one-fourth (23%) performed less than 50 per year. Programs performing 51 to 100, 101 to 150, and more than 151 kidney biopsies per year were 5 times ($P = 0.04$), 4.6 times ($P = 0.04$), and 7.5 times ($P = 0.01$) more likely to be satisfied with their nephropathology education (Tables 1 and 2).

Nephropathology Education During Nephrology Fellowship

The majority (75%) of program directors in our survey stated they had monthly nephropathology conferences. Very few programs (4%) had weekly conferences. Although 13% had biweekly conferences, 8% of the programs had a conference once every 3 months. The majority (92%) of responding programs provided an introductory nephropathology lecture to their fellows (Tables 1 and 2). Nearly three-fourths (72%) of program directors stated that their nephropathologists were very involved with teaching, with 21% stating that they were frequently involved, 2% infrequently involved, and 5% sometimes involved. Programs that had nephropathologists who were very involved in nephropathology education were more likely to have a higher level of satisfaction (odds ratio = 6.75; 95% confidence interval = 1.83–29.2; $P = 0.006$).

Perception of Satisfaction With Nephropathology Education

The final portions of the survey involved providing a level of satisfaction from the N-TPDs regarding the nephropathology education at their institution, and describing reasons why they believed that there were shortcomings. The majority of respondents (61%) stated that they were satisfied with the nephropathology education that was provided to fellows, whereas another 36% stated that they were satisfied, but that the nephropathology education could be better. Only 2 respondents stated that they were not satisfied with their nephropathology education (3%). Of the 14 respondents who listed shortcomings, the most common answers were “lack of resources to schedule

Table 2. Statistical analysis of the results of the various categories of the survey

Variable	Category	OR (95% CI)	P value
Size of Institution	Community hospital with no medical school	0 (NA, NA)	0.99
	Community hospital with an affiliate medical school	1 (0.18–5.4)	1
	Small-medium hospital systems with a medical school	0.8 (0.09–6.61)	0.83
	Large hospital health system with a medical school	2.14 (0.35–1.29)	0.39
Number of fellows	<2	1 (0.08–67.6)	0.6
	3	1 (0.04–25.28)	1
	4	1 (0.03–28.82)	1
	5–8	1.72 (0.06–46.49)	0.7
	>8	2.25 (0.08–67.6)	0.6
Number of kidney biopsies performed	<50/yr	0.4 (0.11–1.19)	0.12
	51–100/yr	5 (1.61–25.3)	0.04
	101–150/yr	4.625 (1.15–33.09)	0.04
	>151/yr	7.5 (1.60–43.03)	0.01
Division of nephropathology	No	0.84 (0.37–1.89)	0.68
	Yes	2.79 (1.1–8.35)	0.05
Nephropathologist at institution	No	0.83 (0.24–2.77)	0.76
	Yes	2.13 (0.57–8.37)	0.26
How involved is nephropathologist with teaching	Infrequently involved	0 (NA, NA)	0.99
	Sometimes involved	0 (NA, NA)	0.99
	Frequently involved	0.44 (0.12–1.36)	0.177
	Very involved	6.75 (1.83–29.2)	0.006
Frequency of nephropathology conferences	Biweekly	5 (0.8–95.8)	0.14
	Weekly	1.1 (0.04–14.4)	0.94
	Monthly	0.22 (0.01–1.57)	0.19
	Every 3 mo	0.07 (0–1.1)	0.08

CI, confidence interval; NA, not applicable; OR, odds ratio.

nephropathology conferences” (6.5%), “lack of an in-house nephropathologist” at their institution, (10%) and “not enough kidney biopsies performed” at their institution (11.5%).

Opportunities for Nephropathology Education

In addition to evaluating the basic structure of their nephropathology education, N-TPDs were also asked to describe opportunities provided to fellows to enhance their nephropathology education. These included sending fellows to a nephropathology conference, didactic lectures by invited nephropathologists from outside institutions, Web-based training and lectures, attending nephropathology courses and sessions at national meetings, and having a dedicated nephropathology elective. In all, 43% of the respondents had a dedicated nephropathology elective, 26% stated that they would send their fellows to a nephropathology conference at other institutions, 56% would send fellows to national meetings, and 21% would use Web-based teaching.

Discussion

Education in nephropathology is an integral component of nephrology fellowship training. Our survey findings suggest that the nephropathology education during nephrology fellowship training is varied across institutions in the United States. Several factors play a role in a successful nephropathology education during fellowship training. These factors include accessibility of material resources, effective interdepartmental communications, close relationships between the nephropathologist and the training program, and quality and duration of instructional support.

Factors that correlated with increased satisfaction in nephropathology education included increased performance of kidney biopsies, presence of an on-site nephropathology division, greater involvement of nephropathologists in teaching, and increased occurrence of nephropathology conferences. Our survey findings also showed a greater likelihood of satisfaction with the program’s nephropathology education when the number of kidney biopsies performed increased from 50 to more than 150 per year. Hence, in addition to having resources for nephropathology education, adequate numbers of kidney biopsy samples available for analysis and infrastructure in both educational instruction and departmental material support are important.

Although there may be ample in-house nephropathologists at 1 institution, there might be none in another. At other institutions, nephropathologists may be at an offsite location such as at a private pathology service center or an adjunct academic institution. Over the past several years, in an effort to boost cost efficiency, an increasing number of institutions that are unable to support or provide fully functional nephropathology services are using outside commercial laboratories with pathology groups for processing kidney biopsy samples and reporting of results.⁹ This could potentially lead to decreased opportunities for nephrology fellows to learn from kidney biopsy sample examination. Our survey showed that programs with a nephropathology division were almost 3 times more likely to be satisfied with their nephropathology education. Even without the presence of a nephropathology division at their

institution, the presence of a nephropathologist on staff was associated with a higher level of satisfaction.

The ACGME requires that fellows demonstrate competence in the evaluation and management of glomerular diseases, renal disorders of pregnancy, tubulointerstitial kidney diseases, and various kidney transplant-related disorders. The ACGME also requires that fellows demonstrate knowledge in nephropathology involving both native and transplanted kidneys. Despite these requirements, one-third (33%) of the respondents, in a recent survey of fellows, suggested the need for additional training in interpreting kidney pathology during fellowship.¹⁰ Nephropathology education during fellowship training may vary depending on several factors, such as how often nephropathology conferences are held, how involved the nephropathologists are with teaching of fellows, and what additional educational tools (such as Web-based learning, videoconferencing) are made available to trainees. Some programs may also have a dedicated nephropathology elective or may send fellows to regional or national kidney pathology conferences. Although not statistically significant, our study showed an increased level of satisfaction with increased frequency of nephropathology conferences for fellows.

Our survey also examined program directors’ overall satisfaction regarding their nephropathology education at their institution and the reasons why they believed that there were shortcomings. The majority of program directors (61%) stated that they were satisfied with the nephropathology education that was provided to their fellows,

whereas another 36% stated that they were satisfied but that this education could be better. The increased level of satisfaction of the program directors was related to the level of involvement of a nephropathologist with teaching. Not only was there a significant relationship between having nephropathologists involved with teaching and level of satisfaction, this was proportional to level of involvement.

Of note, this survey assessed the TPD's perceptions of nephropathology education. This is a limitation of this study. This might greatly differ from a fellow's perceptions of their nephropathology education.

Implementation Considerations

It is impossible to standardize nephropathology training across all institutions due to the differences in the availability of on-site nephropathology staff and services, as well as access to nephropathology conferences. However, several measures to enhance nephropathology education can be considered by the training community. Measures to improve communication between nephrologists and pathologists such as teleconferencing and other exchanges via the Web should be considered. Several additional educational opportunities have also emerged due to introduction of digital pathology to nephrology and online pathology modules.¹¹ These online nephropathology teaching sites have been outlined in Table 3. Web-based

nephropathology teaching modules have also been well received with increased learner satisfaction.¹² Although online or Web-based learning (Table 3) could enhance the knowledge and satisfaction of all fellows, this tool could certainly play an important role in the nephropathology education of fellows in programs that do not have a robust on-site nephropathology staff and services. For example, a recently initiated, Web-based nephropathology educational conference known as "GlomCon" discusses difficult glomerular disease cases among trainees, nephrologists and nephropathologists from community medical centers and academic institutions.¹³ In this biweekly, well-moderated conference, a case is first briefly presented by a nephrologist. This is followed by a review of the pathology slides and case discussion. Participants are also allowed to ask questions and to give their opinions regarding the case. In addition, participants can subsequently connect with each other for providing feedback and opinion on specific or general management questions related to the kidney parenchymal disorder. To enhance the nephropathology experience and education of fellows, measures such as those described above and others should also be strongly considered by the training community, especially in programs in which resources for on-site nephropathology education remain limited.

DISCLOSURE

All the authors declared no competing interests.

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Table 3. Online nephropathology teaching tools

Name	URL
American Journal of Kidney Diseases Renal Pathology Atlas	http://www.ajkd.org/content/atlasofrenalpathologyii
UNC Nephropathology	http://www.uncnephropathology.org/teaching_resources.html
International Society of Nephrology	http://www.theisn.org/topics/renal-pathology
European Society of Pathology	http://www.nephropathology-esp.org/pages/training-courses
GlomCon	https://glomcon.org/

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