

# Education in Nephrology Fellowship: A Survey-Based Needs Assessment

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## ABSTRACT

Educational needs assessments for nephrology fellowship training are limited. This study assessed fellows' perceptions of current educational needs and interest in novel modalities that may improve their educational experience and quantified educational resources used by programs and fellows. We distributed a seven-question electronic survey to all United States–based fellows receiving complimentary American Society of Nephrology (ASN) membership at the end of the 2015–2016 academic year in conjunction with the ASN Nephrology Fellows Survey. One third (320 of 863; 37%) of fellows in Accreditation Council for Graduate Medical Education–accredited positions responded. Most respondents rated overall quality of teaching in fellowship as either “good” (37%) or “excellent” (44%), and most (55%) second-year fellows felt “fully prepared” for independent practice. Common educational resources used by fellows included UpToDate, *Journal of the American Society of Nephrology/Clinical Journal of the American Society of Nephrology*, and *Nephrology Self-Assessment Program*; others—including ASN's online curricula—were used less often. Fellows indicated interest in additional instruction in several core topics, including home dialysis modalities, ultrasonography, and pathology. Respondents strongly supported interventions to improve pathology instruction and increase time for physiology and clinical review. In conclusion, current nephrology fellows perceive several gaps in training. Innovation in education and training is needed to better prepare future nephrologists for the growing challenges of kidney care.

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Although the prevalence of CKD may be plateauing, there is growing demand for nephrology care. Simultaneously, decreasing interest in nephrology among medical students and residents indicates that the future workforce may not be adequate to meet the needs of patients with kidney disease.<sup>1–4</sup> Evaluating and strengthening fellowship training and its appeal to students are keys to preparing future nephrologists to face these challenges.

Few educational needs assessments of nephrology fellowships have been conducted, but the limited literature points to several areas in need of improvement.<sup>5–8</sup> The most recent assessment, a survey of nephrologists generally in practice for <5 years, identified several areas in which participants felt less than well prepared, including peritoneal dialysis (PD) and home hemodialysis (HHD) modalities; performing and

interpreting renal ultrasounds; end of life care; and the care of patients with pediatric kidney diseases.<sup>6</sup> Nephrologists felt well trained in other core areas, including in-center hemodialysis, glomerular disease, hypertension, and general CKD management.

A more recent survey of Australian and New Zealand nephrologists within 10 years of completing fellowship echoed these findings, noting persistent concerns regarding a lack of preparedness in PD, HHD, and conservative care.<sup>7</sup> Notably, this survey showed no improvement in training between cohorts from 2003 to 2009 and 2010 to 2014. Both studies identified practice management and research training as additional areas for improvement.

Although informative, these studies describe perceptions of physicians who have already completed fellowship rather than current fellows. To date, studies of current fellows have focused on specific educational topics in nephrology, such as procedures or end of life care, rather than a global assessment.<sup>9–12</sup> This study,

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**Table 1.** Demographics of educational survey respondents and recipients

Demographic	Respondents	ACGME Fellows (AY 2015) <sup>a</sup>
Total		
N	320	863
Sex, % (differences between respondents and ACGME fellows were not statistically significant [ $P=0.43$ ])		
Women	34	36
Men	66	63
Age, yr		
Mean (PGY-4)	32.9	33.7
Median	32	—
Range	28–62	—
Race/ethnicity, % (differences between respondents and ACGME fellows were not statistically significant [ $P=0.21$ ]) <sup>b</sup>		
Asian/Pacific Islander	36	41
Black	7	7
White	32	23
Other	14	12
Hispanic/Latino	9	8
Unknown	—	10
Medical education, % (MD/DO and USMG/IMG comparisons between respondents and ACGME fellows were borderline statistically significant [ $P=0.05$ ] and statistically significant [ $P=0.03$ ], respectively)		
Allopathic (MD)	89	92
Osteopathic (DO)	11	8
USMG	40	34
IMG	60	65
Fellowship year (%)		
First year	122 (38)	434 (50.2)
Second year	155 (48)	429 (49.7)
No response	43 (13)	—

Percentages may not total 100% due to rounding.  $P$  values for comparison are from chi-squared tests for independence;  $\alpha=0.05$ . AY, academic year; PGY-4, post-graduate year 4; —, not applicable; MD, Doctor of Medicine; DO, Doctor of Osteopathic Medicine; USMG, United States medical graduate; IMG, international medical graduate.

<sup>a</sup>ACGME data for first- and second-year fellows AY 2015–2016.<sup>46</sup>

<sup>b</sup>Comparison for differences between white, black, Asian/Pacific Islander, and other. Differing data collection methods between ASN/George Washington University and ACGME obviate the ability to determine unknown responses or perform further comparisons.

an educational needs assessment performed in conjunction with the annual American Society of Nephrology (ASN) Nephrology Fellows Survey, sought to determine current fellows' educational needs and evaluate their interest in potential educational interventions. The results can help inform training programs to better prepare nephrologists for independent careers and potentially attract more candidates to the specialty.

## METHODS

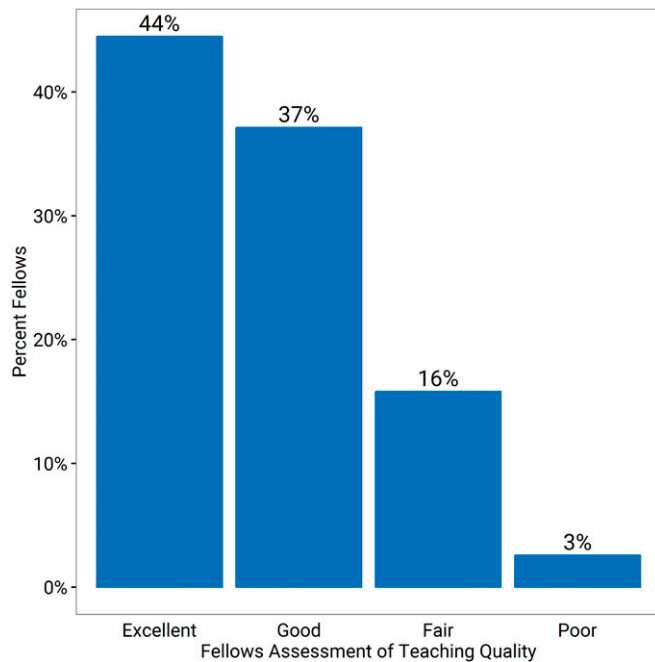
The educational needs assessment survey was created by the lead author (R.W.R.) with guidance from an educational researcher (S.B.M.) followed by an iterative review process with ASN Workforce

Committee members, including the other coauthors. The final survey consisted of seven questions on the following topics: the overall quality of teaching in fellowship, educational modalities used in fellowship, educational topics requiring additional emphasis, and likelihood to participate in novel educational interventions. The complete survey is included in Supplemental Material.

The content assessed generally aligned with that from the 2010 survey by Berns<sup>6</sup> as well as the Accreditation Council for Graduate Medical Education (ACGME) nephrology program guidelines and the ACGME/American Board of Internal Medicine Milestones Project.<sup>13,14</sup> One qualitative question asked respondents to “[d]escribe two changes that could improve [their]

fellowship's educational environment.” The survey was piloted with nephrology faculty within the lead author's institution, and cognitive interviews were performed with medical students to evaluate the clarity of the survey. This survey development process generated confidence in the content validity of the survey.<sup>15</sup>

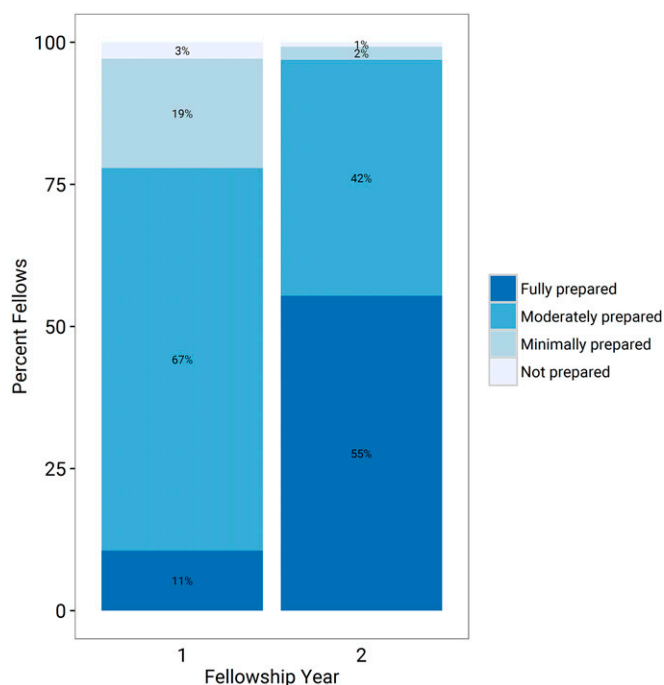
We distributed the survey by email in conjunction with the ASN Nephrology Fellows Survey at the end of the academic year (May and June of 2016) via the secure REDCap survey platform. Further details regarding distribution methods and strategies to increase response rates are presented in Supplemental Material. Contingency table (chi-squared) testing was used to evaluate differences in demographic characteristics between



**Figure 1.** Fellows have positive perceptions of the overall quality of their training. Bars indicate the percentages of respondents for each assessment class.

respondents and fellows nationally as well as differences in perceived preparedness for independent practice between respondents of different years.

Responses for “not prepared” and “minimally prepared” were combined given reduced numbers. We analyzed the quantitative data using descriptive statistics for



**Figure 2.** A majority of second-year fellows report moderate or full preparedness for independent practice.

central tendency (mean and SD), overall counts and percentages, and frequency distributions. Analyses were conducted using GraphPad Prism software. Qualitative data were analyzed *via* an inductive thematic approach. The ASN Nephrology Fellows Survey was reviewed and exempted by George Washington University’s Institutional Review Board (IRB). The educational needs assessment survey questions were also exempted from review by Stanford University’s IRB.

## FINDINGS

### Respondent Demographics

Overall, 377 of 1218 fellows to whom ASN offers complimentary membership completed the survey (31% response rate). Respondents in their first or second year of ACGME-accredited adult nephrology training were included in the analysis (320 fellows). Included respondents represented 37% (320 of 863) of ACGME-accredited fellows for the same academic year (2015–2016). Demographics are outlined in Table 1. With respect to age, sex, and race, respondents were similar to the overall cohort of fellows according to the most recent ACGME data. However, there were statistically significant differences between respondents and the ACGME cohort in the location of medical school of record (United States versus international medical schools) and medical degree (Doctor of Medicine versus Doctor of Osteopathic Medicine).

### Quality and Educational Makeup of Fellowship Teaching

Most respondents described the overall quality of fellowship teaching as either “good” (37%) or “excellent” (44%) (Figure 1). Similarly, almost one half of second-year respondents (42%) felt “moderately prepared” for independent practice, and more than one half (55%) felt “fully prepared” (Figure 2). Second-year fellows felt more prepared than first-year fellows ( $P < 0.01$ ; chi-squared test for independence).

Although the prior 2010 Berns<sup>6</sup> survey did not assess overall preparation for

**Table 2.** Educational modalities in current use (269 fellows responded)

Which of the Following Are Used in Your Fellowship Curriculum? (Select All That Apply)	N (%)
Journal clubs—led by fellows	243 (90)
Curriculum lectures—led by attendings	240 (89)
Renal pathology conferences	239 (88)
Grand rounds—presented by attendings	193 (72)
Grand rounds—presented by fellows	171 (64)
Curriculum lectures—led by fellows	159 (59)
Fellow-led case reports	142 (53)
Journal clubs—led by attendings	135 (50)
Key articles or reading lists/collections	121 (45)
Temporary dialysis catheter simulation training	111 (41)
Morbidity and mortality conferences	111 (41)
Kidney biopsy simulation training	80 (30)
Uninterrupted protected time for renal physiology, pathophysiology, and/or clinical nephrology review (separate from core curriculum lectures)	73 (27)
Communications training for end of life care and dialysis decision making	69 (26)
Online audio/video recordings of presentations (e.g., grand rounds, lectures)	68 (25)
Interventional nephrology training	44 (16)
Formal ultrasound training	32 (12)
Online collaborative learning forum where fellows can post questions, cases, resources, and presentations	24 (9)

independent practice, the percentage of respondents indicating that they were well trained and competent ranged from approximately 80% for in-center hemodialysis and transplant care to 15% for HHD care. Further characterizations of nephrology fellows' overall preparation for independent practice are not present in the literature. In

contrast, a 2001 survey of graduating internal medicine residents found that, although 91% felt very prepared to care for inpatients independently, only 48% felt very prepared for the ambulatory setting.<sup>16</sup>

Importantly, anchor effect bias within a Likert scale may increase the selection of moderate choices rather

than extremes and underestimate the number of fully prepared fellows.<sup>17</sup> However, although this subjective measure of preparedness for a future and as yet unknown job is flawed, it is likely that this preparedness gap is at least partially generated by educational deficiencies in fellowship. Educational innovations designed to improve global performance will likely reduce this gap.

### Educational Modalities and Resources

Participants were asked to identify educational modalities and resources used in fellowship. Table 2 details educational modalities that respondents indicated were used in their fellowships. Traditional modalities (e.g., journal clubs, lectures, and grand rounds) predominated, with between 72% and 90% of respondents reporting their use. Other modalities, including protected time for physiology and clinical nephrology review, reading lists, simulation training for catheters or biopsies, communications training, and ultrasound training, were reported by <50% of respondents.

These results suggest that the general educational structure, as perceived by fellows, is reasonably similar among programs given the prevalence of traditional educational modalities, such as curriculum lectures, journal clubs, and grand rounds. A recent survey of nephrology training program directors also indicated that these modalities are nearly universal.<sup>18</sup> In this survey, simulation training was perceived as less prevalent than expected given the ACGME mandate to include simulation in curricula.<sup>13</sup> Although respondents may not have understood the variety of simulation training that may be included in their fellowship and although the survey did not include all potential simulation curricula, this discrepancy raises concern. Fellows' receptiveness to additional simulation training seemed mixed. Respondents reported that they were less likely to participate in simulation training for catheter placement, biopsies, or communication skills compared with other strategies. In contrast, the desire for biopsy and ultrasound training was

**Table 3.** Educational tools in current use (271 fellows responded)

Which of the Following Educational Tools Have You Used in the Last 3 mo?	N (%)
UpToDate	261 (96)
CJASN articles	181 (67)
ASN NephSAP	171 (63)
JASN articles	160 (59)
Textbooks	156 (58)
KDIGO/KDOQI clinical practice guidelines	128 (47)
AJKD articles	126 (47)
Journal articles in general	113 (42)
Renal fellow network blog	93 (34)
ASN KSAP	74 (27)
AJKD kidney core curriculum	30 (11)
NephJC (Twitter-based journal club)	19 (7)
AJKD Blog	18 (7)
ASN online dialysis curriculum	7 (3)
ASN online geriatrics curriculum	4 (2)

CJASN, *Clinical Journal of the American Society of Nephrology*; NephSAP, *Nephrology Self-Assessment Program*; JASN, *Journal of the American Society of Nephrology*; KDIGO, *Kidney Disease Improving Global Outcomes*; KDOQI, *Kidney Disease Outcomes Quality Initiative*; KSAP, *Kidney Self-Assessment Program*; NephJC, *Nephrology Journal Club*.

**Table 4.** Additional instruction during fellowship (266 fellows responded)

Which Topics Would You Most Like to Receive Additional Instruction in during Fellowship?	N (%)
HHD	136 (51)
PD	119 (45)
Kidney ultrasound interpretation	118 (44)
Acute GN diagnosis/management	101 (38)
Obstetric nephrology	95 (36)
Toxicology	89 (33)
Renal pathology interpretation	85 (32)
Nephrolithiasis	69 (26)
Hemodialysis	67 (25)
Care of adults with pediatric renal disease	62 (23)
Renal pharmacology	61 (23)
Genetic renal diseases	59 (22)
Conservative/palliative management of ESRD	53 (20)
Electrolyte disorders/acid-base disorders	53 (20)
Secondary hypertension diagnosis/management	52 (19)
Nutrition	45 (17)
Kidney biopsy	44 (16)
Temporary dialysis catheter placement	42 (16)
Mineral and bone disease management	40 (15)
Nephrotic syndrome	32 (12)
Urinalysis	31 (12)
Post-transplant outpatient management	30 (11)
Geriatric nephrology	28 (11)
Inpatient general AKI diagnosis/management	26 (10)
Post-transplant acute inpatient management	25 (9)
Outpatient CKD diagnosis/management	24 (9)
Diabetic nephropathy	18 (7)
Anemia of renal disease management	14 (5)
Others specified by respondents: interventional nephrology, renal physiology	N/A

N/A, not applicable.

emphasized in answers to a free response question about educational improvements (discussed below). Notably, there is at least preliminary evidence to

support the use of simulation in nephrology education.<sup>11,19–22</sup>

Fellows were also asked to report extracurricular resources used within the

last 3 months (Table 3). UpToDate was nearly universally used, with the *Clinical Journal of the American Society of Nephrology*, the *Journal of the American Society of Nephrology*, and the ASN *Nephrology Self-Assessment Program* used by a majority of respondents.<sup>23</sup> However, several expert-led and potentially effective educational resources, such as the *American Journal of Kidney Disease (AJKD)* Kidney Core Curriculum, the Renal Fellow Network blog, Nephrology Journal Club, the *AJKD* blog, and the ASN online curricula, seem less utilized.<sup>24–28</sup> These resources deliver content on topics requested by respondents in this survey, such as home dialysis modalities and GN, and their heightened focus on social media formats may prove useful for digital learners. Formal evaluation of their usefulness and dissemination of the content through effective avenues would be valuable for fellows and their programs.

### Educational Content Needs and Suggestions for Improving the Educational Environment

Participants were asked to identify topics that they would like additional instruction in during fellowship (Table 4). Top desired topics (>30% responding) included home dialysis modalities (PD and HHD), radiology and pathology interpretation, obstetric nephrology, GN, and toxicology, suggesting an

**Table 5.** Changes to educational environment suggested by fellows

Theme	Sample Quotations
Structural changes desired	"Protected teaching time not interrupted by pages"
	"Allow 'pager free' time so that focus can be given to lectures"
	"More core lecture series and board question-based conferences"
	"More time emphasized on education over service"
	"Reduce patient load/clinical responsibilities . . . [to] provide more dedicated time for study"
	"More attending involvement in planning a cohesive curriculum"
	"Structured curriculum with readings in textbook and/or key articles to go with lectures/cases"
Educational content desired	"Providing fellows with their own panel of patients rather than those designated to an attending"
	"Introductory lectures during the first 3 months on basic nephrology topics"
	"[Establish] specific . . . electives in second year for either US or IR"
	"Provide protected time for simulations programs, i.e., reading US, dialysis catheter placement"
	"More opportunity to do kidney [biopsies] and [for] training in performing ultrasound"
	"Dedicated renal physiology lectures and training"
	"More stress on home dialysis therapies/outpatient therapies and less in-hospital training"

Qualitative responses were reviewed by the first author (R.W.R.), who selected 14 representative quotes from 13 respondents. US, Ultrasound; IR, interventional radiology.

**Table 6.** Educational strategies (234 fellows responded)

How Likely Are You to Participate in the Following Educational Strategies as a Fellow? (1–5 Likert Scale, with 1 Indicating Very Unlikely, 3 Indicating Neither Unlikely nor Likely, and 5 Indicating Very Likely)	Mean (SD) Likelihood of Participation
Renal pathology conferences	4.30 (0.86)
Dedicated time for renal physiology, pathophysiology, and/or clinical nephrology review	4.03 (1.03)
Training in performing ultrasound	3.75 (1.26)
Fellow-led in-person case-based pathophysiology/management discussions (“morning report style”)	3.73 (1.16)
Formal teaching opportunities (e.g., medical school, IM residency lectures)	3.67 (1.14)
Formalized “pre-tending” as a fellow (acting as an attending during consultation rotations with minimized formal attending supervision)	3.65 (1.22)
Key article reading list with fellow-authored article summaries	3.64 (1.17)
Computer simulation exercises of HD/PD cases where you can alter prescriptions and follow results	3.62 (1.27)
Watching online recordings of lectures, grand rounds, or journal clubs	3.50 (1.27)
Simulated renal biopsy training	3.50 (1.28)
Communications training for end of life care and dialysis decision making	3.49 (1.20)
Conferences between local fellowships (e.g., in New England) targeted at fellows	3.45 (1.27)
Simulated catheter placement training	3.44 (1.29)
Fellow-led online case-based pathophysiology/management discussions where fellows share and contribute to cases on a regular basis	3.41 (1.24)
Interventional nephrology training	3.41 (1.33)
Case-based debates between specialties (e.g., rheumatology and nephrology fellows)	3.39 (1.26)
Problem sets (“homework”) on various topics	3.37 (1.16)
Formal education in “how to teach”	3.34 (1.26)

IM, internal medicine; HD, hemodialysis.

educational need in these areas; 10% or fewer of fellows desired further instruction in topics, such as AKI management, outpatient CKD management, or diabetic nephropathy.

A total of 100 of 320 participants (31%) responded to the open-ended question: “Describe two changes that could improve your fellowship’s educational environment.” Responses centered on two themes: (1) structural changes and (2) desires for specific educational content. Structural changes included requests for more protected time to study independently, lectures and presentations sheltered from the competing interests of clinical care (e.g., “[a]llow ‘pager free’ time so that focus can be given to lectures”), and more faculty involvement in curricular development and implementation. Suggestions for educational content centered largely on

increasing emphasis in four content areas: procedures (e.g., “[p]rovide protected time for simulations programs, *i.e.*, reading [ultrasounds] dialysis catheter placement”), home dialysis modalities, ultrasound and other renal imaging, and renal pathology and physiology. Further representative quotes are listed in Table 5.

The content areas identified by fellows for additional educational emphasis align with those topics previously identified in the Berns<sup>6</sup> 2010 survey of recently graduated nephrologists.

The need for additional training in home dialysis modalities is especially notable given the desire to expand these patient-centered and potentially less expensive options. Without strengthening fellowship training in these key therapeutic options, the full adoption of these modalities across the specialty will be difficult.

### Future Educational Innovations

Lastly, fellows were surveyed on how likely they were to participate in educational interventions reflective of the nephrology educational literature and traditional educational modalities (Table 6). Respondents viewed all potential interventions at least neutrally in aggregate. However, fellows were more likely to participate in renal pathology conferences and “dedicated time for renal physiology, pathophysiology, and/or clinical nephrology review.”

Although interest in simulation within this survey seems mixed, the ability of simulation curricula to increase fellows’ procedural competence should continue to be explored. A lack of procedural confidence and opportunities in fellowship, beyond representing a potential educational challenge, may be a deterrent to recruiting fellows who enjoy

working with their hands or are concerned about limited revenue potential in nephrology.<sup>29</sup>

The use of novel educational tools in nephrology has vastly expanded in the last two decades.<sup>30–33</sup> Although recent literature has emphasized the potential for educational innovations to improve nephrology training, consistent outcome data are lacking.<sup>34–37</sup> These methods, including but not limited to social media (e.g., blogs, Twitter, and physician networks), connectivity aids (e.g., audience response systems and lecture capture), video production, clinical debates, and medical gaming, provide opportunities to create interactive and captivating education placed within a clinically relevant context at all trainee levels. Importantly, although nephrology has taken a strong place in the nascent development of social media educational tools, our understanding of their efficacy remains limited.<sup>38</sup> Assessing and expanding innovation in nephrology education may not only improve education of trainees but also, given the connection between education and interest in nephrology, help address the growing disinterest in our field.<sup>29,39,40</sup>

Parallel with these developing educational tools, the ASN has also sponsored recent workforce activities, including (1) the Kidney Tutored Research and Education for Kidney Students Program, which provides medical students core physiology education as well as ongoing mentorship and scholarship experiences that seem to increase interest in nephrology as a career choice; (2) the Mentoring and Awareness Program for Students, a community CKD screening program; and (3) the Kidney Students and Residents Program, which provides travel grants to medical students and residents to attend ASN Kidney Week.<sup>41–44</sup> Moving forward, the longitudinal assessment of participants in these programs is a priority for the ASN leadership.

### Limitations of the Survey

This study has several limitations, most notably the limited response rate. Multiple approaches to improving participation were used and are discussed in Supplemental

Material. Although the response rate may limit the generalizability of the results, this survey represents, to the best of the authors' knowledge, the largest sampling of nephrology fellows within an educational study to date. Furthermore, respondents were representative of the ACGME fellows cohort in terms of age, sex, and race. The limited response rate may also have contributed to the variance in responses regarding future educational modalities, limiting our ability to discriminate between interventions. Unfortunately, increasing follow-up outreach beyond what was performed has not been associated with improved response rates, and direct financial incentives, which are effective, were unavailable (aside from a chance at winning complimentary ASN membership or Board Review Course and Update registration).<sup>45</sup> Future studies may benefit from these incentives as well as consideration of inclusion within the national fellow in-training examination to improve response rates.

It also must be recognized that surveys may accentuate the concerns of a minority of vocal respondents, further limiting generalizability. As discussed earlier, fellows in training inherently lack the perspective that comes from independent practice, which may partially explain the reduced interest in some topics (e.g., end of life care/geriatric nephrology, nutrition, and outpatient CKD management). However, in limiting this survey to current fellows rather than practicing nephrologists, we could better assess what educational interventions are more likely to be supported by fellows. Future studies should endeavor to capture a greater totality of current fellows' experience and further incorporate the evolving educational tools that we are developing.

### CONCLUSION

As the specialty of nephrology addresses what it means to be a "nephrologist" and what future trainees will require for professional success, the ongoing evolution of training standards, competencies, and educational modalities will be critically important.<sup>4</sup> This study represents the

most current general educational needs assessment of United States nephrology fellows. It outlines areas for additional curricular emphasis, including home dialysis modalities, as well as the potential utility of emerging educational innovations in fellowship. Over time, continued improvements in fellowship curricula may not only improve the education of current trainees but also, help ensure the future of the specialty as well.

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1 **Supplemental Content**

2 Appendix A: Educational Needs Assessment Survey

3 Appendix B: Complete Methods and Recruitment Strategy

4

5

## 6 **Appendix A: Educational Needs Assessment Survey**

### 7 **1) Which of the following are used in your fellowship curriculum?**

8 *Select all that apply*

- 9  Curriculum Lectures—led by fellows
- 10  Curriculum Lectures—led by attendings
- 11  Journal Clubs—led by fellows
- 12  Journal Clubs—led by attendings
- 13  Fellow-led case reports ("morning report style")
- 14  Grand Rounds—presented by fellows (formal presentation on a case/topic)
- 15  Grand Rounds—presented by attendings (formal presentation on a case/topic)
- 16  Key articles or reading lists/collections
- 17  Online audio/video recordings of presentations (e.g., Grand Rounds, Lectures)
- 18  Online collaborative learning forum where fellows can post questions, cases, resources, and
- 19 presentations
- 20  Uninterrupted protected time for renal physiology, pathophysiology, and/or clinical
- 21 nephrology review (separate from core-curriculum lectures)
- 22  Renal Pathology Conferences
- 23  Morbidity and Mortality Conferences
- 24  Kidney biopsy simulation training
- 25  Temporary dialysis catheter simulation training
- 26  Formal ultrasound training
- 27  Interventional Nephrology Training
- 28  Communications training for end-of-life care and dialysis decision-making
- 29

### 30 **2) Which topics would you most like to receive additional instruction in during**

31 **fellowship?**

- 32  Hemodialysis
- 33  Peritoneal Dialysis
- 34  Home Hemodialysis
- 35  Temporary Dialysis Catheter Placement
- 36  Kidney Biopsy
- 37  Inpatient General AKI Diagnosis/Management
- 38  Acute GN Diagnosis/Management
- 39  Nephrotic Syndrome
- 40  Diabetic Nephropathy
- 41  Outpatient CKD Diagnosis/Management
- 42  Secondary Hypertension Diagnosis/Management
- 43  Electrolyte Disorders/Acid-Base Disorders
- 44  Anemia of Renal Disease Management
- 45  Mineral and Bone-Disease Management
- 46  Nephrolithiasis

- 47  Urinalysis  
48  Kidney US Interpretation  
49  Renal Pathology Interpretation  
50  Post-transplant Acute Inpatient Management  
51  Post-transplant Outpatient Management  
52  Care of Adults w/Pediatric Renal Disease  
53  Genetic Renal Diseases  
54  Obstetric Nephrology  
55  Toxicology  
56  Nutrition  
57  Renal Pharmacology  
58  Geriatric Nephrology  
59  Conservative/Palliative Management of ESRD  
60  Other \_\_\_\_\_  
61

62 **3) How would you rate the overall quality of teaching in your fellowship?**

- 63  Poor  
64  Fair  
65  Good  
66  Excellent  
67

68 **4) Which of the following educational tools have you used in the last 3 months?**

69 *Select all that apply*

- 70  UpToDate  
71  ASN NephSAP  
72  ASN KSAP  
73  JASN articles  
74  CJASN articles  
75  AJKD articles  
76  Journal articles in general  
77  AJKD Kidney Core Curriculum  
78  Textbooks  
79  ASN Online Geriatrics Curriculum  
80  ASN Online Dialysis Curriculum  
81  KDIGO/KDOQI Clinical Practice Guidelines  
82  Renal Fellow Network Blog  
83  AJKD Blog  
84  NephJC (Twitter-based journal club)  
85  Other \_\_\_\_\_  
86

87 **5) How likely are you to participate in the following educational strategies as a fellow?**

	Very Unlikely	Unlikely	Neither Likely Nor Unlikely	Likely	Very Likely
Watching online recordings of Lectures, Grand Rounds, or Journal Clubs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Renal Pathology Conferences	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Key article reading list with fellow-authored article summaries	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Problem sets ("homework") on various topics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Computer simulation exercises of HD/PD cases where you can alter prescriptions and follow results	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dedicated time for renal physiology, pathophysiology, and/or clinical nephrology review	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fellow-led in-person case-based pathophysiology/management discussions ("morning report style")	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fellow-led online case-based pathophysiology/management discussions where fellows share and contribute to cases on a regular basis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conferences between local fellowships (ex. in New England) targeted at fellows	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Case-based debates between specialties (e.g., rheumatology and nephrology fellows)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communications training for end-of-life care and dialysis decision-making	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Interventional Nephrology Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Simulated catheter placement training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Simulated renal biopsy training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training in performing ultrasound	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalized "pre-tending" as a fellow (acting as an attending during consultation rotations with minimized formal attending supervision)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formal education in "How to teach"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formal teaching opportunities (e.g., medical school, IM residency lectures)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

89 **6) Describe two changes that could improve your fellowship's educational environment.**

90

91 **7) Rate your current level of preparedness for entering independent general nephrology**  
92 **practice.**

93  Not prepared

94  Minimally prepared

95  Moderately prepared

96  Fully prepared

97

## 98 **Appendix B: Complete Methods and Recruitment Strategy**

99 The educational needs assessment survey was created by the lead author (RR) with guidance  
100 from an educational researcher (SBM) and followed an iterative review process with the  
101 American Society of Nephrology(ASN) Workforce Committee members, including the other co-  
102 authors. The final survey consisted of seven questions on the following topics: the overall quality  
103 of teaching in fellowship; educational modalities used in fellowship; educational topics requiring  
104 additional emphasis; and likelihood to participate in novel educational interventions. The content  
105 assessed generally aligned with those from the 2010 survey by Berns, as well as the  
106 Accreditation Council for Graduate Medical Education (ACGME) nephrology program guidelines  
107 and ACGME/American Board of Internal Medicine Milestones project.<sup>1-3</sup> To allow respondents  
108 to suggest additional changes needed in their programs, one qualitative question asked  
109 respondents to “Describe two changes that could improve [their] fellowship’s educational  
110 environment.” The survey was piloted with nephrology faculty within the lead author’s institution  
111 and cognitive interviews were performed with medical students to evaluate the clarity of the  
112 survey. This survey development process generated confidence in the content validity of the  
113 survey.<sup>4</sup>

114  
115 We distributed the survey by email in conjunction with the ASN Nephrology Fellows Survey at  
116 the end of the academic year (May and June 2016) via the secure REDCap survey platform.  
117 **Multiple approaches to improve participation were implemented. These included incentives**  
118 **(complimentary ASN memberships or Board Review Course Update registration), extending the**  
119 **participation deadline twice, outreach to training program directors through email and verbal**  
120 **contact, as well as reminders to respondents distributed through multiple media channels**  
121 **including social media, direct outreach to fellows through the ASN website, and eight email**  
122 **reminders to recipients. These methods align ASN survey practices with those of other large**

123 medical organizations such as the American Association of Medical Colleges (personal  
124 communication, co-author KAP).

125  
126 Contingency table (Chi-square) testing was used to evaluate differences in demographic  
127 characteristics between respondents, recipients, and fellows nationally as well as for differences  
128 in perceived preparedness for independent practice between respondents of different years.  
129 Responses for “not prepared” and “minimally prepared” were combined given reduced numbers.  
130 We analyzed the quantitative data using descriptive statistics for central tendency (mean and  
131 standard deviation), overall counts and percentages, and frequency distributions. Analyses were  
132 conducted using GraphPad Prism software. Qualitative data was analyzed via an inductive,  
133 thematic approach. The ASN Nephrology Fellows Survey was reviewed and exempted by  
134 George Washington University’s Institutional Review Board (IRB). The educational needs  
135 assessment survey questions were also exempted from review by Stanford University’s IRB.

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