

## RESEARCH

# Evaluation of Curricula Content on Kidney Disease in US Doctor of Pharmacy Programs

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**Objective.** Although pharmacists improve outcomes in the care of patients with kidney diseases and current guidelines advocate multidisciplinary care, pharmacist nephrology training is not well described. This study seeks to characterize required and elective coursework within US Doctor of Pharmacy curricula. This information will be valuable in identification and evaluation of educational gaps for pharmacists as best practices in the education and care of kidney diseases for pharmacists are established.

**Methods.** This prospective, cross-sectional, descriptive study assessed current practices and trends in education on kidney diseases within Doctor of Pharmacy curricula at accredited programs in the United States through an electronic survey.

**Results.** Forty-three percent (N=61) of all ACPE-accredited pharmacy institutions were represented in the survey. Content on kidney diseases was found to be taught in both required and elective coursework, and one-third of responding institutions offered advanced pharmacy practice experiences focused on kidney diseases. Variation was found in the amount of time allotted for the teaching of kidney diseases topics in pharmacy curricula and the types of experiential training offered. Six respondents reported offering postgraduate education that focused on kidney diseases. Most respondents were clinical faculty who had completed residency training and board certification.

**Conclusion.** Given the complex interplay between kidney diseases and other health conditions, the increasing incidence and prevalence of kidney diseases, and the potential expansion of pharmacists' roles in the care of patients with kidney diseases, a review of current Doctor of Pharmacy curricula is necessary to guide any future optimization efforts to ensure practice-ready pharmacists.

**Keywords:** nephrology, curriculum, pharmacy, kidney disease, education

## INTRODUCTION

An estimated 37 million US adults have chronic kidney disease (CKD).<sup>1</sup> Diabetes and hypertension are the leading causes of CKD, which can result in end-stage renal disease (ESRD).<sup>2</sup> With increasing rates of diabetes, hypertension, and obesity, as well as an aging population, the incidence and prevalence of ESRD is projected to increase.<sup>3</sup> Current guidelines recommend the use of medications with demonstrated benefit in delaying disease progression and emphasize multidisciplinary care for patients with CKD. Multidisciplinary care may include a nephrologist, primary care provider, dietitian, pharmacist, social worker, and nursing staff.<sup>4,5</sup>

There are concerns regarding nephrology workforce shortages in the United States, including a shortage of nephrologists and nephrology nurses.<sup>6</sup> The number of nephrologists per ESRD patient in the United States has steadily declined, despite increasing numbers of nephrology physician trainees.<sup>7</sup> Nephrologist advocacy for improving and increasing collaboration and care coordination with other healthcare professionals, including pharmacists, is present in multiple guidelines, as well as in the recent Executive Order on Advancing American Kidney Health (AAKH).<sup>7-11</sup> This executive order established multiple initiatives and the selection of innovative, value-based payment models. Using value-based payment models, AAKH seeks to reduce the number of Americans developing kidney failure and increase the utilization of home-based therapies among new patients with kidney failure. These value-based models provide financial incentives for health care teams to focus on earlier intervention in

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patients with CKD, and kidney care wraparound companies have created new opportunities for pharmacists to provide comprehensive medication management (CMM) for patients with kidney disease.<sup>9,11</sup> Pharmacists have demonstrated an ability to improve medication-related outcomes across the spectrum of kidney diseases and reduce health care costs (eg, deprescribing, reduced hospitalizations).<sup>12-16</sup>

Given the potential increased need and opportunities for pharmacist-provided CMM, pharmacists may benefit from an understanding of kidney diseases.<sup>17,18</sup> However, pharmacy student knowledge of kidney disease at the time of degree completion from an accredited US Doctor of Pharmacy (PharmD) program is unclear.<sup>18</sup> Using quantitative and qualitative standards, the goal of ACPE accreditation is to ensure programs that meet basic expectations of quality education in pharmacy and foster continued improvement to reflect changing clinical practices. To support diversity and innovation, the focus of the ACPE standards is thus on broad educational outcomes (eg, “patient-centered care”), with suggestions related to structural components and key elements rather than a prescription of specific topics or content areas. Thus, in designing pharmacy curricula, schools and colleges of pharmacy include input from leaders, key stakeholders, and national pharmacy organizations to reflect advances in patient care. The American College of Clinical Pharmacy (ACCP) Pharmacotherapy Didactic Curriculum Toolkit provides broad guidance for schools and colleges of pharmacy in curricular design.<sup>19</sup> The ACCP Toolkit is not prescriptive; it instead assigns Tier definitions to suggest the scope of inclusion of topics within an institution’s pharmacy curriculum and reflected the current state of pharmacy practice during its creation. Items are categorized by Tiers 1-3, with higher Tier numbers correlating with the likelihood that students need additional postgraduate training to provide patient care for that topic. For example, students should receive education to provide patient care for Tier 1 topics upon graduation and licensure. Tier 2 items may be discussed in curricula, but postgraduate training may be required for the provision of patient care.

Given the heterogeneity of pharmacist education, as well as the benefits of and need for pharmacist-provided care in diverse practice areas, there is a need to evaluate current kidney disease education in US pharmacy curricula. This study aims to collect information on the scope of required and elective content on kidney disease within US pharmacy professional programs. This information will be valuable in identification and evaluation of educational gaps for pharmacists as best practices in education about kidney disease and pharmacist care of patients with kidney disease are established. Additionally, information may

support the creation of educational standards for kidney disease content in the PharmD curricula.

## **METHODS**

This prospective, cross-sectional, descriptive study assessed current practices in kidney disease education using an electronic survey. A list of all US pharmacy institutions was obtained from the Accreditation Council for Pharmacy Education (ACPE) website.<sup>20</sup> The study team identified a department chair for each institution and sent an electronic survey (QuestionPRO) request, to be shared with the appropriate pharmacy faculty involved in teaching kidney disease content within the respective school’s curriculum. The survey included multiple-choice and free-text questions to collect demographic information (eg, job title/classification, years of teaching experience, educational background) and data regarding content on kidney disease currently taught in the curriculum (eg, topic(s) covered, time allotted to a given topic, required vs elective), advanced pharmacy practice experiences (APPEs), and postgraduate training opportunities. Twenty-one topics on kidney disease were selected for inclusion on the survey using the ACCP Toolkit and input from key opinion leaders in kidney-diseases pharmacy practice involved in the Advancing Kidney Health through Optimal Medication Management Initiative.<sup>17-19</sup> Informed consent was provided electronically. This study was deemed exempt by the University of Texas at El Paso Institutional Review Board.

For all data, descriptive statistics were used. Continuous variables, such as years of teaching experience, were described by mean and standard deviation. Categorical variables, such as job title/classification, were described using frequencies and percentages. Incomplete and/or duplicate responses were not included in analyses.

## **RESULTS**

Sixty-one pharmacy institutions responded to the survey, representing 27 states and 1 US territory. All institutions were either fully accredited (n=60) or had candidate status (n=1) with ACPE. Responses accounted for 43% of all ACPE-accredited programs. Responses were also stratified by commonly recognizable regions and by program characteristics.<sup>21</sup>

Survey respondents had diverse clinical qualifications in the teaching of nephrology content. Full demographic characteristics of survey respondents are shown in Table 1. Half of the responses were from public institutions. Twenty-six (43%) institutions were affiliated with an academic medical center. All survey respondents were members of the faculty at their respective institutions with

Table 1. Demographics of Respondents to a Survey Regarding Current Practices and Trends in Kidney Diseases Education Within Doctor of Pharmacy Curricula at Accredited Programs in the United States

	All Respondents N=61 (%)
<b>Job Title</b>	
Assistant Professor (n=24)	39
Associate Professor (n=24)	39
Professor (n=13)	21
<b>Institutional Role</b>	
Clinical, non-tenure track faculty (n=38)	62
Clinical, tenure-track faculty (n=14)	23
Tenure track faculty (n=6)	10
Other <sup>a</sup> (n=3)	5
<b>Degrees Earned<sup>b</sup></b>	
Bachelor's degree (n=19)	31
Master's degree (n=12)	20
Doctor of Pharmacy (n=58)	95
Doctor of Philosophy (n=2)	3
Doctor of Medicine (n=1)	2
<b>Formal Postgraduate Training Completed<sup>b</sup></b>	
None (n=7)	11
Postgraduate Year-1 (PGY-1) Pharmacy Residency (n=48)	79
Postgraduate Year-2 (PGY-2) Pharmacy Residency (n=31)	51
Postgraduate Fellowship (n=9)	15
<b>Professional Certifications Earned<sup>b</sup></b>	
Any (n=47)	77
Board Certification in Ambulatory Care Pharmacy (BCACP) (n=2)	3
Board Certification in Critical Care Pharmacy (BCCCP) (n=5)	8
Board Certification in Geriatric Pharmacy (BCGP) (n=5)	8
Board Certification in Pharmacotherapy (BCPS) (n=42)	69
Board Certification in Psychiatric Pharmacy (BCPP) (n=2)	3
Other (eg, CDCES, Advanced Practice Pharmacist) (n=8)	13
No certifications (n=13)	21
No response selected (n=1)	2

<sup>a</sup> Includes other, non-tenure-track faculty, tenured faculty, etc.

<sup>b</sup> multiple selections allowed.

the majority (62%, n=38) being clinical, non-tenure track faculty. Respondents reported an average of 11.7 ( $\pm 8.8$ ) years teaching at any school or college of pharmacy and

an average of 9.2 ( $\pm 7.9$ ) years teaching kidney-related topics. Over three-quarters of all respondents (n=48, 79%) had completed at least a postgraduate year 1 pharmacy residency (PGY-1) training program, and 77% reported having at least 1 professional certification.<sup>22</sup>

Coverage of kidney-related topics and time allotted in the curriculum are described in Table 2. While 70% of respondents reported that kidney-related topics are taught as part of a therapeutic course series, the remainder reported kidney-related topics are a required stand-alone course within their school/college of pharmacy's curriculum. The average estimated amount of time allotted per kidney-related topic was 1.58 h ( $\pm 1.71$ ) (Table 2). Seven of the 21 content areas considered important by pharmacy experts in kidney diseases were reported by all respondents as having dedicated time within required coursework. At least 92% of respondents require coursework in ACCP Tier 1 and Tier 2 topics, except for solid organ transplant (75%). ACCP Tier 3 items, for which learners may not expect to receive curricular instruction, were required by at least 41% of responding institutions. In required coursework, the most time was allotted to fluid/electrolytes (4.62 $\pm$ 3.04 h; ACCP Tier 1), acid/base disturbances (2.85 $\pm$ 1.87 h; ACCP Tier 2), and solid-organ transplant (2.64 $\pm$ 2.28 h; ACCP Tier 2). Kidney stones (0.24 $\pm$ 0.41 h; ACCP Tier 3) and disparities in kidney care (0.34 $\pm$ 0.55 h; non-ACCP Tier topic) received the least time in required coursework.

In addition to required coursework, 26 respondents (44%) reported offering nephrology topics in elective coursework. Half of reported electives (n=13) were critical care-specific courses; of these, 1 respondent reported a kidney-focused elective. Within elective coursework, kidney-related topics were allotted an average 1.32 $\pm$ 0.6 h, with the most time given to solid-organ transplant (3.71 $\pm$ 1.61 h).

Experiential education opportunities with an emphasis on kidney diseases pharmacy practice were also assessed. Twenty-one respondents (34%) reported their institution offered an AAPE focused on kidney diseases, and 24 respondents (39%) were unsure. The median APPE rotation was reported to be 6 weeks long. The majority of APPEs focused on kidney diseases were in acute care (n=14), ambulatory care (n=12), hemodialysis (n=12), and/or kidney transplant (n=10). Regarding postgraduate education, 6 survey respondents (10%) reported that their affiliated institution offered nephrology-focused postgraduate training programs. Four respondents (7%) reported offering a pharmacy residency focused on kidney diseases, 1 respondent reported offering a fellowship focused on kidney disease, and 1 respondent reported that the institution offered both a pharmacy residency and a fellowship program focused on kidney diseases.

Table 2. Nephrology Topics in Required and/or Elective Coursework at US Colleges and Schools of Pharmacy

	Within Required Coursework		Within Elective Coursework	
	Included, All Respondents N=61 (%)	Hours Allotted M (SD)	Included All Respondents N=61 (%)	Hours Allotted M (SD)
ACCP Tier 1 Topics				
Slowing CKD progression	92	1.07 (0.78)	12	1.04 (0.40)
PK & Drug Dosing in CKD	93	2.30 (2.64)	16	1.25 (0.59)
Drug-induced Kidney Disease	100	1.45 (0.87)	18	1.09 (0.54)
Fluid/Electrolytes	97	4.62 (3.04)	21	1.38 (0.74)
ACCP tier 2 topics				
Acid/Base disturbances	97	2.85 (1.87)	12	1.56 (1.03)
AKI pathophysiology	100	1.42 (1.10)	13	1.19 (0.60)
AKI treatment	100	1.45 (0.92)	18	1.07 (0.61)
Hemodialysis	98	0.98 (0.67)	13	0.97 (0.42)
Peritoneal dialysis	92	0.56 (0.39)	3	0.75 (0.17)
Solid-organ transplant	75	2.64 (2.28)	12	3.71 (1.61)
ACCP Tier 3 Topics				
Glomerulonephritis	59	0.55 (0.38)	2	2.00 (0.33)
Kidney stones	41	0.58 (0.42)	2	1.00 (0.16)
Non-ACCP-tier topics				
Anemia of CKD	100	1.47 (1.09)	8	1.05 (0.42)
CKD-MBD	100	1.44 (0.99)	8	1.55 (0.86)
CKD pathophysiology	100	1.28 (0.75)	10	1.33 (0.58)
Clinical use of diuretics	97	1.59 (1.43)	13	1.31 (0.64)
CRRT	84	0.77 (0.79)	23	1.07 (0.61)
Disparities in kidney care	41	0.81 (0.55)	10	0.79 (0.38)
Assessing kidney function	100	2.44 (1.89)	20	1.42 (0.98)
KQODI or KDIGO Guidelines	89	1.23 (0.97)	10	1.13 (0.53)
Other <sup>a</sup> (eg, gout, pediatrics)	16	2.16 (0.96)	2	1.00 (0.12)

<sup>a</sup> Other includes gout, pediatrics, etc.

Abbreviations: ACCP = American Colleges of Clinical Pharmacy; AKI = acute kidney injury; CKD = chronic kidney disease; CKD-MBD = CKD Mineral & Bone Disorders; CRRT = continuous renal replacement therapy; KDIGO = Kidney Disease Improving Global Outcomes; KDOQI = Kidney Disease Outcomes Quality Initiative; PK = pharmacokinetics.

## DISCUSSION

This survey represents a broad cross-section of Doctor of Pharmacy curricula within the United States and provides a snapshot of current kidney disease-specific pharmacy student training. Respondents were well-qualified and represented a breadth of teaching and pharmacy expertise at both public and private institutions with experiential education offerings in diverse practice settings, including academic medical centers.

Our survey results show all ACCP Tier 1 and 2 topics in the renal, fluid, and electrolyte conditions section were included in the majority of responding institutions' curricula. However, the amount of time devoted to topics varied widely, which may be due to factors such as faculty

expertise, topic difficulty, or a variety of teaching methods used. Solid-organ transplant was less frequently reported as being included within required curricula compared to all other Tier 1 and 2 topics (75% vs ≥92%), which may be due to the presence of elective course offerings or the absence of a clinical faculty member practicing within solid-organ transplant. More electives focused on acute/inpatient care of patients with kidney disease as compared to outpatient CKD management (n= 13 [21%] vs n= 3 [5%]), which could be due to factors such as time constraints and/or faculty expertise. Similar numbers of acute care and ambulatory care APPEs centering around kidney diseases were reported.

In addition to ACCP-recommended renal, fluid, and electrolyte topics, 9 other kidney-related topics were

identified by nephrology pharmacy experts as important to CMM in patients with kidney diseases. Despite not explicitly being part of the updated 2019 ACCP Toolkit, at least 84% of respondents already included these topics within required coursework. One notable exception was the inclusion of disparities in kidney care (41%). People of African American, Hispanic/Latinx, American Indian, and Alaska Native descent face disparities in healthcare and have been shown to progress to ESRD at faster rates than White patients.<sup>23</sup> Leading nephrology organizations have provided recommendations to use non-race based, comprehensive approaches to assessing kidney function. National pharmacy organizations have advocated for pharmacy curricula to include education and training to help identify and address barriers to optimal medication management and decision-making in communities disproportionately impacted by kidney diseases.<sup>24-26</sup> The profession of pharmacy reinforced its commitment to diversity, equity, inclusion, and antiracism through a recent revision of the “Oath of a Pharmacist,” and our findings would support revision of ACPE Standards with stronger language and key elements to ensure education of pharmacists actively advocating for just and equitable patient care.<sup>27</sup>

Doctor of Pharmacy students are provided a robust baseline of kidney-related knowledge by well-trained clinical pharmacy faculty, though primarily in the acute care setting. However, there may be increasing opportunities for involvement of outpatient pharmacists as medication use practices for new drugs and indications. The sodium-glucose cotransporter 2 inhibitors canagliflozin and dapagliflozin are Food and Drug Administration–approved for reducing CKD progression in adults with type 2 diabetes and diabetic nephropathy with albuminuria and CKD, respectively.<sup>28,29</sup> Finerenone was also recently approved to reduce the risk of CKD progression in patients with CKD and type 2 diabetes.<sup>30</sup> These new pharmacologic agents, coupled with increasing CKD incidence, create further demand for health care professionals, especially pharmacists, to provide CMM to delay CKD progression. Pharmacy nephrology curricula need to ensure education regarding outpatient topics (eg, CKD screening, prevention of CKD and acute kidney injury (AKI), delaying CKD progression) is provided while continuing to provide education on minimizing risk of adverse renal outcomes during hospitalizations and care transitions.

Of the 12 ACCP Tier topics, 66% are designated as Tier 2 or 3, suggesting the graduating pharmacist would need additional postgraduate training to provide direct patient care. Nephrology and primary care practices will see an increasing population of patients with kidney disease, yet despite the demonstrated impact of pharmacists in this area, post-PharmD training opportunities focused

on kidney diseases are limited.<sup>31</sup> This may make it difficult for pharmacists to find adequate postgraduate training to provide patient care for ACCP Tier 2 and Tier 3 topics. This is concerning because the AAKH initiative is shifting patient-care models away from fee-for-service models towards value-based payment in nephrology. This shift encourages the integration of pharmacists as part of the interprofessional team to improve quality of care and outcomes for patients with kidney disease.<sup>9,18</sup> Previously, a pathway for accreditation of PGY-2 residency training programs in nephrology existed; however, this is no longer the case. Ten post-PharmD training programs have been reported previously, but the number of programs is poorly defined and should be examined further.<sup>31</sup>

The combined lack of consistency in nephrology education in Doctor of Pharmacy curricula (as demonstrated by our survey), limited postgraduate nephrology pharmacy training opportunities, and absence of pharmacy practice and education standards in nephrology may constrain pharmacists’ involvement in the care of patients with kidney disease.<sup>15,32</sup> This survey provides quantitative baseline information to create standard competencies for nephrology curricula in US pharmacy programs to develop future pharmacists with a strong foundation in nephrology to care for patients with kidney disease. The national Advancing Kidney Health through Optimal Medication Management (AKHOMM) initiative was formed in part to close the gap between current pharmacist and pharmacy student education and training in nephrology and to identify what is needed for pharmacists to competently work with patients with kidney disease.<sup>33</sup> Nephrology pharmacy practice and education standards have been developed, and additional continuing education modules on kidney-focused topics are under development; these standards and modules will be available for practicing pharmacists and pharmacy students to bridge the gap that exists today in nephrology pharmacy knowledge and skills.

Limitations of this study include that specific details regarding the depth and breadth of nephrology coursework and types of assessment utilized were not reviewed. Moreover, teaching methodology information was not collected. Nephrology-specific training was not collected, as those postgraduate pathways are no longer formally accredited, and responses to length of time teaching nephrology topics is an inference as to instructor comfort level/expertise. Respondents were also allowed to select multiple options for certain survey questions (eg, rotations offered); future surveys could examine specific APPE rotation settings (eg, outpatient vs inpatient hemodialysis) in more detail. Our survey results were limited by a relatively low response rate; however, respondents represented a diverse range of practicing faculty and have

similar characteristics to other US programs. Finally, the ACPE Standards and ACCP Pharmacotherapy Toolkit are not meant to be prescriptive, and individual institutions may set their own benchmark for proficiency in nephrology content in their pharmacotherapy series at the time of graduation.

## CONCLUSION

This survey of Doctor of Pharmacy curricula across the United States suggests that nephrology content is taught in a variety of didactic and experiential education settings from pharmacy faculty who are experienced and well-trained for the provision of nephrology education for pharmacists. There are few postgraduate training programs focused on nephrology, and current offerings should be explored further. Most institutions provide education for ACCP Pharmacotherapy Tier 1 and Tier 2 nephrology topics; however, these topics and rankings should continue to be reevaluated with input based on new value-based care models and practice needs. They should prioritize screening and kidney function assessment; prevention of chronic kidney disease; reducing disease progression; kidney-related healthcare disparities; and new opportunities for pharmacists within this changing healthcare environment to work with patients with kidney disease. Pharmacy programs must also continue to refine their experiential curricula to train practice-ready pharmacy students to provide direct patient care for patients with kidney disease. Continuous improvement and innovation in education can position pharmacy graduates to empower patients who have kidney disease.

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## REFERENCES

1. Centers for Disease Control and Prevention. Chronic Kidney Disease in the United States, 2021. Published March 4, 2021. Accessed April 13, 2023. <https://www.cdc.gov/kidneydisease/pdf/Chronic-Kidney-Disease-in-the-US-2021-h.pdf>
2. Causes of chronic kidney disease. National Institute of Diabetes and Digestive and Kidney Diseases. Published October 1, 2016.

Accessed April 13, 2023. <https://www.niddk.nih.gov/health-information/kidney-disease/chronic-kidney-disease-ckd/causes>

3. McCullough KP, Morgenstern H, Saran R, Herman WH, Robinson BM. Projecting ESRD incidence and prevalence in the United States through 2030. *J Am Soc Nephrol.* 2019;30(1):127-135. doi:10.1681/ASN.2018050531
4. Inker LA, Astor BC, Fox CH, et al. KDOQI US commentary on the 2012 KDIGO clinical practice guideline for the evaluation and management of CKD. *Am J Kidney Dis.* 2014;63(5):713-735. doi:10.1053/j.ajkd.2014.01.416
5. KDIGO 2012 Clinical Practice Guideline for the evaluation and management of chronic kidney disease. *Kidney international supplements.* 2013;3(1):136-150. Accessed April 6, 2023. <https://kdigo.org/guidelines/ckd-evaluation-and-management/>
6. Boyle SM, Washington R, McCann P, Koul S, McLarney B, Gadegbeku CA. The nephrology nursing shortage: insights from a pandemic. *Am J Kidney Dis.* 2022;79(1):113-116. doi:10.1053/j.ajkd.2014.01.416
7. Sharif MU, Elsayed ME, Stack AG. The global nephrology workforce: emerging threats and potential solutions. *Clin Kidney J.* 2016; 9(1):11-22. doi:10.1093/ckj/sfv111
8. Executive Order on Advancing American Kidney Health. The White House. Accessed April 23, 2023. <https://trumpwhitehouse.archives.gov/presidential-actions/executive-order-advancing-american-kidney-health/>
9. Rivara MB, Formica RN, Mehrotra R. Advancing American kidney health: new opportunities for collaborative care. *Am J Med.* 2020;133(7):e335-e337. doi:10.1016/j.amjmed.2020.01.036
10. Kidney Care Choices (KCC) Model. Centers for Medicare & Medicaid Services. Published October 26, 2021. Accessed April 13, 2023. <https://innovation.cms.gov/innovation-models/kidney-care-choices-kcc-model>
11. Lin E, Ginsburg PB, Chertow GM, Berns JS. The “Advancing American Kidney Health” Executive Order: Challenges and Opportunities for the Large Dialysis Organizations. *Am J Kidney Dis.* 2020; 76(5):731-734. doi:10.1053/j.ajkd.2020.07.007
12. Taber DJ, Fleming JN, Su Z, et al. Significant hospitalization cost savings to the payer with a pharmacist-led mobile health intervention to improve medication safety in kidney transplant recipients. *Am J Transplant.* 2021;21(10):3428-3435. doi:10.1111/ajt.16737
13. Gonzales HM, Fleming JN, Gebregziabher M, et al. Pharmacist-led mobile health intervention and transplant medication safety: a randomized controlled clinical trial. *Clin J Am Soc Nephrol.* 2021; 16(5):776-784. doi:10.2215/cjn.159110200
14. Manley HJ, Awew G, Weiner DE, et al. Multidisciplinary medication therapy management and hospital readmission in patients undergoing maintenance dialysis: a retrospective cohort study. *Am J Kidney Dis.* 2020;76(1):13-21. doi:10.1053/j.ajkd.2019.12.002
15. McIntyre C, McQuillan R, Bell C, Battistella M. Targeted deprescribing in an outpatient hemodialysis unit: a quality improvement study to decrease polypharmacy. *Am J Kidney Dis.* 2017;70(5):611-618. doi:10.1053/j.ajkd.2017.02.374
16. Weinhandl ED, Arneson TJ, St Peter WL. Clinical outcomes associated with receipt of integrated pharmacy services by hemodialysis patients: a quality improvement report. *Am J Kidney Dis.* 2013; 62(3):557-567. doi:10.1053/j.ajkd.2013.02.360
17. St. Peter WL, Wazny LD, Patel UD. New models of chronic kidney disease care including pharmacists. *Curr Opin Neph Hypertens.* 2013;22(6):656-662. doi:10.1097/mnh.0b013e328365b364

18. Meaney CJ, Manley HJ, Pai AB, et al. Nephrology practice and research network opinion paper: pharmacists' perspectives on the Advancing American Kidney Health initiative. *J Am Coll Clin Pharm.* 2020;3:1355-1368. doi:10.1002/jac5.1309
19. Flannery AH, Soric MM, Benavides S, et al. 2019 Update to the American College of Clinical Pharmacy Pharmacotherapy Didactic Curriculum Toolkit. *J Am Coll Clin Pharm.* 2020;3(2):455-464. doi:10.1002/jac5.1178
20. Programs by State. Accreditation Council for Pharmacy Education. Accessed April 13, 2023. <https://www.acpe-accredit.org/accredited-programs-by-state/>
21. USGS Regional Map. United States Geological Services. Published August 16, 2019. Accessed April 13, 2023. <https://www.usgs.gov/media/images/usgs-regional-map>
22. BPS Specialties. Board of Pharmacy Specialties. Accessed April 13, 2023. <https://www.bpsweb.org/bps-specialties/>
23. Johansen KL, Chertow GM, Gilbertson DT, et al. US Renal Data System 2021 annual data report: epidemiology of kidney disease in the United States. *Am J Kidney Dis.* 2022-79(4 Suppl1):A8-A12. doi:10.1053/j.ajkd.2022.02.001
24. Delgado C, Baweja M, Crews DC, et al. A unifying approach for GFR estimation: recommendations of the NKF-ASN task force on reassessing the inclusion of race in diagnosing kidney disease. *Am J Kidney Dis.* 2022;79(2):268-288.e1. doi:10.1053/j.ajkd.2021.08.003
25. Avant ND, McGee HY. The past, present, and futurist role of the pharmacy profession to achieve Black health equity. *Am J Pharm Educ.* 2021;85(9):8610. doi:10.5688/ajpe8610
26. Report of the ASHP Task Force on Racial Diversity, Equity, and Inclusion. *Am J Health Syst Pharm.* 2021;78(10):903-906. doi:10.1093/ajhp/zxab078
27. American Pharmacists Association. Press Releases. Pharmacy organization update Oath of a Pharmacist. Accessed April 13, 2023. <https://pharmacist.com/APhA-Press-Releases/pharmacy-organizations-update-oath-of-a-pharmacist>
28. Invokana [package insert]. Titusville, NJ: Janssen Pharmaceuticals; August 2020.
29. Farxiga [package insert]. Wilmington, DE: AstraZeneca Pharmaceuticals LP; April 2021.
30. Kerendia [package insert]. Whippany, NJ: Bayer HealthCare Pharmaceuticals Inc.; July 2021.
31. Halstenson CE. Clinical education and postgraduate training opportunities in nephrology pharmacy. *J Pharm Pract.* 1993;6(3):113-117. doi:10.1177/089719009300600304
32. Mehrotra R, Shaffer RN, Molitoris BA. Implications of a nephrology workforce shortage for dialysis patient care. *Semin Dial.* 2011;24(3):275-277. doi:10.1111/j.1525-139x.2011.00933.x
33. Advancing Kidney Health Through Optimal Medication Management. Vision and Mission. Accessed April 13, 2023. <https://www.kidneymedicationmanagement.org/Home>