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Mapping Kidney Disease Instruction in US PharmD Programs: A Nationwide Curriculum Analysis

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Abstract

Despite evidence that pharmacists enhance patient outcomes in kidney disease management and guidelines promoting multidisciplinary care, the extent of pharmacist training in nephrology remains poorly defined. This study aims to examine both required and elective coursework related to kidney diseases in Doctor of Pharmacy programs across the United States. The findings will help identify educational gaps and inform the development of best practices for pharmacist training in the care of patients with kidney diseases.This study employed a prospective, cross-sectional, descriptive design to evaluate current educational practices and trends related to kidney diseases within accredited Doctor of Pharmacy programs in the United States, using an electronic survey.Responses were received from 61 pharmacy schools, accounting for 43% of ACPE-accredited programs. Instruction on kidney diseases was included in both mandatory and elective courses, while about one-third of schools offered advanced experiential rotations in nephrology. Considerable differences were observed in the duration devoted to kidney disease topics and the types of practical training available. Six institutions reported providing postgraduate education focused on kidney diseases. Most survey participants were clinical faculty with completed residencies and board certifications.Considering the intricate relationship between kidney diseases and other comorbidities, the rising rates of kidney disease, and the evolving role of pharmacists in patient care, it is essential to review current Doctor of Pharmacy curricula to inform future improvements and ensure graduates are prepared for clinical practice.

Keywords: Curriculum, Nephrology, Kidney disease, Pharmacy, Education

Introduction

Chronic kidney disease (CKD) affects approximately 37 million adults in the United States [1]. Diabetes and hypertension are the leading contributors to CKD, which can progress to end-stage renal disease (ESRD) [2]. With increasing rates of diabetes, hypertension, obesity, and an aging population, the prevalence and incidence of ESRD are expected to rise [3]. Clinical guidelines highlight the importance of medications that slow CKD progression and advocate for a multidisciplinary approach to patient care, often involving nephrologists, primary care providers, dietitians, pharmacists, social workers, and nurses [4, 5].

Workforce shortages in nephrology, including limited numbers of nephrologists and nephrology nurses, remain a significant concern in the US [6]. Despite more individuals entering nephrology training programs, the number of nephrologists per ESRD patient continues to decline [7]. National guidelines and the Executive Order on Advancing American Kidney Health (AAKH) emphasize enhancing collaboration among healthcare providers, including pharmacists, to improve CKD management [7-11]. The AAKH has implemented value-based payment models that incentivize early intervention in CKD and encourage home-based therapies for new ESRD patients. These initiatives also create new opportunities for pharmacists to deliver comprehensive medication management (CMM) for patients with kidney

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disease [9, 11]. Pharmacist-led interventions have been shown to improve medication-related outcomes across CKD stages and reduce healthcare costs through strategies such as deprescribing and preventing hospitalizations [12-16].

As the demand for pharmacist-provided CMM grows, pharmacists' understanding of kidney diseases becomes increasingly important [17, 18]. However, the extent of pharmacy students' knowledge of CKD at graduation from accredited US Doctor of Pharmacy (PharmD) programs is not well established [18]. ACPE accreditation standards aim to ensure that programs provide high-quality education while remaining adaptable to evolving clinical practices. These standards emphasize broad competencies, such as patient-centered care, rather than mandating specific topics, allowing schools to design curricula with input from key stakeholders, professional organizations, and leaders in pharmacy education [18]. The ACCP Pharmacotherapy Didactic Curriculum Toolkit offers guidance for curriculum development by categorizing topics into Tiers 1–3 based on the level of postgraduate preparation required. Tier 1 topics should enable graduates to provide patient care immediately, while Tier 2 topics may require further training [19].

Given the variability in pharmacy education and the growing role of pharmacists in kidney disease management, there is a clear need to evaluate how CKD content is integrated into US pharmacy curricula. This study aims to document the presence of required and elective kidney disease instruction across PharmD programs. The results will help identify gaps in education, inform best practices for pharmacist training, and support the development of standardized curricular expectations for kidney disease content in PharmD programs.

Materials and Methods

This forward-looking, cross-sectional descriptive investigation examined existing approaches to educating students about kidney disease via an online questionnaire. The researchers compiled a complete roster of pharmacy programs across the United States from the Accreditation Council for Pharmacy Education (ACPE) site.[20] For each program, the team located the department chair and distributed a digital survey link (using QuestionPRO), asking the chair to pass it along to faculty members responsible for incorporating kidney disease material into the curriculum. The questionnaire featured a mix of multiple-choice items and open-response fields to capture participant demographics (such as professional title or rank, duration of teaching experience, and academic qualifications) along with details on kidney disease instruction (including specific topics taught, hours devoted to each, and whether mandatory or optional), advanced pharmacy practice experiences (APPEs), and available postgraduate training programs. The survey incorporated 21 distinct kidney disease topics, chosen based on the ACCP Toolkit and suggestions from prominent experts in renal pharmacy practice affiliated with the Advancing Kidney Health through Optimal Medication Management Initiative.[17-19] Participants provided electronic informed consent. The project received an exemption determination from the Institutional Review Board at the University of Texas at El Paso.

All collected data were analyzed using descriptive statistical methods. Continuous measures, like the number of years in teaching, were presented as means accompanied by standard deviations. Categorical measures, including professional title or rank, were summarized through counts and percentages. Any responses that were partial or duplicated were omitted from the analysis.

Results and Discussion

Responses to the survey were received from 61 pharmacy programs across 27 states and one US territory. Of these, 60 programs held full ACPE accreditation, and one program had candidate status, representing 43% of all ACPE-accredited institutions. Data were also analyzed according to commonly recognized geographic regions and program-specific characteristics [21].

Faculty teaching kidney disease topics displayed a wide range of clinical credentials. A full summary of respondent demographics is provided in **Table 1.** Roughly half of the participating institutions were publicly funded, and 26 programs (43%) maintained affiliations with academic medical centers. All respondents were members of their institution's faculty, with the majority (62%, n=38) holding clinical, non–tenure track positions. On average, respondents had 11.7 ± 8.8 years of teaching experience in pharmacy schools overall and 9.2 ± 7.9 years focused on kidney-related subjects. More than three-quarters (n=48, 79%) had completed a postgraduate year 1 (PGY-1) residency, and

77% reported possessing at least one professional certification [22].

Table 1. Details the demographics of survey respondents, providing insight into the current practices and trends in kidney disease education across accredited Doctor of Pharmacy programs in the United States.

	All Respondents N=61 (%)
Job Title	
Assistant Professor (n=24)	39
Associate Professor (n=24)	39
Professor (n=13)	21
Institutional Role	
Clinical, non-tenure track faculty (n=38)	62
Clinical, tenure-track faculty (n=14)	23
Tenure track faculty (n=6)	10
Other[a] (n=3)	5
Degrees Earned[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
Formal Postgraduate Training Completed[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
Professional Certifications Earned[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

[a] Includes other, non–tenure-track faculty, tenured faculty, etc.
[b] multiple selections allowed.

Table 2 summarizes how kidney-related topics are incorporated into US PharmD curricula and the corresponding instructional time. Most programs (70%) integrate these topics within a therapeutic course series, while the remainder offer them as standalone, required courses. On average, each kidney-related topic was allocated approximately 1.58 ± 1.71 hours of instruction. Among the 21 kidney-focused content areas identified by pharmacy experts, seven were universally included in required coursework across all responding programs. Instruction in ACCP Tier 1 and Tier 2 topics was mandatory in at least 92% of schools, with the exception of solid organ transplant, which was required by 75% of respondents. Even topics classified as ACCP Tier 3, which typically do not require student mastery during the PharmD program, were included as required content by 41% or more of institutions.

When examining time allocation within required courses, the highest amounts were devoted to fluid and electrolyte disorders (4.62 ± 3.04 hours; ACCP Tier 1), acid-base

disturbances (2.85 ± 1.87 hours; ACCP Tier 2), and solid organ transplant (2.64 ± 2.28 hours; ACCP Tier 2). In contrast, kidney stones (0.24 ± 0.41 hours; ACCP Tier 3) and disparities in kidney care (0.34 ± 0.55 hours; non-ACCP Tier) received minimal instructional time.

Table 2. Provides a detailed breakdown of nephrology topics covered as required or elective coursework across 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[a] (eg, gout, pediatrics)	16	2.16 (0.96)	2	1.00 (0.12)

[a] 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.

In addition to required courses, 26 programs (44%) reported including nephrology topics as part of elective offerings. Of these electives, roughly half (n=13) were embedded within critical care courses, and only one institution offered a kidney-specific elective. On average, elective kidney-related topics received 1.32 ± 0.6 hours of instruction, with the most time devoted to solid-organ transplant (3.71 ± 1.61 hours).

The survey also explored experiential learning in nephrology. Twenty-one institutions (34%) indicated that they provide an APPE emphasizing kidney disease management, while 24 respondents (39%) were uncertain whether such rotations were available. Reported APPE durations had a median of six weeks. The majority of these rotations were situated in acute care (n=14), ambulatory care (n=12), hemodialysis (n=12), or kidney transplant services (n=10).

Regarding postgraduate opportunities, six programs (10%) reported offering nephrology-focused training. Four of these provide a pharmacy residency in kidney disease, one offers a fellowship, and one institution offers both a residency and a fellowship focused on nephrology. This survey provides a representative overview of kidney disease education within Doctor of Pharmacy programs across the United States, highlighting current training practices for pharmacy students. Survey participants were highly qualified faculty from both public and private institutions, including those affiliated with academic medical centers, and represented a variety of experiential teaching environments.

Most programs incorporated all ACCP Tier 1 and Tier 2 topics related to renal, fluid, and electrolyte disorders. Nevertheless, the time dedicated to individual topics varied considerably, likely reflecting differences in faculty expertise, topic complexity, and instructional

approaches. Solid-organ transplant content appeared less frequently in required courses (75%) compared with other Tier 1 and Tier 2 topics (≥92%), which may relate to the availability of electives or the absence of faculty specializing in this area. Electives were more commonly offered in acute or inpatient kidney care (n=13, 21%) than in outpatient CKD management (n=3, 5%), possibly due to constraints such as curricular time or faculty experience. Acute care and ambulatory care APPEs focusing on kidney disease were reported in similar proportions.

In addition to ACCP-recommended topics, nephrology pharmacy experts identified nine additional subjects considered critical for comprehensive medication management (CMM) in patients with kidney disease. Although these topics are not explicitly included in the 2019 ACCP Toolkit, at least 84% of programs already integrated them into required coursework. One notable exception was disparities in kidney care, which was covered by only 41% of respondents. Certain populations—including African American, Hispanic/Latinx, American Indian, and Alaska Native communities—experience faster progression to ESRD than White populations [23]. Professional and national pharmacy organizations have advocated for curricular content that equips students to recognize and address barriers to optimal medication management in these populations [24-26]. The pharmacy profession has reinforced its commitment to diversity, equity, inclusion, and antiracism through the updated "Oath of a Pharmacist," supporting revisions to ACPE Standards that emphasize training pharmacists to actively promote equitable patient care [27].

Pharmacy students currently receive substantial foundational training in kidney-related conditions, primarily focused on acute care. However, the emergence of new pharmacotherapies, including SGLT2 inhibitors such as canagliflozin and dapagliflozin [28, 29] and finerenone [30], has expanded opportunities for pharmacists to engage in outpatient CKD management. These developments, together with rising CKD prevalence, underscore the need for pharmacists to provide CMM aimed at slowing disease progression. Therefore, nephrology curricula should incorporate outpatient-focused topics, such as CKD screening, prevention of CKD and AKI, and strategies to delay CKD progression, while maintaining instruction on minimizing adverse renal outcomes during hospitalizations and care transitions.

Of the 12 ACCP Tier topics, 66% are classified as Tier 2 or 3, suggesting that additional postgraduate training is likely required for graduates to provide direct patient care. Despite increasing CKD patient populations, post-PharmD nephrology training remains limited, which may hinder pharmacists' ability to manage Tier 2 and 3 conditions [31]. The AAKH initiative promotes value-based nephrology care, emphasizing interdisciplinary collaboration and integrating pharmacists to improve outcomes [9, 18]. Although PGY-2 nephrology residencies were previously accredited, formal accreditation is no longer available. Existing post-PharmD nephrology programs are few and not well-documented, highlighting a need for further evaluation [31].

The inconsistency in nephrology education across PharmD programs, combined with limited postgraduate training and the lack of formal practice standards, may restrict pharmacists' engagement in kidney disease care [15, 32]. This survey establishes a quantitative baseline to inform standard competency development in nephrology curricula, aiming to prepare pharmacists with the knowledge and skills needed for effective patient care. The Advancing Kidney Health through Optimal Medication Management (AKHOMM) initiative was created, in part, to address educational gaps in pharmacy training and to define the skills required for pharmacists to manage kidney disease effectively [33]. Nephrology-specific education and practice standards have been developed, and additional continuing education modules are in progress to support both students and practicing pharmacists in bridging current knowledge and skill gaps.

Study limitations include the lack of detailed information regarding the depth of nephrology coursework and the methods of assessment employed. Teaching approaches were not collected, and postgraduate nephrology pathways are no longer formally accredited, so reported teaching experience may reflect instructor familiarity rather than standardized content. Respondents could select multiple options for certain survey questions, such as rotations offered, and future research could provide more granular analysis of APPE settings (e.g., outpatient versus inpatient hemodialysis). Although the survey response rate was modest, participating faculty represented diverse institutions similar to other US programs. Finally, ACPE Standards and the ACCP Toolkit provide guidance rather than prescriptive

content, allowing institutions to set their own benchmarks for nephrology education at graduation.

Conclusion

Findings from this survey of US Doctor of Pharmacy programs demonstrate that nephrology is integrated into both classroom instruction and experiential learning, delivered by faculty with significant training and expertise in kidney disease education. Postgraduate training programs in nephrology remain scarce, suggesting a need to examine and potentially expand these opportunities. While most institutions cover ACCP Pharmacotherapy Tier 1 and Tier 2 topics in nephrology, ongoing evaluation of topic relevance and prioritization is needed to align with evolving value-based care practices and clinical demands. Key focus areas for curricula should include kidney function assessment and screening, prevention and mitigation of slowing disease progression, chronic kidney disease, addressing disparities in kidney care, and preparing pharmacists for emerging roles in patient management.

Additionally, pharmacy programs must continue to enhance experiential learning to ensure graduates are prepared for direct patient care in nephrology settings. Sustained innovation and iterative improvements in educational strategies will better position pharmacy graduates to support, guide, and empower patients living with kidney disease.

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