



Acute Kidney Injury Survivor Care Following Hospital Discharge: A Mixed-Methods Study of Nephrologists and Primary Care Providers

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Rationale & Objective: Widespread delivery of high-quality care for acute kidney injury (AKI) survivors after hospital discharge requires a multidisciplinary team. We aimed to compare management approaches between nephrologists and primary care providers (PCPs) and explored strategies to optimize collaboration.

Study Design: Explanatory sequential mixed-methods study using a case-based survey followed by semi-structured interviews.

Setting & Participants: Nephrologists and PCPs providing AKI survivor care at 3 Mayo Clinic sites and the Mayo Clinic Health System were included.

Outcomes: Survey questions and interviews elucidated participants' recommendations for post-AKI care.

Analytical Approach: Descriptive statistics were used to summarize survey responses. Qualitative data analysis used deductive and inductive strategies. A connecting and merging approach was used for mixed-methods data integration.

Results: 148 of 774 (19%) providers submitted survey responses (24/72 nephrologists and 105/705 PCPs). Nephrologists and PCPs recommended laboratory monitoring and follow-up with a

PCP shortly after hospital discharge. Both indicated that the need for nephrology referral, and its timing should be dictated by clinical and non-clinical patient-specific factors. There were opportunities for improvement in medication and comorbid condition management in both groups. Incorporation of multidisciplinary specialists (eg, pharmacists) was recommended to expand knowledge, optimize patient-centered care, and alleviate provider workload.

Limitations: Survey findings may have been affected by non-response bias and the unique challenges facing clinicians and health systems during the COVID-19 pandemic. Participants were from a single health system, and their views or experiences may differ from those in other health systems or serving different populations.

Conclusions: A multidisciplinary team-based model of post-AKI care may facilitate implementation of a patient-centered care plan, improve adherence to best practices, and reduce clinician and patient burden. Individualizing care for AKI survivors based on clinical and non-clinical patient-specific factors is needed to optimize outcomes for patients and health systems.

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Acute kidney injury (AKI) affects 20% of hospitalized patients and increases the risk for new or worsening chronic kidney disease (CKD), cardiovascular disease, rehospitalization, and death.¹⁻⁸ To mitigate these adverse health outcomes, focused post-hospital follow-up of AKI

occur, there is a critical need to engage a multidisciplinary team in follow-up care.⁹

Primary care providers (PCPs) are ideal partners to collaboratively care for AKI survivors alongside nephrologists. PCPs have established relationships with patients and are familiar with the full spectrum of a patient's conditions, of which AKI is typically one of many. PCPs also have insight into non-clinical factors that affect patients' health and an understanding of local resource constraints, such as access to specialists. At most, outpatient nephrologists see one-third of AKI survivors in post-hospital follow-up,¹⁴⁻¹⁶ making the primary care setting the main source of post-AKI care for most patients. It is unknown how different provider specialties (PCPs and nephrologists) approach AKI survivor care practices following hospital dismissal and their preferred strategies for collaborative care delivery. This lack of knowledge hinders the ability to design and implement scalable health care delivery models that leverage coordinated care to meet the needs of the diverse population of AKI survivors.

Editorial, ...

survivors is recommended. Though evidence-based guideline recommendations are lacking, expert-recommended best practices for follow-up include kidney function monitoring, education, medication review and reconciliation, and blood pressure optimization.⁹ The best way to deliver this care efficiently, effectively, and sustainably is unknown. Studies have tested nephrologist-directed AKI survivorship clinics, but the feasibility of recruitment and retention, acceptability to patients, and scalability of specialist-oriented models are concerns that have hindered dissemination of these models into routine care.¹⁰⁻¹³ AKI survivors and nephrologists acknowledge that for widespread uptake of post-AKI care models to

PLAIN-LANGUAGE SUMMARY

We conducted this study to better understand how primary care providers and nephrologists approach delivering post-hospital care to survivors of acute kidney injury (AKI). Surveys and interviews probed recommendations of primary care providers and nephrologists on kidney function monitoring, comorbid condition management, and collaborating with experts from various medical specialties and disciplines. Results emphasized a need for patient-centered care, based on clinical and non-clinical factors, to optimize outcomes. A multidisciplinary team-based model of post-AKI care that includes other specialists (eg, pharmacists, nurses, dieticians) may facilitate implementation of a patient-centered care plan, improve adherence to best practices, and reduce clinician and patient burden.

To address these knowledge gaps, we conducted a mixed-methods study¹⁷ of PCPs and nephrologists who care for non-dialysis-dependent AKI survivors. The primary aim was to compare AKI survivor care management between nephrologists and PCPs using clinical cases. Key practices evaluated included the timing of post-dismissal follow-up, laboratory testing practices, medication and comorbid condition review, and provider and patient education. The secondary aim was to explore strategies to optimize collaborative care, specifically related to how and when to engage nephrologists and multidisciplinary team members. These data can inform how PCPs and other multidisciplinary team members can be integrated into a comprehensive care model to improve health care access and reduce the strain on nephrologists.

METHODS

This was a 2-phase, explanatory sequential mixed-methods study¹⁷ conducted from October 2020 to January 2022. The Institutional Review Board at Mayo Clinic reviewed and approved this study (#20-008793) and participants provided informed consent. A detailed description of the methods was published previously.¹⁸

Phase 1—Quantitative Strand

Three sample cases of AKI survivors were developed. Following each case, closed-ended questions prompted respondents to select their preferred recommendations (Table S1). As no comprehensive evidence-based guideline exists for post-AKI care, questions were based on the Kidney Awareness Monitoring and Prevention Society framework, a kidney health care bundle recommended to improve post-AKI care quality, developed by experts (Table S2).⁹ Select questions contained evidence-based “best answers” (eg, guideline-directed blood pressure

goals, package insert guidance for drug dosing in kidney dysfunction).^{19–24} The survey was pilot-tested to enhance validity, and the instrument was refined.¹⁸

The sampling frame included staff physicians and advanced practice providers (APPs; nurse practitioners and physician assistants) with at least 1 year of experience in Nephrology, Internal Medicine, and Family Medicine who provide post-hospital care for AKI survivors at Mayo Clinic in Rochester, Florida, Arizona, and the Mayo Clinic Health System. These sites included providers affiliated with academic and community practices in urban, suburban, and rural settings who treat patients from various sociodemographic backgrounds. The invitation to participate in the study was extended via email and the survey was administered using RedCap Survey technology.

Data Collection and Analysis

Descriptive statistics were used to report demographics and summarize survey responses. For the 6 ‘best answer’ responses, 1 point was assigned for each best answer selected and 0 points assigned for other answers (total possible 6 points). Mean best answer scores were compared between nephrologists and PCPs using the *t* test. With 18 participants per group, we had 80% power to detect a mean between-group difference of 2 points, assuming a standard deviation of 2, using an alpha of 0.05.

We used a connecting and merging approach for mixed-methods data integration, where results from the survey informed the sampling strategy and questions for the qualitative strand.

Phase 2—Qualitative Strand**Sample**

Purposive sampling of survey responders was used to recruit providers for semi-structured interviews. Participants were sampled based on key factors that may influence post-AKI care recommendations (eg, academic vs rural practice setting). Recruitment of participants ceased when data analysis suggested thematic saturation.²⁵

Data Collection and Analysis

An open-ended interview guide was developed to establish a deeper understanding of select post-AKI care recommendations observed in the quantitative strand, with a focus on how and when to engage nephrologists and multidisciplinary specialists for collaborative care. We explored emerging issues not measured by the survey, including educational needs and themes identified during inductive analysis. Interviews were conducted by an experienced qualitative researcher (D.M.F.), recorded, and transcribed verbatim with permission from participants.

Deductive (using a priori codes related to post-AKI care components and collaborative care strategies) and inductive (identification of emerging themes) strategies were

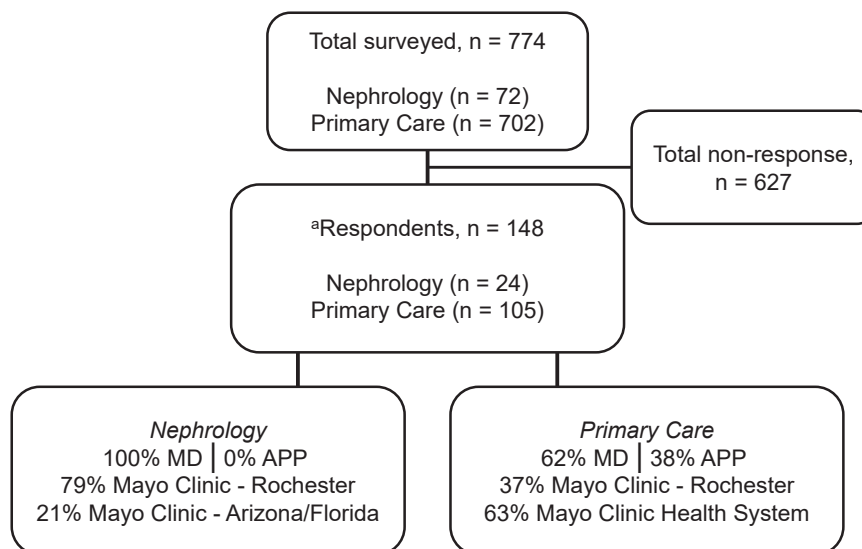


Figure 1. Participant flowchart. Abbreviations: APP, advanced practice provider; MD, medical doctor. ^aIncomplete response, n=19.

used to analyze data. Content experts (H.P.M., E.F.B.) and a qualitative data analyst (D.M.F.) discussed themes and created a preliminary codebook, which was then applied to all data. Themes were compared between nephrologists and PCPs, and areas of complementarity, concordance, and discordance were identified.

RESULTS

Participants

Of the 774 participants contacted, 148 providers submitted complete or partial responses to the study questionnaire (19% response rate). Of these, 24 were nephrologists and 105 were PCPs (Fig 1, Table 1). Nineteen responders did not provide demographic data and thus their responses could not be categorized according to specialty.

Seventeen of the 40 survey respondents contacted participated in qualitative interviews (Table 1). Eight interview participants were from a community or rural practice site. Of the 23 providers who did not respond to the invitation to interview, all but 2 were PCPs and 14 were affiliated with a community or rural practice site.

Overview of Findings

Quantitative and qualitative data were organized by the domains of (1) post-AKI care components and (2) collaborative care strategies. An emerging theme from qualitative interviews was the importance of delivering patient-centered post-AKI care, where providers and patients partner to co-design personalized care. To facilitate thematic analysis, we organized these findings using an established patient-centered care framework (Table 2).²⁶

Post-AKI Care Components

Timing of Post-Dismissal Follow-up

Eighty-five percent of nephrologists and 63% of PCPs recommended post-hospital laboratory follow-up within 2 weeks of discharge.

Interview participants elaborated that follow-up with a PCP should occur within 1-2 weeks of hospital discharge and variably thereafter with nephrologists. Nephrologists indicated preference for nephrology follow-up within 1-3 months of hospital dismissal. Some interviewees from both disciplines preferred an earlier evaluation by nephrologists (eg, within 1-3 weeks) for patients with multiple comorbid conditions, more severe AKI, or incomplete kidney function recovery by dismissal.

"Follow-up with a [PCP] within a week of discharge. Follow-up with a Nephrologist, that time period is a bit more nuanced." (ID 5; Nephrologist, physician)

PCPs emphasized patient-centered care when scheduling follow-up, including the need to consider non-clinical factors (ie, transportation, access to technology, insurance and costs). They also expressed concerns about organizational barriers, such as limited access to nephrologists and long wait times for appointments (Table 2).

Laboratory Monitoring

Urine studies (eg, urine protein, urinalysis) were recommended more often by nephrologists than by PCPs (Table 3, questions 1, 5). The proportions of respondents recommending urine studies in both groups were highest when a patient had evidence of proteinuria on admission.

Table 1. Participant Characteristics

Survey Respondents			
	Overall n=148	Neph n=24	PCP n=105
Years in practice			
1-5	44 (30%)	7 (29%)	37 (35%)
6-10	19 (13%)	2 (8%)	17 (16%)
>11	66 (44%)	15 (63%)	51 (49%)
No response	19 (13%)		
Degree			
Physician	89 (60%)	24 (100%)	65 (62%)
NP/PA	40 (27%)	0	40 (38%)
No response	19 (13%)		
Trained elsewhere			
Yes	57 (39%)	15 (63%)	42 (40%)
No	72 (48%)	9 (37%)	63 (60%)
No response	19 (13%)		
Practice site			
Mayo Clinic Rochester	58 (39%)	19 (79%)	39 (37%)
Mayo Clinic Health System	66 (45%)	0	66 (63%)
Mayo Clinic Arizona	3 (2%)	3 (13%)	0
Mayo Clinic Florida	2 (1%)	2 (8%)	0
No response	19 (13%)		
Interview Participants			
	Overall n=17	Neph n=8	PCP n=9
Years in practice			
1-5	5 (29%)	2 (25%)	3 (33%)
6-10	8 (47%)	4 (50%)	4 (45%)
>10	4 (24%)	2 (25%)	2 (22%)
Degree			
Physician	11 (65%)	7 (86%)	4 (44%)
NP/PA	6 (35%)	1 (14%)	5 (56%)
Practice site			
Mayo Clinic Rochester	7 (41%)	5 (63%)	2 (22%)
Mayo Clinic Health System	8 (47%)	1 (13%)	7 (78%)
Mayo Clinic Arizona	1 (6%)	1 (13%)	0
Mayo Clinic Florida	1 (6%)	1 (13%)	0

Note: Data reported as n (% of the column total).

Abbreviations: Neph, nephrologist; NP, nurse practitioner; PA, physician assistant; PCP, primary care provider.

Medication and Comorbid Condition Care

The mean (standard deviation) sum of “best answers” selected (maximum possible = 6) was 4.5 (1.2) for nephrologists and 4.1 (1.1) for PCPs ($P = 0.20$). Eight percent of nephrologists and 22% of PCPs did not recommend therapeutic drug monitoring of a high-risk medication (ie, lithium). Thirty-seven percent of nephrologists and 29% of PCPs did not recommend appropriate discontinuation of a glucose-lowering medication (ie, metformin) in the setting of advanced CKD. Sixty-seven percent of nephrologists and 73% of PCPs did not recommend guideline-directed statin therapy.

In qualitative interviews, nephrologists and PCPs alike endorsed the need to iteratively review medications

because of dynamic kidney function among AKI survivors and strongly recommended engaging a clinical pharmacist for medication management. Pharmacist involvement was also recognized as a solution for overcoming barriers to medication-related guideline adherence identified in the survey.

“If I could have the ideal setup, my patients would all have easy access to a clinical pharmacist to review potential medication interactions, ensure medications are dosed correctly for the current kidney staging, help them with timing of medications, which ones can be taken together... We don't have the time during our post-hospital clinic visits.” (ID 17; Nephrologist, APP)

Provider and Patient Education

Interview participants offered potential solutions for inconsistencies in follow-up care and guideline adherence. PCPs desired educational resources and practice guidance (eg, algorithms, online best-practice documents) endorsed by nephrologists addressing various clinical scenarios in AKI survivor care. Core components of interest included the ideal type and timing of kidney function tests, nephrology referral criteria, and the appropriateness of telehealth.

“Having an algorithm or guidelines of what to do for follow-up appointments wouldn't be a bad idea...we try to provide [recommendations for follow-up] but I'm not sure we're successful.” (ID 8; PCP, physician)

All providers emphasized the need for patient-centered education on AKI survivorship, tailored to the etiology of kidney injury, degree of kidney function recovery, presence or absence of underlying CKD, and the patient's ability to understand and participate with recommendations (Table 2). Core components recommended by both specialties included explanation of kidney injury and disease and the importance of avoiding re-injury, self-monitoring and management (eg, blood pressure monitoring, holding antihypertensives and diuretics in dehydration), nephrotoxin avoidance, and essential dietary modifications (eg, avoidance of potassium in hyperkalemia, protein consumption in CKD). Although most nephrologists and PCPs encouraged education delivery before hospital dismissal, PCPs suggested continuation throughout the transition of care, given concerns about retention of in-hospital information.

“Patients can't take [education] in because it's stressful and confusing. Even patients without cognitive impairment cannot remember what's told to them in the hospital because they're dealing with the stress going on.” (ID 4, PCP, physician)

Collaborative Care Delivery for AKI Survivors

Perceptions of the nephrologist's role varied by specialty. Survey responses indicated 63% of nephrologists and 30%

Table 2. Implementing a Patient-Centered Care Model for Acute Kidney Injury Survivors

Recommendation	Representative Quotes
Structure: Organizational-level components of health care delivery	
Increasing integration of, and access to, input from diverse health care professionals (eg, pharmacists, dieticians)	<ul style="list-style-type: none"> • “We only have one kidney-trained dietician... and we keep [her] very busy, but sometimes there’s a pretty big wait to get in to see her. Having greater access to the clinical pharmacist and to the kidney dietician would be a tremendous improvement in helping with education and support our patients with AKI.” (ID 17, Nephrologist, APP) • “If they have more than 5 meds on their list, I send them to a pharmacist to go over medication reconciliation” (ID 7, PCP, physician) • “I would consult [a pharmacist] myself. Sometimes we, as nephrologists, are looked at as somehow the pharmacists, but I’m giving very general advice, not specialized advice.” (ID 6, Nephrologist, physician) • “I’m not familiar enough with [medications and dietary recommendations] that I would have to do my own research.” (ID 15, PCP, APP)
Development of patient-centered kidney health education	<ul style="list-style-type: none"> • “A one-size-fits-all approach is what I’ve seen time and time again by some of the people... and I just don’t even agree with some of the things that are being said.” (ID 6; Nephrologist, physician) • “[The education] would depend on severity. Most people should have a class on keeping your kidneys healthy, like we have for stage 3 CKD. But if their kidney function returns to baseline, they might not need that... Patients with more advanced CKD or AKI should have a class on renal replacement therapy options.” (ID 2, Nephrologist, physician)
Process: Components of the patient-health care provider interaction	
Shared decision-making, patient goals of care	<ul style="list-style-type: none"> • “Is this consistent with the patient’s goals of care? Do we want to do all this? Just because we can doesn’t mean we have to. We have to make sure that we take that kind of patient preferences into account.” (ID 4; PCP, APP) • “Another follow-up thing that needs to happen is ensuring we understand the patient’s goals of care. We sent a patient who had CKD, 95 years old, to see a nephrologist because she was having problems, but she didn’t want intervention. I’m not sure that was of benefit to her.” (ID 2, Nephrologist, physician)
Patient access to resources necessary to complete follow-up (eg, transportation, technology)	<ul style="list-style-type: none"> • “It can be hard to get family members to take time off work to drive them [long distances]... many [patients] don’t feel comfortable driving in [cities] or don’t have a driver’s license.” (ID 17; Nephrologist, APP) • “I factor in things like their insurance, like if they’ve got a high deductible plan, if they are in-network or out-of-network and we need to transition their care to somebody that’s covered better... Rural communities, some of our smaller towns don’t have reliable internet access... I’ve been working with telehealth, could they go into one of our clinic sites to use the internet to be able to connect [with a nephrologist].” (ID 1, PCP, APP) • “Oftentimes if they do not have insurance, they may not have the means of transportation. Maybe they have to pay a cab or need to pay someone to bring them to the appointment and don’t have the social support of the financial means to do that.” (ID 12, Nephrologist, physician)
Existing care team complexity	<ul style="list-style-type: none"> • “For example, if the patient’s primary issue is heart failure and they are being managed by a cardiologist that has been involved in their renal care, sometimes they are already relatively well-managed by their cardiology team. Also, they are overwhelmed with appointments and the care that we are providing... the patient won’t be able to tolerate more, I think that’s very important to realize, adding appointments to a patient already busy schedule, I’m not sure if that helps.” (ID 11; Nephrologist, physician)
Outcomes: outcomes experienced by patients resulting from the care model	
Risk of future kidney-related complications	<ul style="list-style-type: none"> • “[Nephrologist follow-up] really depends on the severity of the AKI, the creatinine when they leave the hospital and how close it is to baseline versus not and underlying conditions, if they have underlying CKD and other comorbidities and what stage.” (ID 12, Nephrologist, physician)
Timing of specialist availability	<ul style="list-style-type: none"> • “I’d probably have [nephrology] involved earlier than what currently happens, but the availability of nephrology is so bad that I often end up doing things, caring for patients probably way too long before they can get into nephrology.” (ID 13; PCP, APP) • “We are a small practice... Our new consults lag was at 57 days. Limited access limits follow-up and new patient care that we can provide.” (ID 5; Nephrologist, physician) • “Often a visit with the Nephrology teams in [community practice] can be 2 to 3 months’ wait.” (ID 1, PCP, APP)
Care provider and laboratory accessibility (eg, physical location, hours of operation)	<ul style="list-style-type: none"> • “We have patients a significant distance outside of [our city] and there is no lab out there to even get follow-up labs.” (ID 4; PCP, APP) • “People who are too far away to have dialysis in our system aren’t well-served by continuing to come here because it becomes too many cooks and the patient is getting billed for the same services twice.” (ID 12; Nephrologist, physician)

(Continued)

Table 2 (Cont'd). Implementing a Patient-Centered Care Model for Acute Kidney Injury Survivors

Recommendation	Representative Quotes
Timely availability of test results in rural areas	<ul style="list-style-type: none"> • “We have lab work that gets sent to [a send-out site] it can be 24 to 48 hours before we get those results. That’s part of why unfortunately our patients have to make multiple trips. One to the lab and then back to the clinic to see us a couple days later.” (ID 17; Nephrologist, APP) • “When labs aren’t done...I’m actually having 2 consults because I’m going to have to talk to them face-to-face about what the labs might be... then I’ll call them again later.” (ID 6; Nephrologist, physician)

Qualitative analysis of emerging themes revealed nephrologists and PCPs favored patient-centered care when recommending post-AKI care components and collaborative care. These can be organized according to factors related to organizational structure and processes and patient outcomes experienced as a result of the health care delivery model.²⁶

Abbreviations: AKI, acute kidney injury; APP, advanced practice provider; CKD, chronic kidney disease; PCP, primary care provider.

of PCPs (42% among tertiary care center PCPs, 30% among community practice PCPs) recommended outpatient nephrology referral in a case with evidence of proteinuria and incomplete kidney function recovery at dismissal (Table 3, question 8). When proteinuria and incomplete recovery were combined with multiple comorbid conditions, 100% of nephrologists and 90% of PCPs recommended nephrology referral (Table 3, question 11). In the case of a younger patient with AKI requiring temporary dialysis, liberated by dismissal but with incomplete recovery, 88% of nephrologists and 61% of PCPs (73% among tertiary care center PCPs, 61% among community practice PCPs) recommended nephrology referral (Table 3, question 4).

Both quantitative and qualitative data showed outpatient nephrology referrals were universally desired in patients with higher severity or persistent AKI, pre-existing CKD (stage 3 or higher), and high comorbid condition burden. In interviews, nephrologists added the additional criteria of unresolved insults/risk factors for AKI or future CKD.

“AKI is a spectrum, right? If you have a severe AKI that would require renal replacement therapy, I think that needs to be [managed by] nephrology to make sure there is no chronic kidney disease after AKI. But if we’re talking about mild AKI that did not require a significant amount of specific nephrologic care, somebody in primary care trained for AKI follow-up... could review that. It’s a very heterogenous group ...it’s challenging to group them in one big umbrella of AKI.” (ID 11; Nephrologist, physician)

Nephrologists and PCPs emphasized the key role of PCPs in AKI survivor care in qualitative interviews. Initial kidney follow-up performed by the PCP was deemed critical to maintaining care continuity, especially when access to timely nephrology follow-up was limited. This was particularly prominent in community and rural settings. In addition, both specialties preferred PCP follow-up to precede nephrology follow-up to facilitate non-kidney-related, transitional care and ensure the necessary laboratory and imaging studies were performed before a nephrology appointment. Several participants volunteered that provider-to-provider communication through a shared electronic health record would be ideal for care

coordination, though this was not universal, as one provider preferred direct (ie, phone) conversation.

“I feel pretty strongly that if my patient has been admitted to the hospital, I would like to see them in the outpatient setting because I’m the one that knows them and should be coordinating their care.... Continuity is really important.” (ID 8; PCP, physician)

“We rely on our primary care colleagues to do the initial touch-base...and at least have lab work repeated within 5-10 days of discharge. ... then follow-up with Nephrology.” (ID 17; Nephrologist, APP)

Qualitative interviews emphasized the importance of factoring in patient-specific considerations when recommending nephrology referral (Table 2). PCPs stressed shared decision-making when it comes to nephrology referral (eg, alignment with the patients’ care goals).

“I’d refer to nephrology if the patient is not improving as we would expect or if there’s a significant, like one stage, change in CKD. But again that is dependent upon the patient’s situation. An 88-year old who has many other comorbidities and isn’t interested in a whole bunch of interventions and wouldn’t consider dialysis, I’m more likely to manage on my own...taking care of that patient in terms of goals of care.” (ID 8, PCP, APP)

Where patients received their local medical care (near the place of hospitalization vs a significant distance) and the transportation considerations influenced both specialties’ recommendations for patient-centered care (Table 2). Nephrologists considered whether the specialty care available in the patients’ home health system fit their needs (eg, dialysis support, transplantation assessment) and what other types of medical specialists were already part of the care team. When other specialists were involved in managing kidney disease risk factors (eg, cardiologists managing heart failure), several nephrologists were reluctant to increase the complexity of the care team by adding a nephrologist.

During qualitative interviews, both provider types recognized multidisciplinary care providers as team members with the capacity to offload PCPs’ and nephrologists’ burden. Leveraging their specialty knowledge was

Table 3. Survey Responses

Question/Responses	Neph n=24	PCP n=105
Case 1 Summary: 40-year-old, AKI-Dialysis, no dialysis but incomplete recovery at dismissal		
Question 1. What kidney function follow-up tests, if any, would you recommend for kidney function monitoring after discharge? (Select all that apply)		
a. Serum creatinine	22 (92%)	105 (100%)
b. Cystatin C	6 (25%)	9 (9%)
c. Urine albumin-creatinine ratio	13 (54%)	35 (33%)
d. None/other	8 (33%)	10 (10%)
Question 2. When would you recommend follow-up laboratory monitoring of kidney function?		
a. Within 14 days	15 (63%)	87 (83%)
b. Within 1-2 months	9 (37%)	17 (16%)
c. Within 6 months	0	1 (1%)
d. Defer timing as indicated for other health care needs	0	0
Question 3. How would you optimize this patient's medication regimen at discharge? ¹⁹		
a. Switch atorvastatin to rosuvastatin	0	2 (2%)
b. Monitor lithium levels and consider dose reduction (best answer)	22 (92%)	82 (78%)
c. Discontinue apixaban and initiate warfarin therapy	1 (4%)	4 (4%)
d. None of the above/unsure	1 (4%)	17 (16%)
Question 4. To what extent do you agree that this patient should be referred to a nephrologist for follow-up at the time of hospital discharge?		
a. Agree	21 (88%)	64 (61%)
b. Disagree	3 (12%)	41 (39%)
Case 2 Summary: 65-year-old, AKI stage 2 with proteinuria, incomplete recovery at dismissal		
Question 5. What kidney function follow-up tests, if any, would you recommend for kidney function monitoring after discharge? (Select all that apply)		
a. Serum creatinine	22 (92%)	100 (100%)
b. Cystatin C	5 (21%)	4 (4%)
c. Urine albumin-creatinine ratio	19 (79%)	53 (51%)
d. None/other	5 (21%)	13 (12%)
Question 6. Based on the 2017 ACC/AHA guideline recommendations for the management of hypertension, what is an appropriate blood pressure goal for this patient? ²⁰		
a. <140/90 mm Hg	2 (8%)	22 (21%)
b. <130/80 mm Hg (best answer)	21 (88%)	80 (76%)
c. <120/90 mm Hg	1 (4%)	2 (2%)
d. <150/90 mm Hg	0	0
e. Unsure	0	1 (1%)
Question 7. What additional therapy, if any, would you consider adding at outpatient follow-up, based on her kidney function at the time of discharge and past medical history? (Select all that apply) ^{20,21,22}		
a. Lisinopril (best answer)	22 (92%)	93 (89%)
b. Ezetimibe	0	0
c. Atorvastatin (best answer)	8 (33%)	28 (27%)
d. Furosemide	3 (13%)	3 (3%)
e. None	1 (4%)	6 (6%)
Question 8. To what extent do you agree that this patient should be referred to a nephrologist for follow-up at the time of hospital discharge?		
a. Agree	15 (63%)	31 (30%)
b. Disagree	9 (37%)	74 (70%)
Case 3 Summary: 70-year-old, AKI stage 2 with proteinuria, multimorbidity, incomplete recovery at dismissal		
Question 9. What action should be taken with regard to his metformin prescription at this time? ²³		
a. Discontinue (best answer)	15 (63%)	76 (72%)
b. Reduce the dose to metformin 500 mg twice daily	6 (25%)	23 (22%)
c. Continue at the current dose	3 (13%)	2 (2%)
d. Unsure	0	4 (4%)

(Continued)

Table 3 (Cont'd). Survey Responses

Question/Responses	Neph n=24	PCP n=105
Question 10. What other work-up, if any, would you recommend in the outpatient setting given his baseline comorbidities? (Select all that apply) ²⁴		
a. None	2 (8%)	9 (9%)
b. Rheumatologic work-up for recurrent gouty arthritis	6 (25%)	13 (12%)
c. Anemia and metabolic bone disease work-up in the setting of chronic kidney disease (best answer)	19 (80%)	73 (70%)
d. Hematologic work-up given his history of thromboembolism and bleeding	10 (42%)	41 (39%)
Question 11. To what extent do you agree that this patient should be referred to a nephrologist for follow-up at the time of hospital discharge?		
a. Agree	24 (100%)	95 (90%)
b. Disagree	0	10 (10%)

Note: Data reported as n (% of the column total).

Abbreviations: ACC, American College of Cardiology; AHA, American Heart Association; AKI, acute kidney injury; Neph, nephrologist; PCP, primary care provider.

considered key to providing patient-centered care and optimizing the quality and efficiency of health care delivery. Several providers from both disciplines indicated nurse follow-up for patients at ‘low risk’ for post-hospital complications would be appropriate. They indicated this would require established guidance regarding issues to triage to a physician or APP but may expand capacity for post-AKI care and better allocate resources. Nurses were seen as preferred team members to deliver core education on kidney health. Pharmacists and dieticians were endorsed as key partners for discipline-specific consultation. PCPs from community and rural health systems cited a lack of awareness about multidisciplinary resources and limited access as reasons these team members were not more regularly consulted.

“Could we do a better job? Maybe. Do I think clinical pharmacy and/or [dieticians] being involved would be good? Yeah, probably, especially clinical pharmacy. They’re pretty stinking good.” (ID 14; PCP, APP)

DISCUSSION

There were many commonalities in the approach to post-hospital AKI survivor care among PCPs and nephrologists, including recommendations for laboratory monitoring and follow-up with a PCP shortly after hospital discharge, using clinical (eg, severity of AKI) and non-clinical (eg, access to transportation) patient-specific factors to dictate the need and timing of nephrology referral, and more frequent incorporation of multidisciplinary specialists (eg, pharmacists, nurses, dieticians). Results complement existing expert recommendations for key care components by illuminating barriers and facilitators affecting ‘where’ and ‘how’ they might be delivered. This information is of particular importance in the absence of guidelines to direct post-AKI care.

Both disciplines supported early laboratory monitoring and assessment by a PCP shortly after hospital discharge, with nephrology referral based on indication and patient

preferences. A team-based approach with follow-up in primary care, followed by specialty referral, could successfully contain health care costs and limited deleterious outcomes in patients needing complex care.^{25,27–29} These models can often accommodate a shorter time to follow-up than nephrologist-centric post-AKI care, where the median time to follow-up is 15–48 days, if accessible at all.^{10,11} Initial follow-up with primary care is also attentive to patient concerns about post-AKI care, including long travel time for appointments at referral centers, hospitalization fatigue, care fragmentation, and a reluctance to add additional specialists to their health care team.^{10,30} Guided by nephrologist recommendations for post-AKI care and referral criteria, PCPs’ clinical assessment and consideration of patient-specific socioeconomic and demographic factors may enhance the appropriate selection of patients for specialist referral and efficient use of health care resources. This is particularly important in the setting of a declining number of nephrology specialists, especially in low-income and rural areas, and increasing demand due to the burden of AKI.³¹ Longitudinal PCP follow-up also lends itself to continual evaluation of patient-specific risk factors for CKD (eg, kidney function recovery, comorbid conditions), which is recommended for AKI survivors at 90 days.⁹

Our results highlighted unique contributions from multidisciplinary specialists in a team-based care model. Whereas nephrologists demonstrated greater mastery of best practices for post-AKI care (eg, urine protein monitoring and individualized blood pressure goals), PCPs showed familiarity with a breadth of comorbid conditions (eg, diabetes) vital to providing comprehensive care following AKI. Pharmacists were widely acknowledged as critical to delivering expert-level medication management and monitoring throughout AKI survivors’ evolving kidney disease. Their involvement in peri-discharge care has been shown to reduce the risk of 30-day readmission and polypharmacy.^{32,33} Despite these findings and growing consensus of their importance in collaborative care models,^{9,34} pharmacists have not been a universal

component of existing post-AKI care clinics. Other opportunities for multidisciplinary specialist contribution included nurse involvement in triage for patients with a low risk of complications and kidney health education, and dietitians to provide kidney-oriented nutrition counseling. Patient-centered education focused on knowledge about kidney injury and self-management may significantly improve kidney health outcomes.³⁵

Heterogeneity in the AKI survivor population was widely acknowledged, and patient-specific factors were important determinants of the need and urgency for nephrology follow-up. In qualitative interviews, PCPs suggested creating algorithms and electronic health record-based clinical decision support tools to standardize post-AKI care and nephrology referral. Similarly, risk stratification for individuals with early-stage CKD has been recognized as a method for improved health equity, care quality, and resource utilization.³⁶ This investigation and others have emphasized the importance of a patient-centered model for post-AKI care. A collaborative care model inclusive of diverse experts can augment care quality for patients with even the most complex needs.³⁷ Attentiveness to transparency and shared decision-making can improve patient-provider communication. Recognition of the health care delivery outcomes patients experience can highlight areas of need and inform iterative process improvements.²⁶ These results underscore factors in organizations' structure, processes, and outcomes that must be attended to achieve patient-centered care.

This study is not without limitations. Survey findings may have been affected by non-response bias. Though a response rate of 19% (33% and 15% among surveyed nephrologists and PCPs, respectively) is in line with previous clinician surveys,^{38–40} non-responders may have systematically differed from participants. This study was conducted during the COVID-19 pandemic and results may have been influenced by the unique challenges facing clinicians and health systems, including limited resources, high patient acuity and inpatient census, sweeping changes related to telehealth, and increasing demands on provider time. Qualitative interviews probed for information relevant to these factors, where able. Participants were from a single health system and their views or experiences may differ from those in other health systems or serving different populations. To account for this, we engaged a diverse array of providers from various training backgrounds, geographic locations, and practice settings to enhance generalizability of findings. Explicit guideline recommendations for the 'who' and 'how' to follow-up AKI survivors do not exist. Our questionnaire therefore probed provider perspectives, and only where clear recommendations are available in the published literature (ie, drug dosing thresholds) did we deem an answer preferred.

In conclusion, a multidisciplinary team-based model of post-AKI care may facilitate implementation of a patient-centered care plan than can improve adherence to best practices and promote collaborative care, while reducing

clinician and patient burden. Individualizing care based on clinical and non-clinical patient-specific factors is needed to optimize outcomes for patients and health systems.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Table S1: Survey Instrument

Table S2: KAMPS Framework for Kidney Follow-up Care

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