Kidney Medicine

Acute Kidney Injury Survivor Remote Patient Monitoring: A Single Center's Experience and an Effectiveness Evaluation

Mariam Charkviani, Andrea G. Kattah, Andrew D. Rule, Jennifer A. Ferguson, Kristin C. Mara, Kianoush B. Kashani, Heather P. May, Jordan K. Rosedahl, Swetha Reddy, Lindsey M. Philpot, and Erin F. Barreto

Rationale & Objective: Remote patient monitoring (RPM) could improve the quality and efficiency of acute kidney injury (AKI) survivor care. This study described our experience with AKI RPM and characterized its effectiveness.

Study Design: A cohort study matched 1:3 to historical controls.

Setting & Participants: Patients hospitalized with an episode of AKI who were discharged home and were not treated with dialysis.

Exposure: Participation in an AKI RPM program, which included use of a home vital sign and symptom monitoring technology and weekly in-center laboratory assessments.

Outcomes: Risk of unplanned hospital readmission or emergency department (ED) visit within 6 months.

Analytic Approach: Endpoints were assessed using Cox proportional hazards models.

Results: Forty of the 49 patients enrolled in AKI RPM (82%) participated in the program after hospital discharge. Seventy three percent of patients experienced one AKI RPM alert, most commonly related to fluid status. Among those with stage 3 AKI, the risk of unplanned readmission or ED visit within 6 months of discharge was not different between AKI RPM patients (n = 34) and matched controls (n = 102) (HR 1.33 [95% CI, 0.81-2.18]; $P = 0.27$). The incidence of an ED visit without hospitalization was significantly higher in the AKI RPM group (HR 1.95, [95% CI, 1.05-3.62]; $P = 0.035$). The risk of an unplanned readmission or ED visit was higher in those with baseline eGFR < 45 mL/min/1.73 m^2 exposed to AKI RPM (HR 2.24 [95% CI, 1.19-4.20]; $P = 0.012$) when compared with those with baseline eGFR ≥45 mL/min/1.73 m^2 (HR 0.69 [95% CI, 0.29-1.67]; $P = 0.41$) (test of interaction $P = 0.04$).

Limitations: Small sample size that may have been underpowered for the effectiveness endpoints.

Conclusions: AKI RPM, when used after hospital discharge, led to alerts and interventions directed at optimizing kidney health and AKI complications but did not reduce the risk for rehospitalization.

Complete author and article information provided before references.

Correspondence to E.F. Barreto (Barreto.Erin@mayo.edu)

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Acute kidney injury (AKI) affects 20% of hospitalized patients,[1,2] and survivors are at increased risk of chronic kidney disease (CKD),[3] end-stage kidney disease, cardiovascular disease,[4] increased hospital readmissions, and decreased quality of life.[3,5] Despite the increased risk of complications after an AKI event, recent evidence suggested that 30% of AKI survivors lacked appropriate follow-up after hospital discharge, which has been linked to poor outcomes.[6-8] Without monitoring, AKI survivors could experience cardiac and pulmonary edema due to incomplete AKI recovery or intravascular volume depletion due to the use of high-dose diuretics or post-AKI polyuria. AKI survivors can develop potentially life-threatening electrolyte abnormalities due to underlying changes in kidney function or exposure to drugs that affect the electrolyte balance (eg, renin-angiotensin system inhibitors, diuretics, mineralocorticoid antagonists, and potassium supplementation).

Coexistent with the imperative to improve AKI survivor health outcomes is the pressure to facilitate safe and timely hospital discharge to reduce health care resource utilization.[9,10] Patients with AKI experience a 3.5-day longer length of hospital stay than patients without AKI.[11] Clinicians may elongate AKI survivor lengths of stay to monitor vital signs, fluid balance, creatinine trajectory, and electrolytes during potential AKI recovery. Although this approach facilitates rapid delivery of supportive interventions, longer lengths of hospital stay increase health care costs and the risk for iatrogenic complications, and worsen the patient experience.[12,13] There is a need to develop new, safe, and effective care delivery models for AKI survivors that balance these competing priorities.[8,13]

One strategy to facilitate AKI survivor care is remote patient monitoring (RPM). Remote patient monitoring uses digital applications and devices to collect, analyze, and record physiologic and other patient-generated health data outside of a clinical setting.[14,15] The collected data are then used by clinicians to aid in the timely detection of impending decompensations or adverse events and provide early intervention.[16] In October 2021, Mayo Clinic implemented a first-of-its-kind RPM program for hospitalized AKI survivors expected to be discharged to home, not treated with dialysis. The purpose of this study was to characterize our experience with the AKI RPM program and describe its effectiveness. We hypothesized that participation in the AKI RPM program would be associated with a decreased risk of rehospitalization.

METHODS

Study Design and Setting

We performed a cohort study with matched historical controls that included adults (≥18 years) hospitalized at Mayo Clinic in Rochester, Minnesota, with an episode of AKI who were discharged to home not treated with dialysis. This study was limited to patients cared for by the nephrology consult services during the hospitalization. No formal AKI survivor clinic, as has been described,[17] existed during the study period. Rather, AKI follow-up was at the discretion of the clinical teams. The study was approved by the Mayo Clinic institutional review board (#22-000931).

Remote Patient Monitoring Program

The previously described[18] Mayo Clinic AKI RPM program (Item S1) was launched as a practice improvement initiative in October 2021. This program integrated a multidisciplinary care team approach, including nephrologists, RPM trained nurses, and nephrology specialty nurses, into comprehensive patient care and management.[19] Briefly, candidates for AKI RPM were patients who had an inpatient nephrology consultation for an episode of AKI during the hospitalization. Hospitalized patients with AKI were identified using an electronic health record screening list based on the KDIGO serum creatinine criteria.[20] Candidate patients were approached for participation in AKI RPM if they were expected to be discharged to home, not treated with dialysis, and expected to receive follow-up care at a Mayo Clinic-affiliated facility in the Midwest. Mayo Clinic Midwest includes the academic medical center hub in Rochester, Minnesota, and 44 other community and rural hospitals, clinics, and care facilities in the Midwest. Certain patient groups were excluded from participating in the AKI RPM: pregnant patients, those expected to dismiss on immunosuppression to be managed by nephrology (ie, select glomerular diseases), those with dementia or cognitive impairment, or non-English speaking patients lacking a family member who could translate and communicate with the AKI RPM health care team. Patients actively enrolled in other institutional care transition programs (eg, in-home care for high-risk aging patients) or other RPM programs (eg, cirrhosis and COVID-19) were also not eligible for AKI RPM participation. Patients with a left ventricular assist device (LVAD), or who received any transplant or CAR-T cell therapy within 100 days of enrollment were also ineligible to participate in AKI RPM.

After exclusion criteria were applied, eligible patients were approached for AKI RPM participation. Interested patients were enrolled and provided home monitoring technology, which automatically transmitted the data to AKI RPM nurses. Weekly in-center serum creatinine and electrolyte evaluations were scheduled. Abnormalities in vital signs, symptoms, or laboratory data triggered alerts classified as routine, semi-urgent, urgent, or emergency. Nurses evaluated the data daily and adhered to prespecified protocols for management and escalation of care if needed. Communication occurred by telephone and virtual interactions in the electronic health record-based patient portal. The minimum program duration was 4 weeks. The maximum program duration was 3 months. AKI RPM participants were eligible for graduation if they remained off dialysis with a stable creatinine for 2 consecutive weeks and had no urgent or emergent alerts in the preceding 1-week interval. Patients with an estimated glomerular filtration rate (eGFR) < 45 mL/min/1.73m^2 or a urine albumin to creatinine ratio (UACR) > 300 mg/g at the time of AKI RPM program graduation were referred to a CKD clinic. All other patients were referred to primary care.

Experience With AKI RPM

The first aim was to characterize the experience with the AKI RPM program to assess the potential burden of daily self-monitoring and weekly laboratory testing. Patients enrolled in the program from October 2021 (program launch) to November 2022 were included. Descriptive analyses included the proportion of patients enrolled in AKI RPM who actively participated after hospital discharge, duration of program involvement, loss to follow up before graduation, nature of AKI RPM alerts and actions taken, and graduation disposition (CKD clinic vs primary care).

Effectiveness

An observational cohort study was performed to evaluate the effect of AKI RPM program participation on clinical outcomes. AKI RPM participants were matched to historical controls sampled from the same hospital before AKI RPM program launch. Patients in the AKI RPM and historical control groups were followed for 6 months or until death, whichever occurred first.

AKI RPM Group

The exposure of interest was AKI RPM program participation from October 2021 to November 2022. Among AKI RPM program participants, only patients with stage 3 AKI based on KDIGO serum creatinine criteria[20] who actively participated in the program were included in the effectiveness evaluation.

Historical Control Group

The control group was selected from AKI survivors hospitalized from October 2018 to September 2021. The AKI identification, patient education, and follow-up during this period were at the discretion of the primary team. It was customary for patients to receive some degree of laboratory monitoring and clinical follow-up after discharge,[6] but timing and components were not standardized. Care providers had access to similar educational brochures and pamphlets on AKI and kidney health during this timeframe as those in the exposed group.

Historical controls were selected using the same criteria as those outlined for patients enrolled in the RPM program: adults aged ≥18 years with AKI stage 3[20] during a

hospitalization at Mayo Clinic in Rochester, Minnesota, and an inpatient nephrology consultation. If a patient had multiple encounters with an AKI diagnosis during the timeframe, we selected the first of those encounters. Patients in the AKI RPM group were not eligible to be used as controls. Similar to the AKI RPM group, controls were eligible if discharged to home, not treated with dialysis, and expected to receive follow-up care at a Mayo Clinic-affiliated facility in the Midwest. Pregnant patients, those diagnosed with dementia, and non-English speaking patients were excluded. Patients in other RPM programs (eg, COVID-19) were excluded, as were those with an LVAD or transplant within 100 days (Table S1). Historical controls were selected in a 1 case:3 control ratio based on frequency matching of baseline eGFR, number of hospitalizations in the preceding 6 months, and sex, and exact matching on intensive care utilization during hospitalization, use of acute dialysis during hospitalization, and stage of AKI recovery at discharge.[21]

Data Collection and Definitions

Electronic health record data were obtained via the Mayo Clinic Unified Data Platform for demographics and patient characteristics (eg, age and sex), laboratory data (eg, serum creatinine), comorbid conditions (eg, CKD and end-stage kidney disease), hospitalization features (eg, need for intensive care unit level of care and use of acute dialysis), and post-discharge care considerations (eg, discharge disposition and readmissions) (Table S1). Stage 3 AKI was identified with the KDIGO serum creatinine criteria.[20] Degree of AKI recovery was classified as recovered or stage 0 (serum creatinine < 1.5× baseline, but not back to baseline level), stage 1 (1.5-1.9× baseline), stage 2 (2-2.9× baseline), or stage 3 (3× baseline or ≥4 mg/dL).[21] Admission and dismissal eGFRs were calculated with the CKD EPI eGFR creatinine equation (mL/min/1.73 m^2).[22] The preadmission baseline creatinine concentration for AKI staging, recovery, and eGFR calculation was the median of all outpatient creatinine values in the 6 months to 7 days before the hospitalization.[23] If unavailable, this value was estimated using an eGFR of 60 mL/min/1.73 m^2.[24] The primary reason for readmission was independently evaluated by 2 study team members with expertise in nephrology (MC and AK) and categorized as associated with kidney health (eg, AKI recurrence, volume overload) or not associated with kidney health (eg, fracture).

Effectiveness Endpoints

The primary endpoint for the effectiveness analysis was an unplanned hospital readmission or emergency department (ED) visit (without a corresponding hospitalization) within 6 months of discharge. These were separately evaluated in a secondary analysis. Primary reasons for readmissions and ED visits were characterized as associated/not with kidney health. We also characterized the proportion of patients with new or worsening kidney dysfunction from 90 days to 6 months after discharge defined as a new diagnosis code for CKD, a transition from a prehospitalization eGFR ≥60 mL/min/1.73m^2 to < 60 mL/min/1.73m^2 after discharge or a 30% decline in kidney function from prehospitalization to after discharge. Follow-up for this outcome began 90 days after discharge as CKD requires persistent kidney dysfunction for at least 90 days after an episode of AKI. Only those with at least 1 serum creatinine measured from 90 days to 6 months after discharge were included in this analysis. The incidence of new dialysis in the 6 months after discharge was described. Death within 6 months was described.

Statistical Analysis

Patient and baseline clinical characteristics were compared between those in the RPM program and their controls using a Wilcoxon Rank Sum test for continuous data and the χ^2 test for categorical data. Incidence rates of hospital readmission/ED visits and new or worsening kidney dysfunction were estimated using the Kaplan-Meier method. The risks of these events were compared between groups using Cox proportional hazards models. We also assessed if these associations persisted in subgroup analyses stratified by baseline eGFR (≥45 vs < 45 mL/min/1.73 m^2), congestive heart failure or cardiovascular disease, liver cirrhosis, and neutropenia, as some of these disease states could qualify patients for other institutional RPM programs. All analyses were performed using SAS version 9.4 software (SAS Institute, Inc) and R version 4.2.2 (R Core Team, R Foundation for Statistical Computing).

RESULTS

Experience With AKI RPM

In the 13-month study, 49 patients with AKI enrolled in the AKI RPM program, out of which 40 (82%) patients actively participated in the program after hospital discharge (Fig 1). In these 40 patients, the median (IQR) preadmission baseline eGFR was 38 (27-60) mL/min/1.73m^2 (Table S2). The median duration of program participation was 32 (28-39) days. Eight (20%) patients were lost to follow up or withdrew before meeting graduation criteria.

Among the 40 patients who actively participated after discharge, at least one AKI RPM program alert occurred in 29 (73%) participants, and 73 total alerts were recorded (Figs S1-S3). Alerts based on abnormal symptoms were most common, specifically for weight gain or edema. The leading intervention recommendation by RPM providers was diuretic adjustment (25 of 73 alerts) (Fig 2). The AKI RPM program made 6 ED referrals in 5 unique patients. Two ED referrals were due to worsening shortness of breath. The other 4 referrals were for hyperkalemia and elevated creatinine levels, hypotension, hypocalcemia, and fever and hematuria. Among the 32 patients who

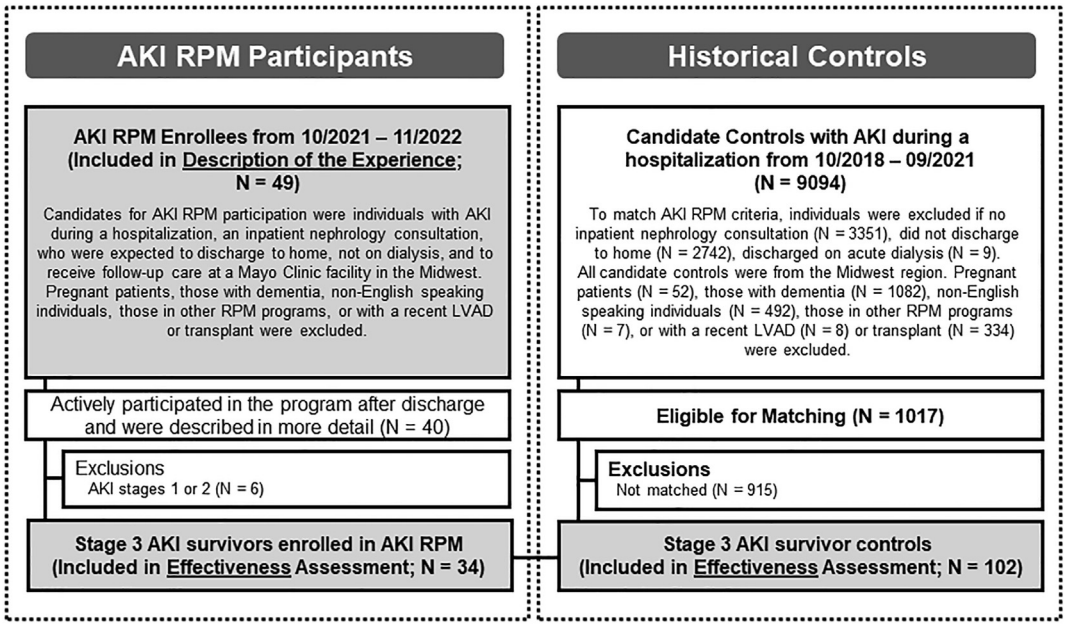

Figure 1. Patient flow through study. Shaded gray boxes indicate the levels of analysis. 49 patients with AKI were enrolled in the AKI RPM program during the study period of which 40 (82%) submitted at least one set of clinical or laboratory data after discharge. Among those 40 patients, alerts and associated interventions were characterized in detail. AKI RPM program participants with stage 3 AKI were then matched to a group of historical controls in whom similar eligibility criteria was applied. Abbreviations: AKI RPM, acute kidney injury remote patient monitoring; LVAD, left ventricular assist device.

participated in AKI RPM through to graduation, 24 (75%) were referred to nephrology for an eGFR < 45 mL/min/1.73m^2 or a UACR > 300 mg/g. Seventeen (71%) of those patients completed a nephrology visit within 90 days of program graduation.

Effectiveness Compared With Historical Controls

The 34 AKI RPM program participants with stage 3 AKI who actively participated after discharge were matched to 102 historical controls who also had stage 3 AKI during a hospitalization. The AKI RPM program participants and controls were not statistically significantly different for all matching criteria (P-values > 0.05; Table 1).[21]

Readmission

The primary endpoint of the cumulative incidence of ≥1 unplanned hospital readmission or ED visit (without a corresponding hospitalization) within 6 months of discharge was not different between groups (AKI RPM group n = 22 [65%] vs control n = 54 (53%); HR 1.33 [95% CI, 0.81-2.18], P = 0.27; Fig 3). In separated analyses, unplanned hospital readmissions were not different, but the cumulative incidence of ≥1 ED visit alone (without a corresponding hospitalization) was significantly higher in the AKI RPM group (N = 16; 47%) than in the control group (N = 27; 26%) (HR 1.95 [95% CI, 1.05-3.62]; P = 0.035). When unplanned hospital readmissions and ED visits were counted toward the outcome only when associated with kidney health, the cumulative incidence of ≥1 ED visit alone (without a corresponding hospitalization) within 6 months was significantly higher in the AKI RPM group (n = 7; 21%) compared with controls (n = 7; 7%) (HR 3.23 [95% CI, 1.13-9.22]; P = 0.028) (Fig S4). These occurrences associated with kidney health reflect a minority of the ED visits in 6 months in the 2 groups (AKI RPM: n/N = 7/16 [44%] and control: n/N = 7/27 [26%]).

In stratified analyses according to baseline comorbid conditions, the effect of AKI RPM program participation on the risk of an unplanned readmission or ED visit was modified by the baseline severity of CKD. Among those with an eGFR < 45 mL/min/1.73 m^2, those in the AKI RPM program experienced a greater risk of an unplanned readmission or ED visit (HR 2.24 [95% CI, 1.19-4.20]; P = 0.012), whereas among those with an eGFR ≥45 mL/min/1.73 m^2 there was no significant difference in risk of an unplanned readmission or ED visit between those in/not in the AKI RPM program (HR 0.69 [95% CI, 0.29-1.67]; P = 0.41) (test of interaction P = 0.04; Fig 4).

Other Secondary Outcomes

The risk for new worsening kidney dysfunction in the 90 days to 6 months after discharge was not different between AKI RPM program participants and controls (HR 0.92 [95% CI, 0.53-1.61]; P = 0.78). There was no difference in the risk of new initiation of dialysis within 6 months after discharge (HR 0.70 [95% CI, 0.24-2.08]; P = 0.52) or the risk of death (AKI RPM group n = 6 [17%] vs control n = 14 [13%]; HR 1.27 [95% CI, 0.49-3.31]; P = 0.63).

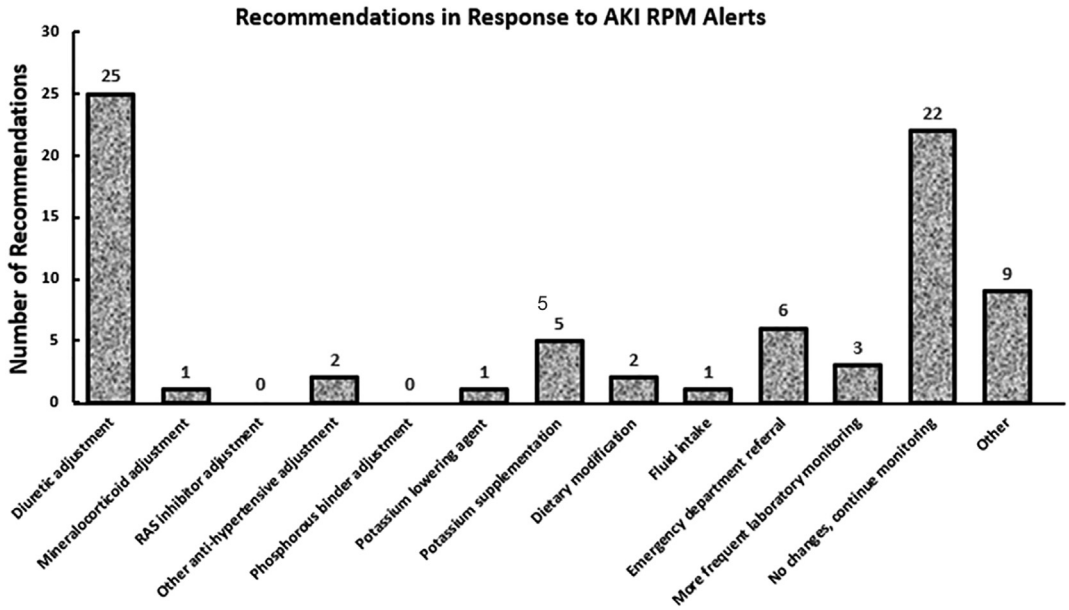

Figure 2. AKI RPM recommendations. Recommendations made for the 40 patients enrolled in AKI RPM that actively participated after discharge. Abbreviations: AKI RPM, acute kidney injury remote patient monitoring; RAS, renin-angiotensin system (inhibitor).

DISCUSSION

This single-center study described the experience with an RPM program to facilitate AKI survivor care for those discharged from the hospital, not treated with dialysis. Enrolled patients were willing to participate in home vital sign and symptom monitoring and in-center laboratory assessments. The most common alerts and recommendations related to fluid status. Most AKI RPM program participants had persistently reduced GFR or albuminuria at graduation and were successfully seen by nephrology specialists within 90

Table 1. Baseline Demographics and Patient Characteristics of the Patients Included in the Comparison Between AKI RPM and Historical Controls

Characteristic	AKI RPM (n = 34)	Control (n = 102)	*P*
Age at hospital admission, y[a]	68 (57-76)	64 (55-73)	0.23
Male sex[a]	22 (65%)	74 (73%)	0.38
Non-Hispanic White	32 (94%)	92 (90%)	0.67
Select comorbid conditions			
CHF	11 (32%)	29 (28%)	0.66
CVD	6 (18%)	20 (20%)	0.80
Cirrhosis	6 (18%)	14 (14%)	0.58
Neutropenia	6 (18%)	20 (20%)	0.80
Elixhauser comorbidity score	6 (3-11)	6 (4-9)	0.64
Number of inpatient admissions in the 6 months before hospital discharge[a]	0 (0-1)	0 (0-1)	0.62
Preadmission eGFR, mL/min/1.73m^2[2,a]	40 (26-60)	53 (28-60)	0.16
Dialysis during index encounter[a]	8 (24%)	24 (24%)	>0.99
ICU encounter during index hospitalization[a]	14 (41%)	42 (41%)	>0.99
Length of stay for index hospitalization, d	7 (4-11)	9 (6-11)	0.067
eGFR at discharge, mL/min/1.73m^2[2,a]	12 (9-17)	14 (11-21)	0.18
AKI recovery stage at discharge[a,b]			>0.99
0	6 (18%)	18 (18%)	
1	4 (12%)	12 (12%)	
2	4 (12%)	12 (12%)	
3	20 (59%)	60 (59%)	

Note: Data reported as N(%) for categorical variables and median (IQR) for continuous variables.
Abbreviations: AKI RPM, acute kidney injury remote patient monitoring; CHF, congestive heart failure; CVD, cardiovascular disease; eGFR, estimated glomerular filtration rate; ICU, intensive care unit.
[a]Factors used to select and match historical controls to AKI RPM program participants.
[b]Degree of AKI recovery was classified as recovered or stage 0 (SCr < 1.5× baseline, but not back to baseline level), stage 1 (1.5-1.9× baseline), stage 2 (2-2.9× baseline), or stage 3 (3× baseline or ≥4 mg/dL).[21]

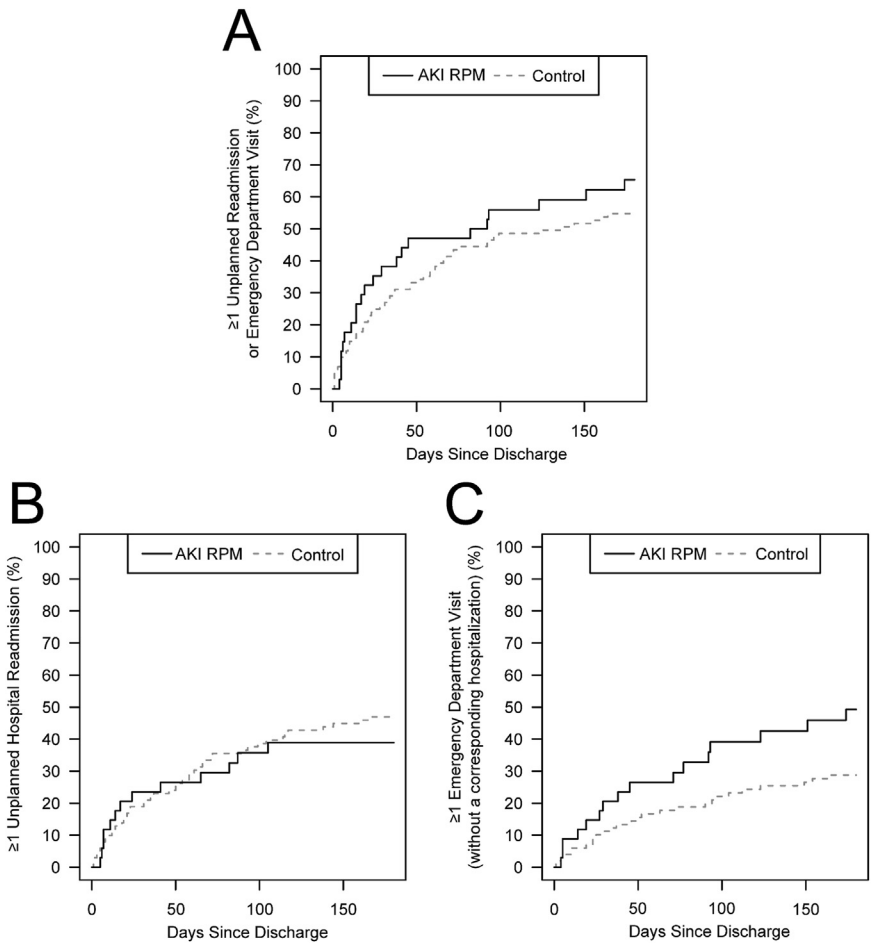

Figure 3. Risk of an unplanned readmission or ED visit within 6-months of discharge. Panel A: Risk of ≥1 unplanned hospital readmission or ED visit in the 6-months after discharge was not different between groups (HR 1.33 [95% CI, 0.81-2.18]; $P = 0.27$). Median (IQR) time to first unplanned hospital readmission or ED visit was 22 (8-73) days in the AKI RPM group versus 32 (10-68) days in the controls ($P = 0.82$). Panel B: Risk of ≥1 unplanned hospital readmission was similarly not different between groups (HR 0.84 [95% CI, 0.45-1.55]; $P = 0.58$). The median (range) number of hospital readmissions within 6 months was 1 (1-5). Panel C: Risk of ≥1 ED visit alone (without a corresponding hospitalization) was higher in the AKI RPM group compared to control (HR 1.95 [95% CI, 1.05-3.62]; $P = 0.035$).

days. Compared with matched historical controls, no differences were observed in the incidence of an unplanned hospital readmission or ED visit within 6 months with AKI RPM. We did observe a statistically significant increase in the incidence of ED visits alone (without a corresponding hospitalization) in patients with AKI RPM, most of which were unrelated to kidney health. Risk of an unplanned readmission or ED visit was higher in AKI RPM patients with an eGFR < 45 mL/min/1.73m^2 compared with those with an eGFR ≥45 mL/min/1.73m^2.

The post-discharge course of AKI survivors is dynamic[25] and, without proper monitoring, may lead to complications.[21] It is for these and other reasons that, until recently, AKI survivors without other barriers to discharge, were maintained in the hospital for monitoring until durable kidney recovery was observed. New advances in digital health have made it possible to reimagine AKI survivor care delivery models.[26] We previously reported high patient satisfaction with the AKI RPM program; most patients were willing to recommend the program to others.[18] We observed successful referral of patients with CKD to nephrology follow-up. Three-fourths of patients who completed the AKI RPM program had evidence of CKD. Among those referred to the nephrology clinic, 71% completed a visit within 90 days. This achievement addresses ongoing inadequacies demonstrated in CKD care.[27] Initiatives like the AKI RPM program serve as a bridge to facilitate long-term kidney care after an AKI event. These efforts are responsive to recent data which confirms patients' interest in becoming more aware of their AKI diagnosis and methods for management and secondary prevention after hospital discharge.[13]

Contrary to our hypothesis and previous studies from our institution in other syndromes,[28] we did not identify a clinical effectiveness benefit of AKI RPM program participation. Incidence of rehospitalization, new or worsening kidney dysfunction, and dialysis dependence were all similar up to 6 months after discharge. There did appear to

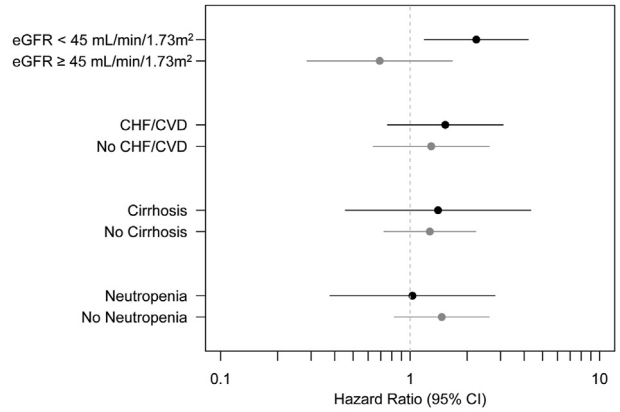

Figure 4. Forest plot with stratified risk of unplanned hospital readmission or ED visit according to baseline comorbid conditions. During the study timeframe, Mayo Clinic launched other RPM programs including for cirrhosis, congestive heart failure, and febrile neutropenia. Stratified analyses of the impact of AKI RPM on the risk of ≥1 unplanned hospital readmission or ED visit in the 6-months after discharge in these groups and patients with CKD were performed. Patients with an estimated GFR < 45 mL/min/1.73 m^2 had a higher risk of readmission when in the AKI RPM group when compared with historical controls (HR = 2.24 [95% CI, 1.19-4.20]; $P = 0.012$). In patients with an estimated GFR ≥45 mL/min/1.73 m^2 there was no difference in risk of readmission between the AKI RPM group and controls (HR = 0.69 [95% CI, 0.29-1.67]; $P = 0.41$) (test of interaction $P = 0.04$). No differences were noted in other groups.

be an increase in ED visits in the AKI RPM group relative to historical controls, most of which were unrelated to kidney health. Recruitment biases, enrollment of sicker patients in AKI RPM as compared with historical controls, and residual confounding may explain these findings.

It is possible that the lack of effectiveness seen with AKI RPM could also be explained by over-detection. Over-detection refers to the identification of abnormalities that do not cause harm or do not progress to cause symptoms or harm during a person's lifetime.[29] As a first-of-its-kind program, the protocol for AKI RPM including the thresholds selected for alerting were based on expert opinion. The AKI RPM thresholds for laboratory values, signs, and symptoms, could be re-evaluated. Alternatively, although an increase in referrals to the ED may be interpreted as a failure of effectiveness, it may also reflect that the acute needs of the AKI survivor population are not being addressed by the current standard of care.

Other limitations of these findings must be considered. These results are based on patients at an academic medical center who agreed to be enrolled in AKI RPM, which likely reflects a somewhat more motivated population to seek and participate in care. Data were not available to characterize the proportion of patients screened and approached for participation who ultimately enrolled. The reasons a patient dropped out of the program were also not available. Future AKI survivor efforts should explore feasibility and effectiveness of RPM in more diverse patient populations (geographically, degree of rurality, and race or ethnicity). The study included a relatively small sample size by design, as the program was in its infancy, which may have been underpowered for the effectiveness endpoints. Despite the small sample size, preliminary data regarding incidence of and time to unplanned readmissions and ED visits, and number or cause of alerts will be useful for other practices trying to design RPM programs. The study was also not able to directly observe whether the AKI RPM-guided medication interventions were enacted correctly by patients. We identified an interesting relationship between baseline severity of CKD and the effect of AKI RPM on readmissions, where worse CKD was associated with a higher risk with AKI RPM. This deserves future exploration. Our study was also performed during the COVID-19 pandemic, which could have significantly impacted rates of hospitalization, ED visits, and patient attitudes toward using technology for medical care. Historical controls were selected from both before and during the early phase of the pandemic. Although use of historical controls was necessary to evaluate the AKI RPM program, it could have introduced biases that were incompletely accounted for in the findings. Finally, it is possible that ED visits or hospital readmissions occurred outside the Mayo Clinic system, which would not be fully captured by the study findings. All included patients were from the Midwest region where Mayo Clinic is the primary health care provider, which makes this less likely.

In conclusion, our study characterized the experience of implementing an AKI RPM program. Patients were able to be recruited into the program and were willing to actively participate. Most AKI RPM alerts and recommendations related to fluid status. The majority of AKI RPM program graduates with CKD completed specialty nephrology follow-up within 90 days. We found no difference in readmissions or ED visits, new or worsening kidney dysfunction, new dialysis initiation, or mortality by 6 months. Based on these data, advocating for routine AKI RPM program participation for AKI survivors would be premature. Nephrologist-guided care transition recommendations remain the best practice. Continued exploration of digital health tools is needed to understand their effect on patient outcomes and to identify specific subgroups of AKI survivors who may benefit the most from this resource.

SUPPLEMENTARY MATERIALS

Supplementary File (PDF)

Figure S1: All AKI RPM program alerts for the 40 patients that actively participated after discharge.

Figure S2: Laboratory alerts for the 40 patients enrolled in AKI RPM that actively participated after discharge.

Figure S3: Clinical alerts for the 40 patients enrolled in AKI RPM that actively participated after discharge.

Figure S4: Risk of an unplanned readmission or emergency department visit associated with kidney health within 6-months of discharge.

Item S1: Description of AKI RPM Program.

Table S1: Diagnosis and Procedure Codes Used Throughout the Study.

Table S2: Baseline Patient Characteristics and Demographics in the 40 Patients Enrolled in AKI RPM that Actively Participated After Discharge.

ARTICLE INFORMATION

Authors' Full Names and Academic Degrees: Mariam Charkviani, MD, Andrea G. Kattah, MD, Andrew D. Rule, MD, Jennifer A. Ferguson, MS, Kristin C. Mara, MS, Kianoush B. Kashani, MD, Heather P. May, PharmD, Jordan K. Rosedahl, BA, Swetha Reddy, MBBS, MD, Lindsey M. Philpot, PhD, MPH, and Erin F. Barreto, PharmD, PhD

Authors' Affiliations: Division of Nephrology & Hypertension (MC, AGK, ADR, KBK), Division of Epidemiology (ADR, LMP), Division of Community Internal Medicine (JAF, LMP), Department of Quantitative Health Sciences (KCM, JKR), Division of Pulmonary and Critical Care Medicine (KBK), Department of Pharmacy (HPM, EFB), Mayo Clinic, Rochester, MN; Division of Critical Care Medicine, Department of Medicine (SR), and Division of Nephrology and Hypertension, Department of Medicine (SR), Mayo Clinic, Jacksonville, FL.

Address for Correspondence: Erin F. Barreto, PharmD, Mayo Clinic College of Medicine, 200 First Street SW, Rochester, Minnesota, 55905. Email: Barreto.Erin@mayo.edu

Authors' Contributions: MC, AGK, ADR, and EFB: designed the study, interpreted the data, drafted, and critically revised the article. JAF, KCM, JKR: abstracted data, performed statistical analysis, and provided critical revision of the article. SR: abstracted data and provided critical revision of the article. KBK, HPM, and LMP provided critical revision of the article. Each author contributed important intellectual content during article drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

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