

# Characteristics and Effectiveness of Dedicated Care Programs for Patients Starting Dialysis: A Systematic Review

Mirna Attalla,<sup>1</sup> Zoe Friedman,<sup>2</sup> Sandra McKeown,<sup>3</sup> Ziv Harel,<sup>4</sup> Jay Hingwala,<sup>5</sup> Amber O. Molnar,<sup>6</sup> Patrick Norman,<sup>7,8</sup> and Samuel A. Silver<sup>1,7</sup>

## Abstract

**Background** Dedicated care programs that provide increased support to patients starting dialysis are increasingly being used to reduce the risk of complications. The objectives of this systematic review were to determine the characteristics of existing programs and their effect on patient outcomes.

**Methods** We searched Embase, MEDLINE, Web of Science, Cochrane CENTRAL, and CINAHL from database inception to November 20, 2019 for English-language studies that evaluated dedicated care programs for adults starting maintenance dialysis in the inpatient or outpatient setting. Any study design was eligible, but we required the presence of a control group and prespecified patient outcomes. We extracted data describing the nature of the interventions, their components, and the reported benefits.

**Results** The literature search yielded 12,681 studies. We evaluated 66 full texts and included 11 studies ( $n=6812$  intervention patients); eight of the studies evaluated hemodialysis programs. All studies were observational, and there were no randomized controlled trials. The most common interventions included patient education ( $n=11$ ) and case management ( $n=5$ ), with nurses involved in nine programs. The most common outcomes were mortality ( $n=8$ ) and vascular access ( $n=4$ ), with only three studies reporting on the uptake of home dialysis and none on transplantation. We identified four high-quality studies that combined patient education and case management; in these programs, the relative reduction in 90-day mortality ranged from 22% (95% CI, -3% to 41%) to 49% (95% CI, 33% to 61%). Pooled analysis was not possible due to study heterogeneity.

**Conclusions** Few studies have evaluated dedicated care programs for patients starting dialysis, especially their effect on home dialysis and transplantation. Whereas multidisciplinary care models that combine patient education with case management appear to be promising, additional prospective studies that involve patients in their design and execution are needed before widespread implementation of these resource-intensive programs.

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## Introduction

The transition period during dialysis initiation, particularly the first few months, is associated with increased morbidity and mortality. During this time, the hospitalization rate at 90 days approaches 1.4 admissions per patient year and the mortality rate at 180 days for patients aged >65 years is 44% (1,2). These poor outcomes after starting dialysis are multifactorial, related not only to dialysis complications but also preexisting comorbidities, cardiovascular disease, and infection (2,3). Functional status and mental health are also negatively affected (4,5), further compounding the health care needs for an increasingly elderly incident

dialysis population (6). Despite dialysis initiation being a well-recognized vulnerable period for patients, nearly all dialysis programs provide similar care to both incident and prevalent patients on maintenance dialysis.

Dedicated care programs or transitional care units, which aim to provide increased support for patients starting dialysis, may improve outcomes in this high-risk group of patients. Examples of these programs have been informally described (7–9), noted to consist of structured care pathways or case management, patient education, and increased involvement from multidisciplinary health care providers (*i.e.*, social workers,

<sup>1</sup>Department of Medicine, Kingston Health Sciences Centre, Queen's University, Kingston, Canada

<sup>2</sup>Department of Biology, Queen's University, Kingston, Canada

<sup>3</sup>Health Sciences Library, Queen's University, Kingston, Canada

<sup>4</sup>Department of Medicine, St. Michael's Hospital, University of Toronto, Toronto, Canada

<sup>5</sup>Department of Internal Medicine, University of Manitoba, Winnipeg, Canada

<sup>6</sup>Department of Medicine, McMaster University, Hamilton, Canada

<sup>7</sup>Kingston General Health Research Institute, Kingston, Canada

<sup>8</sup>Department of Public Health Sciences, Queen's University, Kingston, Canada

**Correspondence:** Samuel A. Silver, Division of Nephrology, Queen's University, 76 Stuart St., 3-Burr 21-3-039, Kingston, ON K7L 2V7, Canada. Email: [samuel.silver@queensu.ca](mailto:samuel.silver@queensu.ca)

dietitians, and psychologists). The rationale for these programs and their components is that more intensive multidisciplinary care during the transition to dialysis will help optimize vascular access and laboratory parameters, as well as address lifestyle and psychosocial challenges. There may also be an opportunity to promote the benefits of home dialysis and kidney transplantation (9).

As descriptions of dedicated care programs continue to emerge, it remains unclear how these programs should be designed and organized, as well as which outcomes they might improve and the associated costs. Accordingly, the aims of this systematic review were to describe the characteristics of previously evaluated dedicated care programs for patients starting maintenance dialysis and to determine their effect on patient outcomes so as to provide guidance for other centers who wish to institute similar programs.

## Materials and Methods

We reported this systematic review in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines (10). The protocol has been registered with PROSPERO (CRD42018099814).

### Data Sources and Searches

We used a comprehensive search approach developed with a health sciences librarian (SM) to locate published studies. We conducted a preliminary search in Ovid Embase using a combination of text words and subject headings, followed by an analysis of relevant citations to identify other text words and subject headings. We then adapted the optimized Ovid Embase search strategy for Ovid MEDLINE, Web of Science, Ovid EBM Reviews for the Cochrane Central Register of Controlled Trials, and the Cumulative Index of Nursing and Allied Health Literature. We searched all databases from inception to March 2018, with a search update completed to November 20, 2019. We screened the reference lists of all identified articles to locate any additional studies. The complete search strategies for Ovid Embase and Ovid MEDLINE are provided in Supplemental Appendix 1.

### Study Selection

The target population was adult patients on maintenance dialysis over the age of 18 with ESKD. Any study design was eligible, but we required English-language articles and the presence of a control group. We excluded unpublished conference abstracts, as well as studies that did not preferentially report data on incident patients, describe dedicated care programs (*i.e.*, programs that provide increased support for patients on dialysis), or include patient outcomes.

We defined dedicated or transitional care programs as different models of care designed to enhance the adjustment on dialysis for new patients, which is a categorization used by others (8,9). Because of anticipated heterogeneity in the approaches to transitional care, we required the interventions to include at least one component from a taxonomy of complex and quality improvement interventions adapted from the Cochrane Effective Practice and Organizations of Care group, which have been previously described (11–13). These components included patient education, self-

management, psychosocial support, health care provider education/reminders, case management, and checklists. We also prespecified a wide range of eligible patient outcomes, which included mortality, hospitalizations, quality of life, choice of kidney replacement modality (including kidney transplantation), vascular access, BP, dialysis adequacy, and laboratory parameters (*e.g.*, hemoglobin, albumin, and phosphate).

### Data Abstraction

For initial selection, two authors (MA and ZKF) scanned through the titles and abstracts. We resolved any discrepancies by discussion with the corresponding author (SAS). We reviewed selected full-text papers in detail to ensure eligibility before data abstraction. For each study, we collected data on the study details (*e.g.*, study design, population, and inpatient/outpatient setting), patient characteristics (*e.g.*, age, sex, and comorbidities), the nature of the interventions (*e.g.*, target, components, and staff affected), and the measured outcomes. We assessed study quality using the Newcastle–Ottawa Quality Assessment Scale for nonrandomized studies (14). Two authors (MA and ZKF) evaluated study quality and risk of bias, with discrepancies resolved by the corresponding author (SAS).

### Analysis

We qualitatively synthesized the results of all included studies, focusing on the patient population, study design, details of the intervention, and outcomes. We did not perform meta-analyses because there were too few studies to apply random effects-based methodology and the included studies were too heterogeneous to apply fixed effects-based methodology.

## Results

Our search strategy yielded 12,681 unique citations. We identified six additional studies through bibliography review. We excluded 12,621 citations on the basis of title/abstract screening due to duplicate articles, reviews, non-incident population, nonrelevant interventions, lack of comparison group, or absence of patient outcomes. We then reviewed the full texts of the remaining 66 studies and excluded 55 articles due to review articles ( $n=9$ ), nonincident dialysis population ( $n=5$ ), nonrelevant interventions ( $n=30$ ), lack of comparison group ( $n=6$ ), or absence of patient outcomes ( $n=2$ ); we excluded three more articles that were only available as abstracts ( $n=2$ ) or did not have English-language full texts ( $n=1$ ). This strategy yielded 11 studies for further analysis (15–25), which totaled 6812 intervention patients (Figure 1).

### Study Characteristics

Of the 11 programs, seven evaluated patients on hemodialysis, three evaluated patients on peritoneal dialysis, and one evaluated patients transitioning to either modality (Table 1). Only one program targeted inpatient dialysis starts (25). Most of the studies were conducted in the United States ( $n=6$ ) and had retrospective designs ( $n=7$ ); we did not identify any quasiexperimental or randomized trials. The median (25th/75th percentile) number of intervention

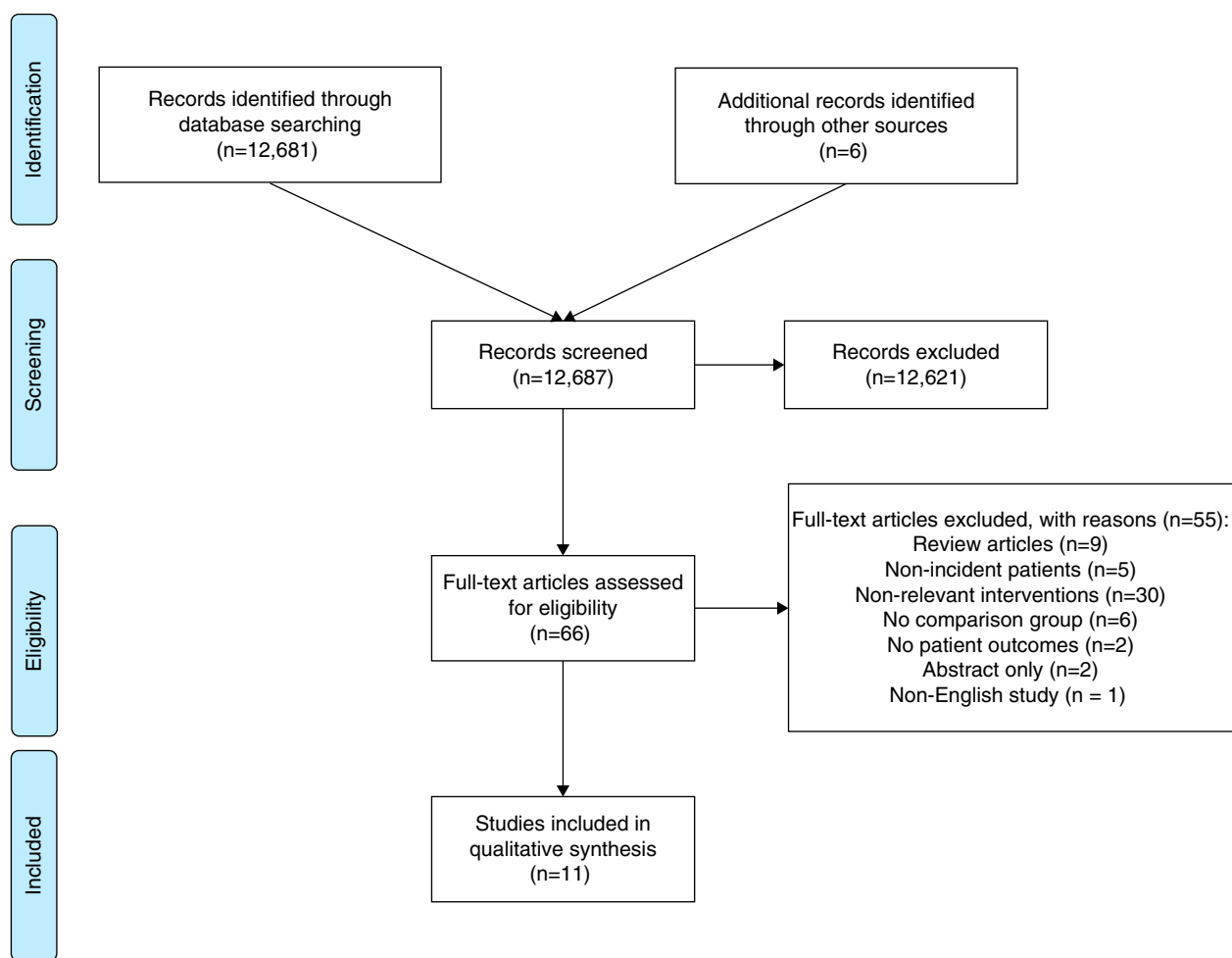


Figure 1. | Preferred Reporting Items for Systematic Review and Meta-Analyses flow diagram of included studies.

patients was 341 (56–804), and only three studies included >500 patients in each group (17,20,22). The most common interventions included patient education ( $n=11$ ), case management ( $n=5$ ), self-management ( $n=4$ ), and psychosocial support ( $n=4$ ), with nurses involved in 9/11 dedicated care programs. Case management involved initial patient education followed by structured pathways and/or follow-up of modality decisions ( $n=4$ ), vascular access ( $n=4$ ), or laboratory parameters ( $n=2$ ). The self-management and psychosocial support interventions were all combined and delivered in hemodialysis units, usually by social workers ( $n=3$ ). The control groups consisted of historical ( $n=3$ ) or contemporary ( $n=8$ ) patients who received local standard of care, without the specialized interventions and personnel above to prioritize and specifically address the needs of incident patients.

There were important differences in study quality and risk of bias (Table 2). We rated six studies as high quality, five of which were published after 2005. The five low-quality studies were rated as such because they lacked comparability and failed to adjust for differences in patient case mix or potential confounders. The most common variables adjusted for in the higher-quality studies included age

( $n=5$ ), sex ( $n=5$ ), and diabetes ( $n=4$ ), with two studies using propensity score methodology (20,22). All three studies that focused exclusively on peritoneal dialysis were rated low quality (18,21,23).

### Study Outcomes

Only five studies specified a primary outcome (Table 1). Mortality and vascular access were the most common primary or secondary outcomes reported (mortality  $n=8$  and vascular access  $n=4$ ). Other common outcomes included dialysis adequacy ( $n=3$ ), anemia parameters ( $n=3$ ), nutritional parameters ( $n=3$ ), and peritoneal dialysis complications/technique survival ( $n=3$ ). We also identified three studies that reported on the uptake of home dialysis. Only two studies included quality of life as outcome and only one described hospitalizations, none of which were published after 2007. No study measured transplant uptake, reported costs or cost-effectiveness, or collected feedback from patients, caregivers, or staff.

We identified four high-quality studies that evaluated an effect of combined patient education and case management programs on mortality and vascular access (Table 3). In these programs, the relative reduction in 90-day mortality

**Table 1. Characteristics of dedicated care programs for patients new to dialysis**

Study/ Country/Yr/ Setting	Study Design	No. of Control Patients	No. of Intervention Patients	Mean age	Men (%)	RRT Modality	Intervention Components	Description of Control Group	Staff Required	Duration of Follow- Up	Primary Outcome	Secondary Outcomes
Friend <i>et al.</i> (15)/USA/ 1986/single-center hospital-based hemodialysis Unit	Retrospective cohort	38	88	49	57	Hemodialysis	Peer support group to discuss common problems of stress, quality of life, and coping mechanisms (patient education, self- management, and psychosocial support)	Hemodialysis patients at the same facility	Multidisciplinary team members invited to attend, as needed	5–15 yr	Mortality	None
Rasgon <i>et al.</i> (16)/ USA/1993/ multiple hemodialysis units affiliated with the same health maintenance organization	Prospective cohort	57	45	50	62	Hemodialysis	Multidisciplinary patient education and social work support designed to assist patients on hemodialysis in integrating dialysis into their lives and maintaining employment (patient education, self- management, and psychosocial support)	Maintenance hemodialysis patients within the same health maintenance organization	Physician and social worker	6 mo	Employment status	Karnofsky Scale of Physical Performance, quality of life, self- esteem, and attitude toward work
Wingard <i>et al.</i> (17)/ USA/2007/ multiple hemodialysis units affiliated with large dialysis organization	Prospective cohort	1020	918	62	46	Hemodialysis	Patient education program coupled with interventions focused on anemia management, adequate dialysis dose, nutrition, reduction of catheter use, review of medications, logistical support, and psychosocial assessment, as well as encouragement to participate in self-care and rehabilitation services (patient education, self- management, psychosocial support, and case management)	Hemodialysis patients in the same dialysis chain, area, and often the same physician practices	Case manager (often nurses)	1 yr	Not specified	Mortality, hospitalization days, quality of life, dialysis knowledge, hematocrit, albumin, dialysis adequacy, and vascular access
Souqiyeh <i>et al.</i> (18)/ Saudi Arabia/2008/ single-center peritoneal dialysis unit	Retrospective cohort	64	312	46	50	PD	Patient education on PD technique and telephone support after training (patient education)	Patients trained on PD at other hospitals in Saudi Arabia	Nurses	1–3 yr	Not specified	PD technique survival, mortality
Hanko <i>et al.</i> (19)/ Canada/2011/ single-center hospital-based hemodialysis unit	Retrospective cohort	42	36	59	63	Hemodialysis	Standard assessment and education on home dialysis of suboptimal/ late hemodialysis starts until modality plan established (patient education)	Suboptimal hemodialysis starts at the same facility	Nurse, with focus on home therapies	6 mo	Modality selection	None

Table 1. (Continued)

Study/ Country/Yr/ Setting	Study Design	No. of Control Patients	No. of Intervention Patients	Mean age	Men (%)	RRT Modality	Intervention Components	Description of Control Group	Staff Required	Duration of Follow- Up	Primary Outcome	Secondary Outcomes
Lacson <i>et al.</i> (20)/ USA/2011/large dialysis organization	Prospective cohort	27,052	3165	63	57	Hemodialysis and PD	Multiple-touch program with initial predialysis education completed in a single group class session, followed up by contact at 30, 90, and 180 d to review treatment options, inquire about kidney function/ status, plan dialysis access, and provide feedback to the referring physician (patient education and case management)	Patients in the same dialysis chain	Program leaders, usually home dialysis nurse	3 mo	Mortality, modality selection, central venous catheter use	PD uptake, vascular access
Ghaffari (21)/USA/ 2012/since-center study	Prospective cohort	9	18	48	63	PD	Standardized process by which patients without a plan for dialysis modality were started on PD, including rapid PD access placement, PD nursing education, and standardized protocols for modality selection (with recommendation), initial prescription, and prevention and management of complications (patient and provider education with case management)	Patients from the same facility started on PD nonurgently	Physician, nurse, PD access provider	3 mo	Not specified	PD technique survival, PD complications, mortality, need for hemodialysis, dialysis adequacy, hemoglobi, iron saturation, calcium, phosphate, PTH, and albumin
Wilson <i>et al.</i> (22)/ USA/2012/large hemodialysis organization	Retrospective cohort	2424	1212	64	57	Hemodialysis	Structured intake process, 90-d patient education program and management pathway, monthly monitoring of patient/ facility progress (patient education, self- management, psychosocial support, and case management, checklists)	Patients in the same dialysis chain	Multidisciplinary team consisting of nephrologists, nurses, dietitians, social workers, and clinical care providers	1 yr	Not specified	Mortality, dialysis adequacy, vascular access, hemoglobin, and albumin
Yu <i>et al.</i> (23)/China/ 2014/since-center study	Retrospective cohort	249	370	44	60	PD	Dedicated PD team for catheter insertion, patient education, follow-up, and continuous quality improvement (patient and provider education)	PD patients at the same facility before program implementation	Physician, nurse	3 yr	Not specified	PD technique survival, PD complications, mortality, and cardiac morphology
Gill <i>et al.</i> (24)/Canada/ 2017/regional hemodialysis program	Retrospective cohort	146	463	66	62	Hemodialysis	Multidisciplinary assessment of vascular access suitability, referrals, surgery, monitoring, and surveillance, with monthly rounds to evaluate challenging patients (patient and provider education with case management)	Patients in the same region before program implementation	Physician, nurse, surgeon, interventional radiologist	1 yr	Probability of catheter-free fistula use within 1 yr	Vascular access procedures, mortality

Table 1. (Continued)

Study/ Country/Yr/ Setting	Study Design	No. of Control Patients	No. of Intervention Patients	Mean age	Men (%)	RRT Modality	Intervention Components	Description of Control Group	Staff Required	Duration of Follow- Up	Primary Outcome	Secondary Outcomes
Schanz et al. (25)/ Germany/2018/ three hospital-based nephrology programs	Retrospective cohort	151	185	68	63	Hemodialysis	Structured, patient- centered in-hospital education program on dialysis modality; option to involve family members and peer support (patient education)	Patients at two of the three hospitals before program implementation	Nurse, with focus on home therapies	1 yr	Modality selection	None
PD, peritoneal dialysis; PTH, parathyroid hormone; RRT, renal replacement therapy.												

ranged from 22% (95% CI, -3% to 41%) to 49% (95% CI, 33% to 61%). The likelihood of achieving arteriovenous access at 90 days was more variable, with odds ratios that ranged from 0.99 (95% CI, 0.78 to 1.26) to 2.06 (95% CI, 1.88 to 2.26). The mortality results were similar in the two studies that reported 1-year outcomes. The likelihood of arteriovenous access continued to fluctuate at 1 year, with odds ratios that ranged from 1.09 (95% CI, 0.83 to 1.29) to 2.01 (95% CI, 1.72 to 2.35); however, the one study that focused exclusively on vascular access found no difference in catheter-free fistula use (odds ratio 0.87; 95% CI, 0.52 to 1.43) after introduction of a multidisciplinary assessment and monitoring process (24).

In the three studies that reported on the uptake of home dialysis (19,20,25), its utilization increased across three different settings. In outpatients with CKD, the odds of peritoneal dialysis increased five-fold (odds ratio 5.13; 95% CI, 3.58 to 7.35) (20). In patients who started hemodialysis in the hospital or without predialysis education, the odds of home dialysis increased four-fold (odds ratio 3.75; 95% CI, 1.08 to 13.05) (19). Last, in patients still admitted to hospital, delivery of an in-hospital education program increased the uptake of peritoneal dialysis from 0% to 15% (25). Across all settings, peritoneal dialysis was the most common home modality initiated, and the three dedicated care programs were led by home dialysis nurses/educators.

The only high-quality study that measured quality of life demonstrated improvement on the Kidney Disease Quality of Life Short Form from baseline to 6 months after starting hemodialysis (17). This test was only administered to the intervention group, but the changes in the Mental and Physical Composite Scores were statistically significant, and the 6-month scores higher than the Dialysis Outcomes and Practice Patterns Study reference scores (26).

### Discussion

In this systematic review of dedicated care programs designed to support patients initiating dialysis, we found few high-quality evaluations that included patient outcomes, with most studies only reporting on mortality and vascular access. However, multidisciplinary programs that combined patient education with case management (*i.e.*, structured care pathways usually led by dialysis nurses) during the first 3 months of dialysis did appear to achieve 20%–50% relative reductions in mortality (17,20,22). These results provide dialysis programs with multidisciplinary models of care to emulate if resources permit, but also reinforce the need for prospective interventional trials to inform care for this vulnerable population in whom over one in four patients die within 120 days of starting dialysis (27).

Our review identified an important strategy for improving early mortality that was used by large dialysis organizations with access to nurses, dieticians, social workers, and case managers: the coupling of patient education with periodic follow-up by multidisciplinary teams of dialysis staff to ensure the achievement of important care milestones (*e.g.*, vascular access, hemodialysis adequacy, and anemia targets). A similar strategy

**Table 2. Newcastle–Ottawa Scale for quality assessment of nonrandomized studies**

Study	Design	Selection				Comparability		Outcome			Total Points
		S1	S2	S3	S4	C1	C2	O1	O2	O3	
Friend <i>et al.</i> (15)	Retrospective cohort	1	1	1	1	1	1	1	1	0	8
Rasgon <i>et al.</i> (16)	Prospective cohort	1	0	1	1	1	0	0	1	0	5
Wingard <i>et al.</i> (17)	Prospective cohort	1	1	1	1	1	1	1	1	0	8
Souqiyeh <i>et al.</i> (18)	Retrospective cohort	0	0	1	1	0	0	0	1	0	3
Hanko <i>et al.</i> (19)	Retrospective cohort	1	1	1	1	1	0	1	1	1	8
Lacson <i>et al.</i> (20)	Prospective cohort	1	1	1	1	1	1	1	1	0	8
Ghaffari (21)	Prospective cohort	0	1	1	1	0	0	1	1	1	6
Wilson <i>et al.</i> (22)	Retrospective cohort	1	1	1	1	1	1	1	1	0	8
Yu <i>et al.</i> (23)	Retrospective cohort	1	1	0	1	0	0	0	1	0	4
Gill <i>et al.</i> (24)	Retrospective cohort	1	1	1	1	1	1	1	1	1	9
Schanz <i>et al.</i> (25)	Retrospective cohort	1	1	1	1	0	0	1	0	1	6

For quality assessment, >7 points is considered “high quality.” S1, representativeness of exposed cohort; S2, selection of controls; S3, ascertainment of exposure; S4, outcome not present at start of study; C1/C2, design/analysis controls for important factors; O1, assessment of outcomes; O2, follow-up duration sufficient for outcomes to occur; O3, all subjects accounted for.

has also been found to be effective in improving the proportion of patients with nondialysis CKD interested in home dialysis and the proportion of prevalent patients on hemodialysis who completed steps in the transplant process (28,29). These latter interventions were evaluated with randomized controlled trials, and so it would be important to further test the combination of patient education and case management in patients initiating dialysis to ensure these promising results can be reproduced in more rigorous designs outside of large dialysis organizations.

Another promising strategy that we identified involved intensive education by home dialysis nurses to promote the uptake of home dialysis (19,20,25). This strategy was effective in three different settings: (1) outpatients with CKD, (2) outpatients with ESKD categorized as suboptimal hemodialysis starts, and (3) patients still admitted to hospital.

However, only 221 patients in two studies received home dialysis education after initially starting hemodialysis and multivariable adjustment in both studies was suboptimal (19,25). These results suggest that it is important to include home dialysis nurses in transitional care programs, but the optimal population, setting, and timing of their engagement remains unclear.

Current efforts are underway to develop and implement care models for patients starting dialysis that specifically target home dialysis and transplantation, and combine some of the beneficial components identified in this study; that is, combined patient education and case management delivered by a multidisciplinary team of home dialysis staff (8,9,30). These preliminary reports describe 4- to 8-week programs that consist of dedicated multidisciplinary teams delivering educational curriculums and milestone-based

**Table 3. Mortality and vascular access outcomes for combined patient education and case management programs**

Study	Adjustment Methods	Outcomes	
		3 Mo	1 Yr
Wingard <i>et al.</i> (17)	Cox models (mortality)	Mortality: relative risk <sup>a</sup> 0.51 (95% CI, 0.39 to 0.67) AV access: odds ratio <sup>b</sup> 0.99 (95% CI, 0.78 to 1.26)	Mortality: hazard ratio 0.59 (95% CI, 0.45 to 0.79) AV access: odds ratio <sup>b</sup> 1.09 (95% CI, 0.83 to 1.29)
Lacson <i>et al.</i> (20)	Cox models (mortality)	Mortality: hazard ratio 0.61 (95% CI, 0.50 to 0.74)	Not reported
	Logistic regression (AV access)	AV access: odds ratio 2.06 (95% CI, 1.88 to 2.26)	
Wilson <i>et al.</i> (22)	Propensity-score matching	Mortality: hazard ratio 0.78 (95% CI, 0.59 to 1.03) AV access: odds ratio <sup>b</sup> 1.10 (95% CI, 0.94 to 1.29)	Mortality: hazard ratio 0.80 (95% CI, 0.67 to 0.95) AV access: odds ratio <sup>b</sup> 2.01 (95% CI, 1.72 to 2.35)
Gill <i>et al.</i> (24)	Cox models (mortality)	Not reported	Mortality: hazard ratio 0.94 (95% CI, 0.53 to 1.68)
	Logistic regression (AV access)		AV access: odds ratio 0.87 (95% CI, 0.52 to 1.43)

AV, arteriovenous; CI, confidence interval.

<sup>a</sup>Relative risk calculated from 3-mo mortality rates.

<sup>b</sup>Unadjusted odds ratios calculated from manuscript.

care in a setting physically isolated from the main hemodialysis unit. Other novel, less-studied components include more frequent hemodialysis to eliminate the long-interval, hemodialysis delivery *via* home machines to increase patient comfort and familiarity, and early advance care planning.

To help inform these and the development of other care models for patients starting dialysis, our systematic review also identified several important knowledge gaps and potential solutions. Importantly, none of the dedicated care programs reported patient involvement or feedback in their design or execution; this may explain why we did not identify any studies focusing on patient-reported outcome/experience measures such as depression, anxiety, caregiver burden, or decisional regret. The participation of both patients and staff may help determine the necessity and feasibility of understudied dialysis unit structures (*i.e.*, nursing ratios, social work/psychologist involvement, and caregiver and peer support) and processes (*i.e.*, inpatient/outpatient setting, advance care planning, and more frequent dialysis). Furthermore, patients and staff can help identify the outcomes that programs should target (31,32), as care models focused on quantity of life, home dialysis, and transplantation may not require the same elements as those that focus on quality of life, mental health, or reducing hospitalizations. These decisions will also affect the patient populations most likely to benefit, and whether dedicated care programs should be available to all incident patients or reserved for high-risk patients without prior CKD education who “crash” onto dialysis.

Once these steps are undertaken, potential programs should be piloted using quality improvement principles (33), collecting data on fidelity (*i.e.*, the program was delivered as intended), retention/comprehension of the education components, and costs. None of the studies reported the costs associated with their interventions, which may be particularly important to spreading successes to universal health care systems and smaller dialysis units. Finally, evaluation of these new interventions needs to move beyond retrospective studies toward quasiexperimental and randomized designs to build confidence that these resource-intensive efforts produce improvements in patient outcomes. Pragmatic, cluster-randomized controlled trials may be particularly well suited to achieve this objective (34,35).

The strengths of our systematic review include the use of a comprehensive search strategy that documented key components of the dedicated care programs reported in the literature, along with a broad range of prespecified patient outcomes. We also used operational definitions for the different care models to facilitate future comparisons (11–13).

Our study also has limitations. First, the high study heterogeneity and small sample size precluded quantitative analyses, and prevented any formal conclusions on the efficacy of a specific care program. Factors that contributed to heterogeneity included the nature of the interventions, descriptions of control groups, and patient outcomes. Even for similar programs (Table 3), adjustment for case-mix differences was inconsistent, which was particularly evident for the vascular access outcomes. Second, most high-quality studies that reported benefits were conducted by large dialysis organizations (17,20,22), whose results may not be

generalizable to smaller programs with less resources. Third, we excluded studies without control groups so we could better compare clinical outcomes; as a result, some unique components of other dedicated care programs may have been missed. This limitation also applies to unpublished studies.

Our systematic review found that few studies have evaluated dedicated care programs for patients starting dialysis, and most only report on mortality and vascular access. Programs that combine patient education with case management that entails periodic patient follow-up toward care milestones delivered by a multidisciplinary team (including dialysis nurses) appear to be a promising strategy if resources permit, with statistically significant reductions in 90-day mortality. However, uncertainty remains on how to leverage these care models to improve other outcomes that matter to patients such as the uptake of home dialysis, transplantation, mental health, and quality of life. Given that home dialysis and transplantation are key priorities of the Advancing American Kidney Health kidney care strategy, we expect there will be several opportunities in the near future to redesign patient-centered dialysis care for incident patients (36). These efforts should involve patients, the multidisciplinary dialysis team, and pragmatic interventional trialists before widespread implementation of any resource-intensive care models.

#### Disclosures

All authors have nothing to disclose.

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#### Author Contributions

M. Attalla, Z. Friedman, S. McKeown, and S. Silver were responsible for data curation; M. Attalla, Z. Friedman, Z. Harel, J. Hingwala, A. Molnar, P. Norman, and S. Silver were responsible for formal analysis; M. Attalla, S. McKeown, and S. Silver were responsible for methodology; M. Attalla and Z. Friedman were responsible for project administration; S. Silver conceptualized the study and was responsible for funding acquisition, investigation, resources, software, supervision, validation, and visualization; M. Attalla, Z. Friedman, S. McKeown, P. Norman, and S. Silver wrote the original draft; and all authors reviewed, edited, and approved the final version of the submitted manuscript.

#### Supplemental Material

This article contains the following supplemental material online at <http://kidney360.asnjournals.org/lookup/suppl/doi:10.34067/KID.K3602020000405/DCSupplemental>.

Supplemental Appendix 1. Database search strategies.

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