

## Patient Education and Peritoneal Dialysis Modality Selection: A Systematic Review and Meta-analysis

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**Background:** Educational interventions are increasingly used to promote peritoneal dialysis (PD), the most common form of home therapy for end-stage renal disease. A systematic review of the evidence in support of dialysis modality education is needed to inform the design of patient-targeted interventions to increase selection of PD. We performed a systematic review and meta-analysis to characterize the relationship between patient-targeted educational interventions and choosing and receiving PD.

**Study Design:** Systematic review and meta-analysis.

**Setting & Population:** Published original studies and abstracts.

**Selection Criteria for Studies:** We searched MEDLINE, EMBASE, CINAHL and EBM. We included controlled observational studies and randomized trials of educational interventions designed to increase PD selection.

**Intervention:** Predialysis educational interventions.

**Outcomes:** The primary outcome was choosing PD, defined as intention to use PD regardless of whether PD was ever used. The secondary outcome, receiving PD, was defined as an individual receiving PD as his or her treatment.

**Results:** Of 3,540 citations, 15 studies met our inclusion criteria, including 1 randomized trial. In the single randomized trial (N = 70), receipt of an educational intervention was associated with a more than 4-fold increase in the odds of choosing PD (OR, 4.60; 95% CI, 1.19-17.74). Based on results from 4 observational studies (N = 7,653), patient-targeted educational interventions were associated with a 2-fold increase in the odds of choosing PD (pooled OR, 2.15; 95% CI, 1.07-4.32;  $I^2 = 76.7%$ ). Based on results from 9 observational studies (N = 8,229), patient-targeted educational intervention was associated with a 3-fold increase in the odds of receiving PD as the initial treatment modality (OR, 3.50; 95% CI, 2.82-4.35;  $I^2 = 24.9%$ ).

**Limitations:** Most studies were observational studies, which can establish an association between education and choosing PD or receiving PD, but does not establish causality.

**Conclusions:** This systematic review demonstrates a strong association between patient-targeted education interventions and the subsequent choice and receipt of PD.

*Am J Kidney Dis.* ■(■):■-■. © 2016 by the National Kidney Foundation, Inc.

**INDEX WORDS:** Peritoneal dialysis (PD); patient-targeted educational intervention; patient choice; dialysis modality; modality selection; choosing PD; patient-centered care; medical decision-making; renal replacement therapy (RRT); end-stage renal disease (ESRD); systematic review.

The prevalence of end-stage renal disease (ESRD) continues to increase.<sup>1</sup> Although patients with kidney failure constitute <0.1% of the adult population, they account for 5% to 7% of health care expenditures in high-income countries.<sup>2</sup> This is largely driven by the cost of providing long-term dialysis therapy, which, although life-saving, is resource intensive.<sup>2</sup> Conventional in-center hemodialysis (HD) and home peritoneal dialysis (PD) are the 2 main treatment options for patients requiring dialysis. Although PD and HD are

associated with comparable clinical outcomes<sup>3,4</sup> and PD is much less expensive to provide in the developed world,<sup>5</sup> PD use relative to other modalities is declining.<sup>1</sup> This has led to renewed interest in understanding the determinants of PD use and designing interventions to maximize the safe and effective use of PD.

Patients with kidney failure should be educated about the treatment options available to them and encouraged to make an informed decision regarding their preferred form of renal replacement therapy,

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Received May 5, 2015. Accepted in revised form February 22, 2016.

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0272-6386

<http://dx.doi.org/10.1053/j.ajkd.2016.02.053>

unless they opt for conservative care. Current international guidelines support informed decision making by recommending that patients receive education about different modality options.<sup>6</sup> Although a number of factors have likely had a role in PD use,<sup>7-9</sup> the availability of modality education and the way in which modality education is provided may affect the proportion of patients who ultimately choose PD as their preferred treatment.

We conducted a systematic review of controlled observational and experimental studies to evaluate the association between structured patient-targeted dialysis modality education interventions and the choosing or receiving of PD in adults with chronic kidney disease (CKD). The primary outcome of interest was choosing PD; in other words, whether an individual intended to use PD, regardless of whether the individual ever received it. The secondary outcome of interest was receiving PD, defined as whether an individual went on to receive PD as his or her dialysis treatment.

## METHODS

We did a systematic review according to a prespecified protocol (PROSPERO [International Prospective Register of Systematic Reviews] number: CRD42014010017) and reported in accordance with published guidelines.<sup>10,11</sup>

### Search Strategy

We searched MEDLINE, EMBASE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Evidence-Based Medicine Reviews (EBMR) in September 2015 (Item S1, provided as online supplementary material). In addition, we reviewed abstracts from the annual meeting of the American Society of Nephrology for 2009 to 2014 and hand-searched reference lists of included articles for relevant citations. Each reviewer (B.W. and D.J.D.) independently performed title and abstract screening, and the full text of any study considered relevant according to the selection criteria outlined in the next section was retrieved for detailed review.

### Selection Criteria

Two reviewers (B.W. and D.J.D.) independently assessed the full text of each potentially relevant study for inclusion using predetermined eligibility criteria. Studies of adults (aged  $\geq 18$  years) with CKD that reported patient-targeted education strategies about available dialysis modalities were included if they reported relevant outcomes (choosing PD or receiving PD only or choosing/receiving of PD with home HD) and incorporated a standard-care control group. We included both experimental and controlled observational studies and studies of all languages. Cross-sectional studies, case reports, review articles, and editorials without original data were excluded. Disagreements were resolved by a third coinvestigator (M.T.J.).

### Data Extraction

All data were extracted in duplicate and included study characteristics (country, year, study design, sample size, and study duration), patient characteristics (age, sex, and mean estimated glomerular filtration rate at the time of education; Table 1), descriptions of the educational intervention (Table 2), and specific features of the education intervention (educators, diet, duration,

discussion format, inclusion of family members, medium of material; Table 3).

### Outcomes

The primary outcome of interest was choosing PD; in other words, whether an individual intended to use PD regardless of whether the individual ever received it. This was expressed as an odds ratio (OR) that represented the odds that a patient receiving targeted modality education chose PD divided by the odds that a patient receiving standard care chose PD. A secondary outcome of interest was receiving PD. This captured whether an individual went on to receive PD and was calculated by dividing the odds of receiving PD in those receiving targeted modality education by the odds of receiving PD in patients receiving standard care.

### Risk-of-Bias Assessment

For randomized studies, we evaluated risk of bias using criteria adapted from Higgins et al.<sup>12</sup> A risk-of-bias assessment tool based on Newcastle-Ottawa Scale criteria was applied to observational studies.<sup>13</sup> Quality assessment did not influence the decision to include studies.

### Data Synthesis and Analysis

Characteristics of included studies were compiled in tabular form according to the outcome of interest. The principal summary measures used were ORs. We compared the likelihood of choosing PD or receiving PD for participants who received educational intervention relative to the odds for those who did not receive educational interventions. Data were analyzed using Stata, version 13.1 (StataCorp LP). Due to expected differences between studies due to study design, patient population, and the different education strategies, we combined results using a random-effects model by DerSimonian and Laird.<sup>14</sup> Studies' unadjusted estimates were pooled in the meta-analysis. The weight of each study in the meta-analysis was represented by size of the treatment effect estimated from that study. A random-effects model was used to determine the relative weight of each study. Statistical heterogeneity was quantified using the  $I^2$  statistic. Stratified analyses and metaregression were used to examine whether the association between educational intervention and outcomes was modified by the following variables defined a priori: geographical region in which the study was conducted (European, Asian, and North American studies), severity of kidney disease at the time of receipt of education (only CKD stage 5 and patients with ESRD vs all patients with CKD), and whether the study reported choosing PD or receiving PD, or choosing or receiving PD and other self-care dialysis modalities combined.

## RESULTS

### Search Yield

The search strategy generated 3,540 unique citations; 3,373 citations were excluded after reviewing title and abstract. The initial study eligibility agreement between reviewers for abstract and title screening was high ( $\kappa = 0.91$ ). A total of 167 articles were retrieved for full-text review (Fig 1). Of these, 15 primary articles and abstracts were eligible for inclusion in our systematic review. Reasons for exclusion included primary or secondary outcomes of interest not reported in the article ( $n = 59$ ), not a report of original research ( $n = 42$ ), lack of a control group ( $n = 19$ ), intervention not clearly defined ( $n = 19$ ), and cross-sectional design ( $n = 13$ ; Fig 1). Among the 15 included studies, 7 were before-and-after studies, 5 were cohort studies, 2 were

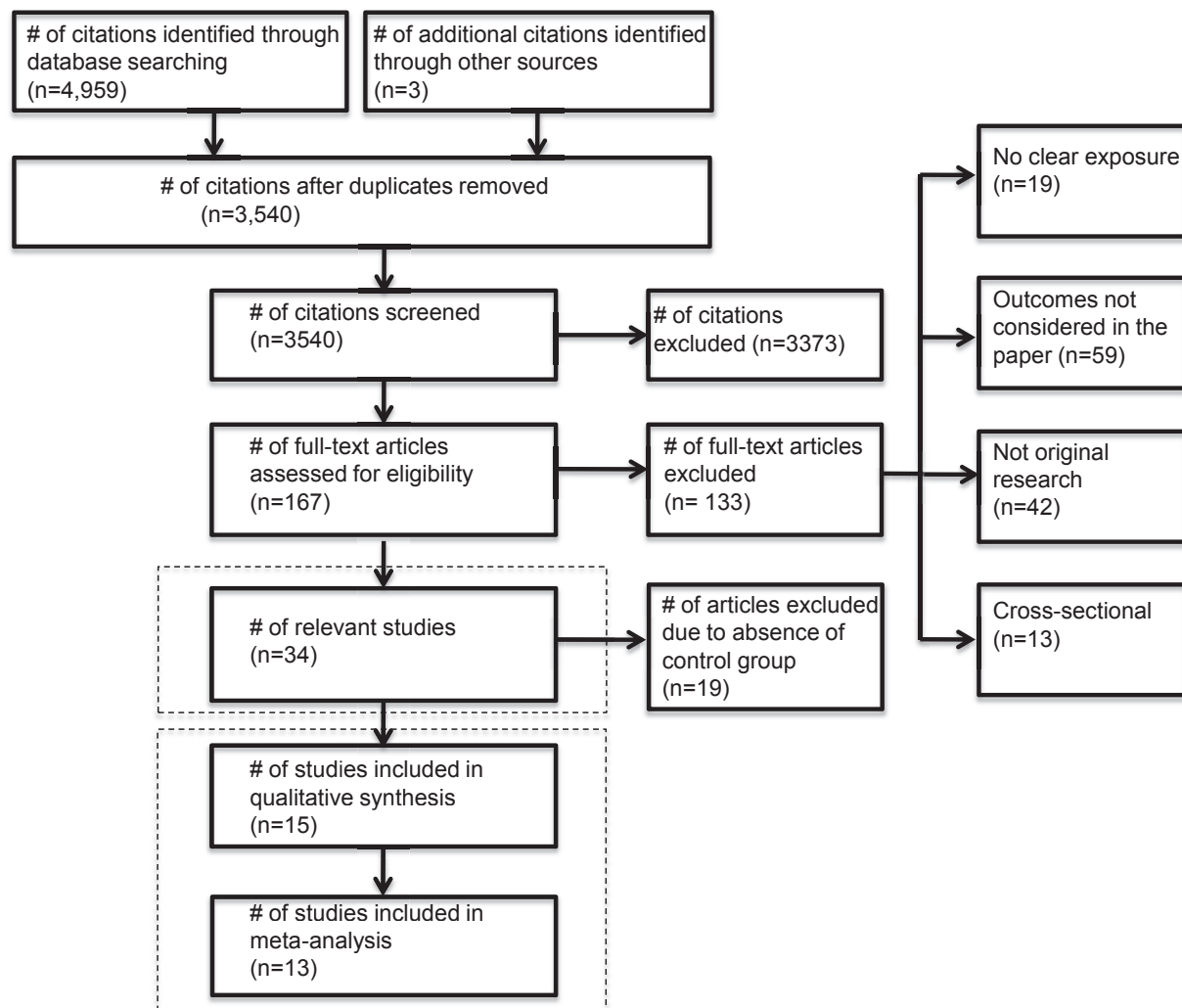


Figure 1. Study selection flowchart.

case-control studies, and 1 was a randomized controlled trial (RCT). Of the 15 studies included in the systematic review, 2 could not be included in the meta-analysis due to missing information.<sup>15,16</sup>

### Study and Participant Characteristics

Attributes of the 15 studies included in the systematic review are outlined in Table 1. Of the 15 studies, 7 were from North America; 5, from Europe; and 3, from Asia. The number of participants included in the studies ranged from 63 to 21,302, for a total of 31,653 participants. Mean age across studies ranged from 58 to 70.8 years, and percentage of men ranged from 45% to 64.3%. Duration of follow-up across studies ranged from 12 to 144 months. Mean estimated glomerular filtration rate ranged from  $\leq 15$  to 20.4 mL/min/1.73 m<sup>2</sup>. Two studies included only patients with CKD stage 5 or ESRD.<sup>17,18</sup> Most studies reported choosing or receiving PD only, whereas one study examined choosing/receiving PD or home HD<sup>19</sup>

and one study examined receipt of PD, home HD, and transplants.<sup>17</sup> All studies included patients considered eligible for PD.

### Risk-of-Bias Assessment

Quality assessment of observational studies is reported in Table S1.<sup>13</sup> All observational studies had a clear indication of a patient group that received an educational intervention that was representative of the average exposed patient in the community, with the exception of one study.<sup>18</sup> Only 3 observational studies performed a statistical analysis adjusted for important prognostic variables.<sup>17,20,21</sup> For the single RCT,<sup>19</sup> all quality indicators were met with the exception of blinding (Table S2). In addition, the Calgary Health Trust Funds supported the RCT.

### Features of Educational Interventions

As expected, the nature of educational interventions varied greatly between studies. Full descriptions of the

**Table 1.** Study and Patient Characteristics of Included Studies

Study	Study Design	Country	Study Era	N	Mean Age, y	% Male	Mean eGFR, <sup>a</sup> mL/min/1.73 m <sup>2</sup>	Follow-up, mo	Outcome(s) Evaluated
Agraharkar <sup>15</sup> (2003)	Prospective before-after	US	2001-2002	136	NR	NR	NR	16	Receiving PD
Gadallah <sup>16</sup> (2001)	Prospective before-after	US	NR	436 (201 preintervention, 235 postintervention)	NR	NR	NR	48	PD prevalence
Gómez <sup>29</sup> (1999)	Prospective before-after	ES	1996-1997	174 (86 intervention, 88 control)	NR	NR	NR	13	Receiving PD
Hanko <sup>17</sup> (2011)	Retrospective cohort	CA	2005-2008	78 (36 seen by nurse, 42 not seen by nurse)	58.0 (seen by nurse), 60.2 (not seen by nurse)	64% (seen by nurse), 62% (not seen by nurse)	NA; all patients already on HD	48	Receiving PD
King <sup>27</sup> (2008)	Retrospective before-after	US	1994-2006	1,844	Median 61	51%	NR	144	Choosing PD
Lacson <sup>20</sup> (2011)	Prospective cohort	US	2008	5,600 (2,800 educated patients, 2,800 matched noneducated patients)	63.4 (educated), 63.5 (noneducated)	56.6	NR	12	Choosing PD, receiving PD
Manns <sup>19</sup> (2005)	RCT	CA	2003	70 (35 intervention, 35 control)	65.2 (intervention), 63.6 (control)	60% (intervention), 49% (control)	20.4 (intervention), 20.3 (control)	12	Choosing PD
Marron <sup>22</sup> (2005)	Case-control	ES	2002	621 (232 intervention, 389 control)	NR	NR	NR	12	Receiving PD
Marron <sup>23</sup> (2006)	Case-control	ES	2003	1,153 (928 intervention, 225 control)	NR	NR	NR	12	Receiving PD
Ohno <sup>32</sup> (2006)	Before-after	JP	2001-2004	77 (37 preintervention, 40 postintervention)	NR	NR	NR	48	Receiving PD
Okada <sup>30</sup> (2012)	Before-after	JP	2009-2010	63	69.1	51%	38.4	24	Choosing PD
Provenzano <sup>31</sup> (2009) (abstract only)	Cohort	US	2008-2009	21,302 (304 intervention, 20,998 control)	NR	NR	NR	12	Receiving PD
Ravani <sup>21</sup> (2003)	Prospective before-after	IT	1999-2002	145 (52 traditional, 93 formal predialysis education program)	70.8 (traditional), 65.2 (predialysis education program), <i>P</i> = 0.02	55.8% (traditional), 59.1% (predialysis education program)	NR	42	Choosing PD
Ribitsch <sup>18</sup> (2013)	Retrospective cohort	AT	2004-2008	227 (70 intervention, 157 control)	Median 57.5 (intervention), 56 (control)	64.3% (intervention), 66.2% (control)	≤15 mL/min; all CKD stage 5 patients	48	Receiving PD
Wu <sup>9</sup> (2009)	Prospective cohort	TW	2006-2008	163 (123 noneducated, 40 educated)	61.2 (noneducated), 65.5 (educated), <i>P</i> = 0.05	55.9% (non-educated), 45.3% (educated)	23.4 (noneducated), 24.2 (educated)	11.7 ± 0.9 <sup>b</sup>	Receiving PD

Abbreviations: AT, Austria; CA, Canada; ES, Spain; eGFR, estimated glomerular filtration rate; HD, hemodialysis; IT, Italy; JP, Japan; NA, not applicable; NR, not reported; PD, peritoneal dialysis; RCT, randomized controlled trial; TW, Taiwan; US, United States.

<sup>a</sup>eGFR calculated with Modification of Diet in Renal Disease Study equation.

<sup>b</sup>Mean ± standard deviation.

**Table 2.** Educational and Control Interventions and Outcomes Used in the Included Studies

Primary Author	Description of Education Intervention	Outcome(s) Defined/Ascertained	Description of Control Intervention
Agraharkar <sup>15</sup>	A nephrologist explained all available dialysis modalities and their advantages and disadvantages to the patient and patient's family members. An educational video demonstrating all the available RRTs was then shown to the patient and family members. New patients were encouraged to meet with pre-existing PD patients. A multidisciplinary team met collectively with the patient and family.	Receiving PD; defined as percentage of patients receiving PD after enrolling in a long-term home dialysis program	Not reported
Gadallah <sup>16</sup>	Patients were invited to visit both HD and PD units and discuss the details of dialysis with dialysis patients. Patients were given commercially available booklets and ESRD education films to review and discuss with their families before making a modality choice. Patients were subsequently given the opportunity to ask the nephrologist questions regarding modalities.	Choosing PD; defined as percentage of ESRD patients choosing PD modality	Not reported
Gómez <sup>29</sup>	Materials used in first visit included a flip chart and guidebook on ESRD and the treatment options available; in the second visit, a video was watched by clinic staff and the patient together and a handbook that gives standard answers to frequently asked questions was provided.	Receiving PD; defined as percentage who initiated PD among those who received the intervention	Not reported
Hanko <sup>17</sup>	A nurse assessed and educated patients as follows. (1) Initial assessment: chart review; interview(s) with patient and, if relevant, next of kin/caregivers; review of the assessments from other team members (eg, social worker). (2) Suitability for independent modalities: advantages, potential barriers, and contraindications to independent nurse modalities. (3) Education: conducted during face-to-face meetings. (4) Modality choice: if no contraindications or significant barriers were identified, patients were encouraged to consider independent RRT modalities. (5) Follow-up: by the nurse until a long-term plan for nurse was established.	Receiving PD; defined as percentage of incident PD among patients already on HD	Patients with suboptimal HD starts who were not educated by the nurse
King <sup>27</sup>	Patients are enrolled in 6 classes, each 60-75 min, held during 1 weekend or over a 2-week period. 3 classes focus on treatment modalities (1 each on HD, PD, transplantation). There are also patient presenters, who are sometimes accompanied by family members, for the treatment option classes. The other 3 classes cover introduction to kidney disease, diet and kidney disease, and financing and coping with kidney disease.	Choosing PD; percentage of participants who indicated their dialysis treatment choice as PD	Not reported

(Continued)

**Table 2 (Cont'd).** Educational and Control Interventions and Outcomes Used in the Included Studies

Primary Author	Description of Education Intervention	Outcome(s) Defined/Ascertained	Description of Control Intervention
Lacson <sup>20</sup>	Education completed in a single group class session, then, with patient consent, followed up by contact at 30, 90, and 180 d thereafter to: (1) review treatment options; (2) inquire about each patient's kidney function/status and, if appropriate, dialysis access planning; and (3) provide feedback to the referring physician. Educational information provided by flipchart, video, and handouts.	Choosing PD; defined as percentage of patients selecting PD as first treatment choice Receiving PD; defined as patients at 90 d among those already on HD who opted for in-center HD therapy	Standard care—educated patients; specifics not reported
Manns <sup>19</sup>	Educational intervention consists of 2 phases. Phase 1 included handing out 4 educational manuals and a 15-minute video on self-care dialysis. Phase 2 occurred 2 wk after educational material was given to patients, involved a 90-min small group interactive session involving 3-6 patients (plus family members), a nephrologist, and a predialysis nurse, and solutions to overcome some of the barriers to self-care dialysis. Each small group then presented their solution to the larger group, including reasons for their choices. Finally, participants were shown selected portions of the "Self-care dialysis" video.	Choosing PD; defined as percentage of patients who intended to initiate dialysis with PD	There is a multidisciplinary CKD clinic in which patients are case managed by a renal nurse clinician. Patients receive teaching about kidney disease, including dietary instructions and detailed information about different RRT modalities. This occurs by an initial 3-h 1-on-1 session in which a nurse, dietician, and social worker see patients. Patients are then followed up by the nephrologist and multidisciplinary care team every 3-6 mo.
Marron <sup>22</sup>	Dialysis education; specifics not reported	Receiving PD; defined as percentage of patients initiating PD	Not reported
Marron <sup>23</sup>	Dialysis education; specifics not reported	Receiving PD; defined as percentage of patients initiating PD	Not reported
Ohno <sup>32</sup>	As a new patient reaches the stage of requiring dialysis, a specially trained dialysis education nurse presents advantages and disadvantages of HD and PD and authors' experience with these modalities	Receiving PD; defined as percentage of patients treated with PD since inception of program	Not reported
Okada <sup>30</sup>	A PD promotion program issues pamphlets, providing predialysis education, and giving public lectures	Choosing PD; defined as percentage of patients selecting PD	Not reported
Provenzano <sup>31</sup>	Monthly classroom educational sessions are offered on comorbid conditions, steps to help preserve kidney function, tools to improve quality of life and dialysis modality selection	Receiving PD; PD modality at 90 d from dialysis initiation or initial modality if patient had <90 d of dialysis	Not reported
Ravani <sup>21</sup>	Formal predialysis follow-up program (PEP), which included full-time physicians and nurses who devoted ~1/3 of their work time to the program. Patients participated in at least three 2-h formal individual educational sessions over 3 mo. Average duration of each visit was ~1 h and average estimated no. of visits per patient-y was 6.	Choosing PD; defined as selection of PD rather than HD as the first-choice dialysis modality	Patients received dialysis orientation from the physician in charge and the PEP team, but close to dialysis initiation date. Average duration of each visit was ~1 h, and average estimated no. of visits per patient-y was 5.

(Continued)

**Table 2 (Cont'd).** Educational and Control Interventions and Outcomes Used in the Included Studies

Primary Author	Description of Education Intervention	Outcome(s) Defined/Ascertained	Description of Control Intervention
Ribitsch <sup>18</sup>	On 2 consecutive d, groups of patients (maximum 6) and their relatives receive information concerning the basic pathophysiologic principles of CKD and RRTs including HD, PD, and kidney transplantation. The interactive program is presented by a multidisciplinary team, including nurses, dietitians, and nephrologists. In a 2-h session on d 1, patients are given basic information about medical, dietary, and lifestyle issues. The 2-h session on d 2 features practical demonstrations of HD and PD.	Receiving PD: incidence rates defined as no. of new patients initiating with either HD or PD in a given y	Patients did not receive structured education; specifics not reported
Wu <sup>9</sup>	Multidisciplinary predialysis education team comprised a nurse for case management, social workers, dietitians, HD and PD patient volunteers, and 10 nephrologists. The program consisted of an integrated course involving individual lectures on renal health, delivered by the case-management nurse, according to guidelines in a standardized instruction booklet. Lectures focused on nutrition, lifestyle, nephrotoxin avoidance, dietary principles, and pharmacologic regimens.	Receiving PD; defined as percentage of patients with ESRD warranting PD initiation	The same nephrologists instructed all participants regarding kidney function, laboratory data evaluation, and clinical indicators of chronic kidney failure, as well as strategies for its management and treatment. All patients were provided with written instructions. Nursing staff provided instructions for daily living and explained criteria used for HD and PD selection and the difference between the 2 modalities.

Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; PEP, pre-dialysis education programs; RRT, renal replacement therapy.

educational interventions are provided in [Table 2](#). In 2 studies, a full description of the educational intervention was not provided.<sup>22,23</sup> Specific components of each study's educational intervention are highlighted in [Table 3](#). Seven studies included a physician as an educator, 10 included a nurse, and 4 included a multidisciplinary team. Eight studies carried out their educational intervention over 2 or more days, and 5 studies included information for diet, which is less restrictive in PD patients compared with HD patients. In 8 studies, the educational intervention was delivered as a group presentation, whereas 5 had 1-on-1 education sessions only and 2 studies included both. As for the medium used for presentation, 6 used video, 7 used printed materials, and only 1 used website material. Finally, 4 of the studies included family members in the educational process.

### Features of Control Groups

Only 6<sup>9,17,18,19,20,21</sup> of the 15 studies reported a description of the control intervention ([Table 2](#)). Two

of the 6 studies included standard education from a nephrologist,<sup>9,21</sup> and 2 studies had standard education given by a multidisciplinary team.<sup>19,21</sup>

### Primary Outcome: Choosing PD

A total of 6 studies reported the primary outcome, and 5 provided sufficient data for meta-analysis. In the single randomized trial, receipt of the educational intervention was associated with a more than 4-fold increase in the odds of choosing PD (OR, 4.60; 95% confidence interval [CI], 1.19-17.74; [Fig 2](#)). Of these 5 studies, 4 were observational and 1 was an RCT ([Fig 2](#)). Based on 4 observational studies including 7,653 participants, patient-targeted educational intervention was associated with a 2-fold increase in the odds of choosing PD (pooled OR, 2.15; 95% CI, 1.07-4.32;  $I^2 = 76.7%$ ; [Fig 2](#)).

Stratified analyses and metaregression were performed to further explore reasons for the heterogeneity among observational studies. Geographical region in which the study was conducted was not

Table 3. Components of Educational Interventions

Study	Educator			Duration ≥ 2 d	Discussion Format			Medium			Family Members Involved
	Physician	Nurse	Multidisciplinary		Diet	1-on-1	Group	Video	Print	Website	
Manns <sup>19</sup> (2005)	✓	✓		✓	✓	✓	✓	✓		✓	✓
Ohno <sup>32</sup> (2006)		✓				✓				✓	
Okada <sup>30</sup> (2013)						✓		✓		✓	
Provenzano <sup>31</sup> (abstract only)						✓				✓	
Ravani <sup>21</sup> (2003)	✓	✓		✓		✓				✓	✓
Ribitsch <sup>18</sup> (2013)	✓	✓	✓	✓	✓	✓				✓	
Agraharkar <sup>15</sup> (2003)	✓	✓	✓	✓	✓			✓		✓	
Gadallah <sup>16</sup> (2001)	✓					✓		✓	✓	✓	✓
Gómez <sup>29</sup> (1999)		✓		✓		✓		✓	✓	✓	
Hanko <sup>17</sup> (2011)		✓		✓		✓		✓	✓	✓	
King <sup>27</sup> (2008)		✓	✓	✓	✓	✓		✓		✓	✓
Lacson <sup>20</sup> (2011)	✓	✓		✓		✓		✓		✓	
Wu <sup>9</sup> (2009)	✓	✓	✓		✓			✓		✓	

Note: Relevant information for Marron<sup>22</sup> 2005 and Marron<sup>23</sup> 2006 was not reported.

significantly associated with choosing PD ( $P = 0.1$ ). These studies failed to detect significant differences in studies examining the impact of modality education on choosing PD only versus studies reporting the impact of modality education on the choice of any self-care dialysis modalities ( $P = 0.6$ ).

### Secondary Outcome: Receiving PD

Ten observational studies reported on the receipt of PD as the initial dialysis modality; 9 studies including 8,229 participants had sufficient data for meta-analysis<sup>14</sup> (Fig 3). Patient-targeted educational intervention was associated with a more than 3-fold increase in the odds of receiving PD (OR, 3.50; 95% CI, 2.82-4.35;  $I^2 = 24.9%$ ; Fig 3).

Metaregression was performed to explore reasons for between-study heterogeneity. Metaregressions for both the geographical region in which the study was conducted ( $P = 0.1$ ; 5 European, 2 Asian, and 2 North American studies) and the distinction between studies that reported PD only versus those that included all dialysis modalities ( $P = 0.9$ ; 9 PD only studies and 1 PD plus other modalities study) failed to show statistical significance. Furthermore, a potential effect difference among those with varying severity of kidney disease (only patients with CKD stage 5 and ESRD vs all patients with CKD) at the time of receipt of education failed to show statistical significance ( $P = 0.9$ ; 7 studies of patients with CKD stage 5 and ESRD and 7 studies of all patients with CKD).

## DISCUSSION

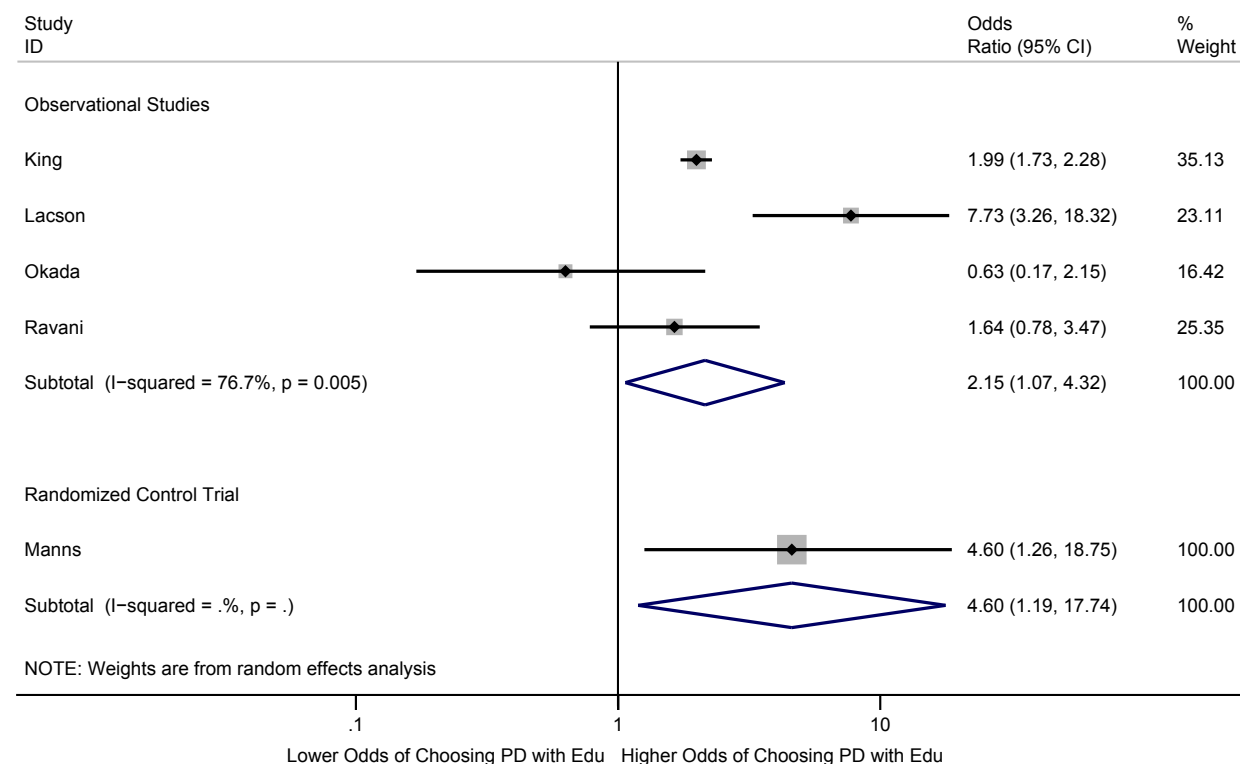
In this review of 15 studies, we found that compared to standard care, patient-targeted modality education was associated with a 2.1-fold increase in

the odds of choosing PD in observational studies, a 4.6-fold increase in the odds of choosing PD in the lone RCT, and a 3.5-fold increase in the odds of patients receiving PD as their initial dialysis therapy. In addition, we observed a large degree of statistical heterogeneity for our primary outcome. Choosing PD was not explained by geographical region or by making the distinction between studies that reported PD only versus those that included all dialysis modalities.

We recently described a 6-step framework for understanding the drivers of PD uptake in incident patients with ESRD.<sup>24,25</sup> This framework helps clarify the potential impact of targeted modality education on incident PD use in environments in which patients are free to make an informed choice. Patients must be identified, assessed for PD eligibility, offered the therapy if they are candidates, and choose PD, and then programs must be successful in getting them to initiate the treatment. A 1% change in the proportion of patients making it through any of these steps has an equal impact on incident PD use. Targeted modality education specifically addresses modality choice and, based on our results, appears to be effective. The expected impact on incident PD use is likely dependent on the baseline choice rate in a program, individual-level predictors of receiving PD (age, social support, etc), and center-level differences such as clinical cultures that are more supportive of PD use. Our work and that of others indicate that patients who are educated about their treatment options will choose PD 50% to 60% of the time.<sup>24,26</sup>

Although this review demonstrates that patient-targeted education appears to be strongly associated





**Figure 2.** Forest plot for impact of patient-targeted education on odds of choosing peritoneal dialysis (PD), stratified by study type. Abbreviation: CI, confidence interval.

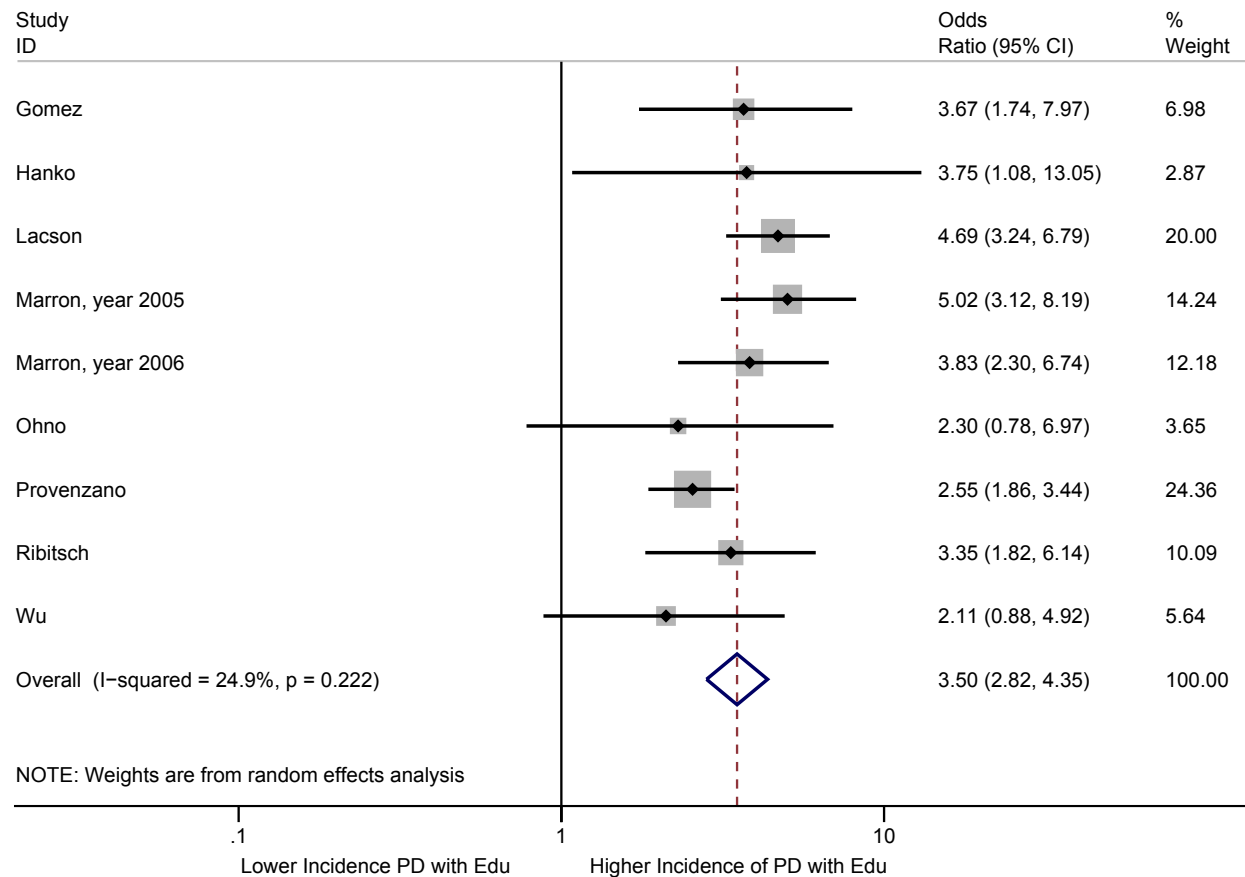
with choosing PD and receiving PD, the variability in design of the educational strategies identified and in the strength of association across studies highlights remaining questions about when and how educational interventions should be delivered. The interventions varied greatly between studies and were not reported in 2. The approach to modality education in the single RCT included physician and nurse educators, was conducted over more than 2 days, included detailed dietary information, had 1-on-1 and group discussions, used video and printed material, and included family members.<sup>19</sup> The standard-care group did not receive these interventions. Interestingly, it was only after receiving phase 2 of the educational intervention (small groups including family members) that the authors demonstrated a significant increase in the proportion of patients planning to initiate self-care dialysis (23 of 28 [82%] in the intervention group vs 17 of 34 [50%] in the control group;  $P = 0.02$ ).<sup>27</sup> This suggested that small group sessions, the inclusion of family members in educational interventions, and delivering educational interventions over multiple days were potentially important elements of modality education.

Timing of modality education may also be an important consideration. Most modality education programs direct their efforts to patients with advanced CKD prior to dialysis therapy initiation, but ~50% of

patients will initiate urgently in the hospital.<sup>25</sup> Our findings suggest that the relative impact of modality education on the likelihood of choosing PD is similar in patients who have already initiated HD therapy. This subset of patients typically initiates renal replacement therapy with HD by a catheter, although some centers offer acute PD starts, and may not be targeted for modality education. This represents a missed opportunity because high-performing centers convert a significant number of such patients to PD in the first 6 months of therapy.<sup>24</sup>

We made a distinction between choosing PD and receiving PD for the purposes of our review. This was done because choosing PD at a particular point in time may not translate into receiving PD because patients change their minds, they may no longer be eligible for PD due to the occurrence of adverse events or deterioration in their clinical conditions, or transplantation may have occurred. The difference in heterogeneity observed in choosing PD and receiving PD may reflect these facts. The stronger association of patient-targeted education with receiving PD than with choosing PD may simply be a consequence of the different education strategies among the different complement of studies included in each analysis and the different study populations.

There is an interest in increasing PD penetrance in many jurisdictions worldwide. Regional, national, and



**Figure 3.** Forest plot for impact of patient-targeted education on odds of receiving peritoneal dialysis (PD). Abbreviation: CI, confidence interval; Edu, education.

international bodies have identified increasing PD use as a strategic priority. Although modality education targets one specific step in the process of care that determines PD use, it appears to be effective. However, making clear recommendations based on the current literature about how best to implement modality education is challenging for the mentioned reasons. Further work to help elucidate the critical components of a successful modality education program with respect to timing of intervention, the ideal person or persons to deliver the material, the nature of the intervention (1-to-1 vs small group sessions), and the duration of the intervention (single day vs multiple days) is required. Understanding the cost of such interventions and the resources required to implement them would help clarify the cost-effectiveness. This may vary according to baseline rates of PD use. For example, in an area in which PD penetration is low, modality education may lead to a significant increase in PD use. In programs in which PD use is higher at baseline, there may be an attenuated effect. Based on our review, we can recommend the intervention described in the single RCT because the evidence of efficacy is the strongest.

Our study has important limitations. First, there is a relative paucity of high-quality literature on the effectiveness of patient education on receiving PD. The majority of studies identified were observational and only 1 was an RCT. The design of observational studies can establish an association between education and choosing PD and receiving PD, but does not establish causality. We also observed a large degree of statistical heterogeneity for our primary outcome, choosing PD. This is likely explained by differences in the study populations and educational interventions evaluated. In addition, the standard-care group in most studies was poorly defined and it is not clear whether much of the benefit of the interventions tested related to simply making people aware of a treatment choice that they might not otherwise have heard about.<sup>28</sup> A limitation to our analysis was that only one study reported on both outcomes of choosing and receiving PD. This may have introduced a reporting bias if the other studies only reported the most significant outcome. Another limitation to our analysis is that dropout rates were poorly reported across studies, and this may have introduced uncertainty in the meta-analysis. Also, given the limited

number of available studies and limited statistical power, metaregression was not able to identify the features of educational interventions that may explain the variability in effectiveness. Finally, another limitation of our study is that most studies are observational and unadjusted estimates were pooled; thus, the unadjusted treatment effects may be confounded with factors that are differentially prevalent between the groups.

In conclusion, this systematic review establishes the strong associations between patient-targeted dialysis modality education and choosing and receiving PD. The variability in the design of the educational strategies identified and the strength of association across studies highlight the uncertainty about when and how educational interventions should be delivered, as well as the likelihood of impact according to baseline PD penetration.

### ACKNOWLEDGEMENTS

Aspects of this work were presented in abstract form at the Canadian Student Health Research Forum, Manitoba, Canada, June 10, 2015.

Mr Devoe acknowledges librarian Helen Lee Robertson for help with conducting the literature search for review.

*Support:* None.

*Financial Disclosure:* The authors declare that they have no relevant financial interests.

*Contributions:* Research idea and study design: DJD, RRQ, PR, BW, MTJ, DJR, LB; data acquisition: DJD, BW; data analysis/interpretation: DJD, BW, MTJ, DJR, RRQ, RP, JK; statistical analysis: DJD, BW, MTJ, DJR; supervision or mentorship: RRQ, PR, MTJ, BJM, MJO. Each author contributed important intellectual content during manuscript 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. DJD takes responsibility that this study has been reported honestly, accurately, and transparently; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

*Peer Review:* Evaluated by 3 external peer reviewers, a Statistical Editor, a Co-Editor, and the Editor-in-Chief.

### SUPPLEMENTARY MATERIAL

Table S1: Quality assessment of included observational studies.

Table S2: Quality assessment of included RCT.

Item S1: Search strategies.

Note: The supplementary material accompanying this article (<http://dx.doi.org/10.1053/j.ajkd.2016.02.053>) is available at [www.ajkd.org](http://www.ajkd.org)

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