Published in final edited form as:

Patient Educ Couns. 2012 August ; 88(2): 184–188. doi:10.1016/j.pec.2012.02.015.

Patient Knowledge of Blood Pressure Target is Associated with Improved Blood Pressure Control in Chronic Kidney Disease

Julie A. Wright-Nunes, MD, MPH¹, J. Matthew Luther, MD², T. Alp Ikizler, MD³, and Kerri L. Cavanaugh, MD, MHS^{3,4}

¹Department of Internal Medicine, Division of Nephrology, University of Michigan Health System, Ann Arbor, MI, U.S.A

²Department of Pharmacology, and Department of Internal Medicine, Vanderbilt University Medical Center, Nashville, TN, U.S.A

³Department of Internal Medicine, Division of Hypertension and Nephrology, Vanderbilt University Medical Center, Nashville, TN, U.S.A

⁴Vanderbilt Center for Health Services Research, Vanderbilt University Medical Center, Nashville, TN, U.S.A

Abstract

Objective—To describe patient hypertension knowledge and associations with blood pressure measurements.

Methods—Patients with chronic kidney disease (CKD) were asked about the impact of high blood pressure on kidneys and their target blood pressure goal. Systolic blood pressure was measured using automated sphygmomanometers.

Results—In 338 adults with hypertension and pre-dialysis CKD, the median [IQR] age was 59 [47, 68] years, 45% [n=152] were women, and 18% [n=62] were non-white. Lower systolic blood pressure (SBP) was associated with female sex (SBP mmHg median [IQR] 132 [117,149] women vs. 137 [124,152] men; p=0.04), less advanced CKD (SBP 134 [122,147] stages 1–2 vs. 132 [118,148] stage 3 vs. 140 [125,156] stages 4–5; p=0.01), and patient ability to correctly identify SBP goal (SBP 134 [119,150] correct vs. 141 [125,154] incorrect; p=0.05). In adjusted analysis, knowledge of blood pressure goal remained independently associated with lower SBP (–9.96 mmHg [–19.97, –1.95] in correct respondents vs. incorrect; p<0.001).

Conclusion—Patient knowledge of goal blood pressure is independently associated with improved blood pressure control.

Practice Implications—Interventions to improve patient knowledge of specific blood pressure targets may have an important role in optimizing blood pressure management.

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Corresponding Author: Julie Wright-Nunes, MD, MPH, University of Michigan Health System, Department of Internal Medicine, Division of Nephrology, 311 Simpson Memorial Building, 102 Observatory, Ann Arbor, Michigan 48109, Office: 734-764-5178, Fax: 734-615-4887, juwright@med.umich.edu.

Conflicts of Interest: The authors have no conflicts of interest to disclose.

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1.0 Introduction

Chronic kidney disease is a growing epidemic [1], associated with significant patient morbidity and mortality at all stages of disease severity [2]. High blood pressure is a risk factor for chronic kidney disease (CKD) and the second leading cause of kidney failure in the United States [1]. Additionally, uncontrolled high blood pressure increases risk of cardiovascular morbidity and death [3]. Thus, optimal control of high blood pressure is critical to patient health, particularly in those with kidney disease.

Unfortunately, attainment of optimal blood pressure in patients with kidney disease is low [4]. Among 3213 participants in the National Health and Nutrition Examination Survey (NHANES) IV with CKD, only 37% had blood pressure controlled to levels consistent with current national guidelines [3] of less than 130/80 mmHg. Systolic hypertension accounted for the majority of those not achieving target [4].

Although a multitude of factors may pose barriers to achieving good blood pressure control [5], research indicates much opportunity exists to improve patient understanding about their therapeutic goals of treatment [6]. Patients with CKD perceive a lack of basic knowledge about hypertension diagnosis, and are confused about specific self-care behaviors required to optimally manage their health [6]. Data suggest that health care providers often give patients general advice (e.g. “lose weight”), but patients instead want practical and specific information to support their self-care efforts [7].

Models of optimal care in chronic disease promote patient education and goal setting to improve outcomes [8–10]. Clinical benefits are observed in many chronic conditions when education programs include specific disease information and goal setting with patients [11,12]. However, there is little data available in patients with kidney disease, examining whether a relationship exists between clinical measures, specifically blood pressure control, and patient knowledge about goals of blood pressure treatment.

We examined associations between patient hypertension knowledge and systolic blood pressure (SBP) in patients with pre-dialysis CKD and hypertension. We chose to examine associations with systolic blood pressure because of its strong association with cardiovascular outcomes and mortality [13–15]. We hypothesized patient knowledge of specific blood pressure treatment goals would be associated with improved blood pressure control.

2.0 Methods

2.1 Study Design

The study design was cross sectional, and part of a larger study of 100 questionnaire items to validate a survey of kidney disease specific knowledge in patients with pre-dialysis CKD [16]. Patients with established CKD stages 1–5 (per National Kidney Foundation / Kidney Disease Outcomes Quality Initiative Guidelines) [17] were enrolled from nephrology clinics at one academic center. Each participant was asked two questions designed to assess objective blood pressure knowledge. These were:

1. Can high blood pressure hurt the kidney? Yes / No [“Yes” was considered correct]
2. On average, your blood pressure should be? 160/90, 150/100, 170/80, < 130/80 [“<130/80” was considered correct]. The item response was designed so that the first three options were clinically unacceptable as treatment goals, and not too similar to the “correct” response of <130/80.

2.2. Participants

Included were patients with established CKD who self-reported a diagnosis of hypertension. Research indicates the majority of people with kidney disease are aware of their hypertension diagnosis [18]. Additional inclusion criteria were age ≥ 18 years, and having received previous nephrology clinic care at least once prior (i.e. they were not new patients). Exclusion criteria were significant cognitive impairment, an active kidney transplant, those receiving dialysis, and patients unable to understand or read English. The study was approved by the Vanderbilt Institutional Review Board, and all participants provided written, informed consent.

2.3 Outcomes

The primary outcome was systolic blood pressure. Blood pressure was measured by trained clinical personnel using automated sphygmomanometers (Dinamap Pro 100). All personnel attended in-service training and passed testing on appropriate blood pressure measurement technique. In a separate intake room, patients were brought in and seated. Care was taken to allow for ≥ 5 minutes of rest, at which time blood pressure was measured with an appropriate sized arm cuff.

Patient characteristics were measured including age, sex, race, estimated glomerular filtration rate (eGFR, calculated using the 4 variable MDRD equation) [17], history of diabetes mellitus, educational attainment, health literacy status [19], number of nephrology visits in the past year, and annual household income. Additionally, we asked patients one question about their subjective blood pressure knowledge: "How much do you know about your goal blood pressure? 1=I don't know anything, 2=I know a little amount, 3=I know a good amount, 4=I know a lot." Patients selected one response. We assessed awareness of their chronic kidney disease diagnosis: "Do you have chronic kidney disease? Yes / No."

2.4 Statistical Analysis

Associations between categorical patient characteristics or survey responses and systolic blood pressure (SBP) readings were examined using Wilcoxon rank-sum or Kruskal Wallis tests, as appropriate. Multiple linear regression was used to examine adjusted associations between all patient characteristics and SBP, with testing to ensure model assumptions were met.

Additional exploratory analysis examined the relationship between objective knowledge questions and proportion of patients who met SBP recommended goal, defined as < 130 mmHg. For this analysis, a new variable was created by placing patients into one of two categories. One category consisted of patients "at goal" (SBP < 130 mmHg) and the other category consisted of the remaining patients "not at goal" (SBP ≥ 130 mmHg). Two sided Fisher's exact test was used to examine the association between categorized SBP and the objective hypertension knowledge questions.

Statistical analysis was performed using STATA version 10.0 (College Station, Texas). Findings with a $p \leq 0.05$ were considered statistically significant.

3.0 Results

3.1 Study Details

Four hundred and six patients enrolled in the study (response rate of 67%). Five patients withdrew due to time constraints (2), illness (2), and not wanting to complete the survey (1). Sex and age data were available on survey non-responders, and there were no differences in these demographics compared to those who chose to take the survey. Of 401 participants,

338 (86%) self-reported a diagnosis of hypertension, and these patients comprised our study sample for analysis. The median [IQR] age was 59 [47, 68] years. Forty-five percent were women, and 18% of non-white race. (Table 1) The median [IQR] SBP was 135 [119, 150] mmHg, with a range of 75–217 mmHg.

The majority of patients in this study sample knew that high blood pressure could hurt the kidney (97%), and correctly identified their target blood pressure of < 130/80 (91%). However, sixty-nine patients (21%) rated themselves as having little or no knowledge about their goal blood pressure.

3.2 Unadjusted Associations

Univariate analyses between SBP, patient characteristics, and survey responses are summarized in Table 2. Female sex (SBP mmHg median [IQR] 132 [117, 149] in women vs. 137 [124, 152] in men; $p=0.04$), less advanced CKD (134 [122, 147] stages 1–2 vs. 132 [118, 148] stage 3 vs. 140 [125, 156] stages 4–5; $p=0.01$), and correctly identifying blood pressure goal (134 [119, 150] correct vs. 141 [125, 154] incorrect; $p=0.05$) were all significantly associated with lower systolic blood pressure measurements. Further univariate examination revealed no significant associations between SBP and the other variables measured.

3.3 Adjusted Associations

The adjusted analysis included age, sex, race, and patient characteristics that were significantly associated with SBP on univariate analysis. Knowledge of blood pressure goal (-9.96 mmHg [$-19.97, -1.95$] vs. incorrect; $p<0.001$) was independently associated with lower SBP. Older age and non-white race were independently associated with higher SBP. (Table 3) Additional exploratory analyses were performed to examine the relationship between objective knowledge and *categories* of SBP. Although 42% of patients who correctly identified their blood pressure goal had a systolic blood pressure < 130 mmHg, versus 26% in the group who answered incorrectly, this finding did not meet statistical significance ($p=0.09$).

4.0 Discussion and Conclusion

4.1 Discussion

In this study of patients with chronic kidney disease, we revealed a significant and independent association between patient knowledge about blood pressure goal and systolic blood pressure. This difference was observed in spite of the fact that a high number of patients were able to identify their target blood pressure and the fact that the study was performed in patients aware of their hypertension diagnosis. These results suggest asking simple questions may provide an opportunity to rapidly identify patients with chronic kidney disease who may be at higher risk for inadequate blood pressure control.

Prior research shows that despite high awareness and treatment of hypertension, blood pressure control remains suboptimal [20,21]. Although we did not observe an association between the question “can high blood pressure hurt the kidney” and SBP, we did find that patient knowledge of their blood pressure goal and SBP were independently associated, with almost a 10 mmHg difference between patients who correctly identified goal compared to those who did not in adjusted analysis. These findings are consistent with research in primary care populations, where a significant relationship has been identified between patient knowledge and a higher proportion of patients attaining blood pressure [22,23] and glycemic goals [24]. Together these findings suggest educational programs aimed to

personalize and ensure understanding of the goals of treatment may be effective intervention targets.

On the other hand, the high overall objective knowledge about target blood pressure goal in our study population appears in contrast to previous research in primary care, whereby in one survey, only 9% of patients knew their blood pressure target [25], and in another survey where only 28% were able to report their systolic blood pressure target [22]. A reason for the differences observed in these studies versus ours may be attributable to differences in the way questions were presented -- our study offered multiple choice response options. The other studies did not publish exact verbiage of their knowledge questions, and our results may not be directly comparable to responses that are 'written in' or 'open-ended'. In addition, compared to our study population, these studies had more male patients [25], patients of older age [22,25], lower educational attainment [22], and did not enroll patients specifically from nephrology clinics. Previous knowledge surveys in CKD show lower disease specific knowledge is associated both with older age and less formal education [26], and may provide some explanation for the higher knowledge in our study. Patients with moderate to advanced kidney disease have high awareness (81–99%) about their hypertension diagnosis [20,21,27]. We suspect our sample with CKD, under nephrology specific care, benefited from provider emphasis on blood pressure education and is a significant contributor to the differences in hypertension knowledge observed between our study population and previously reported studies.

Another interesting finding was that although the median blood pressure of the study sample was close to established guidelines, the proportion of patients meeting SBP goal of < 130 mmHg was only 41%. This is similar to data in CKD patients taken from the general population [4], and a much lower proportion in goal than desired. However, our findings are consistent with research in patients with CKD seen in a large integrated health care system, where 79% were coded for their CKD diagnosis, yet only 46% had a most recent blood pressure in goal of <130/80 [28]. A possible explanation is that management targets of providers may not be based on attainment of guidelines. Recent literature points out a lack of randomized trials showing benefit in consistently keeping blood pressure <130/80 mmHg in patients with CKD [29]. Among patients with CKD and hypertension, a study of 236 primary care patients found that 28% of encounters did not discuss hypertension at all [30]. This debate among providers regarding the target of the therapy itself may in part contribute to limited or even complete lack of discussion between patients and providers about the rationale and goals of therapy.

There are limitations to this study. First, the SBP assessment was based on a one time clinic reading. However, research shows high readings using automated sphygmomanometers are not likely to be associated with normal ambulatory readings [31]. In addition, these are "real world" blood pressure measurements, using methods comparable with larger practical trials and upon which current guidelines for management are based [3]. Second, although our patient population exhibits demographic characteristics very similar to all patients with CKD stages 1–5 in the United States [1], our participants were drawn from nephrology clinics in one center, and findings may not be generalizable to other populations, especially those with more advanced CKD. Thirdly, there may have been a propensity for individuals to take our survey only if they felt knowledgeable about the survey questions. If we assume feeling informed reflects being informed, this could potentially affect our results, resulting in a bias towards data collection in only the more knowledgeable patients. We do not feel this was the case, however, as patients did not know ahead of time the specific nature of the survey questions, but rather only knew it was a general knowledge questionnaire. In addition, studies in other diseases as well as CKD reveal that what one feels they know about a condition and what one actually knows, are two different constructs [32,33] and relate to

outcomes differently [34]. However, if patients in this sample were more knowledgeable, it further strengthens our findings in that we found significant associations between lower knowledge and less optimal SBP, despite high numbers of patients that identified their blood pressure target, and despite the fact that patients reported their diagnosis of hypertension. Lastly, this study was cross sectional, thus causality cannot be inferred. Patients who had lower blood pressure could have feasibly ‘guessed’ their blood pressure goal, by assuming the closest number to their own blood pressure was in fact the correct response.

4.2 Conclusion

Established patients with CKD seen in nephrology clinics at one academic center who did not correctly identify their guideline recommended blood pressure target were at risk for having higher blood pressure, as were those of older age and non-white race. Asking patients one or two specific and directed questions about blood pressure knowledge may assist in identifying those at risk for having higher blood pressure and offer a way for providers to reinforce patient understanding of their blood pressure goals.

4.3 Practice Implications

Our work can inform educational interventions aimed at optimizing patient understanding about blood pressure and its management. Research shows specific hypertension knowledge is critically important in patient hypertension self-care behaviors, and patients who know their target level of blood pressure are 13 times more likely (CI: 5.0–32.6; $p < 0.001$) to adhere to medication regimens than those patients who do not know their target [35]. Randomized trials of educational interventions that include specific, literacy-sensitive, patient directed education, show positive impact on reducing blood pressure [36], and are associated with sustained patient benefits [37]. Our research emphasizes that even when patients are aware of their hypertension diagnosis, a significant number are at risk for not understanding their goals of management, and important consequences to their health if those goals are not met. We may consider the potential for even lower knowledge about goal blood pressure and subsequently worse blood pressure control in those patients with CKD unaware of their hypertension diagnosis. Our research further supports the importance of ensuring patients fully understand management goals in order to support behaviors for optimal blood pressure. Asking patients what they know about their blood pressure goal is easy and feasible to do in a busy practice setting. By doing so, we could identify people at risk for higher blood pressure, and tailor our education efforts in this population.

Acknowledgments

This work was supported in part by T32 DK007569 (JWN), K23 DK080952-2S1 (KC) and K24 DK062849 (AI) from the NIH, National Institute of Diabetes and Digestive and Kidney Diseases and the American Kidney Fund, Clinical Scientist in Nephrology Fellowship Grant (JWN). The funding agencies did not have a role in the design, conduct, or reporting of the study. This research has been presented, in part, at the 2010 American Society of Nephrology Fall Conference.

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Table 1**Baseline Characteristics**

Baseline Characteristics, N=338	Median [IQR] or n (%)
Age, years	59 [47, 68]
Female	152 (45)
Race, non-white	62 (18)
CKD Stage, (1–2, 3, and 4–5)	338 (100)
1–2	71 (21)
3	163 (48)
4–5	104 (31)
Self-reported Diabetes Mellitus, n=324	128 (40)
Respondents answering “No” to the question: “Do you have chronic kidney disease?”	98 (29)
Education Attainment High School	315 (93)
Health Literacy Assessment < 9 th Grade Level	63 (19)
3 Nephrology Appointments within last year	198 (59)
Annual Household Income, Dollars, n=318	318 (94)
25,000	57 (18)
25,000 – 55,000	106 (33)
> 55,000	155 (49)
Hypertension Knowledge Questions	
Correct response “Can high blood pressure hurt the kidney?”	329 (97)
Correct response “On average, your blood pressure should be?”	307 (91)
Self-rating of patient knowledge about goal blood pressure, n=333	
1 = “I don’t know anything”	16 (5)
2 = “I know a little amount”	53 (16)
3 = “I know a good amount”	137 (41)
4 = “I know a lot”	127 (38)

Table 2

Univariate Associations between Patient Characteristics and Systolic Blood Pressure

Characteristics, N=338	Median [IQR] SBP, mmHg	p
Age, years		0.07 [*]
< 59	133 [119,147]	
59	136 [119,153]	
Sex		0.04 [*]
Female	132 [117,149]	
Male	137 [124,152]	
Race		0.07 [*]
Non-white	141 [127,152]	
White	134 [119,150]	
CKD Stage, (1–2, 3, and 4–5)		0.01 ⁺
1–2	134 [122,147]	
3	132 [118,148]	
4–5	140 [125,156]	
Self-reported Diabetes Mellitus, n=324		0.60 [*]
No	134 [121,148]	
Yes	134 [118,143]	
Response “Do you have Chronic Kidney Disease?”		0.06
Yes	133 [119,149]	
No	140 [124,152]	
Education Attainment		0.80 [*]
< High School	135 [115,150]	
High School	134 [120,150]	
Health Literacy Assessment		0.20 [*]
< 9 th Grade Level	138 [122,158]	
9 th Grade Level	134 [119,149]	
Nephrology Appointments with past one year		0.70 [*]
2 visits	134 [120,150]	
3 visits	136 [119,150]	
Annual Household Income, Dollars, n=318		0.30 ⁺
25,000	137 [123,150]	
25,000 – 55,000	134 [123,151]	
> 55,000	134 [117,148]	
Hypertension Knowledge Questions		
Response “Can high blood pressure hurt the kidney?”		0.10 [*]
Correct	134 [119,150]	
Incorrect	140 [124,184]	

Characteristics, N=338	Median [IQR] SBP, mmHg	p
Response "On average, your blood pressure should be?"		0.05 [*]
Correct	134 [119,150]	
Incorrect	141 [125,154]	
Self-rating of patient knowledge about goal blood pressure, n=333		0.20 ⁺
1 = "I don't know anything"	133 [125,144]	
2 = "I know a little amount"	143 [119,154]	
3 = "I know a good amount"	135 [122,149]	
4 = "I know a lot"	132 [118,148]	

^{*} Rank sum used for categorical variables with two categories

⁺ K Wallis used for categorical variables with three or more categories

Table 3

Adjusted linear regression analysis of characteristics associated with systolic blood pressure.

Characteristics, N=338	β coefficient [95% CI] (change in SBP, mmHg)	p value
Age, per 1 year increase	0.32 [0.15, 0.49]	< 0.001
Sex, Male vs. Female	3.70 [−0.91, 8.32]	0.10
Race, Non-white vs. White	6.70 [0.67, 12.71]	0.03
CKD Stage, (1–2, 3, and 4–5)		
stage 3 vs. 1–2	−6.41 [−13.29, 0.46]	0.07
stages 4–5 vs. 1–2	1.70 [−5.65, 0.95]	0.70
Health Literacy Assessment, 9 th grade vs. < 9 th grade	−1.53 [−7.53, 4.47]	0.60
Response “On average, your blood pressure should be?” Correct vs. Incorrect	−9.96 [−19.97, −1.95]	< 0.001