

RESEARCH LETTER

Ambulatory and Home Blood Pressure Monitoring in Hemodialysis Patients: A Mixed-Methods Study Evaluating Comparability and Tolerability of Blood Pressure Monitoring



To the Editor:

Out-of-dialysis unit blood pressure (BP) measurement is a better predictor of adverse outcomes compared with traditional dialysis unit BP measurement among patients receiving thrice-weekly in-center hemodialysis.^{1–4} Forty-four-hour ambulatory BP monitoring in maintenance hemodialysis patients provides valuable prognostic information but is often not practical in clinical practice.⁵ Home BP monitoring may be better suited for longitudinal BP monitoring to guide hypertension management.^{6,7} However, limited evidence exists regarding the tolerability of ambulatory versus home BP in hemodialysis patients.^{8,9}

We evaluated data from the Blood Pressure Lowering in Dialysis (BOLD) Trial (NCT03459807), a pilot randomized trial in which participants were randomly assigned to targeting a home systolic BP (SBP) versus predialysis SBP < 140 mm Hg.¹⁰ Fifty hemodialysis patients were recruited, of whom 31 (N = 16 in the home BP arm, N = 15 in the dialysis-unit BP arm) agreed to optional 44-hour ambulatory BP monitoring (Item S1). Participants completed questionnaires about their experience with ambulatory and home BP monitoring. Data were obtained in the 2 weeks before the intervention, including mean predialysis BP (up to 6 treatments), 2 midweek home BP measurements (each the mean of 3 readings), and 44-hour ambulatory BP monitoring. The study received

institutional review board approval at both sites (USCF IRB #16-20963 and UW IRB #00003248), and all participants provided informed consent.

Mean age of participants who performed ambulatory BP monitoring was 56 ± 14 years and 13 (42%) were Black (Table 1). Mean predialysis SBP was 146 ± 19 mm Hg, 44-hour ambulatory SBP was 140 ± 21 mm Hg, daytime SBP was 141 ± 20 mm Hg, and nighttime SBP was 134 ± 25 mm Hg. Twenty-four (77%) participants did not experience an appropriate 10% nocturnal BP decline (non-dippers), including 7 (23%) who experienced an increase in nocturnal BP (reverse dippers). The mean number of successful ambulatory BP readings was 67 ± 16 over 44 hours. Three (10%) of the 31 participants had fewer than 15 BP readings and did not wear the monitor beyond the first day.

In participants who performed both ambulatory and home BP monitoring (N = 16), when asked to provide unstructured comments about their BP monitoring experiences (Table 2), participants most commonly described ambulatory BP monitoring neutrally (eg, “No problem” and “... After a few hours I barely noticed when a BP was being taken”). Several participants described ambulatory BP monitoring as uncomfortable (eg, “... at times the pressure was way too high and unbearable”), intrusive (eg, “Hard to perform daily tasks within the 30-minute interval during the day. I had to stop what I was doing and I lost my train of thought”), or difficult to use (eg, “The cord is too long, I kept sitting on it”). In contrast, participants described home BP monitoring more positively, praising the ease of using the monitors and the new knowledge gained (eg, “It was fun and gave me knowledge of my own BPs”) and referencing planned ongoing use (eg, “I really liked the home BP monitor! I’d like to own one as a result of the study”). While some

Table 1. Characteristics of BOLD Trial Participants Who Underwent Ambulatory and Home BP Monitoring at Baseline

Characteristic	All Participants Who Underwent 44-h Ambulatory BP Monitoring (n = 31)	Subset of Participants Who Underwent Both Ambulatory and Home BP Monitoring (n = 16)
Mean age, y	55.5 ± 13.5	56.6 ± 13.6
Black race	13 (42%)	7 (44%)
Mean home SBP, mm Hg; n = 16	142.1 ± 25.0	142.1 ± 25.0
Mean predialysis SBP, mm Hg	145.7 ± 18.9	142.3 ± 14.9
44-h ambulatory BP monitoring		
No. of readings	66.8 ± 15.7	69.5 ± 15.4
44-h mean SBP, mm Hg	139.7 ± 20.7	140.5 ± 20.7
44-h mean DBP, mm Hg	75.7 ± 12.4	73.9 ± 13.3
44-h mean heart rate, beats/min	79.1 ± 9.5	76.6 ± 9.5
44-h SBP average real variability	13.7 ± 3.7	13.7 ± 3.1
Daytime mean SBP, mm Hg	141.4 ± 20.0	142.2 ± 20.0
Daytime mean DBP, mm Hg	77.2 ± 12.4	75.3 ± 13.8
Nighttime mean SBP, mm Hg	133.7 ± 24.7	136.9 ± 24.6
Nighttime mean DBP, mm Hg	71.2 ± 13.6	70.2 ± 13.9
Nondippers	24 (77%)	14 (88%)
Reverse dippers	7 (23%)	4 (25%)

Note: Values expressed as mean ± standard deviation or number (percent).

Abbreviations: BOLD, Blood Pressure Lowering in Dialysis; BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic blood pressure

Table 2. Unstructured Responses to Ambulatory BP Monitoring and Home BP Monitoring Experience Surveys Describing Participant Experiences Using Each Device, Grouped by Theme

Ambulatory BP Monitoring (n = 31)	Home BP Monitoring (n = 16)
Positive or Rewarding Experience	
<p>"It was a good experience because I was able to see what my pressure was at home. It was easy."</p> <p>"It was good and accurate, easy to use."</p> <p>"Everything was good. I got used to wearing the cuff, wasn't ready to return it."</p>	<p>"It was fun experience."</p> <p>"Extremely easy."</p> <p>"It fit my arm comfortably. The settings were easy to use."</p> <p>"It was a good experience."</p> <p>"Comfortable use."</p> <p>"Easy to use."</p> <p>"I really liked the home BP monitor! I'd like to own one as a result of the study."</p> <p>"It was fun and gave me knowledge of my own BP's."</p> <p>"[I liked] the device, it was easy to use."</p>
Neutral Experience	
<p>"Once I had it on, I was aware of it but it was not always drawing my attention. It was just there. After a few hours I barely noticed when a blood pressure was being taken."</p> <p>"No problem."</p> <p>"Easier to put on with the sleeve; it stays on. Day and night didn't make a difference."</p> <p>"I was able to garden, work, grocery shop, and walk the dog. I was able to do everything while wearing it."</p> <p>"Slept through the night... Enough cord to move around; didn't hinder my movement."</p> <p>"Easier to put on with the sleeve. If there was a timer (to alert you 1-2 min before it is about to go off), that would be helpful."</p>	<p>"It was a learning experience."</p> <p>"Went well."</p>
Difficulty or Frustration With Using the Device	
<p>"It didn't stay on at night."</p> <p>"Wish the cord was less noticeable/tucked in pocket without kinking it. Smaller device to put in pocket, felt like lugging extra wallet."</p> <p>"The cord is too long, I kept sitting on it."</p> <p>"I noticed that while driving... the monitor had trouble getting a reading. It was better at night although I was awoken by the cuff every time it did a reading. It was also a little bulky...."</p>	<p>"It is just heavy and bulky."</p> <p>"Thank you for being patient [with] me when I forgot to take AM and PM checks!"</p> <p>"Too many error messages."</p>
Disturbing or Intrusive to Daily Tasks	
<p>"Hard to perform daily tasks within the 30 - minute interval during the day. I had to stop what I was doing and I lost my train of thought. It kept inflating multiple times. After straightening the cuff (so arrow is pointing down the arm), it was better."</p> <p>"I am right handed so I had to stop activities when it went off."</p> <p>"Hard not to move. The cuff kept inflating 2-3 times. I had to do things during the day, so it was hard to keep still. It would be easy if I was disabled."</p>	
Cuff Caused Pain or Discomfort	
<p>"Fine with going off every 30 min if it was less painful; at times the pressure was way too high and unbearable. Otherwise, it was fine and comfortable. Easy to put on."</p> <p>"The sleeve of the cuff could be a little more giving; my shoulder is sore. A little more elasticity. It was worse than wearing a girdle."</p> <p>"A little more painful than dialysis cuff."</p> <p>"It would go off when I was trying to do something with my right hand, irritating my shoulder."</p> <p>"If you could move it around to different parts of your body (i.e. arm, leg), that would be easier. The cuff got hot."</p> <p>"Device is heavy to wear. Cuff was hot and sweaty."</p> <p>"Though the experience wasn't bad, during the day the cuff irritated my skin."</p>	

Abbreviation: BP, blood pressure.

participants expressed minor concerns regarding the home BP monitoring device (eg, "It is just heavy and bulky"), none of the participants described it as uncomfortable or

intrusive. On being asked to perform repeat ambulatory BP monitoring 4 months after randomization, 10 (32%) participants did not agree to repeat the monitoring.

Home BP demonstrated the strongest correlation with ambulatory daytime SBP in the initial 24 hours post-dialysis (Fig S1; $r=0.76$; 95% CI, 0.43 to 0.91; Fig S2, mean difference, 3.8; 95% limits, -27.9 to 35.5 mm Hg). Predialysis SBP did not correlate well with 44-hour ambulatory SBP ($r=0.47$; 95% CI, -0.03 to 0.78). Comparing ambulatory versus home BP (Table S1), 2 participants were reclassified from controlled (normal out-of-dialysis and normal predialysis BP) to masked (elevated out-of-dialysis, normal predialysis BP) hypertension, 1 was reclassified from white-coat (normal out-of-dialysis, elevated predialysis BP) to uncontrolled (elevated out-of-dialysis and elevated predialysis BP) hypertension, and 1 was reclassified from masked to controlled hypertension; concordance was seen in 12 of 16 participants.

In conclusion, we observed that home BP monitoring was better tolerated than ambulatory monitoring and identified several themes regarding the tolerability and acceptability of home and ambulatory BP monitoring in hemodialysis patients. Of the subset of participants who agreed to undergo ambulatory BP monitoring, many were unwilling to have repeat monitoring. Ambulatory BP monitoring was described by several participants as uncomfortable and intrusive in daily activities. Alternatively, home BP monitoring was described as easy to perform, with individuals demonstrating high rates of adherence (97.4% during 16 weeks¹⁰) and expressing motivation to continue monitoring after the study. BP values obtained by home BP monitoring were better correlated with those obtained by ambulatory monitoring than predialysis BP. Nonetheless, there may be differences in BP values obtained by home versus ambulatory BP monitoring. Home BP monitoring may be a practical alternative to ambulatory BP monitoring for longitudinal monitoring and management of hypertension in hemodialysis patients.^{7,9}

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SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1: Correlation of baseline ambulatory, home, and predialysis systolic BP measurements using: (A) 44-hour ambulatory BP monitoring and (B) initial 24-hour postdialysis ambulatory BP monitoring

Figure S2: Bland-Altman plots demonstrating patient-level differences between home BP values and (A) 44-hour ambulatory BP values and (B) daytime ambulatory BP values in the initial 24-hours post-dialysis

Item S1: Supplementary methods

Table S1: Changes in classification of out-of-office BP parameters compared with predialysis BP between home and ambulatory BP monitoring.

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