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Original Article

A study of renal function influence by integrating cloud-based manometers and physician order entry systems

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Abstract

Background: No evidence exists from randomized trials to support using cloud-based manometers integrated with available physician order entry systems for tracking patient blood pressure (BP) to assist in the control of renal function deterioration. We investigated how integrating cloud-based manometers with physician order entry systems benefits our outpatient chronic kidney disease patients compared with typical BP tracking systems.
Methods: We randomly assigned 36 chronic kidney disease patients to use cloud-based manometers integrated with physician order entry systems or typical BP recording sheets, and followed the patients for 6 months. The composite outcome was that the patients saw improvement both in BP and renal function.
Results: We compared the systolic and diastolic BP (SBP and DBP), and renal function of our patients at 0 months, 3 months, and 6 months after using the integrated manometers and typical BP monitoring sheets. Nighttime SBP and DBP were significantly lower in the study group compared with the control group. Serum creatinine level in the study group improved significantly compared with the control group after the end of Month 6 (2.83 ± 2.0 vs. 4.38 ± 3.0, $p = 0.018$). Proteinuria improved nonsignificantly in Month 6 in the study group compared with the control group (1.05 ± 0.9 vs. 1.90 ± 1.3, $p = 0.09$). Both SBP and DBP during the nighttime hours improved significantly in the study group compared with the baseline.
Conclusion: In pre–end-stage renal disease patients, regularly monitoring BP by integrating cloud-based manometers appears to result in a significant decrease in creatinine and improvement in nighttime BP control. Estimated glomerular filtration rate and proteinuria were found to be improved nonsignificantly, and thus, larger population and longer follow-up studies may be needed.

Keywords: blood pressure monitoring; chronic kidney disease; cloud-based manometers integrated to physician order entry systems; usual blood pressure record sheets

1. Introduction

Hypertension is the most common chronic disease that may lead to devastating organ damage including renal disease, stroke, and cardiovascular diseases. Hypertension and diabetes

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mellitus are the two most common causes of chronic kidney disease (CKD) worldwide.[1] Poorly controlled blood pressure (BP) is well-known to be an independent predictor of progression to end-stage renal disease (ESRD) in CKD patients.[2,3] Even a mild to moderate elevation of baseline BP in CKD patients is a risk factor for ESRD. Thus, guidelines typically recommend strict and lower BP targets in CKD groups compared with those without CKD.[4,5] Intensified BP control with the objective of 130/80 mmHg is a crucial treatment strategy for slowing CKD progression, although it is achieved in only approximately 10% of patients. Moreover, diurnal BP changes are common in CKD patients, and recent studies have also revealed that the control of nighttime BP may reduce instances of cardiovascular events in these patients.[6] Therefore, it is critical for CKD patients to have the ability to accurately self-monitor their BP regularly in their homes, including nighttime BP.

The treatment and target for hypertension may be changing. However, the fact that patients should self-monitor their BP at home is the only factor that never changes, and this is always crucial. It can help physicians monitor and treat actual hypertension, despite treating the patients for clinical BP alone. Although cloud-based manometers have been developed, they still cannot be integrated with physician order entry systems. The ideal model of a BP measuring device is one that can integrate manometer data into physician order entry systems, and quickly assess patient BP when used at home. This would not require the need to log into other systems or serve any other function.

In a project coordinated with the National Taiwan University of Science and Technology, Taipei, Taiwan, we integrated cloud-based manometers with the order entry systems of nephrologists in treating CKD patients to help them maintain proper control over their BP. We also conducted a randomized controlled trial to investigate the relationship between intensive BP monitoring and CKD progression in this population. Our discussion explains the desirability of integrating cloud-based manometers into physician order entry systems using evidence-based medicine.

2. Methods

2.1. Participants

For our study, we recruited 36 participants who were CKD patients with hypertension, with an initial glomerular filtration rate (GFR) < 60 mL/minute/1.73 m^2 under typical antihypertensive medication. Our exclusion criteria included: (1) those patients who could not utilize the system effectively; (2) those with end-stage kidney disease undergoing renal replacement therapy; (3) those with an active infection or clinical congestive heart failure; or (4) a specific indication of, or contraindication, to the study procedure. The protocol and procedures of this study were approved by the Institutional Review Board of Taipei Medical University-Joint Institutional Review Board, and all the participants read and provided written informed consent. All participants were enrolled between September 2012 and March 2013, and we followed them until the end of the study, which lasted 6 months.

2.2. Study design

Study participants were randomly assigned to 1 of 2 recording systems. One group used cloud-based manometers integrated with physician order entry systems, and the other group used the regular BP recording sheets to track their BP. Daily recording and integration were performed in the integrated cloud-based manometer recording system group, and three monthly outpatient department follow-up readings were conducted at an outpatient clinic for the regular BP recording sheet group. The target BP in both groups was determined according to recent guidelines, which is < 130/80 mmHg for CKD patients with proteinuria.[4,5] Physicians verified patient BPs in their order entry system weekly, and more frequently if required as per the study group. Thus, the BP in the study group was more conveniently seen by their physicians, and patients were called back as needed to improve their BP control. In the control group, regular medication adjustments were conducted with every outpatient clinic follow-up visit, according to their BP record sheet.

2.3. Measurements and laboratory procedures

We assessed BP during outpatient clinic visits conducted at baseline and every 3 months during the first 6 months of follow-up. We arranged additional clinic visits with further BP assessments as required and titrated the antihypertensive medications so that we could shift the BP level within the target range in the study group. During each BP assessment, we obtained three consecutive seated BP measurements by using a clinic sphygmomanometer after the patients were at rest for at least 5 minutes, by using the mean of the last two readings recorded. We collected the morning spot urine for protein and creatinine, and available laboratory services were used to measure the serum and urinary levels of creatinine and protein as well as lipids during regular visits.

2.4. Outcomes

A composite endpoint was defined as the changes in each patient's BP as well as assessments of renal function, including changes to the estimated GFR (eGFR), creatinine, and urine protein excretion.

2.5. Statistical analysis

The summaries of clinical and demographic characteristics included the means and standard deviations of nominal variables that we analyzed using Chi-square tests. The repeated measure of analysis of variance (ANOVA) was used to evaluate the cross-sectional relationship between BP and the selected ratio variables, which included age, body mass index, eGFR, serum creatinine, and hematocrit.