



Tan Tock Seng
HOSPITAL
National Healthcare Group

Pilot Study of Pharmacist-Led Patient-Centric Remote Chronic Kidney Disease (CKD) Management System Using Health Discovery Plus (HD+) Program

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Background and Objectives

Poorly controlled hypertension is strongly associated with CKD progression, cardiovascular morbidity and mortality, in a dose-dependent manner.¹ Blood pressure (BP) control is challenging in patients with advanced CKD. Multiple anti-hypertensives are often prescribed to optimize BP control, increasing risk of polypharmacy and non-adherence.

Objectives:

- To evaluate the effectiveness and safety of remote BP monitoring using the HD+ program on BP control, proteinuria and estimated glomerular filtration rate (eGFR) in patients with advanced CKD.
- To empower CKD patients to manage their BP, CKD-related symptoms and reduce medication discrepancies.
- To improve patients' satisfaction of the healthcare service provided.

Methods

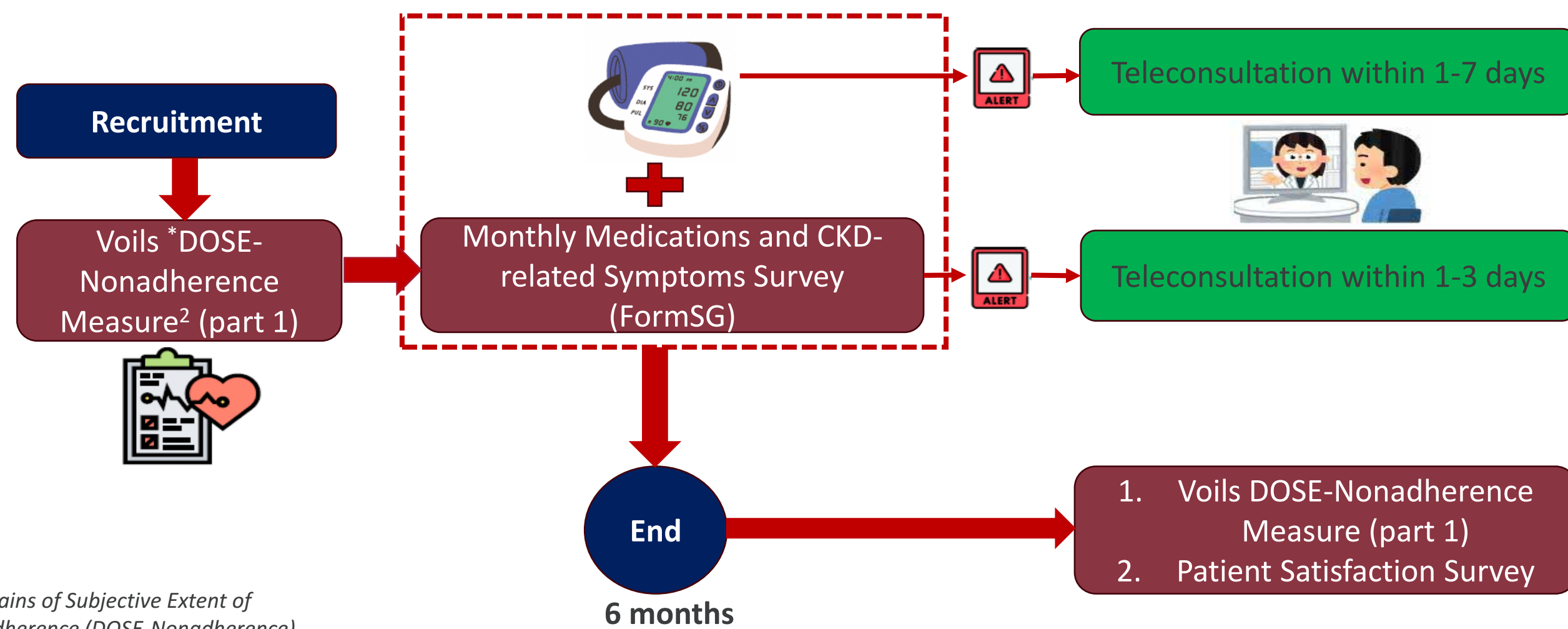
Thirty CKD stages 3B-4 (eGFR 15-44 ml/min/1.73m²) patients with hypertension, were enrolled from Tan Tock Seng Hospital (TTSH) nephrology clinics, between 1 September 2022 to 30 June 2023. Patients continued regular clinic reviews as part of standard clinical care and were followed up for 6 months.

Inclusion Criteria

- Able to read and understand English
- Aged 21 years and above
- Have a compatible handphone to install HD+ application, and a valid Singpass account.

Exclusion Criteria:

- CKD stage 5 or dialysis or renal transplant
- Visual or cognitive impairment
- Pregnant or breastfeeding
- Institutionalized



*Domains of Subjective Extent of Nonadherence (DOSE-Nonadherence)

Figure 1: Study Workflow

- Patients had to monitor their BP at least once daily 3 times per week during the follow-up period. BP monitoring frequency was increased to twice daily for 1 week if any new anti-hypertensive was started or if there were dose titrations of medications.
- Home BP readings were shared with the healthcare team (HCT), comprising pharmacists and nephrologists, via the HD+ dashboard.
- Teleconsultations were conducted to titrate anti-hypertensives for optimization of BP control, manage CKD-related symptoms and resolve any drug-related problems (DRPs) identified.
- Demographics, clinical and laboratory data were collected. The paired samples t-test was used to compare the baseline and final indicators (BP, eGFR, proteinuria) using Microsoft Excel. A p-value of <0.05 was considered statistically significant.

Results

Twenty-eight out of 30 patients completed the follow-up. Two patients withdrew due to personal reasons and were unable to comply with regular BP monitoring. Diabetes was the most common etiology of CKD (43.0%), followed by Glomerulonephritis (26.7%).

Mean Age (years)	60.7 ± 12.4
Mean eGFR (ml/min/1.73m ²)	28.9 ± 7.9
Gender, Female (%)	53.0
Race, Chinese (%)	80.0
Race, Malay (%)	13.0
CKD, Stage 3B (%)	47.0
CKD, Stage 4 (%)	53.0
Mean Proteinuria (g/day)	2.3 ± 2.3
Mean Number of Anti-hypertensives	2.1
Patients on ACEi/ARBs (%)	86.7

Table 1: Baseline Demographics

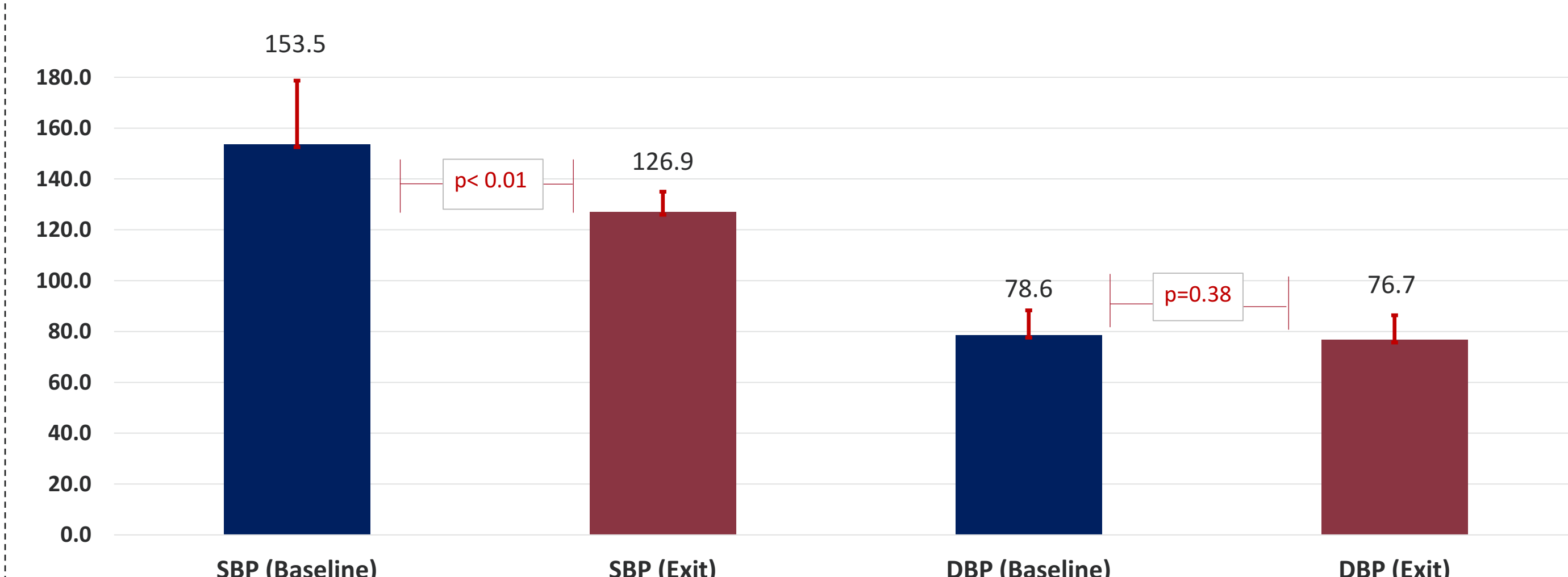
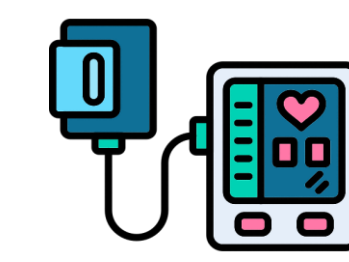
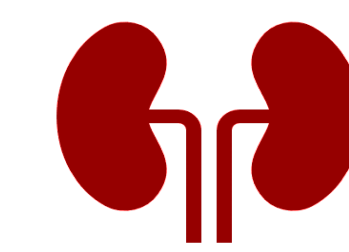


Figure 2: Blood Pressure Control at Baseline and After 6 months (Exit)



The proportion of patients with BP ≤ 130/80 mmHg improved by 33.1 % (13.3 % to 46.4 %).



There was a significant difference in eGFR (28.9 ± 7.9 ml/min/1.73m² vs 26.6 ± 8.0 ml/min/1.73m², p = 0.01), but not for proteinuria (2.3 ± 2.3 g/day vs 1.8 ± 1.5 g/day, p = 0.06).



The mean Voils DOSE-Nonadherence measure scores improved from 1.3 (baseline) to 1.1 (exit), where lower scores indicated better adherence. The mean adherence rate to BP monitoring was 79.9%. There were no study-related adverse events reported.

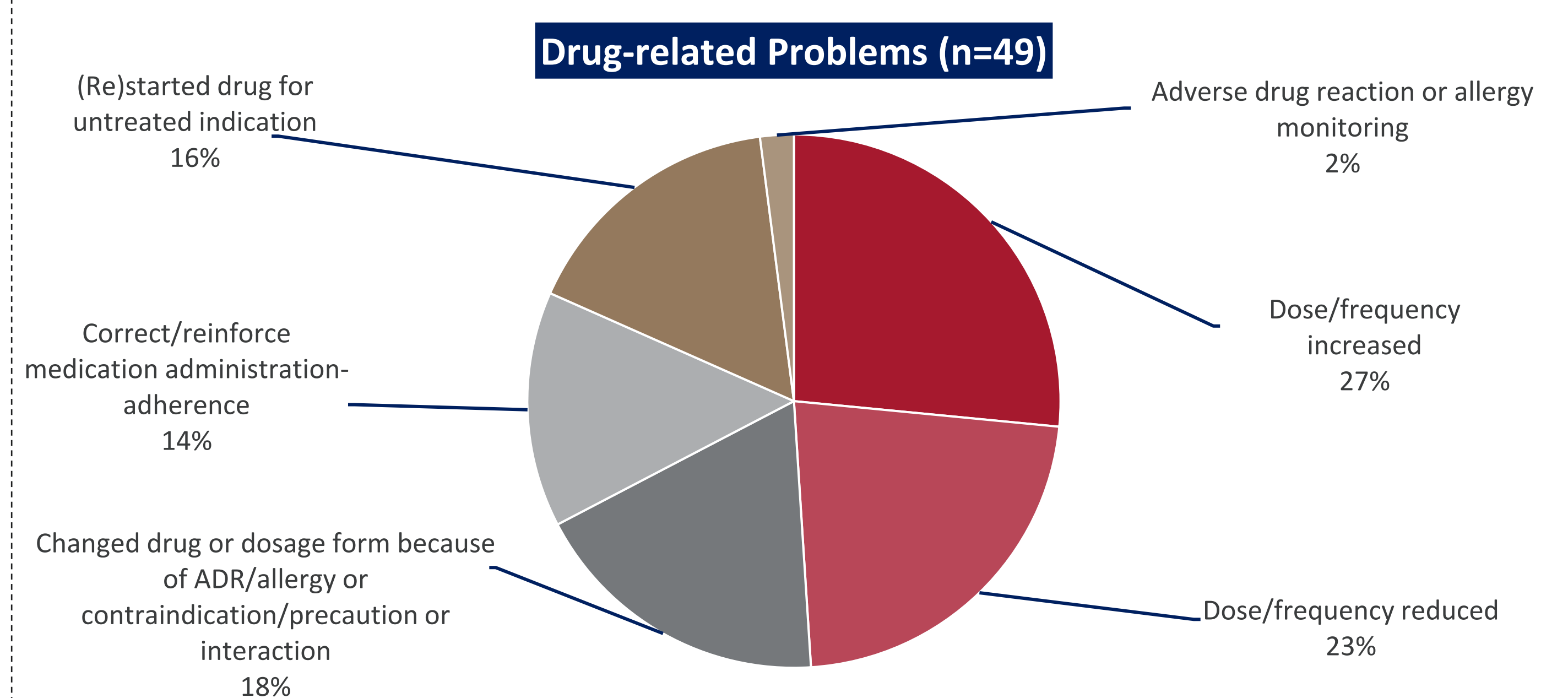


Figure 3: Drug-related Problems

Patient Satisfaction Survey Results

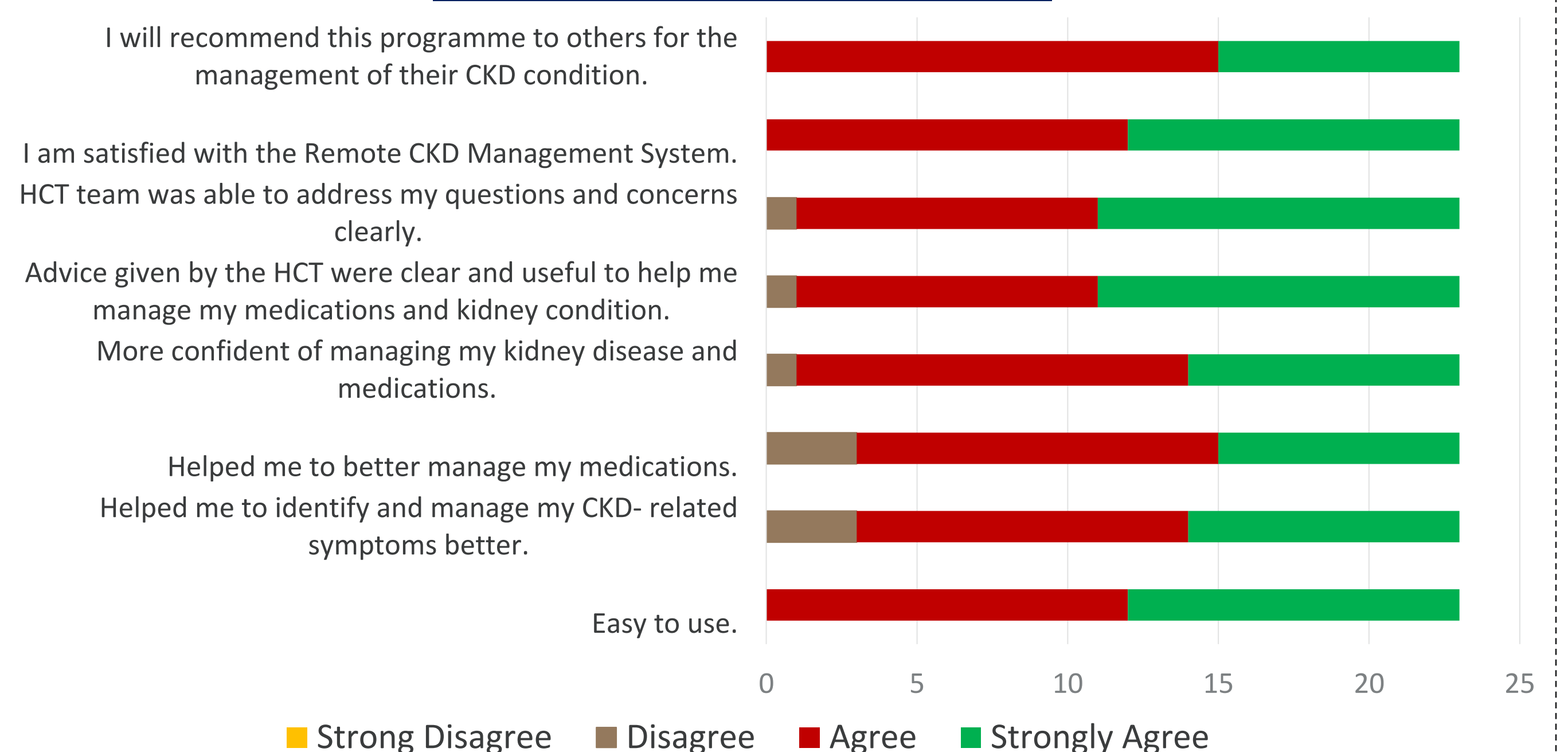


Figure 4: Patient Satisfaction Survey Results

- Patients had increased accessibility to HCT's advice.
- Nephrologists felt more confident titrating anti-hypertensives and had increased job satisfaction.
- Teleconsultations minimized provider scheduling and reduced the need for any clinic visits or admissions due to medication or BP management issues.

Discussion

This is the first study in Singapore, where remote BP telemonitoring was led by pharmacists in patients with advanced CKD. Close monitoring and prompt medication titrations resulted in significant SBP reduction with no adverse events observed. The sustained effect on SBP control beyond the study period cannot be confirmed. In comparison to the study by Dopp et al,³ the percentage of patients with advanced CKD, with BP ≤ 130/80 mmHg upon exit were similar (46.4 % vs 44.0%). In addition, our study population achieved a greater SBP reduction (- 26.6 ± 25.1 vs - 16 ± 4) mmHg at the end of follow-up. The significant reduction in eGFR at the end of the study may be attributed to hemodynamic changes from stricter BP control, initiation and active titration of ACEi/ARBs. With the small study population and short follow-up duration, only a non-significant trend in proteinuria reduction was observed. Other limitations include a lack of matched control group for comparison. There was a risk of selection bias where more motivated and adherent patients were recruited. As BP readings were not synced via Bluetooth from the BP machines, the accuracy of the shared BP readings could not be verified.

Conclusion

Remote BP monitoring using the HD+ Program, with timely interventions from the HCT was effective, feasible and safe to improve BP control in patients with advanced CKD. This care model can be expanded to the CKD population, to optimize BP control, address DRPs, while achieving patient and clinician satisfaction. A larger sample population and longer follow-up will be required to evaluate the benefits on kidney function with this model of care.

References:

- Hypertension as Cardiovascular Risk Factor in Chronic Kidney Disease. *Circ Res.* 2023; 132(8): 1050-1063.
- Content Validity and Reliability of a Self-Report Measure of Medication Nonadherence in Hepatitis C Treatment. *Dig Dis Sci.* 2019;64(10):2784-2797. Approved for NHG use only, Copyright.
- Interdisciplinary Telehealth Team Positively Impacts Difficult-to-Control Hypertension in CKD. *Kidney360.* 2023;4(6):e817-e823.

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Project Attachment

1. Patient Education Leaflet for Health Discovery Plus Mobile Installation and Use

Health Discovery+ App Installation & Manual BP Submission User Guide

Download HD+ App | Submit Vital

WHAT YOU'LL NEED

Smartphone (With Internet Access and Singpass App installed)

Phone Operating System:
- iOS 12.0.0 and above
- Android 9.0 and above

Blood Pressure Monitor

Brought to you by: In collaboration with:

1. DOWNLOAD HD+ APP

Download the app from the Apple App Store or Google Play Store.

2. LOGIN

- a. Launch HD+ App on mobile phone.
- b. Tap the QR code and log in with Singpass App.
- c. Once logged in, select a 4-digit passcode, or allow biometric login if available.
- d. For first-time login, read and accept Terms of Use.
- e. Upon successful login, you will be directed to HD+ homepage.

3. TAKE & SUBMIT BP READINGS

- a. In HD+ App, click 'Record Blood Pressure'.
- b. Click on 'Manual'.
- c. Measure your BP & enter your BP readings into the box accordingly.
- d. Click on 'Submit'.
- e. BP readings submitted.

a

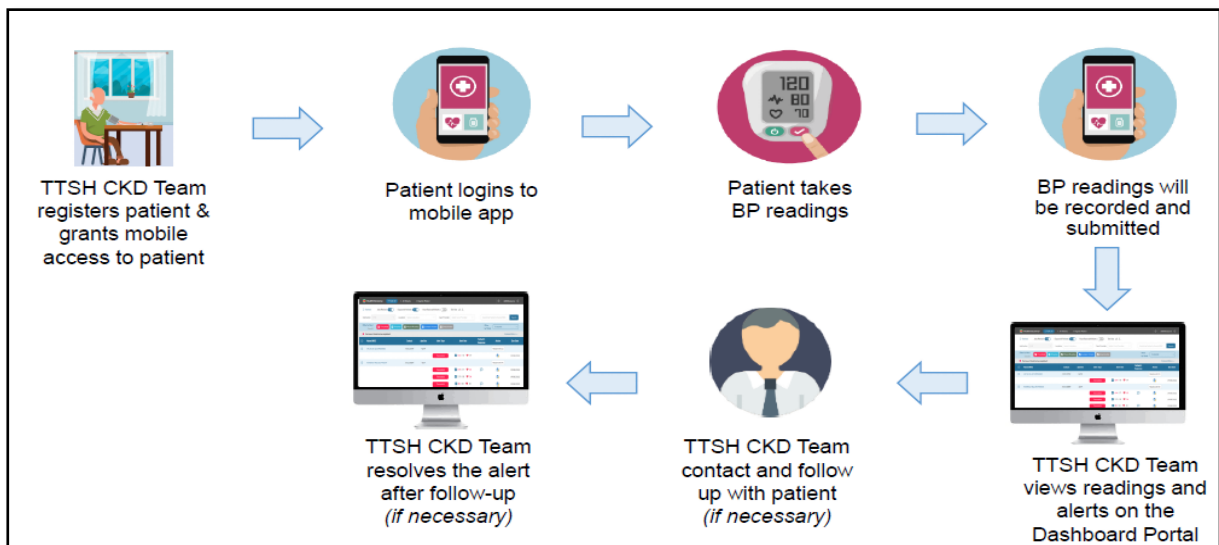
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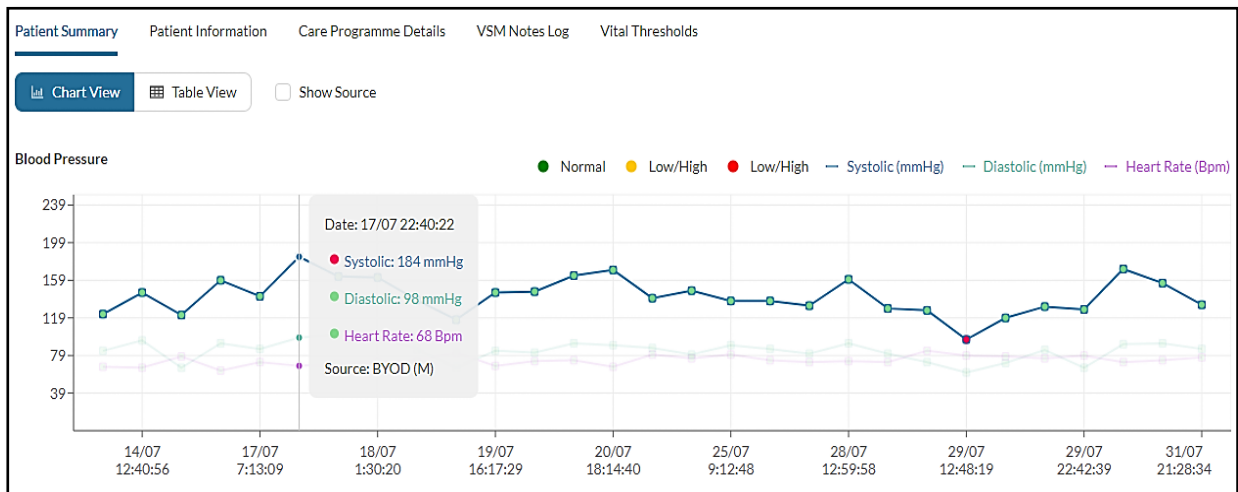
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2. Project Overview and Workflow

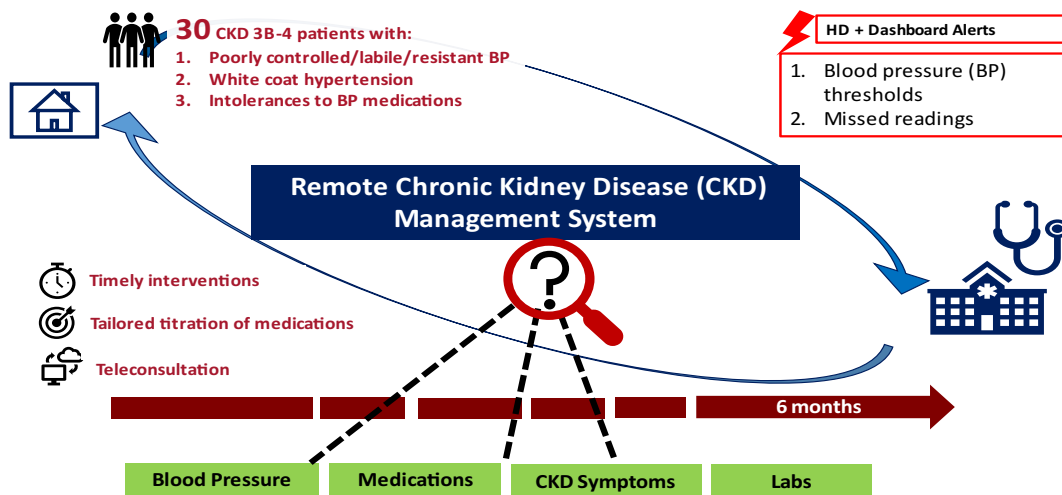


CHI Learning & Development System (CHILD) Submitted Project Attachment

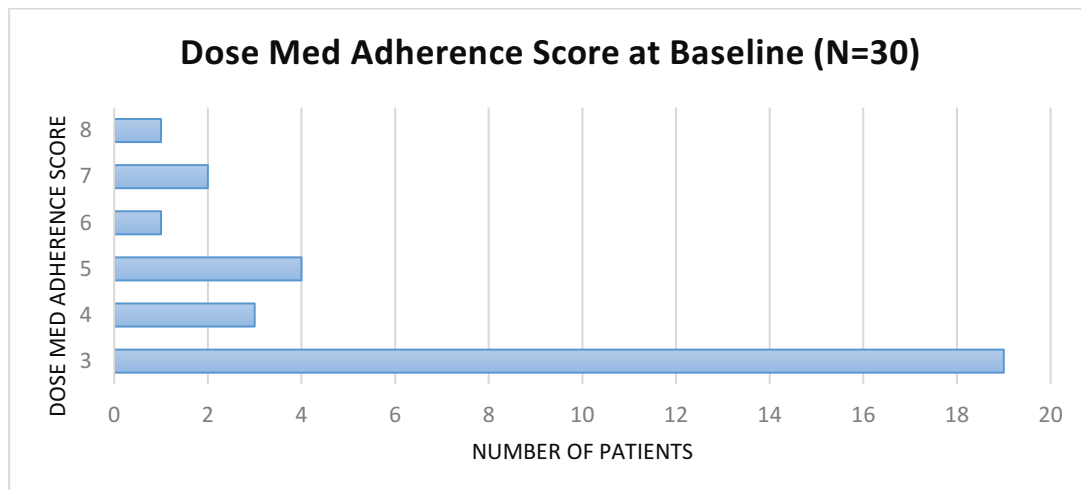
3. Chart View of BP trend, on HD+ Dashboard



Methods



Results



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