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ORIGINAL PAPER

Safety, Feasibility, and Acceptability of Telemedicine for Hypertension in Primary Care: A Proof-of-concept and Pilot Randomized Controlled Trial (SATE-HT)

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Abstract

Hypertension (HT) continues to be a leading cause of cardiovascular death and an enormous burden on the healthcare system. Although telemedicine may provide improved blood pressure (BP) monitoring and control, it remains unclear whether it could replace face-to-face consultations in patients with optimal BP control. We hypothesized that an automatic drug refill coupled with a telemedicine system tailored to patients with optimal BP would lead to non-inferior BP control. In this pilot, multicenter, randomized control trial (RCT), participants receiving anti-HT medications were randomly assigned (1:1) to either the telemedicine or usual care group. Patients in the telemedicine group measured and transmitted their home BP readings to the clinic. The medications were refilled without consultation when optimal control (BP < 135/85 mmHg) was confirmed. The primary outcome of this trial was the feasibility of using the telemedicine app. Office and ambulatory BP readings were compared between the two groups at the study endpoint. Acceptability was assessed through interviews with the telemedicine study participants. Overall, 49 participants were recruited in 6 months and retention rate was 98%. Participants from both groups had similar BP control (daytime systolic BP: 128.2 versus 126.9 mmHg [telemedicine vs. usual care], $p = 0.41$) and no adverse events. Participants in the telemedicine group had fewer general outpatient clinic attendances (0.8 vs. 2, $p < 0.001$). Interviewees reported that the system was convenient, timesaving, cost saving, and educational. The system could be safely used. However, the results must be verified in an adequately powered RCT.

Trial registration: NCT04542564.

Keywords Hypertension · Mobile app · Telemedicine · Randomized control trial

Introduction

Hypertension (HT) is the leading preventable cause of cardiovascular disease and death globally [1]. In Hong Kong, about 30% of the adult population has hypertension, and majority (> 80%) are managed in government-funded general outpatient clinics (GOPCs) in the primary healthcare system [2]. Patients with optimal HT control also attend the GOPCs every 3–4 months for blood pressure (BP) measurement and refill of medications, which places an enormous burden on the healthcare system in Hong Kong. To better allocate healthcare resources, telemedicine systems have the potential to reduce the number of doctors' consultations by automatically confirming optimal disease control (i.e., BP control in patients with HT) and refilling medications.

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Well-implemented telemedicine systems can help healthcare systems cope with larger patient volumes and facilitate better allocation of resources [3].

The use of telemedicine has dramatically increased in the last few years due to the 2019 coronavirus disease (COVID-19) pandemic and is likely to remain the main channel for patients' encounter worldwide [4]. Furthermore, transferring home BP monitoring (HBPM) data and intensifying treatments by telemedicine to the physician-in-charge can improve systolic BP (SBP) control by approximately 4 mmHg because it also encourages self-monitoring and self-management. Additionally, it promotes behavioral changes, treatment compliance, and self-efficacy [3, 5–8].

Although telemedicine typically represents more intensive treatments and has been examined in patients with suboptimal control of HT in previous randomized controlled trials (RCTs), there is currently a relative lack of studies examining the safety, acceptability, and feasibility of using automatic telemedicine systems to reduce physician consultations [5, 9, 10]. Furthermore, telemedicine was not found to be cost saving for patients with HT in a recent review [11]. A telemedicine app and system ('HealthCap') has been developed to record HBPM, provide automatic feedback in response to different BP levels, transfer BP data to the case physicians, and confirm optimal BP control on HBPM (details under methods). We hypothesized that when optimal control of BP is confirmed on HealthCap, the index physician's consultation can be safely deferred, and medications can be automatically prescribed.

Although we believe HealthCap can reduce consultations with the physician, be timesaving for patients, and allow better resource allocation, a pilot RCT is needed because the feasibility for a full-scale RCT and patients' acceptability using HealthCap are not known, and telemedicine is currently understudied, especially with telemedicine rarely being practiced in Southeast Asia. A systematic review in 2018 that explored barriers to implementation of telemedicine did not find any Southeast Asia or Chinese studies [12]. The feasibility of implementing telemedicine systems differs geographically due to different cultures, patients' demographics (age, education, and level of e-health literacy), and expectations [12]. In Hong Kong, implementation could be difficult because patients with HT are old and less educated, which are known barriers [10].

For the primary outcome, we hypothesized that an RCT examining HealthCap was feasible (by examining recruitment and retention rates) and acceptable. For secondary outcomes, we hypothesized that reducing physicians' consultations with HealthCap would be safe. Furthermore, we hypothesized that patients randomized to HealthCap would have similar BP control (primary outcome in future definitive RCT), have a reduced number of doctors' consultations, and have non-inferior self-efficacy and treatment compliance when compared with usual care at 6 months. Participants randomized to HealthCap were interviewed to understand their experiences, including any difficulties.

Methods

This pilot RCT was approved by the joint CUHK-NTEC Clinical Research Ethics Committee (Ref no.: 2020.294) and registered in the clinical trial registry (ClinicalTrials.gov no.: NCT04542564). Participants were randomized in a 1:1 allocation ratio to receive telemedicine (HealthCap) or usual care.

Intervention: HealthCap

HealthCap was developed by an expert team in primary care and with patients' feedback. It is commercially available in English and Chinese on the Apple and Google platforms. It prompts regular HBPM (every 1–2 weeks), records patients' HBPM readings, formulates the mean BP values in the past 7 and 30 days, and provides automatic feedback to patients. For example, patients are diagnosed with elevated BP when their mean SBP or diastolic BP are consistently 136–179 mmHg and 86–119 mmHg, respectively. These patients are encouraged to monitor BP frequently and to book an early medical appointment if elevated BP persists. For very high BP (BP ≥ 180/120 mmHg), HealthCap advises double-checking and emergency treatments. These threshold levels are in accordance with local and international recommendations [13]. Furthermore, BP readings and their mean values are automatically transferred to the physician's office.

In the current project, HealthCap reminded patients to take dual BP readings both in the morning and evening for 1 week prior to the index consultation (Appendix 1). These data were then sent to a password protected computer in the respective clinic and the physician-in-charge retrieved BP data 1–2 days before the index consultation. This measurement algorithm was used in previous studies and was the only one included in the Hong Kong Primary Care guidelines [14]. If the 7-day HBPM mean was optimal (i.e., < 135/85 mmHg), other parameters were checked by an online questionnaire and were confirmed by the physicians, these included: (i) self-reported good drug compliance and no drug side effects, (ii) absence of symptoms of complications (i.e., chest pain and hemiplegia), and (iii) no other health complaints that needed a consultation. If the answers were all negative, medications were prepared in the clinic, and the index physician appointment was deferred for three months. However, if any of the answers were positive or 7-day HBPM mean was suboptimal (i.e., ≥ 135/85mmHg),

the patient was asked to consult the doctor in-person as planned. The doctor would assess the patient and was advised to step up the medications according to the Hong Kong Primary Care guidelines [14], as appropriate.

Usual Care

In Hong Kong, patients with well-controlled HT are routinely seen every 3–4 months. Participants in usual care who used to conduct HBPM were not excluded from the RCT because HBPM is beneficial, and it was unethical to withhold HBPM from patients. However, no extra training or advice was provided. They were also asked not to download or use any HT mobile app during the study period.

For any other health complaint, patients had unlimited access to private clinics, GOPCs, and emergency departments. These were not limited to the participants in either group of the trial.

Participants

The participants were recruited from two large GOPCs (Lek Yuen and Fanling Clinics) in Hong Kong. They were patients receiving antihypertensive medications with well-controlled HT defined as BP < 135/85 mmHg on out-of-office BP measurements (ambulatory blood pressure monitoring (ABPM) or HBPM) [13]. Out-of-office measurements are more reproducible and predictive to cardiovascular outcomes than office BP [15, 16]. Patients were excluded if they had severe mental illnesses that impaired their ability to use HealthCap and if they required regular face-to-face consultations (e.g., other diseases such as asthma or diabetes). As a pilot trial, we aimed to recruit 50 patients, similar to other pilot trials [17]. The detailed inclusion and exclusion criteria are presented in Appendix 2.

Randomization

Stratified randomization according to age (≥ 65 years or < 65 years) and education level (primary school or below versus secondary education or above), with blocks of four or six was used to achieve a 1:1 allocation ratio. The aim was to achieve similarity with respect to sociodemographic characteristics between the two groups because age and educational levels are important barriers to telemedicine implementation [11]. The randomization sequence was generated by an independent statistician and sealed in light-opaque envelopes. The envelopes were opened only after confirmation of eligibility and a consent form was signed. Although the nature of the intervention prohibited blinding of the doctors and patients after allocation (an inherent difficulty shared by app-based intervention RCTs), the outcome assessor(s) and statistician were blinded to the allocation [18].

Outcome Measures

As a pilot RCT, the primary outcomes included the rates of recruitment and retention. Good feasibility was defined as the rate of recruitment of 50 patients within 6 months by two recruiting doctors and a retention rate of ≥ 80%. Acceptability was further assessed by interviewing 21 patients in the telemedicine group at 6 months (end of the study).

Appendix 3 provides a detailed description of the secondary outcomes. In summary, the secondary outcomes included daytime/night-time/24-hour BP parameters from ABPM, office BP, health service utilization (e.g., number of visits to the emergency department and GOPC), number and types of anti-HT medications, body mass index, serum creatinine, fasting glucose and lipid levels, self-efficacy, medication and diet adherence, exercise level, and health and e-health literacy (see Appendix 3 for the validated tools used to assess these outcomes). The validated device PhysioQuant (Envitec, Belgium) was used to measure ABPM, following international guidelines and using a fixed period to define daytime (6am to 10pm) and night-time (10pm to 6am) [26]. BP was measured every 30 min during daytime and 60 min during night-time and the readings were considered valid if there was > 70% of valid readings overall, > 20 valid awake and > 7 valid asleep BP readings in 24-hour intervals; ABPM was performed on a routine working day and on the non-dominant arm [26]. All outcomes were collected at recruitment and at 6 months. Sociodemographic information including age, sex, marital status, educational level, smoking status, and alcohol use (assessed by the validated AUDIT questionnaire) were collected on recruitment [19].

Statistical Analysis

Baseline characteristics were compared using two-sample t-tests for continuous variables and the chi-square test for categorical variables. The recruitment and retention rates were calculated. Data from validated scales were regarded as continuous outcomes if the data were normally distributed. Data that were not normally distributed were categorized. Continuous variables were examined with analysis of variance, and the effects of telemedicine on ABPM were examined using analysis of covariance, with BP as the baseline and treatment group as the covariate, following the intention-to-treat principle. Categorical secondary outcomes were analyzed using the Fisher exact test or the Chi-square test as appropriate. Subgroup analysis was conducted

Table 1 Baseline characteristics of the telemedicine and usual care groups

Variable	Level	Total	Telemedicine	Usual care
		(N = 49)	(N = 24)	(N = 25)
Age, mean year (SD)		59.9 (8.4)	59.7 (7.4)	60.1 (9.3)
Female, N (%)		26 (53%)	17 (70%)	9 (36%)
Systolic blood pressure, mean mmHg (SD)		132.7 (10.3)	131.9 (12.0)	133.4 (8.6)
Diastolic blood pressure, mean mmHg (SD)		75.8 (9.4)	76.1 (8.8)	75.6 (10.7)
Marital status, N (%)	Single	5 (10%)	2 (9%)	3 (12%)
	Married	34 (71%)	15 (65%)	19 (76%)
	Divorced	6 (13%)	4 (17%)	2 (8%)
	Widowed	3 (6%)	2 (9%)	1 (4%)
Education, N (%)	Elementary school	14 (29%)	7 (29%)	7 (28%)
	Middle school	28 (57%)	16 (67%)	12 (48%)
	College-preparatory school or higher	7 (14%)	1 (4%)	6 (24%)
Employment, N (%)	Full-time	18 (37%)	8 (33%)	10 (40%)
	Part-time	3 (6%)	2 (8%)	1 (4%)
	Unemployed	3 (6%)	0 (0%)	3 (12%)
	Housewife	9 (18%)	6 (25%)	3 (12%)
	Retired	16 (33%)	8 (33%)	8 (32%)
Household income, N (%)	No income	11 (35%)	5 (28%)	6 (46%)
	10,000-$19,999	9 (29%)	5 (28%)	4 (31%)
	$20,000–29,999	2 (6%)	1 (6%)	1 (8%)
	30,000–39,999	3 (10%)	3 (17%)	0 (0%)
	More than $40,000	6 (19%)	4 (22%)	2 (15%)
Smoking status, N (%)	Non-smoker	39 (80%)	20 (83%)	19 (76%)
	Current smoker	6 (12%)	2 (8%)	4 (16%)
	Ex-smoker	4 (8%)	2 (8%)	2 (8%)
Hazardous drinker †, N (%)			1 (4%)	1 (4%)

†Hazardous drinker was defined as men having a score of ≥ 4 and women having a score of ≥ 3 on AUDIT questionnaire. P-value < 0.05 (marked by *) was considered statistically significant

for baseline characteristics that were unbalanced between the two groups.

Data from the interviews were analyzed using thematic analysis, and the interviews were audio-recorded, transcribed, and thematically coded. The coding was independently cross-checked for reliability by two researchers (SW/EKPL).

Results

Participants' Characteristics and Rate of Recruitment/Retention (Primary Outcome)

The mean age (± SD) of our participants was 59.9 (± 8.4) years. Most of the participants were women (53.1%), had an education level lower than high school (85.7%), had a household income of < HKD$ 20,000 (~ USD$ 2,565) (64.5%), and were non-smokers (79.6%). The baseline characteristics were similar between both groups, except that more female patients were recruited in the telemedicine group (70% versus 36%) (P = 0.015) (Table 1).

Forty-nine participants were recruited within 6 months; one participant did not show up on the recruitment days. The rate of recruitment was thus about eight participants per month. Only one participant dropped out immediately after recruitment because of family objection (Fig. 1). The retention rate was 98%, with 55% (27/49 participants) of participants receiving ABPM at the study endpoint. No adverse event was observed in either group.

Other Outcomes

Participants in the telemedicine group had fewer visits to GOPCs (0.8 versus 2 consultations; P < 0.001) and had higher low-density lipoprotein (LDL) (3.5 versus 3.0 mmol/L; P = 0.037) (Table 2) compared to those in the usual group. Participants in both groups had similar BP on ABPM (daytime SBP: 128.2 mmHg [telemedicine group] versus 126.9 mmHg [usual care group], p = 0.41) and office

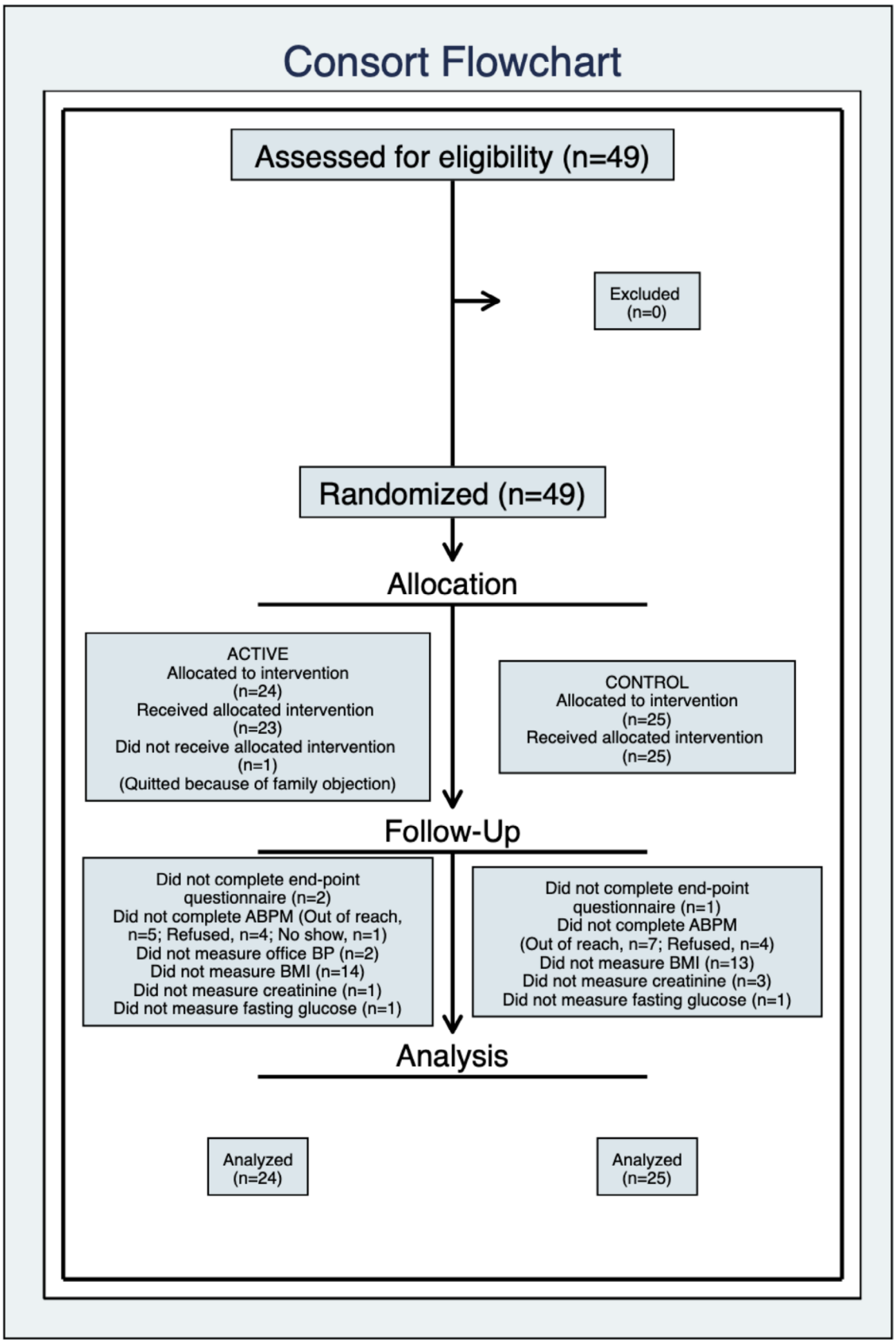

Fig. 1 Consort diagram

Table 2 Outcomes about GOPC utilization, blood pressure, medication change and physical test in intervention and usual care groups at follow-up

Outcomes	Intervention (N = 24)	Usual care (N = 25)	p-value
No. of attendance in GOPC	0.8 (1.0)	2.0 (0.8)	< 0.001*
Blood Pressure			
24 h Systolic ABPM (mmHg)	126.2 (8.7)	124.8 (10.4)	0.60
24 h diastolic ABPM (mmHg)	78.4 (11.3)	79.8 (9.0)	0.88
Daytime Systolic ABPM (mmHg)	128.2 (8.4)	126.9 (9.3)	0.41
Daytime diastolic ABPM (mmHg)	79.9 (10.9)	81.6 (8.9)	0.86
Office systolic BP (mmHg)	125.0 (10.0)	129.8 (9.5)	0.089
Office diastolic BP (mmHg)	73.0 (6.6)	71.0 (8.4)	0.38
Change in medications			
Decrease	5 (21%)	1 (4%)	0.072
No change	19 (79%)	24 (96%)	
Physical Test			
BMI (kg/m^2)	24.7 (4.0)	26.1 (5.5)	0.32
eGFR, mean $mL/min/1.73m^2$ (SD)	90.1 (13.4)	82.6 (14.0)	0.063
Fasting Glucose (mmol/L)	5.3 (0.4)	5.5 (0.7)	0.40
HDL (mmol/L)	1.5 (0.3)	1.3 (0.3)	0.054
LDL (mmol/L)	3.5 (0.7)	3.0 (0.9)	0.037*
Triglycerides (mmol/L)	1.3 (0.5)	1.3 (0.5)	0.94

P-value < 0.05 (marked by *) was considered statistically significant

SBP (125 mmHg [telemedicine group] versus 129.8 mmHg [usual care group], p = 0.089), e-health literacy, self-efficacy, drug use, other healthcare utilization and medication, exercise, and diet adherence (Tables 2 and 3). Subgroup analyses yielded similar results (see Appendix 4).

Patients' Interview

Participants perceived the telemedicine system as safe, convenient, and time efficient. The telemedicine system encouraged HBPM, educated patients about the threshold levels of elevated BPs, and reassured participants when BP was normal. Some participants observed that home BP was more reliable than office BP and preferred telemedicine. Some participants also believed that using telemedicine allowed for better allocation of resources to patients in need (Appendix 5).

However, the study participants perceived that older age and forgetfulness in measuring home BP were barriers to the telemedicine system. They found that the randomization procedures were acceptable, but some participants found ABPM inconvenient and did not understand why it was needed (Appendix 5). The qualitative results were in accordance with the quantitative results, including the high retention rate (Table 4).

Discussion

Main Findings

The telemedicine system was well accepted by patients and safe; participants from both groups had no adverse events and had similar BP and physical outcomes, except LDL levels that were higher in the telemedicine group. The difference in LDL could be explained by an outliner in the telemedicine group, whose LDL increased from 1.9 mmol/L to 4.3 mmol/L, and no significant difference between two groups was detected after excluding this outlier. The recruitment and retention rates of this pilot RCT were high. However, many patients defaulted the ABPM. Because this trial was conducted during the COVID-19 outbreak and was self-funded, ABPM could not be arranged timely at the end-of-study visits and patients paid two extra visits for the ABPM on a working day without incentives. This was unavoidable because personnel allocation was tight in the Hong Kong healthcare system during the pandemic and extra workloads (e.g., vaccination administration) were imposed on the clinics. However, we showed that patients from both groups had similar office BP at 6 months (study endpoint). Therefore, to conduct a more definitive RCT to ascertain the effectiveness, acceptability, and safety of telemedicine services, we suggest: (i) offer incentives for ABPM that can improve patient compliance, (ii) hire a research assistant to conduct ABPM at the end-of-study visit (in contrast to overburdening the existing clinic system), (iii) explain the necessity of ABPM as the most reliable reference standard of BP measurement [16], and (iv) include other BP measurement methods as outcome measures, including office BP and home BP, which are more acceptable to patients [20].

Our results are confirmed by previous studies which showed that telemedicine was well accepted by patients with HT [21]. However, while previous studies used telemedicine as an intensification of treatment and was expensive to build and maintain, the current study showed that telemedicine can represent less frequent patient visits and may

Table 3 Outcomes from validated scales, health utilization and drug utilization in intervention and usual care groups at Follow-Up

Outcomes	Intervention (N = 24)	Usual care (N = 25)	p-value
Validated scale			
e-health	20.0 (6.1)	18.4 (6.7)	0.41
Medication adherence	35.0 (1.3)	34.5 (3.3)	0.48
Diet adherence	27.6 (4.7)	26.2 (5.4)	0.33
Self-efficacy			
Bad	21 (88%)	23 (92%)	0.67
Good	3 (12%)	2 (8%)	
Literacy			
2	1 (4%)	0 (0%)	0.42
3	2 (8%)	5 (20%)	
4	21 (88%)	20 (80%)	
Exercise			
Insufficient	14 (58%)	9 (36%)	0.29
Moderately active	6 (25%)	11 (44%)	
Active	4 (17%)	5 (20%)	
Health Utilization			
No. of attendance in AED			
0	21 (88%)	23 (92%)	0.67
1	3 (12%)	2 (8%)	
No. of attendance in SOPC			
0	18 (75%)	16 (64%)	0.31
1	3 (12%)	6 (24%)	
2	1 (4%)	3 (12%)	
3	2 (8%)	0 (0%)	
No. of hospital admission			
0	24 (100%)	23 (92%)	0.49
1	0 (0%)	2 (8%)	
No. of Visit to private physician			
No visit	20 (83%)	19 (76%)	0.57
1–2 Visits	3 (12%)	4 (16%)	
3–4 visits	0 (0%)	2 (8%)	
>=7 visits	1 (4%)	0 (0%)	
Drug Utilization			
Use of diuretics			
No	23 (96%)	25 (100%)	0.49
Yes	1 (4%)	0 (0%)	
Use of betablockers			
No	22 (92%)	23 (92%)	1.00
Yes	2 (8%)	2 (8%)	
Use of CCB			
No	2 (8%)	8 (32%)	0.074
Yes	22 (92%)	17 (68%)	
Use of ARB/ACEI			
No	19 (79%)	11 (44%)	0.012*
Yes	5 (21%)	14 (56%)	

P-value < 0.05 (marked by *) was considered statistically significant

potentially be cost-saving [22, 23]. Therefore, in contrast to previous studies that showed improved BP in patients with suboptimal BP, our study provided preliminary strong evidence that BP control was non-inferior in the telemedicine group in patients with optimal HT control [22].

Clinical and Research Implication

As telemedicine systems are very heterogeneous in design, every telemedicine system should be scientifically validated prior to widespread implementation in healthcare systems [23]. However, most commercially available mobile apps and telemedicine systems have not been validated [24]. Our results showed that the HealthCap telemedicine system was safe and non-inferior to usual care, although this needs to be confirmed in a full-scale, parallel-group, and non-inferiority RCT. Such a trial can have a longer study period (i.e., 1 year) and include a formal cost-effectiveness analysis. Furthermore, patients commented that they felt empowered by HealthCap (e.g., more HBPM monitoring), but our quantitative results did not find an increase in self-efficacy scores. This could be due to our limited sample size and should be investigated further.

Our results show that the telemedicine system is safe and acceptable to patients and can be implemented in healthcare systems. However, patients should be allowed to consult their doctors if suboptimal BP is detected, or new problems arise. Although telemedicine systems are generally accepted by physicians, some physicians are concerned about the additional workload [21]. The current version of HealthCap telemedicine system still requires the physician or nurse to manually confirm responses to the three safety questions (see Method). If these steps can be fully automated in the telemedicine system, this would further reduce the workload and costs.

Strength and Limitations

Our pilot trial showed that the HealthCap telemedicine system is safe and accepted by patients while maintaining adequate BP control. This is one of the first studies to show use of telemonitoring in Southeast Asian patients and may replace consultations for BP monitoring. Our RCT was preregistered, and the randomization process was adequate, with qualitative results in agreement with the quantitative results.

This study has a few limitations. As a pilot trial aimed at investigating the feasibility of a definitive RCT, our sample size did not allow us to provide a definite conclusion [25]. However, a pilot study is recommended prior to a larger scale trial by international guidance, and the current study provides important data (e.g., retention and recruitment rates) for RCTs planning [25]. Patients' non-adherence to ABPM may also be a barrier to interpretation of the ABPM results, although office BP in both groups was similar. Although we interviewed patients from the telemedicine group (21 of 24 patients), we did not interview the physicians-in-charge because only two physicians were involved. A definitive

Table 4 Side-to-side table for qualitative and quantitative results

Quantitative results	Qualitative results
High retention rate (98%)	Participants found the telemedicine system saved time and was convenient
	Participants perceived that the healthcare resources can be allocated better and be given to patients in need
Similar BP and physical outcomes between both arms	Telemedicine systems prompted more self-monitoring and self-management. It also taught patients the cut-off of elevated BP
	Participant were reassured when normal BP was detected at home
No adverse event was detected and no increase in hospitalization, emergency department visits in the telemedicine group	Participants felt that the telemedicine system was safe. They were allowed to see their doctors if they had new problems or suboptimal BP control
Many participants did not undergo ABPM	ABPM was perceived as inconvenient. Participants did not understand why ABPM was needed.

RCT will likely involve more physicians and physician interviews. Our RCT only included patients with well-controlled HT and excluded patients with other diseases that required regular doctor assessment. Therefore, our results had limited external validity to patients with multimorbidity, but we argue that the reduction of physicians' contact with these patients was not appropriate. Furthermore, optimal BP control was defined as < 135/85 mmHg, but a lower target (< 130/80 mmHg) may be considered in patients with HT complications, such as chronic kidney diseases. HealthCap may further evolve to individualize BP targets. However, patients with comorbidities who require regular consultations were excluded from the current RCT. Moreover, future studies may also extend the evaluation of telemedicine services to other stakeholders, such as patient caregivers and policymakers.

Conclusion

In conclusion, the HealthCap telemedicine system is feasible. It was generally accepted by the patients and appeared safe with no reported side effects or increased healthcare utilization in the telemedicine group. Replacing physicians' consultations with an automated telemedicine system does not appear to lead to inferior BP control. These results need to be further verified in an adequately powered RCT.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10916-023-01933-4.

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Author Contribution All authors contributed to the research protocol and the manuscript. EKP Lee conceptualized the project. M Leung, SY Leung, and JJH Han recruited participants, provided patients' follow up, and collected data. S Wang analyzed the data. KKF Tsoi and EKP Lee provided expert opinion on the design of the HealthCap.

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Data Availability The data, materials and code related to this study can be made available on request.

Declarations

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval The questionnaire and methodology for this study was approved by the joint CUHK-NTEC Clinical Research Ethics Committee (Ref no.: 2020.294).

Consent to participate Informed consent was obtained from all individual participants included in the study.

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