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Behavioural Economics to Improve Antihypertensive Therapy Adherence (BETA): protocol for a pilot randomised controlled trial in Los Angeles

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ABSTRACT

Introduction Non-adherence to antihypertensive therapy is one of the major barriers to reducing the risk of cardiovascular disease. Several interventions have targeted higher medication adherence, yet most do not result in sustained adherence. Routinisation has emerged as a potential method for mitigating this problem, but requires high motivation during the relatively long habit formation phase. This pilot randomised controlled trial aims to test the feasibility, acceptability, and preliminary efficacy of behavioural economics-based incentives and text messages to support the routinisation of the medication-taking behaviour for promoting long-term medication adherence.

Methods and analysis This study will recruit and randomly assign 60 adult patients seeking care for hypertension at the Cedars-Sinai Medical Center in Los Angeles to one of the three groups, *Control* (n=20), *Messages* (n=20) and *Incentives* (n=20) in a 1:1:1 ratio. All participants will receive information about the importance of routinisation and will select an existing behavioural routine ('anchor') to which they will tie their pill-taking to, and the corresponding time. Additionally, participants in the *Messages* group will receive daily text messages reminding them of the importance of routines, while those in the *Incentives* group will receive daily text messages and conditional prize drawings. The interventions will be delivered over three months. Participants will be followed for six months post-intervention to measure behavioural persistence. Surveys will be administered at baseline, month-3 and month-9 visits. Primary outcomes include: (1) electronically measured mean medication adherence during the intervention period and (2) post-intervention period; and (3) mean timely medication adherence based around the time of the participants' anchor during the intervention period, and (4) post-intervention period.

Ethics and dissemination The study was approved by the Cedars-Sinai Institutional Review Board (Study ID: Pro00057764). Findings will be published in scientific peer-reviewed journals.

Trial registration number NCT04029883.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study represents one of the first randomised controlled trials assessing the potential efficacy of combined text message reminders and small conditional incentives to support habit formation aimed at achieving long-term medication adherence among patients with hypertension disorder.
⇒ This study combines qualitative and quantitative data collection methods in a phased approach to assess the feasibility and acceptability of the intervention.
⇒ The phased approach includes an intervention period (enrolment through month 3), and a post-intervention follow-up period (month 3 to month 9) to allow for the evaluation of long-term adherence and habit maintenance once the incentives and text messages are withdrawn.
⇒ Study outcomes include electronically captured adherence measures (that are found to be more reliable than self-reported adherence measures) as well as changes in blood pressure and hypertension control.
⇒ Limitations of this pilot study include its relatively small sample size and single centre enrolment, which may limit the power to assess effectiveness as well as generalisability of the results, respectively.

INTRODUCTION

Hypertension represents the most common modifiable risk factor for cardiovascular disease including myocardial infarction, heart failure, stroke and renal failure.[1] Nearly one-third of the global population suffers from hypertension, contributing to excess morbidity and mortality worldwide.[2] While efficacious pharmacotherapy is readily available to lower blood pressure and reduce the risk of adverse health events,[1] medication non-adherence threatens its impact. Specifically, it is estimated that during the first year of antihypertensive therapy, patients possess medications on only 50% of the days and that

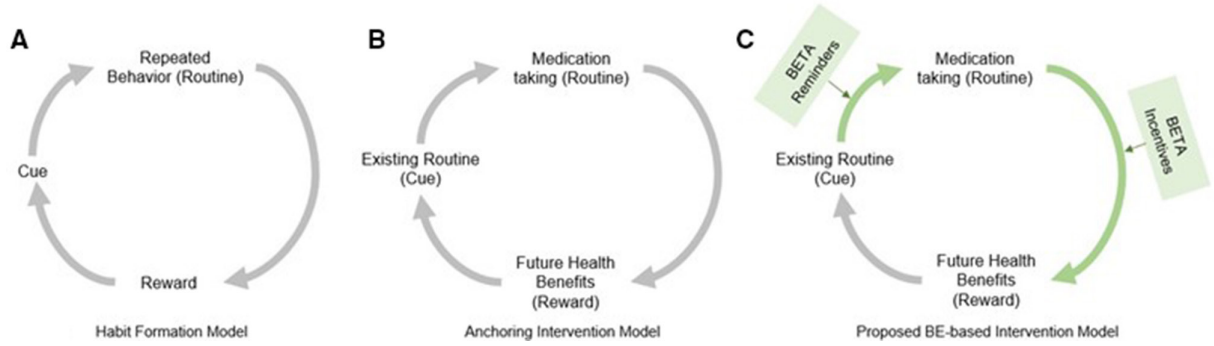

Figure 1 The habit formation model, which underlies anchoring interventions designed for changing health behaviour. The proposed intervention will adapt this cycle to include two behavioural economics-based strategies to support the repetition of behaviours. BE, behavioural economics.

only 20% take their medications frequently enough to obtain cardiovascular benefit.[3 4] Moreover, meta-analyses have shown inconsistent and disappointing results of existing interventions aimed at improving antihypertensive medication adherence.[5–7]

A commonly reported strategy for sustaining high medication adherence is the integration of the medication-taking behaviour into the patients' daily routine.[8 9] According to the Habit Formation model (figure 1A),[10] this involves the shifting of the cognitive pathways that govern the new behaviour to the subconscious system, thus allowing for the behaviour to persist without the need for high motivation.[11–14] However, it is often difficult for patients to form new routines on their own, since this requires sustained daily repetition of behaviours in response to the same contextual cue for approximately 3 months.[15–18]

In this literature, the most common strategy to initiate habits involves anchoring, wherein the targeted behaviour is tied to ('anchored') to an existing routine (such as brushing one's teeth or breakfast) that acts as a contextual cue (figure 1B). While anchoring has been leveraged to promote several health behaviours such as physical activity,[19] smoking cessation[20] and better dietary routines,[21] the interventions relied on the participants' high intrinsic motivation for the targeted behaviour.[22–25]

Table 1 Site sample characteristics

N in catchment area	1 814 274
Age, in years	36.4±4.7
Race, %	
Hispanic/Latino	49
White	20
Black/African American	18
Asian	10
Other/multiple	3
Female, %	51
Hypertension, %	28

Moreover, less than half of the participants in these studies successfully managed to build healthy habits.[26]

Behavioural economics (BE) theory stipulates the lack of salience of medication adherence (the gradual decline in attention to the targeted behaviour due to increasing importance of other activities in one's life), and present bias (the undervaluing of future rewards) as potential factors associated with the difficulty in sustaining healthy behaviours.[27 28] Notably, BE also suggests that conditional rewards and text message reminders can support the routinisation for all patients, including those with low motivation.[28–30] Text messages could likely increase the salience of the anchor and routinisation processes while continuing to reinforce information provided at recruitment, while small incentives conditional on adherence could help overcome present bias.[31–34]

METHODS AND ANALYSIS

Study design

This three-armed pilot randomised controlled trial (RCT) will last for nine months, with intervention administration for the first three months and a post-intervention follow-up for six months.

Study site

The study will take place at the Cedars-Sinai Hypertension Center for Excellence which is part of the Cedars-Sinai Medical Center (CSMC) in Los Angeles, California, USA, and has treated over 3000 patients for difficult-to-control or resistant hypertension, the most frequent cause of which remains medication non-adherence. Table 1 summarises the population characteristics of CSMC's catchment area. Notably, the population is racially and ethnically diverse, with over a quarter of the individuals diagnosed with hypertension.

Sample selection and recruitment

A sample of 60 participants, stratified based on age and gender, will be recruited from CSMC. The sample will be representative of the population at CSMC, approximately proportionally stratified by age and gender.

Participant identification

Research staff will use the hospital electronic health record system to screen the patient population for eligibility based on age and ongoing treatment for hypertension and generate a weekly list of these patients' next scheduled clinical visit, and the names of their providers. Providers of identified patients will be asked for approval to participate in the study, and to contact the patient prior to their visit. If approved, the study coordinator will contact the patients at the beginning of the week to screen for initial eligibility and to gauge preliminary interest. If eligible, the patient's provider will be contacted on the day of the patient's scheduled clinical visit to introduce the study and to prepare for the visit. The study coordinator will then visit the patient at the end of their clinical visit to provide study information, gauge eligibility and interest again, and obtain consent to participate.

Inclusion criteria

The sample will include patients 18 years or older currently prescribed at least one antihypertensive (AH) medication. Participants will also need to own or have access to a phone throughout the duration of the intervention and be willing to receive study text messages.

Exclusion criteria

Patients under the age of 18 will be excluded because there may be special needs associated with paediatric hypertension that would require significant alteration of the study. Patients who are not mentally fit to provide informed consent will also be excluded. Importantly, participation in the study will be contingent on receiving approval from the patient's provider. Patients not willing to use the medication event monitoring system (MEMS) caps for the duration of the study will be excluded. Finally, to avoid confounding, patients already enrolled in another comparable study at CSMC will also be excluded.

Randomisation

Participants will be randomised prior to the recruitment visit but will only be informed of their assignment after the baseline survey has been completed to avoid any effects of the assignment on the participant response. A randomisation tool (developed and made freely available by the National Institutes of Health (NIH) on their website) will

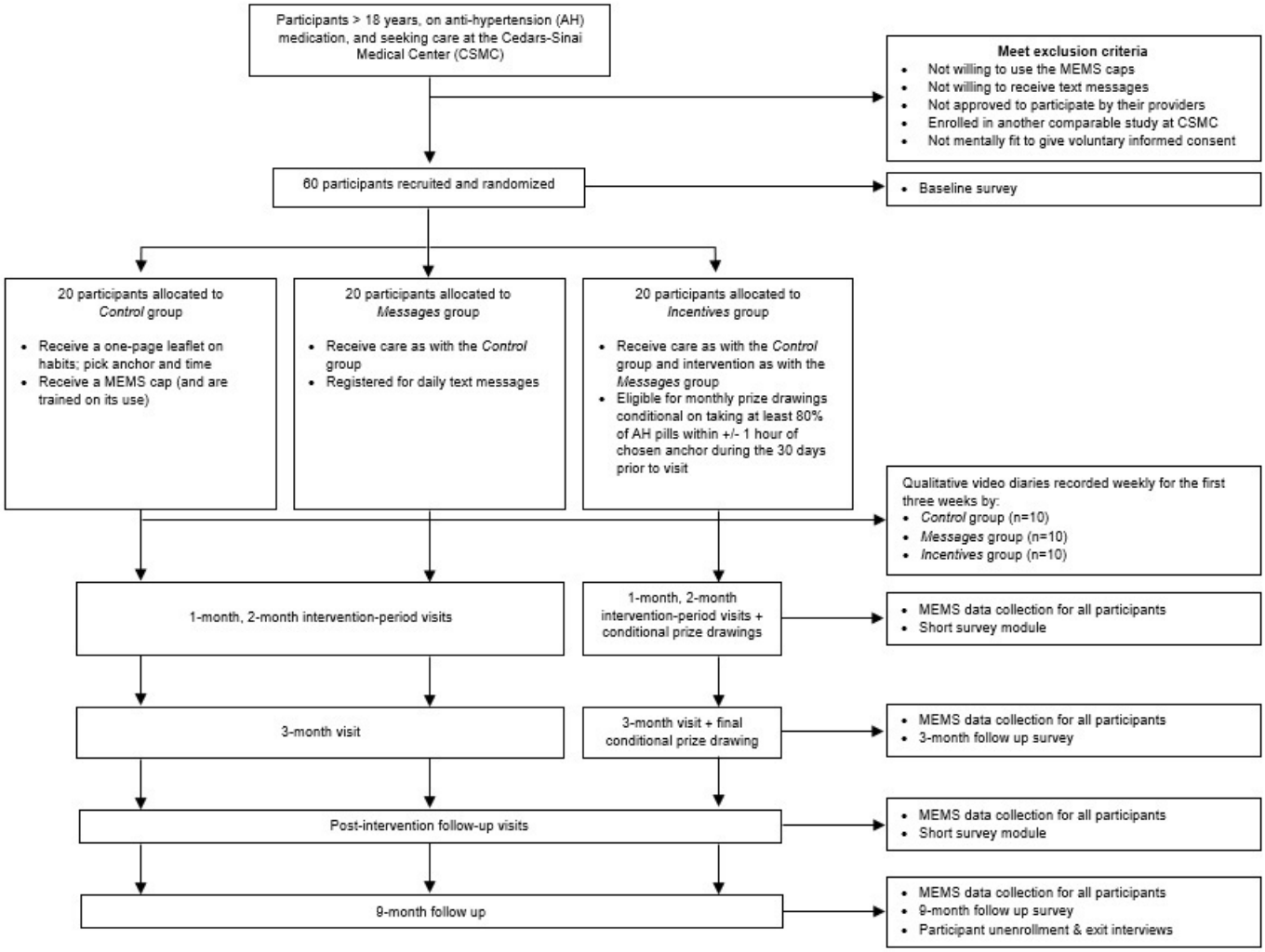

Figure 2 Trial flow chart. MEMS, medication event monitoring system.

be used to randomise the sample in a 1:1:1 ratio. The sealed envelope method will be used to reveal treatment assignment to both the participant and the study coordinator, who will therefore not know the respondent's treatment assignment during the survey. The nature of the intervention does not allow the participant or the coordinator to be blinded to the assignment. However, the data analyst who will conduct the impact analysis will be blinded to the treatment assignment.

Design

The pilot RCT includes one control and two intervention arms. Only one of the intervention arms (*Incentives*) includes monetary incentives that are conditional on sustained timely medication adherence. The interventions will be administered in the first three months after the baseline, during which period all participants in all the groups will be expected to come for monthly study visits. These visits will be used for MEMS data collection, blood pressure (BP) readings and prize drawings for eligible participants in the *Incentives* group. Participants will be followed for six months post the intervention period, during which time MEMS data and BP readings will be collected at each scheduled clinical visit (expected to be once every three months). The final visit will be scheduled for nine months after the baseline visit. Survey data will be collected at baseline, at the end of the intervention period (month 3) and at the end of the post-intervention period (month 9).

Importantly, the pilot RCT will be preceded by a formative phase to develop and evaluate the intervention's feasibility and acceptability. A novel video-based data collection method will also be used for a subsample of participants in each group for the first three weeks during the intervention phase to obtain data on the acceptability of the study. The pilot RCT will be followed up by an adaptation phase to refine the intervention in preparation for a large-scale trial. Figure 2 gives a brief overview of the study design.

Study procedures

Control group: usual care

Participants assigned to this arm will receive care as usual, along with information about habit-building for medication adherence. Specifically, the study coordinators will use a one-page leaflet that details information on how to establish healthy pill-taking routines; participants will then be asked to select an existing routine ('anchor') that most suits their prescription and specify the time at which their anchor typically occurs.

During each of the subsequent study visits, the study coordinator will first measure the participants' BP by following the procedure described in the *Measurement and Data Collection* section. Participants will then fill out a short questionnaire inquiring about their anchoring and adherence behaviours, any clinical changes to their AH regimen, their daily MEMS cap usage and any changes to the participants' contact information or addresses. The study coordinator will then download the readings from the MEMS cap, inquire about the participants' next visit and remind them to continue taking their pills on time. This procedure will be carried out throughout the intervention and post-intervention periods.

Treatment group 1: messages

Participants assigned to this arm will receive daily text messages in addition to care as usual during the 3-month intervention period. Table 2 shows some example text messages. Post the intervention period, they will follow the same procedures as the *Control* group.

Treatment group 2: incentives

Participants assigned to this arm will receive monetary incentives in addition to daily text messages (as with the *Messages* group) and care as usual, during the 3-month intervention period. Participants will be eligible to participate in a prize drawing at month 1, 2 and 3 to win either US$0, US$25 or US$50 if they have taken their medication 80% or more of the time in the last 30 days within an hour of their chosen anchor time. Eligible participants will pull a ball labelled with one of the three amounts listed above out of a bag. The corresponding prize will be added to a refillable debit card (called Forte card) issued to the participants by CSMC for all study-related monetary transfers. After the 3-month intervention, participants will follow the same procedures as the *Control* and *Messages* groups.

MEMS cap procedures

Medication adherence data (for the assessment of the primary outcome measures) will be collected using MEMS caps, electronic pill caps that include a sensor

Table 2 Example text messages to be sent to *Messages* and *Incentives* groups as part of the intervention

Day	Text content
1	Hello, this is BETA. Take your antihypertensive medications together with your existing routine for good health!
2	Hello, this is BETA. Forming routines requires effort now but will pay off in the end!
3	Hello, this is BETA. Don't forget to take your antihypertensive medications every day at the same time!
4	Hello, this is BETA. Taking your antihypertensive medications with your existing routine will make remembering easier!
5	Hello, this is BETA. Remember to stick with your healthy plans!
6	Hello, this is BETA. A routine keeps you healthy if you stick with it!
7	Hello, this is BETA. Every day is a new chance to form a healthy routine!
8	Hello, this is BETA. Did you remember to take your antihypertensive medication today?

			Months								
	Enrolment	Allocation	Post-allocation			Post-Intervention/Closeout					
TIMEPOINT	-1	0	1	2	3	4	5	6	7	8	9
ENROLMENT:											
Eligibility screen	X										
Informed consent	X										
MEMS-Cap Given	X										
Treatment Assignment		X									
INTERVENTIONS:											
T1: Messages		X	←	—	→						
T2: Incentives		X	←	—	→						
ASSESSMENTS:											
MEMS-Cap Measured Adherence		X	←	—	—	—	—	—	—	—	→
Participant Surveys		X			X						X
Video Diaries			X								
Blood Pressure		X	X	X	X						X

Figure 3 Schedule of enrolment, interventions and assessments (Standard Protocol Items: Recommendations for Interventional Trials figure). MEMS, medication event monitoring system.

capturing the date and time of every cap opening. The caps will be distributed among all participants across the three groups to avoid any spurious intervention effects associated with cap use. All participants will be informed that the cap records every bottle opening event, but that the data collected through MEMS caps will not be shared with the clinicians. They will be instructed to use their MEMS cap continuously throughout the study, and to bring the cap and their pill bottle for each clinical visit.

Study timeline

Figure 3 gives the timeline of the study activities.

Recruitment/baseline visit

We expect to enroll one-to-two patients a day during a 3-month recruitment period. During this initial visit, we will conduct the baseline survey, select an anchoring event, and reveal treatment assignment. For participants who are assigned to either *Messages* or *Incentives* group, this visit will mark the initiation of the intervention period. All participants will be given a MEMS cap and will be instructed on its use. Additionally, they will be given a Forte card for transfer of honoraria (and any prize draw wins for participants in the *Incentives* group) associated with the study.

Month 1–3 visits

These monthly visits will serve to (1) collect MEMS readings, (2) assess and note any degradations of existing routine behaviours, (3) identify and record changes to AH regimen, (4) conduct prize drawings with the *Incentive* group and (5) update contact information. In case the participants note the degradation of their selected behavioural anchor, study coordinators will help participants identify a new daily routine for the anchoring strategy. At the month 3 visit, a follow-up survey will be administered.

Post-intervention visits

These visits will coincide with any scheduled clinical visits and will continue for about six months after the intervention phase. During these visits, the study coordinators will download MEMS data and conduct BP readings. A follow-up survey will be administered at the month 9 visit. To encourage visit attendance for the required study visits (baseline visit, two monthly visits during intervention, month 3 visit and month 9 visit), participants will be provided with parking refunds for each of the visits and will also be given an additional honorarium (US$50) on the last visit if they come for all the required visits.

Table 3 Outcomes and measures associated with the BETA study

Constructs assessed through surveys	Measure	Time points				
		Baseline	Month 1–2	Month 3	Month 4–8	Month 9
Demographics	Developed in-house.	X				
Race/ethnicity		x				
Education		x				
Employment status		x				
Household income		x				
Language		x				
Structural barriers	Developed in-house. Adapted[47–49]	X		X		
Distance to clinic		x		x		
Availability of transportation		x		x		
Waiting times		x		x		
Availability of care		x		x		
Insurance		x		x		
Habits associated with regular pill-taking	Developed in-house. Adapted[50 51]	X	X	X	X	X
Medication regimens and routines		x	x	x	x	x
Missed doses and reasoning		x	x	x	x	x
Accessibility to medication		x		x		x
Attitudes and beliefs about antihypertensive medication	Adapted[52]	X		X		X
Understanding of treatment mechanism		x		x		x
Attitudes associated with medication-taking		x		x		x
Perceived health outcomes associated with medication taking		x		x		x
Acceptability metrics	Developed in-house.		X	X	X	X
MEMS caps			*	x	*	x
Text messages			*	x	*	
Prize drawings				x		
Video diaries				x		
Overall acceptability						x

x: all questions associated with the construct are asked.
*Some questions associated with the construct are asked.
MEMS, medication event monitoring system.

Measurements and data collection

Data will be collected for all participants through surveys, MEMS data, chart abstracted data and BP readings. Further, a subsample of participants in each group will be invited to record and upload video diaries.

Surveys

Table 3 describes the different constructs being measured, and the time points at which data will be collected for each.

The baseline survey will ask about participant demographics, structural barriers, attitudes and beliefs pertaining to medication taking behaviours, and adherence and regimen-related information. The 3-month survey will include an additional module pertaining to acceptability metrics associated with the MEMS caps and interventions. The 9-month survey will also include questions pertaining to overall acceptability of the study. During the rest of the study visits, participants will be asked about their medication taking habits, along with inquiries pertaining to anchor and regimen changes. All surveys will be programmed for collection on Research Electronic Data Capture (REDCap) and will be administered using a CSMC issued iPad.

On completion of the main survey assessments (baseline, 3-month and 9-month), participants will be awarded an honorarium (US$50) through a refill into their Forte cards.

MEMS data

The MEMS data will be continuously collected throughout the study period and will be retrieved during each visit. The data will be downloaded and stored electronically using the MEMS cap software that will be installed on a computer system accessible by the study coordinator.

BP readings

A standardised BP technique will be used to determine BP at each visit.[35] Participants will be left alone in a room for five minutes, during which time an automated BP machine will perform a total of five serial BP readings. The first two readings will be thrown out, with the final BP calculated as the average of the last three measurements.

Chart abstractions

The team will chart abstract basic demographics information (such as age), along with history of cardiovascular disease, as well as clinical comorbidity data following participant enrolment. These data will be abstracted to Microsoft Excel spreadsheets which will be securely stored on a password protected computer at CSMC.

REDCap forms

All other study data, including participants' survey responses, monthly visit reports, BP readings, as well as contact information will be recorded by study personnel in REDCap, safely stored at CSMC's secure portal, and securely transferred to the research team at RAND periodically during the study period.

Participant tracking data

Extensive tracking information (including participant phone numbers, email addresses and home addresses) will be collected at recruitment and will be verified at each study visit.

Medallia video diaries

A novel data collection method, that is, video diaries, will be used to collect real-time feedback on the intervention components, allowing for frank and in-the-moment qualitative data collection. Medallia LivingLens,[36] a secure platform that integrates the collection, management, analysis and editing of user-generated video data, will be used for this assessment. A convenience sample of 10 participants from each group will be separately consented to participate in this module and will receive weekly diary prompts during the first three weeks of the BETA intervention. The prompts will be tailored to the participant's intervention group, with topics ranging from experiences with text messages, prize drawings and video diary recording.

Outcomes and measures

Table 4 describes the various outcome measures (four primary and one secondary measure), their definitions, collection mechanisms and time points of collection.

Primary outcomes

The number of pill bottle openings registered by the MEMS cap will be used as a measure of each participant's pills taken per day. *Primary outcomes 1* and *2* will assess mean adherence during the intervention and post-intervention periods for a given participant, respectively. Each of these mean adherence measures will be capped at 100%, that is, any pill bottle openings over the participants' number of prescribed daily pills will be ignored. Additionally, a monthly measure of mean adherence will also be calculated and analysed separately for months in the intervention, and post-intervention periods.

Primary outcomes 3 and *4* are novel measures of routine adherence that will be assessed during the intervention and post-intervention periods, respectively. This measure will be defined as the fraction of scheduled pills taken within a two-hour window (±1 hour) around the participant's anchoring time. As with the first two *Primary outcomes*, this outcome will be calculated as a mean measure during and after the intervention, and as a monthly measure of routinised AH adherence over the nine month study period.

Secondary outcome

Hypertension control will be defined as achieving a target BP of <130/80 mm Hg, a reliable biological measure highly correlated with good AH adherence, in accordance with national guidelines.[37]

Feasibility and acceptability

Feasibility will be measured in terms of recruitment rates, and eligibility criteria (sufficient vs too restrictive) will be examined by investigating the proportion of potential participants screened as ineligible and reasons why. Acceptability will be assessed based on refusal rates, retention of participants in the intervention and control groups, as well as anticipated or experienced responses[38] via questions on the month-3 and month-9 surveys.

Data analysis plan

Both types of data (quantitative and qualitative) will be analysed for the estimation of acceptability, feasibility and, preliminary efficacy of the interventions.

Statistical methods and analysis

Statistical analyses will compare group-level differences in the primary and secondary outcome measures to establish preliminary efficacy. An analysis of covariance framework will be used to test for group differences in each primary and secondary outcome, controlling for the participant characteristics that are found to differentiate the groups at baseline. Further, a non-parametric McNemar's test and an analogous multiple logistic regression will be used to assess group differences for dichotomous

Table 4 Outcome measures definitions and collection strategies

Outcome measure		Definition	Source of data	Measurement time points				
				Baseline	Month 1–2	Month 3	Month 4–8	Month 9
Primary outcomes (PO)								
PO1	Electronically measured mean medication adherence during intervention (treatment; pooled, control)	# of actual once-a-day bottle openings during the intervention period / # of prescribed once-a-day bottle openings during the intervention period	MEMS data		X—X			
PO2	Electronically measured mean medication adherence post-intervention (treatment; pooled, control)	# of actual once-a-day bottle openings during the post-intervention period / # of prescribed once-a-day bottle openings during the post-intervention period	MEMS data				X—X	
PO3	Routinisation of AH adherence during intervention (treatment; pooled, control)	Fraction of scheduled once-a-day pills taken within a 1-hour window around the existing routine behaviour during the intervention period; %	MEMS data		X—X			
PO4	Routinisation of AH adherence post-intervention (treatment; pooled, control)	Fraction of scheduled once-a-day pills taken within a 1-hour window around the existing routine behaviour during the post-intervention period; %	MEMS data				X—X	
Secondary outcomes (SO)								
SO1	Hypertension control	Binary measure; equal to 1 if mean of the last three (of five) consecutive blood pressure measurements taken during the visit is <130/80 mm Hg	Blood pressure readings at the baseline, month-3 and month-9 visits	X		X		X
Acceptability and feasibility outcomes (AFO)								
AFO1	Recruitment rate	# of participants recruited per month / # of expected participants per month	Participant trackers	X				
AFO2	Refusal rates	# of participant refusals / # of participants approached	Participant trackers	X				
AFO3	Retention rates	# of participants retained at month-9 for each group / # of participants recruited at baseline for each group	Participant trackers	X				X
AFO4	Intervention acceptability	Anticipated vs experienced responses on the intervention acceptability metrics	Surveys			X		X

X: cross-sectional data at the time point.
X—X: continuous data across the time points.
AH, antihypertension medication; MEMS, medication event monitoring system.

outcome variables, while controlling for covariates. In addition to static comparisons of group means for each outcome at 3-month intervals, repeated measures and time-series techniques will be used to leverage the longitudinal nature of the data. Consequently, a linear mixed model with repeated observations will be fit using maximum likelihood through 'xtmixed' in the software package Stata to study group-level temporal dynamics in daily measures of the primary and secondary outcomes.

Missing data will be imputed if a participant remains enrolled in the study. In case of dropouts, multiple logistic regression models will be fit to assess whether the dropout is random. If not random, logistic regression will be used to develop non-response weights to correct for dropout. All analyses will reflect these design effects in the calculation of SEs and statistical tests of significance.

Sample and effect-size calculation

This study is not powered to detect statistically significant differences between the randomised groups, given its focus on assessing the feasibility and acceptability of the interventions. However, the estimates of the mean and SD of medication adherence assessed at baseline will inform the sample size calculation for a full-scale trial. Additionally, the analyses described will be conducted primarily to stabilise procedures that can be drawn on for the analyses of the subsequent large-scale trial to conduct BETA at-scale.

Qualitative analysis

Verbatim transcripts and video footage will be uploaded to NVivo,[39] a collaborative qualitative and mixed-methods analysis software. At least two coders will code transcripts and video segments using both inductive and deductive coding.[40 41] We will use open (labelling interview content based on dimensions emerging from it[41]) and in vivo coding (assigning code labels using words or short phrases directly from the text[41]) to establish categories and themes.[42 43] Once the code book is finalised, we will proceed to coding the rest of the transcripts, until we reach reliability (Cohen's kappa) of at least 0.70.[44 45] Video content will be analysed to garner preliminary assessments of body gestures, pointing, gaze, attention, body position, facial expression, and other aspects germane to emotional states.[46]

Data management

All data collected will be securely stored on the CSMC-administered Box folder; key study personnel will be selectively granted access to sub-folders.

Patient and public involvement

To receive critical feedback on the various components of the BETA study, the pilot RCT will be preceded by a formative phase and succeeded by an adaptation phase.

The formative and adaptation phases will include qualitative data collection through semi-structured interviews with patients, providers and clinical administrators. The interviews administered during the formative phase will primarily focus on perceptions of AH pill-taking as an activity of daily life and to refine how BETA could best support AH adherence routinisation. These interviews will also identify structural or other behavioural obstacles for AH adherence, existing practices associated with pill-taking behaviours, as well as demographic-specific barriers to daily pill-taking. The adaptation phase will include 20 in-depth interviews with patients and seven in-depth interviews with providers and clinical administrators to elicit additional qualitative information on programme improvement areas in preparation for a fully powered subsequent trial.

The data collected will be analysed using the process described in the *Qualitative Analysis* subheading, and the resulting insights will be incorporated into the future trial design.

Ethics and dissemination

Ethical and safety considerations

The CSMC Institutional Review Board (IRB) approved the study (Approval ID: Pro00057764).

Given the nature of the trial, a safety monitoring committee, consisting of at least two experts with experience in conducting patient-oriented and physiological studies and/or clinical trials focused on cardiovascular disease, will be established for this study. Throughout the course of the study, the team will assess for adverse medication-related events including worsening renal function, electrolyte syncope, emergency department presentation or admission to the hospital. In case of adverse events, the Clinical Endpoint Committee consisting of physicians will adjudicate each incident based on pre-established protocols and then recommend to the principal investigators whether to continue the protocol and how to report each result to the CSMC IRB. The multiple Principal Investigators (mPIs) will be responsible for submitting all adverse events and protocol deviations to the IRB for review.

Additionally, titration of antihypertensive therapy will be completed by participants' treating physician, not the study team. If BP is found to be above the goal during any of the follow-up visits, the study team will notify the treating provider.

Dissemination plan

The team will use peer-reviewed publications and conference presentations as the primary means of results dissemination. Established guidelines for each academic journal will be followed when defining the level of contribution that warrants paper authorship. The findings will be relevant to those interested in the behavioural mechanisms that underlie successful long-term AH adherence. Additionally, the findings will be used in the design of a larger-scale RCT that can rigorously assess the effectiveness of the interventions for establishing long-term AH adherence.

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Contributors SL and JEE designed the study and led all aspects of developing the protocol. AP conceptualised and designed the Medallia video diary subcomponent and led all the qualitative components of the protocol. JEE, SL and AP advised on the implementation of the interventions. DB, RV, CB, MM, SJ, NG and IG contributed substantially to the design of the instruments, and acquisition of the data. IG drafted the initial protocol manuscript. SL, JEE, AP and IG edited and refined the protocol manuscript. All authors read and approved the final manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; peer reviewed for ethical and funding approval prior to submission.

Data availability statement Due to the sensitive nature of the data collected for this study, requests to access the data set from qualified researchers trained in protocols on the protection of human subjects may be sent to Cedars-Sinai Medical Center at beta-study@cshs.org.

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