Evaluating a tele-asthma self-management intervention, Canadian Asthma Text Messaging Study (CANATEXTS), among adults with asthma: study protocol for a pragmatic randomized controlled trial

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Research Article

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Abstract

Background: While effective treatments are available, asthma control is suboptimal for many asthma patients. To help patients self-manage their asthma symptoms, provision of an asthma action plan (AAP), with instructions on managing worsening asthma symptoms is recommended, as a standard of care; however, only about half of patients correctly adhere to their AAP. Canadian Asthma Text Messaging (CANATEXTS) is a TH intervention facilitating access to an electronic AAP (eAAP) via a mobile device. In a feasibility study to assess the safety and efficacy of CANATEXTS, an 18% reduction in the relative risk of exacerbation was observed among the intervention group compared to control group. This study will assess the effectiveness of CANATEXTS on asthma outcomes in a Canada-wide study.

Methods: This is a superiority a 2-arm, multisite randomized control trial (RCT). This study aims to determine if CANATEXTS reduces asthma exacerbations over a 12-month period, improves asthma control, QoL and medication adherence, and is cost-effective. The intervention includes access to an electronic asthma action plan (eAAP) on patients' mobile devices, disease-related education, and weekly reminders via an SMS interface. The study will include 600 adult participants with asthma recruited from 14 respiratory clinics across Canada. Participants will be randomly assigned to either Intervention (eAAP) or Control (wAAP) groups. All outcomes of interest will be assessed during three in-person assessments (baseline, 6-month, and 12-month) and two telephone follow-ups (3-month and 9-month). Data will be analyzed with a linear mixed-effects model across all time points.

Discussion: TH has the potential to improve adult individuals with asthma's engagement in self-management practices. Our feasibility study showed TH could yield a reduction in asthma exacerbations. If the proposed TH intervention is found to be effective for asthma management in a nation-wide trial, it will generate evidence to support integration of TH in asthma self-management. This study will also provide important information on the cost-effectiveness of CANATEXTS.

Trial registration: ClinicalTrials.gov identifier: NCT02017795; date of registration: 06 May 2018 (registered prospectively)

Background

Asthma is a chronic airways disease, representing a global challenge [1,2]. In 2018, an estimated 339 million people worldwide had asthma [3]. While effective treatments are available, control is suboptimal for individuals with asthma worldwide, including Canada, resulting in an increased risk of exacerbations and reduced quality of life (QoL) [4-6]. According to the Global Initiative for Asthma (GINA) [7], the current standard of asthma care indicates provision of an asthma action plan (AAP) in written format (wAAP) and education on how to apply its instructions to manage worsening asthma symptoms [8]. The wAAP is an individualized set of asthma management instructions that is normally provided by a certified respiratory educator (CRE) using a "traffic light" configuration [9]. Within the wAAP, a "green zone" describes adequate control and continuing routine/maintenance medications, a "yellow zone" describes loss of control and instructions for therapeutic intensification, and a "red zone" indicates an asthma exacerbation requiring immediate medical assistance [10,11]. The proper use of wAAP facilitates optimal asthma management [12], improved QoL [13], and reduced healthcare utilisation and mortality [14], all of which reduce healthcare costs [15-17]. Despite this evidence base, less than 15% of adult asthma patients in Canada have an individualized wAAP [5,18,19], and of those who receive it less than 50% of patients use it correctly [16,20], often due to language barrier, poor understanding of the recommendations, and lack of proximal access when it is needed [17,18,21,22].

Telehealth (TH) [23] utilizes electronic information and telecommunication technologies to augment healthcare delivery, for example, through virtual appointments and disease-specific education [24,25]. As the COVID-19 pandemic has caused challenges to in-person visits for both patients and care providers [26], nowadays, clinicians and patients use TH for a diverse range of clinical services [27], and it has been shown to improve health outcomes, possibly through enhanced access to care services [24,25,28]. While the effectiveness of TH to improve health outcomes beyond standard care is established for other chronic diseases [29,30], evidence of its utility for respiratory management is less clear [31-33]. In particular, there are no published trials in the literature showing the benefits of a TH intervention on asthma exacerbation reduction among adult patients [27,34]. Some descriptive and cross-sectional studies have shown modest or no effect of TH use on asthma outcomes [34-36], however, lack of a systematic approach and inadequacy of the TH technology used in health practice and previous studies are potential reasons for the minimal effect [29,37,38].

In the past 8 years, our research team has conducted studies to understand TH in asthma care. Initially, a critical review of systematic reviews summarized 438 articles assessing the effects of TH on asthma outcomes [39]. The review concluded there is equipoise in using TH in asthma management, as reported elsewhere [40-42]. Next, eight focus group sessions were conducted with 91 adult asthma patients to understand their perceived possible challenges and potential benefits to optimally using their wAAP [43-45]. Information from the review and patients' insights were applied in conceptualizing a TH intervention framework. Procedures suggested by other researchers [46,47] were then applied to ensure the framework integrated the most evidence-based strategies in terms of functionality and usability of mobile applications for asthma management. Finally, 26 in-person interviews were conducted with Information Technology (IT) experts, clinician scientists, and health researchers to obtain their input about the framework and intervention design that would be technically and operationally feasible [48].

This needs assessment stage led to the development of Canadian Asthma Text Messaging (CANATEXTS), a TH platform containing weekly SMS reminder check-ins and access to AAP through digital devices (eAAP) [49], as shown in Figure 1. CANATEXTS was then pilot tested in a feasibility study to assess its efficacy in reducing asthma exacerbations among 106 adult asthma patients recruited from one specialty respiratory clinic in Vancouver, Canada [50]. The Knowledge to Action (KTA) Model [51,52] was applied during development and feasibility testing. The pilot test of CANATEXTS intervention demonstrated potential efficacy. For instance, an 18% reduction in the relative risk of an exacerbation among the eAAP (intervention) group compared to the wAAP (control) group was observed. The eAAP group also had greater improvements in in terms of their QoL, asthma control, and medication adherence.

Following pilot testing, CANATEXTS was refined based on suggestions from patients during the feasibility study, and key TH intervention insights from the literature [53,54]. The purpose of this article is to describes the protocol for a randomized controlled trial to assess the effectiveness of the revised CANATEXTS intervention; which is underpinned by evidence-based community engagement strategies, applies patients' and professionals' viewpoints, and integrates insights from the literature.

Study Aims and Hypotheses

This study will aim to determine if access to an eAAP via mobile device, accompanied with an interactive SMS interface reduces asthma exacerbations, improves asthma control, QoL and medication adherence, and is cost-effective.

The hypotheses are: 1) weekly reminder check-ins and two-way SMS, and timely access to an eAAP will improve asthma outcomes (e.g., reduce exacerbations, improve asthma control, QoL, and medication adherence) compared to standard asthma care (wAAP); 2) the TH intervention will be more cost-effective compared to the current standard of care for asthma.

As asthma prevalence has been reported to be greater in women than men [55,56], assuming equal willingness to participate, we anticipate more women will participate in the trial. Although the effects of TH delivered by SMS were previously shown to be equivalent between women and men [57,58], we will explore possible differences in the effect of the intervention on asthma exacerbations between females and males.

Primary research question

Over the 12-month study period, does a user-friendly, electronic-based asthma action plan (eAAP) with an interactive SMS interface (CANATEXTS) reduce asthma exacerbations, compared to standard care (wAAP)?

Secondary research questions

(1) Over the 12-month study period, does CANATEXTS improves asthma control, QoL, and medication adherence? (2) Is CANATEXTS cost-effective compared to standard care? (3) Do outcomes of CANATEXTS intervention differ by sex, disease severity, age, and education level?

Methods

Design

This is a 2-arm, single-blinded, open label, multi-centre RCT stratified by site with a 1-year study period for each participant. The study received ethics approval from the University of British Columbia (Canada) Clinical Research Ethics Board (Ethics # H21-02767). Collaborating sites will obtain ethics approval prior to participating.

Study Population and Eligibility Criteria

The study population consists of adult (19 years or older) asthmatic patients with any self-identified gender orientation. Participants will be recruited from 14 collaborating sites (respiratory clinics) across Canada; study sites can be obtained from the corresponding author. Inclusion criteria are: (1) physician-diagnosed asthma; (2) history of at least one exacerbation in the previous 12 months; (3) moderate or severe asthma, based on criteria defined by GINA [7]); (4) a prescription of both reliever and controller inhalers, or use a combined inhaler that functions both as a reliever and controller medication [7,59]; (5) ability to communicate in English or French; and (6) own a mobile phone/tablet with SMS capability and internet access. According to 2019 Consumer Technology Association's report [60], 86% of Canadians (over age 15) own a smartphone. Patients must plan to be present in the study region (near their site) for the duration of the study. Patients will be excluded, if: (1) they cannot communicate in English or French; (2) have a major underlying illness such as cancer, COPD, or those with asthma and COPD overlap (ACO); (3) had a recent asthma exacerbation within the past six weeks; and (4) are not taking their prescribed asthma medication regularly. The anticipation is that including patients with moderate asthma, in addition to those with severe asthma, will improve the generalizability of the findings, as more asthmatic patients will benefit from accessing and using an eAAP to better self-manage their health condition [61,62].

Enrollment and Randomization:

Enrollment. Potential subjects will be identified by respiratory clinicians at each collaborating site and screened for eligibility by the site research coordinator (RC). Next, a baseline assessment appointment and meeting with the certified respiratory educator (CRE), who will develop an individualized wAAP for each participant, will be scheduled. Participants will then be randomized to one of two study arms (Figure 2). (A) Control group/standard care (wAAP) Arm: will receive their wAAP and information on how to use it by the site's CRE. (B) Intervention group/telehealth (eAAP) Arm: will be provided access to their eAAP via a web URL, receive weekly SMS check-ins for one year, and be able to communicate with the site's RC and CRE via an integrated and interactive (two-way) SMS feature.

Randomization. To maintain consistency of participant allocation to study groups and study blindness [63], a statistician unassociated with the study will generate randomization schedule and protocol via computer (SAS PROC PLAN) [64]. Randomization will be performed by centrally-sealed allocation and stratified by site: where the site's RC will assign eligible participants to study groups via a password-protected website that contains the randomization codes. Permuted blocks of random size will be used to ensure a balanced sample size by group within participating sites, and to reduce the ability to guess subsequent allocations [63,65,66].

After randomization, the site's RC will review the study procedures with all participants and provide separate training to intervention group participants on how to digitalize their wAAP, signup with/log into the online/offline platform to access/check their eAAP, and use interactive SMS for non-emergency queries.

Addressing bias and blinding

To minimize bias and conceal the study group allocation [63.65,66], the randomization will be centralized at the Vancouver site, and the allocation of the participants will be sent via a remote secure channel to the RC in each site. A blinded research assistant at each site who will not be involved in recruitment will conduct evaluations. In addition, to maintain the anonymity of participants and protect the information, a secure password-protected server network will be applied [67,68] for transferring study-related data

between the collaborating sites and the central site. In addition, the exchange of SMS between a site's CRE/RC and participants will be conducted via a secure password-protected server network [34]. To further minimize bias, data analysts, health economists, trainees, and research coordinators conducting the phone and in-person assessments will be blinded to the study group allocation. The CRE and RC at each site will be aware of group allocations of participants, as they will implement the intervention, upload eAAP into the platform, and respond to intervention group's SMS queries.

TH Intervention

Overview

The TH intervention consists of two main components promoting self-management practices. **Component 1:** The eAAP participants will receive weekly SMS check-ins to prompt action plan use. This generalized text will have a random greeting pertaining to their asthma control such as '*Have your asthma symptoms worsened*?' or '*Was your asthma less well controlled during the past week?'.* If the participant responds "YES" to the initial SMS, an automatic text with a link to the online platform will be sent, encouraging them to login to view their eAAP and follow the instructions to select the appropriate action(s) on their eAAP. They will also be reminded the eAAP is available offline (without internet connectivity) via the downloaded app on their device [69,70]. If the participant responds "NO" or "NO CHANGE" to the initial SMS, they will receive a second SMS indicating that they should continue taking their medication as prescribed and view their eAAP if their asthma symptoms worsen (Figure 3).

Features of CANATEXTS platform

The platform will automatically alert the RC if a participant is non-responsive for more than two consecutive weeks of SMS check-ins [71]; the RC will then contact these individuals and provide support to resolve any issues. This feature encourages patient engagement and adherence to their AAP when initially unresponsive. A meta-data feature will record the number of times a participant checks his/her eAAP throughout the study. This will enable data collection and assess participant engagement during the trial [72]. Access to such data will facilitate evaluation of the relationships between eAAP use and all outcomes of interests.

The platform can function both online and offline, facilitating patients' convenient access to their eAAP. Data will automatically sync when internet connection is re-established. The link to the login for the eAAP will be the same for both the web app and downloadable app, which can be accessed at anytime using the links sent via SMS.

Component 2: The two-way SMS allows intervention participants to contact their site's RC and CRE about study-related and non-emergency clinical queries [73-75]. The RC will sort queries as technical, study-related, or clinical. Clinical queries will be responded to via text by the site's CRE, within 12-48 hours, and on weekdays. Upon sending a query, an automatic text will be sent to the patient to acknowledge receipt of their request, provide an anticipated return time, and instruct them to call their doctor or 9-1-1 if it is an urgent matter. Necessary training will be provided to CRE in each site to ensure they refer a participant experiencing an emergency to their action plan and advise calling 9-1-1 or going directly to the emergency, if they receive an SMS from a patient experiencing an exacerbation or if they require immediate attention. Based on previous studies [76,77], the anticipation is that each site will receive 12-16 total weekly text inquiries from all the intervention group participants (22-23 participants in each collaborating site).

Standard care (control) group

Participants in the control group will receive a wAAP and instructions from the CRE on how to use their plan. Participants in both study groups will receive equivalent education and instructions from the CREs. In-person and telephone assessments will follow the same procedures for all participants, and there is no intention to give more or less information to either study group. The aim will be

to avoid any counseling that could alter behavior and outcomes to improve the likeliness the observed differences in outcomes will be primarily due to CANATEXTS intervention.

Data collection process

Data will be collected from all participants during three in-person visits via a study questionnaire at baseline, 6-month, and 12-month time points (Figure 4); a physician-visit every 6 months is considered a standard follow-up period in clinical practice in Canada and many developed countries [78]. Two phone assessments will take place at 3- and 9-months post baseline to limit recall bias and collect data on key outcomes (e.g., exacerbations and healthcare utilization). During phone calls, participants will not be prompted or questioned on their action plan use, which could influence adherence behaviours (Hawthorne Effect) [79]. Respiratory clinicians of the study advisory panel confirmed that 3- and 9-month follow-up calls would not deviate from standard care for asthma patients in Canada. Participants will be contacted a week in advance of data collection sessions and follow-up calls, and if needed, contacted via both email and telephone to ensure compliance with study protocol. Data will be entered and coded by the research assistant at each site and double-checked by the research coordinator at the central site. The corresponding author will have access to the final trial dataset, and will provide access to investigators upon reasonable request.

Baseline assessment and AAP development

During the baseline meeting, participants from both groups will sign an informed consent form, review study procedures with the RC, complete the study questionnaire, perform spirometry (lung capacity) test, and provide disease characteristics and demographics (Figure 4). Next, participants will meet with a CRE to develop a wAAP (or update their current action plan if they already have one) according to the GINA management strategy [7], and will receive a colour copy of their wAAP. Then, the CRE will educate each participant on asthma triggers and symptoms, how to use their wAAP, and the necessity of using/ adjusting anti-inflammatory medications with any loss in asthma control. The site RC and patient's care provider(s) will also receive a copy of the patients' wAAP. Intervention participants will have their wAAP digitized into the telehealth platform system.

Follow-up assessments

During the 6- and 12-month post baseline assessments, the same study questionnaire, spirometry test and disease characteristics checklist will be completed. At each site, a study coordinator unassociated with the study will conduct the three in-person assessments (baseline, 6- and 12-month) and two follow-up calls (months 3 and 9) to reduce bias and maintain blinding (Figure 5).

Outcome measures

The primary outcome is a reduction in the rate of asthma exacerbations during the study period (12 months). An asthma exacerbation, as defined by the Global Initiative for Asthma (GINA) [7], is *an asthma attack that requires either taking a course of Oral Corticosteroids (OCS) for at least three days, or an asthma-related ED visit or hospitalization.* Asthma exacerbations will be recorded at 3-month intervals as a total number of independent events. Due to the lack of an existing validated tool for documenting/recording exacerbations, the primary outcome will be self-reported, which has been previously found to be accurate for collecting health status information [80,81]. As researchers' access to medical records may be inconsistent across study sites, we will apply a dual approach to validate self-reported information; including: (1) The site CRE will verify each exacerbation with the patient's primary care physician at the time it is reported and also at the study conclusion to ensure there are no unreported events. (2) Participants will be asked to provide consent to share certain health-related data via their doctor, including exacerbation occurrence and, if practical, a list of prescribed medications from 12 months before and during the 12-month study period. This process will enable the CRE to verify the primary outcome data beyond the participants' self-reported information and should

minimize recall bias among participants. We have successfully used this methodology in previous large intervention studies in which an asthma exacerbation was the primary outcome [82-84]. The secondary outcomes are QoL, asthma control, and medication adherence, which will be assessed using the following validated tools: (a) Asthma Control Test [85]; (b) Mini Asthma QoL Questionnaire (MiniAQLQ) [86]; and (c) Test of Adherence to Inhalers [87,88], respectively. Cost-effectiveness data will be collected by examining the following validated factors: 1) impact of asthma on healthcare resource use (direct costs) [89]; and 2) impact of asthma on work and activity productivity (indirect costs) [90-92].

Sample size estimates and study power

Because exacerbation is a count variable, the effect size of the intervention will be estimated using a Poisson regression model (with correction for over-dispersion) [93]. We applied 3 sources of information to calculate the study's sample size: **(1)** Results from our feasibility study: we found that the exacerbation rate was reduced by 18% in the intervention group, compared to the control group [Relative Risk (RR) = 0.82 [95% CI: 0.49, 1.36]. We used the feasibility study baseline exacerbation rate of 0.771 and Standard Deviation (SD) of 0.915, assuming Poisson distribution, to calculate an over-dispersion factor (sigma-squared) of 1.0859. **(2)** Reviewed the literature on effect size applied by other studies assessing the effectiveness of clinical interventions on reducing asthma exacerbations. McKeever *et al.* [94] assessed the effectiveness of increasing the dose of ICS on reducing exacerbations and deemed a reduction of 30% to constitute an efficacious intervention. Buhl *et al.* [95] conducted a pooled analysis on data from seven RCTs and showed a significant reduction in exacerbation rates ranging from 28% to 38%. **(3)** Expert opinion recommendation: we surveyed 20 expert Canadian respiratory physicians' on what would constitute a clinically meaningful difference in exacerbation rates in a RCT of this nature [96]. The consensus was that 25% would be an acceptable minimal effect size (Table 1). Assuming the exacerbation rate followed a Poisson distribution with mean rate of 0.771 for the control group, an over-dispersion of 1.0859, a RR of 0.75, and considering a Type I error rate of 0.05 (2-sided significance level of 5%) and 0.80 power (Type II (beta = 0.20)), we will require 560 participants to conduct clinically and statistically meaningful analyses. Since the dropout rate in our feasibility study was less than 10%, we assume a dropout rate of 10% to estimate total sample size applying a 2-sided approach in our intervention that would be 622 participants (311 per group). We previously recruited 106 subjects at a single site during the feasibility study [50], and similar recruitment procedures will be applied for this study.

Health services research

Economic evaluation of health technologies is concerned with the trade-off between the incremental costs and incremental effectiveness of technologies [97,98]. As recommended by the Canadian guidelines for health technology assessment [99], our economic evaluation will report the incremental costs for one Quality-Adjusted Life Year (QALY) gained [100], as well as per one exacerbation avoided, associated with the implementation of our intervention, over the lifetime of patients. All overhead costs attributed to applied assessment tools, capital resources required to implement the intervention, and protocol-driven and data management-related costs will be collected. Impact of asthma on work productivity (indirect costs) will be assessed using the Work and Activity Productivity Instrument - General Health (WPAI-GH) [90-92]. The QALY will be measured using the validated MiniAQLQ (primary instrument), as well as EQ5D (secondary instrument), which will be converted to health state utility values [86]. To project the outcomes beyond the time horizon of the trial, we will use decision-analytic modeling [101]. We will adopt a discrete time and discrete state (Markov model) with underlying disease states being the three levels of asthma control, plus a state representing death [102]. Exacerbations will be modeled as events that occur with different rates across control states and that are also affected by the intervention. Future costs and effectiveness outcomes will be discounted at 1.5%, per Canadian guidelines [90,103]. Also, sensitivity analyses will be conducted to assess the changes in the key assumptions as well as the uncertainty in model parameters [101]. We have successfully applied these models and approaches in our previous research [90,98,103].

Types of analyses

Analyses will be based on an intention-to-treat approach for the assessment of the clinical outcomes between the two study groups [104,105]. The main independent variable is the intervention (treatment group assignment) in all models. Regression analysis will

compare the outcome between the two groups, adjusted for baseline values of the corresponding outcome variable. Depending on the distribution of the outcome variable, different regression models will be used as outlined below [106,107]. An adjusted analysis with covariates will be applied to detect a treatment effect in case the covariates are highly impactful. As the number of in-person and phone assessments will be equivalent in both study groups, the expectation is that the intervention will be the main driver of outcomes. **(1)** Exacerbations (primary outcome), will be calculated every three months, as a total count of independent events requiring either OCS use, and/or asthma-related ED visits or hospitalizations due to asthma. Thus, the total of the four 3-month periods will be modeled using a Poisson regression (a Generalized Linear Model with Poisson distribution and logarithmic link function [108]), with an over-dispersion parameter [109,110]. Baseline exacerbation rate will be used as a covariate in the analysis to compare the mean exacerbation rate at 12 months between study and demographic groups. Treatment effects will be expressed as relative risk. A sensitivity analysis will then be conducted based on a negative binomial regression (a Generalized Linear Model with logarithmic link and negative binomial distribution [108]). **(2)** Asthma control, QOL, and medication adherence (secondary outcomes) will be treated as ordinal variables (with 5 or 7 levels). Thus, a mixed effects ordinal regression model will be fitted to assess the treatment effect on all secondary outcomes at 6 months and 12 months, adjusted for baseline values of the corresponding variable. Treatment effects will be presented as odds ratios [111]. The mean FEV1 changes and its 95% CI in each study group will be calculated from the baseline to 6-month and 12-month assessments to show potential improvements in lung function. Mixed effects linear regression adjusted for baseline FEV1 will assess the treatment effect on FEV1 at the two time-points [106]. For all analyses of repeated measure outcomes, instead of estimating the average intervention effect over time, the regression model will allow the effect to potentially differ across time points [112]. **(3)** We will conduct a within-group *a priori* approved post hoc analysis to determine whether frequency of accessing and navigating the eAAP improves asthma outcomes (using exacerbation rate reduction) within the intervention group. The aforementioned regression analysis will be repeated by including frequency of eAAP usage instead of treatment group as the independent variable in the model [113]. **(4)** The cost effectiveness analysis is explained above (see Health services research section). **(5)** For all primary analysis models, potential confounding demographic variables such as age, sex, socio-economic status, disease severity, and previous asthma-related resource use will be included. **(6)** Participants with incomplete assessments will be excluded from the analysis of the primary outcome; however, a sensitivity analysis will be carried out with adequate adjustments for missing data using multiple imputations by chained equations [114]. **(7)** Although the incidence of asthma is higher in women than men, based on results from other studies on asthma-related educational interventions [55-57,115,116], we do not anticipate a difference in intervention effect by sex. Despite this, we will compare the intervention effect between women and men by exploring statistical interaction terms between intervention and sex for primary and secondary outcomes. We will examine the trends in a descriptive manner (e.g., means, proportions), in addition to formally testing the statistical significance of the interaction.

Frequency of analyses

Two interim analyses (at 6 and 9 months post-baseline) of efficacy on the primary and secondary outcomes, in addition to the final analysis, will be conducted applying the Haybittle-Peto approach [109,111,117]. A strict criterion of $p<0.001$ will guide the Data Safety Monitoring Committee (DSMC) to consider halting the trial. A statistician independent of the trial will conduct the interim analysis after one-third and two-thirds of the needed data have been collected.

Data safety monitoring committee (DSMC)

A DSMC will be appointed for the proposed CANATEXTS trial, consisting of two clinicians, a statistician, and health economist; all not involved in the trial. The DSMC members will meet at the start of the study, and every 6 months thereafter, to monitor trial progress, review interim analyses of efficacy, and consider changes to or termination of the trial, if needed. The DSMC will be independent from the sponsor and won't have competing interests. Any protocol modifications will be communicated to the UBC Office of Clinical Research Ethics, as well to study site leads during monthly and DSMC meetings.

Discussion

Our critical appraisal of systematic reviews [39] concluded a knowledge gap exists regarding effective TH interventions for improving asthma clinical outcomes [40-42]. This protocol proposes an intervention applying rigorous scientific methodology to determine the effect of a practical TH intervention on asthma outcomes, particularly, exacerbation reduction. The CANATEXTS feasibility study addressed: **(1)** the first stages of the knowledge to action cycle via confirmation of the practice gap and identification of barriers to integrate telehealth in current health system, through a critical evaluation of systematic reviews [39]; and **(2)** the knowledge creation funnel of the model, specifically, knowledge synthesis, through the development and testing of the eAAP [47]. Therefore, this RCT will evaluate CANATEXTS effectiveness and aim to identify issues affecting feasible integration of TH technology in asthma self-management practices. Evidenced by the literature, disease-related knowledge and education alone are insufficient to facilitate behavioral changes in self-management practices [118]. To overcome this issue and increase the likelihood of successful CANATEXTS implementation, we will first involve knowledge users, including patient partners, healthcare professionals, and scientists on a Steering Committee (SC) to obtain feedback regarding implementation challenges and insights. The Chronic Care Model (CCM) [119] (Figure 6) will be applied to fully engage patients and professional partners to ensure community engagement from study design to knowledge translation [120]. Next, the Interactive Systems Framework [121] will serve as the foundation for understanding factors affecting trial implementation – specifically within the Delivery System (i.e. the interactive SMS and interface between healthcare provider and patient). Last, the COM-Behavior change theory [122] will be applied to describe possible causal mechanisms related to the behaviour change required to implement CANATEXTS [118].

Conclusions

TH interventions have shown benefits in managing various chronic diseases, however, the assessment of how such a technology may influence asthma outcomes is understudied. The CANATEXTS intervention is a step to build the knowledge base, and provide evidence to health professionals and decision makers about the applicability of TH as a complementary approach to current asthma self-management practices. This protocol summarises the design and implications of CANATEXTS, which aims to improve patients' access to an individualized asthma action plan through a digital device, and improve their interactions with care providers via a telecommunication approach to improve asthma control. If the proposed TH intervention proves efficacious, it may improve future care of asthma patients, reduce patient burden, and minimize excessive healthcare costs from unnecessary hospitalization and ED visits.

Declarations

Ethics approval and consent to participate: This research will involve human participants. Participants will be asked to sign an informed consent form before participating in the study. For each stage of this study, separate ethics applications and amendments will be prepared, and ethics approvals will be obtained from the University of British Columbia (UBC) Office of Behavioural Research Ethics.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: Each author has made substantial contributions to acquiring the data, and helped to write, edit, and prepare the manuscript. IP and JMF conceived and designed the study. IP and NT helped acquire the data, helped with data analysis and interpretation of results. IP drafted the manuscript, and the rest of the co-authors (CB and NT) critically revised the manuscript and provided final approval for submission. All authors contributed to the manuscript development and revisions, read and approved of the submitted version and agreed to be accountable for their own contributions. All authors agreed to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Trial status: The CANATEXTS trial is not yet recruiting. Recruitment is expected to begin January 2023.

Date and version identifier: Protocol version #9. April 18th, 2022.

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Tables

Table: Sample size calculation: With a type I error of 0.05 (two-sided) and 80% power. These numbers have NOT accounted for 10% dropout yet.

Exacerbation rate for control group	Over-dispersion parameter	Relative risk (intervention vs. control)	Sample size
0.771	1.0859	0.85	1718 (859 per group)
0.771	1.0859	0.80	920 (460 per group)
0.771	**1.0859**	**0.75**	**560 (280 per group)**
0.771	1.0859	0.70	370 (185 per group)
0.771	1.0859	0.65	256 (128 per group)
0.771	1.0859	0.60	186 (93 per group)

Figures

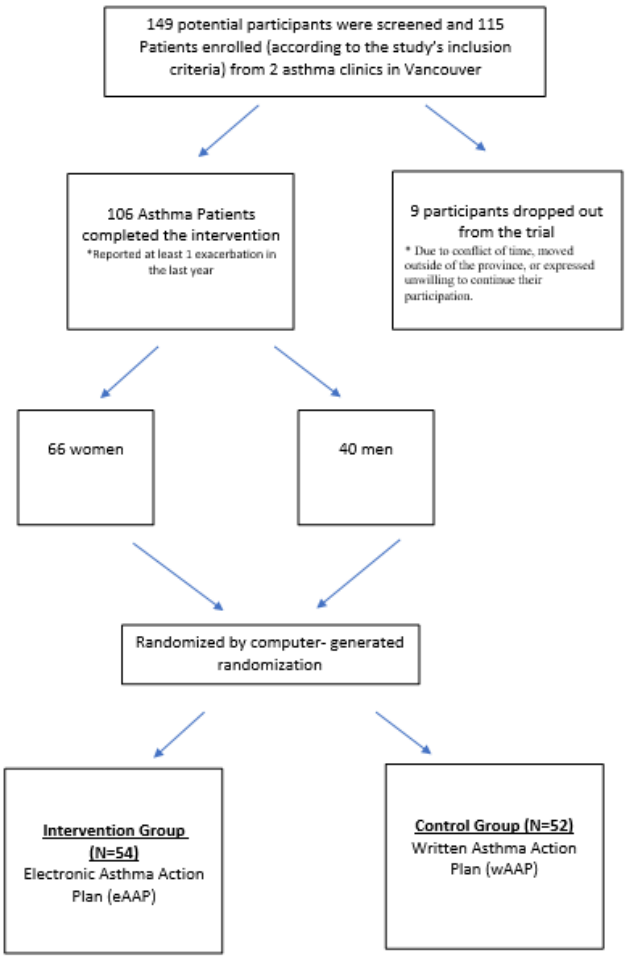

Figure 1

Feasibility (Pilot) study metrics

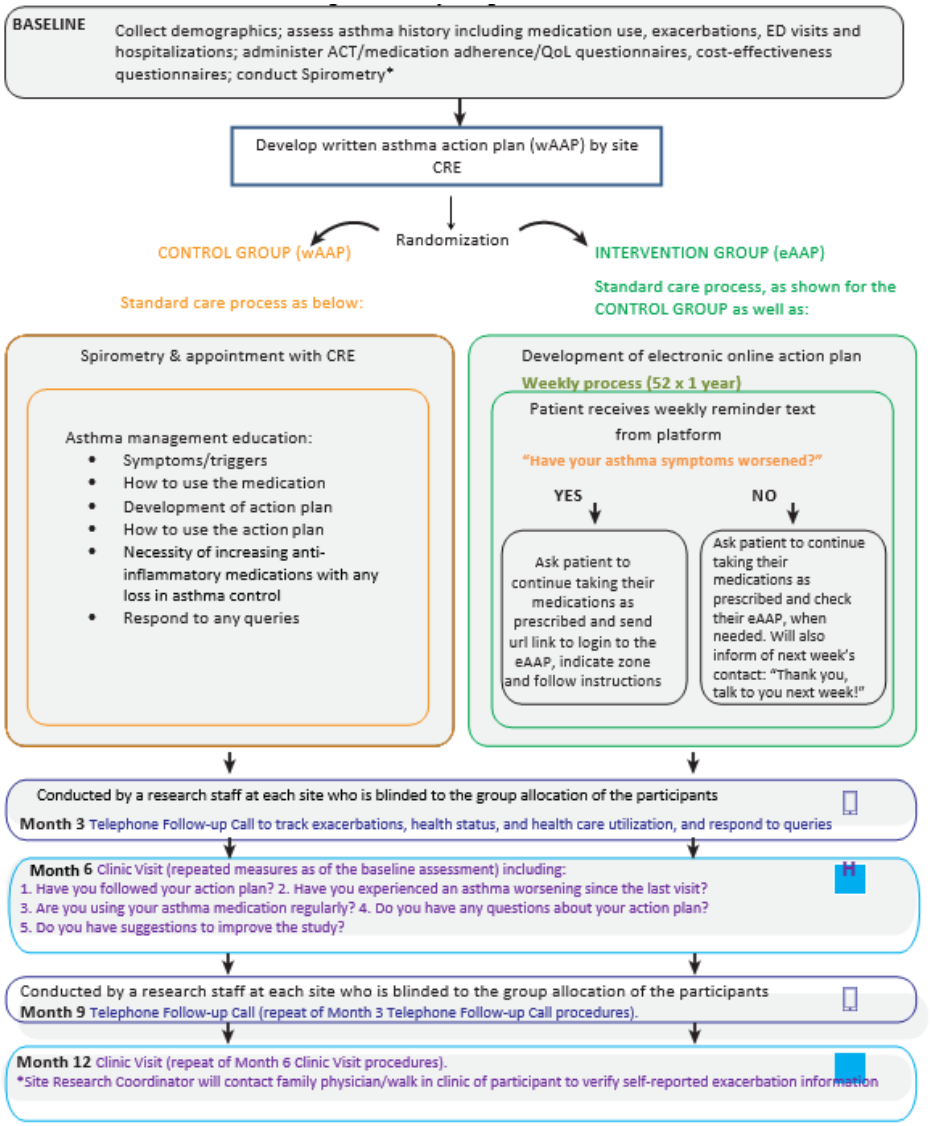

Figure 2

Study design flow chart

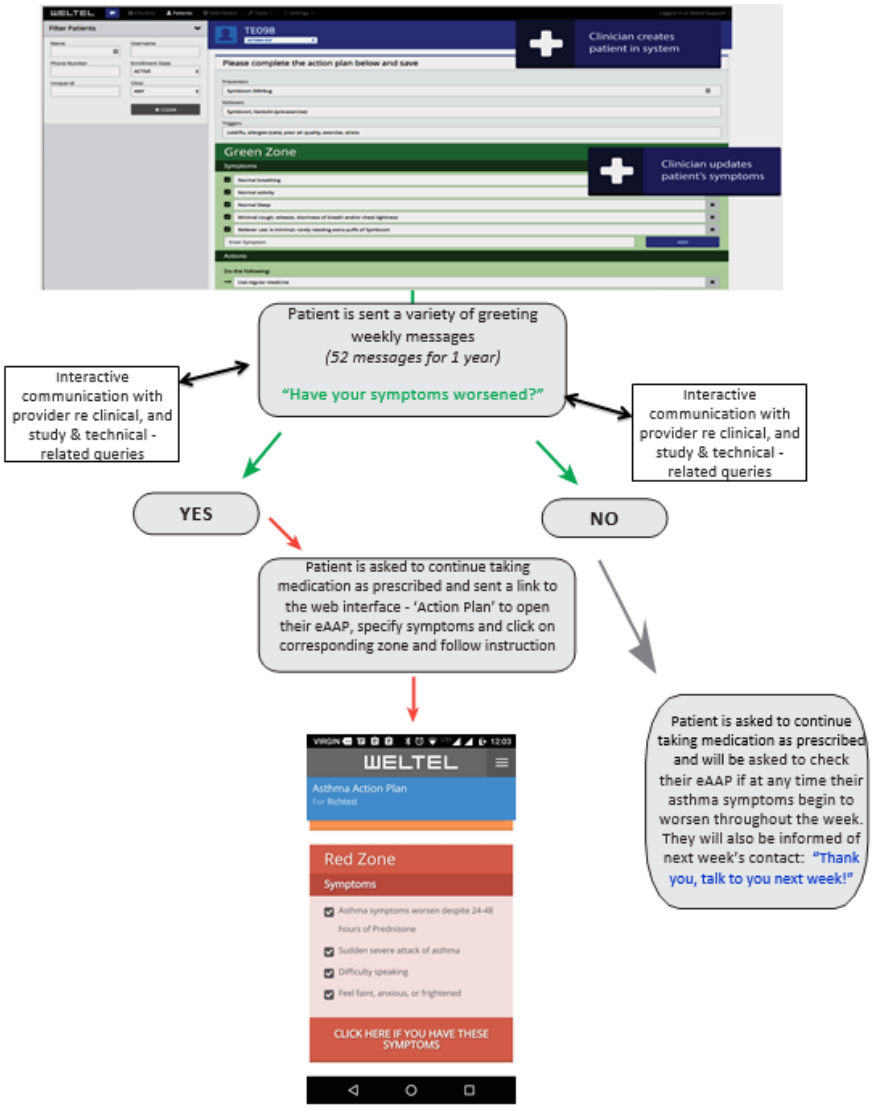

Figure 3

Interactive weekly text messaging process in electronic Asthma Action Plan

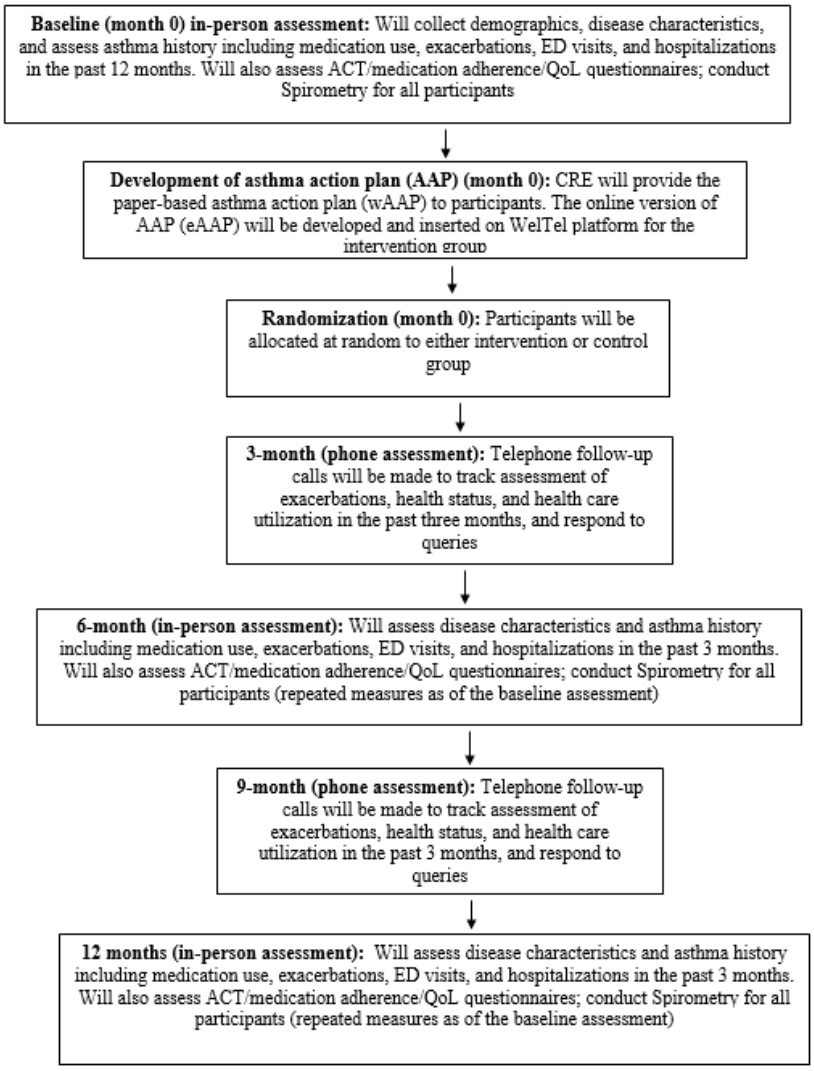

Figure 4

Data collection flowchart for all participants

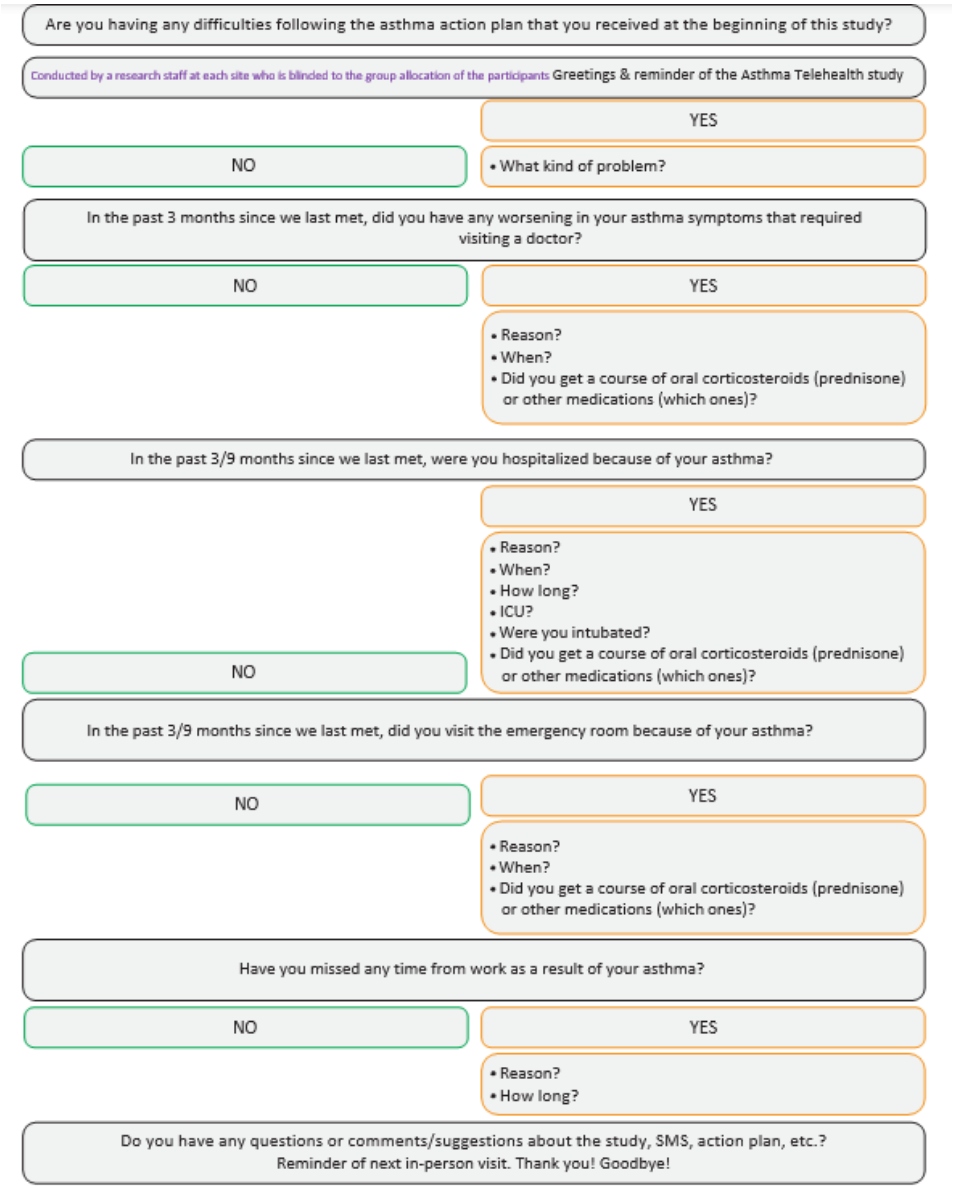

Figure 5

Asthma Telehealth - 3- and 9-months Telephone Follow-up Interview Protocol & Questions

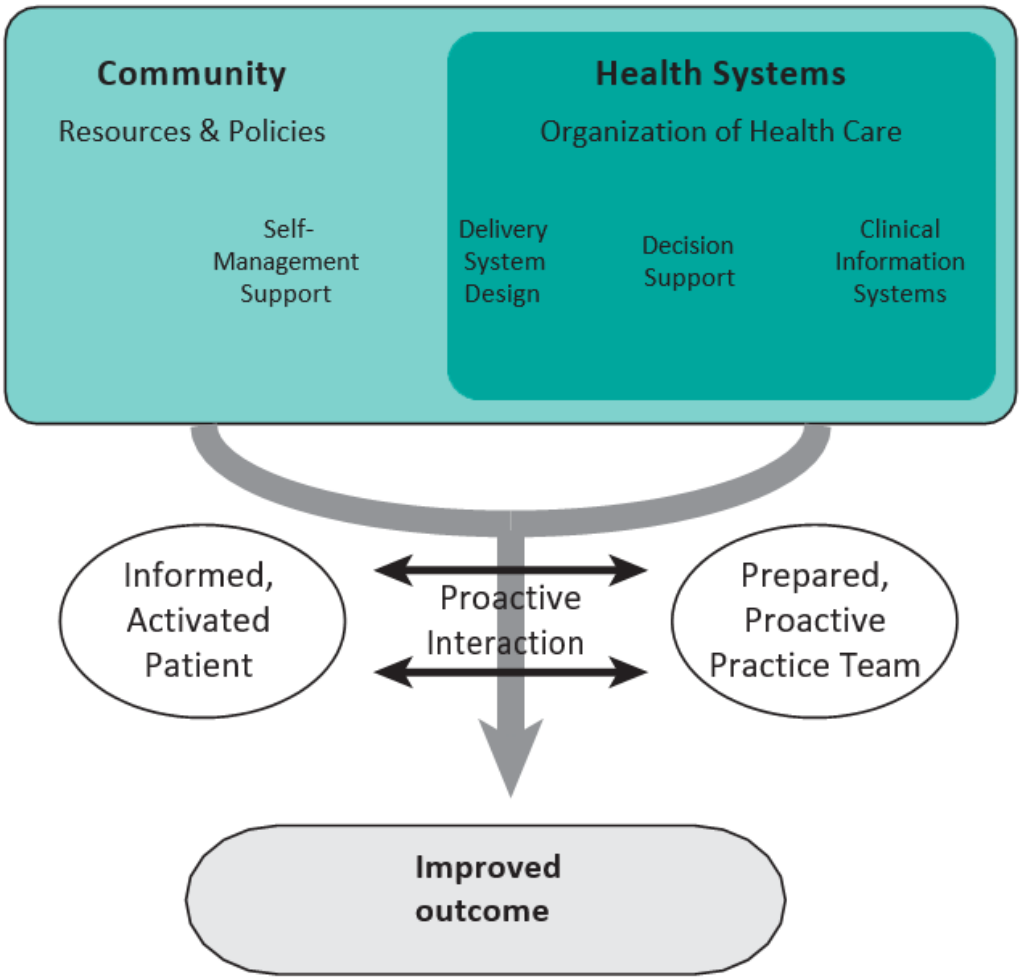

Figure 6

Chronic Care Model (CCM)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AsthmaTelehealthArticleSPIRITTrialsApril182022.doc