Adaptive web-based stress management programs among adults with a cardiovascular disease: A pilot Sequential Multiple Assignment Randomized Trial (SMART)

Sylvie Lambert, RN, PhD, Associate Professor, Ingram School of Nursing, McGill University; Scientist, St. Mary's Research Centre

Steven Grover, MD, MPA, FRCPC, Professor, Department of Medicine, McGill University

Andréa Maria Laizner, RN, PhD, Assistant Professor, Ingram School of Nursing, McGill University & Nursing Practice Consultant – Research, McGill University Health Centre; and Associate Investigator, Cancer Care Program, Research Institute of the McGill University Health Centre.

Jane McCusker, MD, DrPh, Professor Emeritus, Department of Epidemiology, Biostatistics and Occupational Health, McGill University & Principal Scientist, St. Mary's Research Centre

Eric Belzile, St. Mary's Research Centre

Erica Moodie, PhD, Professor, Department of Epidemiology, Biostatistics, and Occupational Health, McGill University

John William Kayser, RN, MSc(A), PhD, CPMHN(C), Nurse Clinician in Mental Health, Guichet d'accès en santé mentale adulte, CIUSSS du Centre-Sud-de-l'Île-de-Montréal

Ilka Lowensteyn, MSc., Kinesiologist Clinimetrica

Michael Vallis, PhD, R Psych, Associate Professor, Department of Family Medicine, Dalhousie University

Mathieu Walker, MD, Associate Professor, Cardiologist and Director, Division of Cardiology, St Mary's Hospital Centre

Deborah Da Costa, PhD, Associate Professor, Department of Medicine Medicine, McGill University & Scientist, Center for Outcomes Research and Evaluation (CORE), Research Institute of the McGill University Health Centre

Louise Pilote, MD, MPH, PhD, Professor, Department of Medicine, McGill University & Investigator, Center for Outcomes Research and Evaluation (CORE), The Research Institute of the McGill University Health Centre

Cindy Ibberson, St. Mary's Research Centre

Judith Sabetti, St. Mary's Research Centre

Manon de Raad, St. Mary's Research Centre

ABSTRACT

Objective: Self-directed, web-based stress management interventions in cardiovascular diseases (CVD) show promise, yet up to 60% of individuals may not benefit from these interventions and require additional support. Sequential Multiple Assignment Randomized Trial (SMART) is an innovative design for adapting interventions to patient needs to enhance effectiveness. This pilot SMART study assessed the feasibility, acceptability, and clinical significance of an web-based, stress management intervention using a stepped-care approach for CVD patients.

Materials and Methods: Fifty-nine patients with CVD and moderate stress were randomized to either a self-directed 6-week, web-based self-directed stress management program (n = 30) or the same intervention plus weekly lay telephone coaching (n = 29). At 6 weeks post-randomization, non-responders were re-randomized to continue with their initial intervention or switch to motivational interviewing (MI) for another 6 weeks. Feasibility and acceptability were evaluated and changes in stress and quality of life were assessed for clinical significance.

Results: SMART procedures were feasible in terms of the proportion of men and women recruited (44:56), missing data (< 10%), and refusal rates (< 30%); however, recruitment was slower than expected. No major protocol infringement was noted. In terms of acceptability, attrition rates were higher among non-responders (39.1%) than responders (3.7%), and almost twice as high in the self-directed group than the lay coach group. The self-directed group also reported low levels of satisfaction (47%). On average 1.7/5 modules were completed. The magnitude and direction of effect sizes generally exceeded the a priori clinical benchmark of 0.2, except for the group that initially received lay coaching and switched to MI after 6 week.

Conclusion: Results suggest that a larger trial would be feasible; however, issues pertaining to attrition and satisfaction for non-responders and those in the self-directed group need to be addressed.

INTRODUCTION

Cardiovascular diseases (CVDs) are primary causes of mortality worldwide, with substantial comorbidity.[1] High stress is one well-documented factor in CVD onset and progression.[2-5] A 2019 study of stress-related disorders in CVD patients within the general population found a robust association between stress-related disorders and multiple types of CVD, independent of family history and history of somatic or psychiatric diseases, particularly for disease onset before age 50.[6] Elevated cortisol levels, decreased insulin sensitivity, increased heart rate, peripheral vasoconstriction and impaired endothelial functioning are associated with stress,[7] exacerbating physiological and behavioral risk factors for CVDs.[2-5] High stress compromises patients' self-efficacy[8] and illness self-management,[9] affecting their ability to navigate health systems, coordinate care, and adhere to treatment.[10 11] The incorporation of stress management into effective health management is urgently needed.

Stress management programs can expand individual coping strategies and reduce stress.[12] Traditionally delivered face-to-face,[13] these programs typically involve cognitive (e.g. problem-solving,) and behavioral (e.g. relaxation, physical activity) skills training. Incorporating psychological or psychoeducational programs, including cognitive behavioral therapy (CBT) and stress management, into standard care for cardiac patients reduces mortality and morbidity and improves physiological outcomes (e.g., blood pressure) and reducing stress and anxiety.[14-17] However, it remains unclear which components of these complex interventions are effective, and for whom.[18] Implementation barriers included cost [19], insufficient program capacity, [20] lack of physician referral, and patient reported issues (distance and travel, perceptions that they could manage independently and severe weather [21]), resulting in 14-43% attendance among eligible patients.[20]

The search for alternative ways of delivering interventions has led to strong interest in the Internet as cost-effective, scalable, and more readily available.[22 23] Although no meta-analyses of web-based stress management programs for CVD were identified, meta-analyses/reviews with other populations[24-31] reached three conclusions. First, most web-based interventions are self-directed (unguided) and based on CBT, producing small, but statistically significant effect sizes (0.13-0.16) [24 26 27]. Second, guided web-based interventions led by a therapist have demonstrated moderate to large effect sizes for improving quality of life (QOL), depression and anxiety.[28 29] Third, effective web-based interventions are typically interactive and tailored,[24 25] focusing on skills-training[24] and using multiple modes of patient contact including e-mail[26] and online social support.[32] Despite the advantages of web-based interventions, patient adherence remains challenging,[33 34] averaging 30% in self-directed interventions for depression,[33] with factors such as low educational levels,[33] low computer literacy, psychological distress and lack of motivation[34] to consider. Potentially due to poor adherence, RCTs have reported that 40-60% of patients using self-directed web-based interventions are non-responders (i.e., they do not derive the anticipated benefits).[35-37]

This suggests that to address adherence issues and enhance outcomes in web-based interventions attention must be given to the type of support or guidance provided throughout the intervention and that this support must be tailored to patient needs (instead of assuming that one size will fit all). Systematic reviews have reported that guided interventions are superior to unguided interventions for patient adherence, including guidance by lay coaches or non-mental health professionals.[38-40] Motivational interviewing (MI), a professionally based counseling approach aimed at enhancing motivation by exploring reasons for change,[41] was identified as particularly effective for decreasing behavioral CVD risk factors while increasing QOL and

treatment adherence.[42] Moreover, MI produced significantly greater decreases in depression compared with usual care.[43 44]

Sequential Multiple Assignment Randomization Trials (SMARTs) represent the latest generation in experimental designs for developing and evaluating adaptive interventions that include (a) identified time points for treatment decisions, (b) tailored patient-related variables, (c) defined type, intensity and duration of interventions, and (d) overarching decision rules.[45-47] SMARTs offer distinct advantages in terms of varying interventions across decision points,[47] engaging the same participants through initial and subsequent interventions, favoring hypothesis generation around moderators of sequenced interventions,[48] and altering interventions to mitigate against non-adherence and attrition among non-responders.[49] No known study has used SMART to evaluate a stress management programs in CVD with varying levels of support across time for non-responders.

The objective of this pilot study was to examine the feasibility, acceptability and clinical significance of an adaptive, web-based stress management intervention based on a stepped-care approach for patients with CVDs, using a SMART design. Feasibility was defined as the practicality of implementing the SMART procedures and offering different types and levels of support in conjunction with a web-based stress management program, using the following measures: fidelity, reach, recruitment and questionnaire completion rates.[50] Acceptability was defined as patient views of the programs, including satisfaction with different types of support offered, appropriateness of program adaptations for non-responders, as well as attrition rates, program adherence and skills learned.[50] Specific criteria were set *a priori* to evaluate feasibility and acceptability, as follows:

- The SMART procedures were feasible if (a) across sites, two to three patients consented per week, (b) refusal rate was less than 30%,[33] (c) missing data are less than 10%,[51] (d) men and women were reached in a proportion of at least 40:60, (e) the programs were delivered by the research team as planned to 90% of the patients, and (f) protocol infringements were amenable to change before the larger SMART.
- The programs were acceptable if (a) attrition was similar across responders and non-responders, and in total did not exceed 20%,[24] (b) 60% of participants report high adherence,[33] and (c) 75% of participants are satisfied.
- An appropriate measure of clinical significance for a pilot is the effect size (ES).[52] The programs were considered clinically (not statistically) significant if a minimal effect size of 0.2[53] on either primary outcome (stress or QOL) was found.

MATERIALS AND METHODS

Design

A multi-center SMART with two intervention stages was piloted.[54] The Complex Interventions Framework[55] and CONSORT checklist,[56] adapted to pilot trials,[52] informed the design. Figure 1 presents the overall study design.

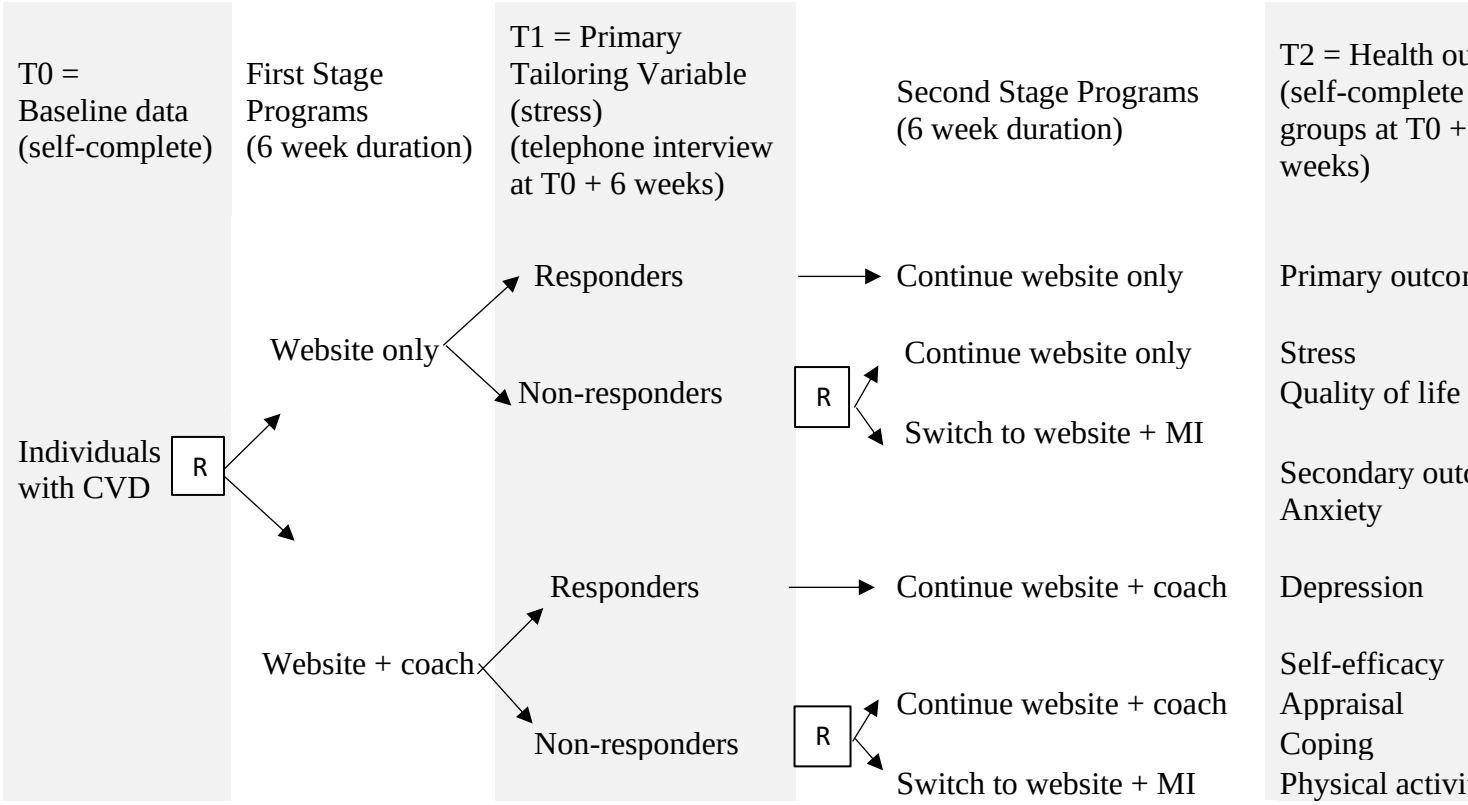

Figure 1. Sequential Multiple Assignment Randomization Trial (SMART) design. Non-responders = participants whose stress scores did not improved by at least 50% or who were not below the threshold DASS score of 16.

Participants

Patients with a physician-confirmed diagnosis of CVD, at 3 months or more following diagnosis or most recent CV event, were enrolled in the study. Other inclusion criteria were: reports moderate stress (measured as a score of ≥ 18 on the stress subscale of the Depression, Anxiety, and Stress Scale (DASS),[57] at least 18 years old, did not participate in a stress management program in the previous year, can regularly access a computer equipped with Internet and email, and understands English or French. Patients who were hospitalized or living in long-term care residences and those with moderate-severe cognitive impairment, severe stress (DASS score $\geq$ 34), suicidal intent, or currently receiving psychological treatment were excluded.

Sample size

The required sample size for the pilot SMARTs [58] was 44, with 90% probability of 4 patients completing all stages of the intervention and 40% estimated response rate to the initial intervention.[35-37] The required sample size was increased to 55 to account for an average 20% attrition rate.[30]

Recruitment

Recruitment occurred in cardiovascular clinics at three participating sites in Montreal, Quebec and one in Halifax, Nova Scotia, Canada, and online through local community organizations. Clinicians introduced the study to patients during scheduled appointments or sent an invitation letter to those without an appointment during the study period. Clinic posters and pamphlets invited self-referral, while dissemination of the project through social media and email lists, newsletters and websites extended recruitment to the community. An experienced research assistant completed the eligibility interview with interested patients, and those eligible were directed to an online consent form and the baseline (T0) survey.

Randomization

Participants were randomized (stratified by recruitment source and stress level) on a 1:1 basis and random block sizes of two or four enforced balance between groups.[59] A computer-generated randomization schedule was programmed into a secure randomization algorithm, accessible only to the study co-ordinator. First stage non-responders (participants whose stress scores did not improved by at least 50% or who were not below the threshold DASS score of 16)

were then randomized to the second stage programs (see Figure 1) using a similar approach at 6 weeks post-intervention.

First and second stage stress management programs

Three stress programs were offered across two intervention stages (see Figure 1). In Stage 1, participants were randomized to either: (a) a self-directed web-based stress management program (Website-only) or (b) the web-based stress management program and lay coach (Website+coach). Non-responders were then re-randomized to continue with their Stage 1 assignment or to a more intense intervention including the web-based stress management program and MI (Website+MI). The sequence of the programs was based on an overall stepped-care approach, whereby minimal intensity support was initially favored and more intense support was offered only to those who needed it.[60] Table 1 details the differences between Website+coach vs. Website+MI.

Website-only. Participants in this group received *My Health CheckUp* (http://myhealthcheckup.com/index.php) and were invited to work through five core stress management modules, with each module including an information component (presented as a slide show) and an online practice-based component. The five modules were (fixed sequence):

1. Stress diary: impact of stress and stress diary to record events and levels of stress.
2. Physical activity: benefits of physical activity, tips for getting started, and a physical activity tracker.
3. Deep breathing and relaxation: relaxation techniques and audio/video guides.
4. Negative thoughts: CBT and thought tracker to recognise and address negative thinking.

5. Sleep hygiene: sleep and sleep hygiene habits and online tool to record application of sleep hygiene techniques and effect on quality of sleep.

Participants were encouraged to access the content every day and spend some time using the practice tools. Each module was meant to be completed within a week. Participants always had access to the content of all modules, including three optional modules on problem-solving, assertive communication, and time management which were information based only.

Website+coach. These participants received *My Health CheckUp* (as described above) as well as weekly, 10-15-minute telephone from a trained, lay coach to provide information and guidance on using the modules. The coach started the calls by greeting participants, setting an agenda for the call, checking on progress in use of the intervention, and administering the short Perceived Stress Scale[61] to help identify specific needs. The calls concluded with setting a SMART goal for the next week and making an appointment for the next call.

Website+MI. The website+MI group included six weekly, 30-45 minute telephone-based MI sessions, in addition to continuation with *My Health CheckUp*. A Master's-level registered nurse with over 11 years of MI experience with various patient populations delivered the intervention. The goal of MI was to build and consolidate patient motivation and confidence in adopting the recommended stress management techniques or the stress management program, through four basic processes: engaging with the patient, having a focused agenda for the session, evoking personal motivation and planning for adoption of a specific stress management technique or use of the program.[41]

Table 1: Intervention elements for Website+coach vs. Website+MI

Intervention Elements	Lay Coaching	Motivational Interviewing
Sessions	6	6
Length	15 minutes	30-45 minutes
Frequency	1 x per week	1 x per week
Duration	6 weeks	6 weeks
Goal	Provide information and facilitate use of the website	Strengthen motivation and confidence for adopting the stress management skills or techniques informed by the program.
Approach	Not counselling, provides information with a positive/encouraging attitude	Formal counselling, uses the MI processes
Skill level	Requires a low level of skill to implement	Requires a significant level of skill to implement, practitioner is a health care professional
Content	• Agenda is pre-determined by coach based on scripts • Ask about use of the modules, but do not explore ambivalence or barriers • Guide participants through modules and through SMART goal setting • Help participant select tools based on their needs	**Engaging:** foster collaboration and confidence in the MI practitioner-participant relationship; **Focusing:** conversation to focus on the use of the stress management program or technique; **Evoking:** elicit participants' personal motivation toward the use of the stress management program or technique; **Planning:** when the participant is ready, consolidate; commitment to a change plan aimed at adopting a stress management technique found in the program.

Blinding

Participants were not blinded to group allocation, as the programs were described in the consent form. However, they were blinded to the specific study objectives, reducing potential response biases.[62]

Data Collection

Participants completed three surveys: at baseline (T0), after completion of Stage 1 programs (T1), and after Stage 2 programs (T2). T0 and T2 surveys were administered online using SimpleSurvey. The T1 survey was completed over the phone.

The T0 survey included all the reliable and valid self-administered measures to capture the primary (stress and QOL) and secondary outcomes of interest. Stress was measured with the 7-item stress subscale of the *Depression Anxiety Stress Scale (DASS)* (alpha=0.88-0.95).[57]·[63] For health-related QOL, the 12-item *Medical Outcome Survey Short Form (SF-12)* (alpha=0.73-0.89) [64] measured physical (Physical Component Score) and mental (Mental Component Score) well-being. Self-efficacy was measured with the 6-item *Self-Efficacy for Management of Chronic Disease* scale (alpha=.85).[65] Patient illness appraisal (threat, harm, loss or challenge) was measured using *Kessler's Cognitive Appraisal of Health Scale*, which includes 28 items (alpha > 0.70).[66] The 28-item *Brief COPE* (alpha = 0.60-0.90) [67] measured 14 individual coping strategies. Patient self-reported activity levels (weekly minutes of walking, moderate-intensity and vigorous-intensity activity) were calculated using the 7-item *International Physical Activity Questionnaire* (alpha = 0.89).[68] The survey also included socio-demographic items and a validated self-report measure of disease burden.[69 70]

At T1, the study coordinator called participants and reassessed stress using the corresponding subscale of the DASS (the primary tailoring variable, see Figure 1).[57] Participants were also asked open ended questions on what they liked and did not like about the program so far.

At T2 (12-13 weeks post-T0), participants completed the same survey as T0 plus the 8-item Client Satisfaction Questionnaire (CSQ).[71] Participants were also asked to report on their use of health and community-based services for usual care and on any changes in diagnoses.

Additional data collection included a study log to track participant recruitment, eligibility at screening, and numbers/characteristics of study decliners and dropouts (including reasons) as well as patient website usage (automatically recorded). Fidelity of the coaching intervention was

measured by the study coordinator who completed a checklist for a random sample of five coach call recordings and logs. For fidelity of the MI intervention, an independent MI interventionist completed the Motivational Treatment Integrity Code (MITI 4.1)[72] for a random sample of five recorded MI sessions.

Data Analysis

For feasibility, data from study logs were used to calculate consent and refusal rates as well as attrition. The percentage of missing data was calculated by examining survey completion. Item and total mean satisfaction (CSQ) scores were calculated to measure acceptability, wherein a total score of at least 24/32 = satisfied. Percentage of withdrawals was calculated at each critical decision point and the groups compared. High adherence to the website was operationalized as completion of at least 4 out of the 5 modules, with completion of a module defined as: (a) clicking through at least 75% of the slides for the information component (slideshow) and (b) having used the practice component at least 3 times.[73-75] Adherence to coaching/MI counseling was categorized as: non-adherence (<25% of phone calls completed), moderate adherence (25-50%), or high adherence (>50%). For each outcome and study group comparison, the effect size was calculated as the mean difference between the two groups divided by the pooled standard deviation.[53]

RESULTS

Participant recruitment

See Figure 2, 183 patients were referred and of these 59 were randomized. The two most common reasons for non-eligibility were a DASS score under 16 (74%) or concurrent counseling

(15%). The total refusal rate, including loss to follow-up, was 43/183 = 23.5%, satisfying the 30% feasibility threshold. Fifty nine patients were randomized over the 45-week recruitment period, falling short of our enrolment goal of 2-3 patients per week.

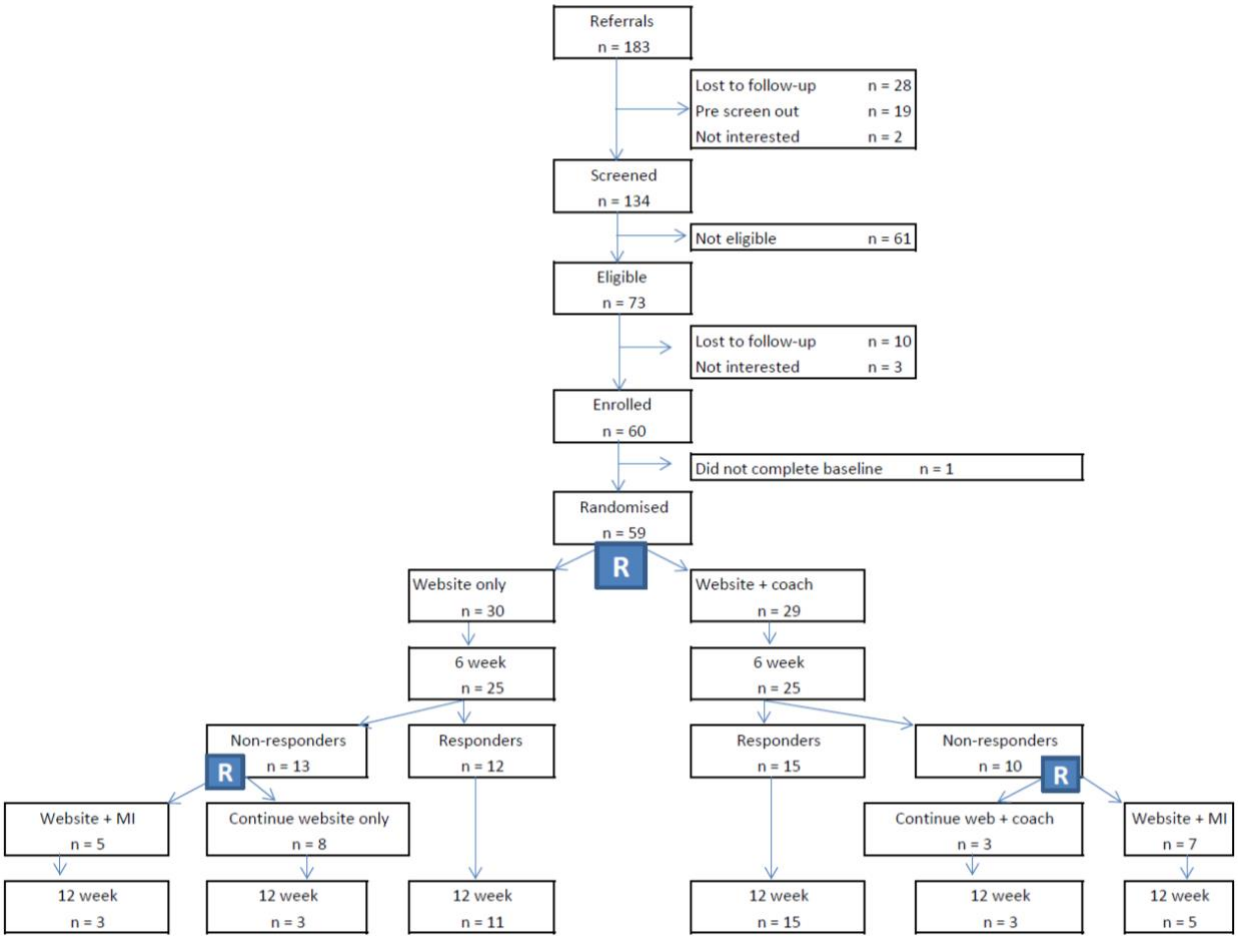

Figure 2. Flowchart for the Adaptive web-based stress management program SMART pilot study

Participant characteristics

See Table 2 for baseline participant characteristics. Overall, 44% of participants were men, which meets our minimal feasibility criterion. In terms of age, over 54% of study participants were 40 – 64 years old and 39% were at least 65 years old. Slightly more than half (57.6%) of

participants were married, and similarly just over half (55.9%) had a university education. Study groups were comparable on most demographics.

Table 2: Participant characteristics (n=59) in the Adaptive web-based stress management program SMART pilot study

	Website-only (n=30)		Website+coach (n=29)	
Variables	**n**	**%**	**n**	**%**
Age				
18-39	2	7	2	7
40-64	15	50	17	59
65+	13	43	10	34
Sex				
Male	15	50	11	38
Female	15	50	18	62
Marital status				
Married	15	50	19	66
Common law	3	10	0	0
In a relationship (not living together)	1	3	1	3
Single	5	17	6	21
Divorced	4	13	3	10
Other	2	7	0	0
Highest level of education				
Primary school	1	3	0	0
Secondary school	5	17	3	10
Certificate	8	27	9	31
University degree	16	53	17	59
Employment situation				
Full time	8	27	11	38
Part time	0	0	2	7
Self-employed	5	17	6	21
On leave	2	7	1	3
Retired	13	43	7	24
Other	2	7	2	7
DASS-Stress (0-42), at baseline, mean (SD)	18.8 (6.5)		19.4 (7.3)	
Normal (0-14)	10	33	10	34
Mild (15-18)	7	23	5	17
Moderate (19-25)	8	27	8	28

	Website-only (n=30)		Website+coach (n=29)	
Severe (26-33)	4	13	5	17
Extremely severe (34+)	1	3	1	3
Comorbidity score (0-110), mean (SD)	12.4 (8.6)		13.9 (9.5)	
Cardiac	22	73	20	69
Hypertension	17	57	12	41
Vision	14	47	8	28
Stomach	12	40	13	45
Back pain	12	40	18	62
Cholesterol	11	37	13	45
Osteoarthritis	11	37	9	31
Obesity	10	33	17	59
Circulatory	7	23	6	21
Hearing	7	23	6	21
Thyroid	7	23	5	17
Rheumatic	4	13	3	10
Heart failure	4	13	5	17
CVA	4	13	4	14
Osteoporosis	3	10	6	21
Cancer	3	10	1	3
Colon	3	10	8	28
Bronchitis	2	7	3	10
Asthma	2	7	4	14
Rheumatoid-arthritis	1	3	4	14
Diabetes	1	3	3	10
Other	8	27	3	10

Retention and attrition

Overall attrition was 32% (n = 19, Figure 2), higher than our a priori benchmark of 20%. Attrition was higher in the Website-only (13/30 = 43.3%) group vs Website+coach (6/29 = 20.7%) group. Attrition was highest among non-responders in the Website-only group re-randomized to the same intervention in Stage 2 (63%).

Missing data

Missing data on demographics and primary outcomes were 0-1%. For the secondary outcomes, missing data at baseline were between 0-3%; however, at follow-up missing data did not meet our feasibility threshold for the Brief COPE-Denial (13%) and Self-Efficacy scale (15%). The online survey was initially programmed to force participants to complete the missing items, but participants reported abandoning the survey altogether if they could not proceed leaving selected items unanswered.

Adherence to the stress management programs

Adherence data are presented in Table 3 (information and practice components). On average 1.7/5 modules were completed by participants. The information slide shows most often completed (at least 75% of slides viewed) were introduction (68%), stress diary (66%), relaxation (53%), and physical activity (53%). The practice component most often used was the stress diary, with 65% of participants clicking at least three times on it. The practice component least used was negative thought (10%). When considering our definition of module completion, 44% of participants completed the stress diary module and as few as 7% completed the CBT module. In terms of coach calls, 76% of participants received 4-6 calls (mean = 4.1, SD = 1.7), with an average duration of 36.5 minutes (SD = 13.1 minutes). Adherence to the MI calls (n = 8) was as follows: two participants refused all calls, two received between 25-50% of the calls and four received > 50%.

Table 3. Web-site use by study group among 12-week completers

	Completers (n=40)							
	Overall (n=40)		Website-only (Stages 1 & 2) (n= 14)		Website+coach (Stages 1 & 2) (n= 18)		Received MI (Stage 2) (n= 8)	
Variables:	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**

	Completers (n=40)							
	Overall (n=40)		Website-only (Stages 1 & 2) (n= 14)		Website+coach (Stages 1 & 2) (n= 18)		Received MI (Stage 2) (n= 8)	
Practice component								
At least 1 "click"								
Stress Diary	31	78	9	64	17	94	5	63
Negative thoughts	18	45	5	36	10	56	3	38
Sleep Hygiene	29	73	8	57	17	94	4	50
Relaxation	28	70	8	57	14	78	6	75
Physical Activity	29	73	7	50	18	100	4	50
At least 2 "clicks"								
Stress Diary	26	65	6	43	16	89	4	50
Negative thoughts	12	30	4	29	6	33	2	25
Sleep Hygiene	24	60	7	50	13	72	4	50
Relaxation	21	53	6	43	9	50	6	75
Physical Activity	23	58	5	36	14	78	4	50
At least 3 "clicks" on different days								
Stress Diary	26	65	6	43	16	89	4	50
Negative thoughts	4	10	1	7	2	11	1	13
Sleep Hygiene	19	48	5	36	10	56	4	50
Relaxation	16	40	5	36	7	39	4	50
Physical Activity	18	45	4	29	10	56	4	50
Information component								
At least 75% of the slides viewed								
Introduction	30	75	11	79	14	78	5	63
Stress Diary	32	80	7	50	17	94	8	100
Recognizing negative thoughts	23	58	6	43	12	67	5	63
Changing negative thoughts	24	60	5	36	13	72	6	75
Scheduling	8	20	2	14	4	22	2	25
Problem solving	17	43	5	36	9	50	3	38
Goal setting	15	38	3	21	10	56	2	25
Communication	19	48	7	50	8	44	4	50
Sleep Hygiene	20	50	5	36	11	61	4	50
Relaxation	25	63	6	43	15	83	4	50
Physical Activity	27	68	7	50	14	78	6	75
Module completion*								
1 Stress Diary	23	58	4	29	15	83	4	50
2 CBT	4	10	1	7	2	11	1	13
3 Sleep	13	33	3	21	7	39	3	13
4 Relaxation	11	28	3	21	6	33	2	25
5 Exercise	16	40	4	29	8	44	4	50
Number of modules								

	Completers (n=40)							
	Overall (n=40)		Website-only (Stages 1 & 2) (n= 14)		Website+coach (Stages 1 & 2) (n= 18)		Received MI (Stage 2) (n= 8)	
0	13	33	8	57	2	11	3	38
1-3	23	58	5	35	14	78	4	50
4-5	4	10	1	7	2	11	1	12
mean (SD)	1.7 (1.5)		1.1 (1.5)		2.1 (1.3)		1.8 (1.7)	

Note. * = A module was considered completed when 75% of the information component was completed and the practice component had been used 3 times. Maximum of 5 modules. For module 2 both components need to have 75+

Fidelity

Data collected from fidelity monitoring of the coach calls confirmed that all reviewed coach calls adhered to the checklist. For the MI calls, The mean for the relational global measures (partnership and empathy) on the MITI was 4.1 (range = 3.5 – 4.5), whereas the mean for the technical global measures (cultivating change talk and softening sustain talk) was 3.5 (range = 2.5 – 4.0). Both scores are within the category "fair", which are just below the optimal category "good," according to the scale guidelines.

Satisfaction

For the Website-only and Website+coach groups respectively, 47% and 74% of participants were satisfied. Within those two groups, 67% of non-responders in the Website-only group who were then randomized to Website+MI were satisfied, whereas 40% of those in Website+coach group who then received MI in Stage 2 were satisfied.

Protocol infringements

No significant protocol infringement occurred. However, some participants' DASS scores were within the eligible range at screening, but by the time of the baseline questionnaire were below

16 (minimum score to be eligible). There were some efforts to mitigate this issue by increasing the eligible screening DASS score to 18; however, this did not resolve the issue. For the purpose of this pilot, these participants were retained.

Clinical significance

As can be noted in Table 4, the magnitude and direction of the effect sizes were generally in the expected directions. In Stage 1, participants seemed to have particularly benefited from the coaching (ES = -0.38), an effect sustained for responders into Stage 2 (ES = -0.63). However, the effect of adding the MI component in Stage 2 for non-responders was mixed. In Stage 2, MI seemed to only benefit the non-responders initially in the Website-Only group (ES = -0.83) and not those initially in Website+coach (ES = 1.90). Anecdotally, participants in Website+coach did not like switching interventionist.

Table 4. Effect sizes at 6 and 12 week (primary outcomes)

Outcomes	Effect Size	Baseline mean (sd)	6-week mean (sd)	12-week mean (sd)	6-week change mean (sd)	12-week change mean (sd)
	DASS-stress					
Stage 1						
6-week completers	-0.38					
Website-only (n=25)		19.3 (6.4)	18.4 (11.0)		-0.8 (10.6)	
Website+coach (n=25)		18.7 (7.2)	14.7 (8.3)		-4.2 (7.0)	
6-week responders at 12 weeks	-0.63					
Website-only (n=11)		17.8 (6.7)	9.6 (4.5)	10.9 (4.6)	-8.2 (7.3)	-6.9 (8.4)
Website+coach (n=15)		15.3 (5.7)	9.1 (2.8)	7.7 (5.4)	-6.3 (8.6)	-7.6 (8.6)
Stage 2						
6-week non-responders (all) at 12 weeks	0.57					
Continued with stage 1 intervention (n=6)		23.0 (6.3)	26.3 (8.7)	15.7 (5.4)		-10.7 (6.2)
Stepped-up to MI (n=8)		26.6 (5.5)	26.8 (6.1)	19.8 (8.2)		-7.0 (6.8)
6-week non-responders (Website-only) at 12 weeks	-0.83					
Continued with stage 1 intervention (n=3)		20.7 (7.0)	32.7 (7.6)	18.7 (6.4)		-14.0 (7.2)
Stepped-up to MI (n=3)		25.0 (4.6)	25.3 (8.1)	13.3 (6.4)		-12.0 (6.0)
6-week non-responders (Website+coach) at 12 weeks	1.90					
Continued with stage 1 intervention (n=3)		25.3 (5.8)	20.0 (3.5)	12.7 (2.3)		-7.3 (3.1)
Stepped-up to MI (n=5)		27.6 (6.2)	27.6 (5.5)	23.6 (6.8)		-4.0 (6.8)
	SF12-PCS					
Stage 1						
6-week responders at 12 weeks	0.40					
Website-only (n=11)		42.7 (14.8)		41.2 (12.4)		-1.5 (8.5)
Website+coach (n=15)		43.6 (10.5)		45.8 (10.9)		2.2 (3.8)
Stage 2						
6-week non-responders at 12 weeks	-0.91					
Continued with stage 1 intervention (n=6)		49.6 (8.2)		51.5 (8.9)		1.9 (2.6)

Stepped-up to MI (n=8)		42.6 (14.8)	43.1 (9.5)	0.5 (8.1)
6-week non-responders (Website-only) at 12 weeks	-0.40			
Continued with stage 1 intervention (n=3)		45.8 (4.9)	46.2 (5.6)	0.4 (2.2)
Stepped-up to MI (n=3)		41 (16.1)	42.8 (10.8)	1.8 (5.6)
6-week non-responders (Website+coach) at 12 weeks	-1.40			
Continued with stage 1 intervention (n=3)		53.4 (10)	56.8 (9)	3.4 (2.5)
Stepped-up to MI (n=5)		43.6 (15.9)	43.2 (10)	-0.3 (9.8)
	SF12-MCS			
Stage 1				
6-week Responders at 12 weeks	-0.04			
Website-only (n=11)		46.3 (6.2)	51.7 (8.6)	5.4 (7.9)
Website+coach (n=15)		45.7 (9.1)	51.3 (8.2)	5.7 (13.1)
Stage 2				
6-week non-responders at 12 weeks	-0.45			
Continued with stage 1 intervention (n=6)		37.2 (10.3)	41.7 (10.1)	4.5 (10.3)
Stepped-up to MI (n=8)		29.3 (5.3)	37.9 (7.3)	8.5 (7.8)
6-week non-responders (Website-only) at 12 weeks	-0.03			
Continued with stage 1 intervention (n=3)		40.7 (9.8)	40.4 (12.9)	-0.3 (3.8)
Stepped-up to MI (n=3)		29.7 (4.2)	40.0 (8.8)	10.4 (5.2)
6-week non-responders (Website+coach) at 12 weeks	-0.85			
Continued with stage 1 intervention (n=3)		33.8 (11.5)	43.1 (9.1)	9.3 (13.4)
Stepped-up to MI (n=5)		29.1 (6.3)	36.6 (6.9)	7.4 (9.5)

Note. Effect size (Cohen's effect size) is defined as the mean difference of the two study groups divided by the pooled standard deviation.
Sd = Standard deviation. All 12-week analyses with completers. SF-12 not administered at 6 weeks.

DISCUSSION

This SMART pilot study examined the feasibility, acceptability, and clinical significance of a web-based, stress management program using stepped-care for CVD patients. A SMART design was chosen as ideally suited for building optimal, multistage treatment strategies adapted to patient needs and preferences, including the best treatments for non-responders.[76] Most of the thresholds for feasibility set in this study were met, but not those for acceptability.

Attrition was higher than the a priori 20% benchmark. Notwithstanding the wide variability in definitions and measurements, a rapid review of attrition rates across 50 trials (see supplementary material) involving 31 guided and 28 unguided interventions revealed that average attrition was, respectively, 30% (range 8.0% - 84.0%) and 40.8% (range 2.0% - 84.0%). The attrition in the present study was lower than average for the guided sub-groups (20.7%) and slightly above for those receiving the unguided intervention (43.3%).

The higher attrition among Website-only participants (relative to the other sub-groups) might be, in part, due to these participants' low satisfaction scores. Anecdotally, participants reported having technical and navigation difficulties with the Website. In other studies poor computer literacy, equipment malfunction, and general discomfort with internet services have been associated with high attrition.[77 78] Most of the attrition in the Website-only group occurred among non-responders at Stage 2, indicating no advantage in re-randomizing non-responders to continue with Website-only beyond Stage 1. This corroborates previous studies reporting the lack of support and feedback inherent in unguided interventions as contributing to high attrition.[77 79] In keeping with the broad aim of SMARTs to enhance retention among non-responders, the Website-only group could be stepped up in Stage 2 in future trials. This is further supported by the large ES noted in participants in the Website-only group re-randomized

to MI. Other reasons for high attrition in the Website-only could include low participant expectations of the program or that the content did not meet participants' needs.[78] To address this, a needs assessment at the outset of the program might help tailor the content or inform participants how the program can directly address their needs.[80]

Although improvements over time in stress were observed among all groups, smaller improvements from 6 to 12 weeks were unexpectedly noted particularly in the group initially in the Website+coach group stepped up to MI in Stage 2. As our MI intervention was manualized, perhaps the challenge of adhering to a manual versus being purely client-centered may explain the small improvement as well as the wide range of scores found on the MI fidelity measure. One meta-analysis found that manualized MI interventions yielded a smaller pooled effect size than those delivered without a manual.[81] Therefore, future research may consider implementing great flexibility with an MI manual, or implementing no manual at all.

Interestingly, the same MI group (Website+coach in Stage 1) also reported a low satisfaction score. As changing interventionist, from coach to MI, occurred only in this condition, the low satisfaction found is perhaps a reflection of a disrupted patient-therapist relationship. Indeed, a positive patient-therapist relationship is shown to be vital to improvement in outcomes.[85] Also, one other SMART reported high attrition rates (41.7%) among non-responders who switched interventionist from Stages 1 to 2.[86]. A handover meeting among the Stages 1 and 2 interventionists and participants might facilitate this transition; or retaining the same interventionist who can switch from simple coaching to MI may avoid disruption. Further research aimed at understanding the needs of non-responders may provide greater insight to elements of an intervention, including challenges with changing interventionists, which in turn might produce greater improvements than found in this study. Hence, tailoring the therapeutic

support, in content and structure, according to participants' needs, might be more appropriate rather than prescribing a specific approach.

Conversely, the sub-group of participants with the highest satisfaction were those receiving lay coaching. In addition to systematic reviews increasingly corroborating the efficacy of guided web-based interventions [82 83], studies also suggest that, as a low-intensity intervention, these do not have to be guided by highly trained professionals to be effective [38 82]. One study did find that phone-based coaching was more effective for participant retention than email-base coaching.[84] In previous studies, our team has also found that phone-based, lay coach support was effective in guiding use of a self-care depression intervention among patients with a chronic physical condition [85] and cancer survivors.[86]

Adherence to web-based interventions has critical therapeutic implications, as individuals might not be receiving the required "dose" to change outcomes.[87] In the present study, 33% of participants did not complete any modules. A systematic review by Beatty et al. [87] has highlighted that up to two thirds of participants never start the web-based intervention offered at all or drop out early on. The same review found that adherence is slightly higher in guided versus unguided web-based interventions,[87] a trend also observed in the present study. In examining adherence according to the number of modules completed, the literature generally indicates that participants complete on average half of the modules offered.[87] In other studies with interventions based on five modules, average module completion rates were 3.3/5 for guided interventions [73 84 88] and 2.7/5 for unguided interventions.[78 79 89] However, definitions of module or program completion vary widely across studies and the minimal clinical "dose" needed is rarely defined (if at all). Focusing simply on number of modules completed assumes

that all modules are equally important. However, depending on the mechanism of action of an intervention, some modules might be more critical than others to achieve the desired outcome.

The main breach of protocol was randomizing participants whose DASS scores had dropped substantially between screening and baseline, making them non-eligible for the study even after raising the threshold score. One possible explanation is the Hawthorne effect as participants became increasingly sensitized to researcher expectations as they learned more about the study leading up to baseline assessment. Alternatively, the rapid improvement may have reflected patient anticipation of improved health and personal care after acceptance and enrollment in a trial. Such expectations are key motivators for patient participation in clinical trials.[90] A possible mitigation strategy will be to combine screening with the baseline interview.

This study has limitations. Results might have been impacted by navigation issues with the Website and before a larger trial, more usability testing is required. Many participants were recruited from a single site, which already offers rehabilitation to patients with CVDs, and these participants might have been more motivated to participate in the stress program. Strengths include using a low-cost coach model that seems to be efficacious and will be further examined in a larger trial. Also, an almost equal proportion of men and women were included. Rigor was ensured by specifying a priori benchmarks for feasibility and acceptability.

CONCLUSION

Overall, this SMART pilot was feasible; however, some aspects of acceptability need further consideration before a larger trial is undertaken, particularly as it pertained to attrition among non-responders and satisfaction. Once these issues have been addressed, a larger SMART will be

conducted, particularly focusing on stepping up non-responders to the Website-only to lay coaching and putting in place strategies to facilitate the transition lay coaching to MI.

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