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Original Article

A Patient-Led Referral Strategy for Cardiovascular Screening of Family and Household Members at the Time of Cardiac Intensive Care Unit Admission

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ABSTRACT

Background: Screening relatives of patients with ischemic heart disease can identify over half of the population with poorly controlled cardiovascular (CV) risk factors. Family or household members (FMs) may be highly motivated to undergo CV primary prevention screening at the time of their relative's admission to the Cardiovascular Intensive Care Unit (CICU).

Methods: Patients aged ≤ 70 years admitted to a tertiary CICU for an acute coronary event were given a letter to refer FMs for CV screening. Interested FMs underwent CV risk-factor assessment and primary prevention counselling. The objectives were to identify FMs with an intermediate or high modified 10-year Framingham risk score (FRS) and to evaluate whether a family-oriented primary prevention strategy improved CV risk.

RÉSUMÉ

Contexte : Le dépistage des parents proches de patients atteints de cardiopathie ischémique permet d'identifier plus de la moitié de la population présentant des facteurs de risques cardiovasculaires (CV) mal contrôlés. Les membres de la famille ou du ménage (MF) peuvent se révéler très motivés à se soumettre à un dépistage de prévention CV primaire au moment de l'admission de leur parent proche à l'unité de soins intensifs cardiovasculaires (USCV).

Méthodes : Les patients âgés de ≤ 70 ans admis dans une USCV tertiaire pour un événement coronarien aigu ont reçu une lettre les invitant à envoyer des MF pour un dépistage CV. Les MF intéressés ont subi une évaluation des facteurs de risques CV et ont reçu des conseils de prévention primaire. Les objectifs étaient d'identifier les MF présentant un score de risque de Framingham (SRF) modifié

People with a family history of cardiovascular (CV) disease have a higher risk of developing CV disease.[1,2] This increased CV risk is mostly mediated by potentially modifiable risk factors, such as hypertension, dyslipidemia, and diabetes. Screening family members of patients with CV disease can identify more than half of the population with suboptimally controlled CV risk factors and prevent more than one-third of admissions to acute CV care units for premature myocardial infarction.[3,4] However, although CV professional societies advocate screening and targeting relatives of patients with CV disease, there is evidence that adherence to these recommendations is lacking.[4,5] Identifying at-risk family members is particularly important and challenging in regions where people lack access to primary care preventive screening, or where cultural barriers exist. Identifying and targeting high-risk families with CV primary prevention programs could significantly decrease risk-factor burden and improve outcomes in this population.

Hospitalization of a family or household member (FM) is an opportune time to motivate for a change in health behaviour. We previously performed a systematic review and meta-analysis of screening strategies and primary prevention interventions in relatives of patients with coronary artery disease.[6] We found that 9 out of 10 patients are motivated to refer relatives for screening at the time of hospitalization for an acute coronary event, and that three-quarters of relatives were willing to participate in screening programs when directly contacted by a relative.

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Ethics Statement: The research reported has adhered to the relevant ethical guidelines.

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See page 512 for disclosure information.

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Results: There were 51 CV probands who referred 101 FMs (62 family, 39 household; mean age: 44.8 ± 15.3; 65 (64.4%) female) for screening. One-third of FMs aged ≥ 30 years (n = 28 of 84; 32.1%) had a new diagnosis of either hypertension, diabetes, or dyslipidemia. Nearly half of FMs (n = 38; 45.2%) had an intermediate or high modified Framingham 10-year CV risk. In FMs aged ≥ 30 years attending the 6-month follow-up (51 of 84; 60.7%), the mean FRS decreased by 4.6% (from 13.2% ± 12.7 to 8.6% ± 10.0, $P < 0.001$), and 30.4% (7 of 23) of FMs had a low FRS who had initially had an intermediate or high FRS.

Conclusions: A patient-led referral strategy at the time of CICU admission led to a high rate of identification of previously undiagnosed CV risk factors in FMs. Implementing a similar referral program on a larger scale could identify a considerable burden of CV risk.

Résultats : Cinquante et un (51) sujets ayant des troubles CV ont référé 101 MF (62 membres de la famille, 39 membres du ménage; âge moyen : 44,8 ± 15,3 ans; 65 (64,4 %) femmes) à un dépistage. Un tiers des MF âgés de ≥ 30 ans (n = 28 sur 84; 32,1 %) ont reçu un nouveau diagnostic d'hypertension, de diabète ou de dyslipidémie. Près de la moitié des MF (n = 38; 45,2 %) présentaient un score de risques CV à 10 ans intermédiaire ou élevé, sur l'échelle du score de risque de Framingham (SRF) modifié. Parmi les MF âgés de ≥ 30 ans ayant participé au suivi sur 6 mois (51 sur 84; 60,7 %), le SRF moyen a diminué de 4,6 % (de 13,2 % ± 12,7 à 8,6 % ± 10,0, $p < 0,001$), et 30,4 % (7 sur 23) des MF avaient un SRF faible après avoir initialement eu un SRF intermédiaire ou élevé.

Conclusions : Une stratégie d'orientation effectuée au moment de l'admission du patient à l'USCV a conduit à un taux élevé d'identification de facteurs de risques CV non diagnostiqués auparavant parmi les MF. La mise en œuvre d'un programme d'orientation similaire à plus grande échelle pourrait permettre d'identifier un nombre considérable de personnes à risques CV.

Building on our prior study, we hypothesized that a patient-led FM referral strategy at the time of the patient's hospitalization for an acute coronary event would identify undiagnosed CV risk factors. Thus, the objectives of this study were as follows: (i) to implement a patient-initiated referral program of FMs at the time of the patient's index hospitalization for acute coronary artery disease; (ii) to identify FMs at intermediate or high 10-year CV risk; and (iii) to use a family-oriented approach to primary CV prevention in FMs. The results of this study could lead to a care model for FM referral and treatment at the time of patient hospitalization for acute coronary disease.

Methods

Design, participants, and setting

The prospective study was conducted at the Jewish General Hospital (JGH), an academic, tertiary care referral centre in Montreal, Quebec, Canada. The hospital's cardiovascular intensive-care unit has 16 beds equipped for advanced hemodynamic and ventilator support. An outpatient cardiology clinic is adjacent to the inpatient unit. Patients admitted to the hospital from February 1, 2018 to January 31, 2019 were assessed for eligibility into the study by a member of the research team. Inclusion criteria were patient age of ≤ 70 years, admission with a primary diagnosis of an acute coronary condition (acute coronary syndrome or coronary artery bypass grafting without a preceding acute coronary syndrome), and at least 1 first-degree FM aged ≥ 18 years. Acute coronary syndromes included ST-elevation myocardial infarction, non-ST elevation myocardial infarction, and unstable angina.[7] Exclusion criteria were no eligible FMs, inability to contact FMs, distance to study centre too far as determined by the patient, and FMs who have been screened for CV disease in the previous 2 years (based on self-report). FMs with known CV disease were also excluded. A family member was defined as a first-degree relative. A household member was defined as a person who self-identified as a household member. There was no timeframe requirement for cohabitation, and living status was not verified.

In keeping with previous primary prevention studies that have included spouses,[8] household members of the patient were included in the study. Partners and other non-genetically related household members, who may not share hereditary predispositions for CV disease, do share social and lifestyle influences, such as smoking habits, low levels of physical activity, and diet, and have higher rates of CV disease than would be expected.[9]

Younger relatives (aged ≥ 18 years) of the CV patient were also included. Younger relatives (typically aged < 30 years) have been excluded from most screening studies, except those involving cascade screening in familial hyperlipidemia.[6] The optimal screening and management strategy for younger relatives of CV patients is unclear. Early risk-factor assessment and counselling of younger patients may promote lifelong changes in lifestyle choices and behaviours, with long-term benefits.[10]

Eligible CV probands were given a referral letter to give to potentially eligible family and/or household members. The letter contained instructions on how to schedule the initial

screening visit, as well as information about the importance of CV disease primary prevention (Supplemental Appendix S1). FMs who scheduled an appointment but did not attend the initial screening visit were not included. Informed consent for participation in the study was obtained from the patient at the time of enrollment during index hospitalization and from FMs at the time of the initial screening visit. Institutional research ethics approval was obtained for this study. The study was registered at ClinicalTrials.gov (NCT03440645).

Risk-factor screening and treatment

An appointment was offered to FMs within 2 to 4 weeks of the patient's hospitalization in order to maximize the motivation of family members to undergo screening. Prior to the initial visit, participants received blood-test

requisitions for a baseline complete blood count, electrolytes, creatinine, lipid profiles, hemoglobin A1c, fasting blood-glucose levels, liver enzymes, and creatine kinase. At the initial screening visit, a targeted history and physical exam were performed by a cardiologist, and investigations were ordered as needed. CV primary prevention assessment followed the Canadian Cardiovascular Society's recommendations.[5] Weight and body-mass index were recorded, and blood pressure was taken with the BpTRU machine (BpTRU Medical Devices, Coquitlam, BC) in accordance to the Hypertension Canada's guidelines.[11] Existing medical conditions were defined by self-report or prescription of a medication to treat the condition (ie, thiazide diuretic for hypertension). New diagnoses of hypertension were based on Hypertension Canada's diagnostic criteria.[11] A participant was considered to have dyslipidemia if there was a "statin-indicated condition" or if criteria were met to "consider initiating pharmacotherapy" according to the Canadian Cardiovascular Society's dyslipidemia guidelines.[5] For each participant eligible for pharmacotherapy for dyslipidemia or antihypertensive medications, there was a shared decision-making approach in which risks and benefits were discussed. Diabetes mellitus was diagnosed based on Diabetes Canada's criteria (fasting plasma glucose $\geq$ 7.0 mmol/L, random plasma glucose $>$ 11.0 mmol/L, HbA1c $\geq$ 6.5%, or plasma glucose $>$ 11.0 mmol/L 2 hours post-oral 75-gram oral tolerance test).[12] Smoking was assessed by patient self-report.

In participants aged $\geq$ 30 years, a modified 10-year Framingham risk score (FRS) was calculated according to the Canadian Cardiovascular Society guidelines.[5] In participants aged $\leq$ 30 years, a 30-year FRS was calculated. CV risk factors that were identified were treated with evidence-based, society-recommended management.[5,11] If needed, participants were referred to nutritionists, smoking-cessation programs, and other allied healthcare professionals. The results of the risk assessment were shared with FMs to support shared decision-making, which has been shown to improve the likelihood that patients will achieve target risk-factor control.[5]

Participants were given a follow-up appointment 6-months after the screening visit. At follow-up, participants had a physical exam and repeated the lipid, fasting glucose, and HbA1c measurements. Interim follow-up appointments were scheduled as clinically indicated prior to the 6-month follow-up visit.

The CV proband and FMs were encouraged to attend the initial screening visit and all subsequent healthcare interactions. However, the history and physical exam were done without other participants present, in order to preserve confidentiality. CV probands accompanying their FMs to the appointments were encouraged to take their secondary preventive medications and continue follow-up with their treating physician, since up to half of patients who have a myocardial infarction stop taking their evidence-based preventative medications within 12 months of the index event.[13]

Patients were encouraged to continue CV primary prevention efforts with their primary care provider at the end of the study. For patients with a primary care provider, the provider was sent the CV risk assessment with recommendations. For patients without a primary care provider, information was provided on how to obtain a primary care provider.

Data collection

The following data were collected from the index patient: age, sex, ethnicity, primary admission diagnosis, and cardiac unit and hospital length of stay. The following data were collected from FMs: age, sex, ethnicity, relationship with CV patient, whether the patient has a primary care physician and last time seen, CV-related symptoms, medications, weight, BpTRU recording, physical examination findings, and other CV risk factors (eg, obstructive sleep apnea). Low-density lipoprotein (LDL) levels were estimated using the Friedewald formula. When triglyceride levels were high, precluding use of the Friedewald formula, direct LDL levels were obtained.[14] Baseline and 6-month CV individual risk-factor values were recorded (ie, blood pressure, lipid levels, HbA1c), as well as baseline and 6-month modified 10-year FRS. FRS scores of $>$ 30% were recorded as 30%.

Measures

The effectiveness of the screening strategy was measured by the total number of participants aged $\geq$ 30 years identified at intermediate or high risk based on the modified FRS score ($\geq$ 10% risk of a CV event during the following 10-year period). The effectiveness of the primary prevention intervention was measured by the change in percentage of the mean modified Framingham 10-year CV risk score for FMs aged $\geq$ 30 years between the initial visit and the 6-month follow-up. Canadian Cardiovascular Society guidelines recommend CV risk assessment using the modified Framingham 10-year risk score to guide therapy, and repetition of the risk assessment when there is an expected change in risk status.[5]

Data analysis

Continuous data are presented as mean with standard deviation, and between-group differences were tested with the Student t test. Categorical data are presented as frequencies and percentages and were compared using the χ^2 test or the Fisher exact test, as appropriate. The difference in mean modified FRS between the initial visit and the 6-month follow-up visit was calculated using the paired-samples t test. All P values are 2-sided, with $\leq$ 0.05 indicating statistical significance. Statistical tests were done using SPSS 24.0 statistical software (IBM Corp, Armonk, NY).

Results

There were 84 CV probands who agreed to approach FMs for participation in the study (Fig. 1). Of these, there were 51 probands (61%) who referred 101 FMs. The mean age of probands was 57.0 $\pm$ 9.4 years, and 14 (27.5%) were female (Table 1). Nearly half of probands were from an ethnic minority group (n = 23; 45.1%). Probands were admitted for acute coronary syndrome (n = 45; 88.2%) and coronary artery bypass grafting (n = 6; 11.8%). The length of hospital stay was 7.0 $\pm$ 5.1 days. There were no differences in characteristics between patients who referred vs did not refer eligible FMs (all $P > 0.05$).

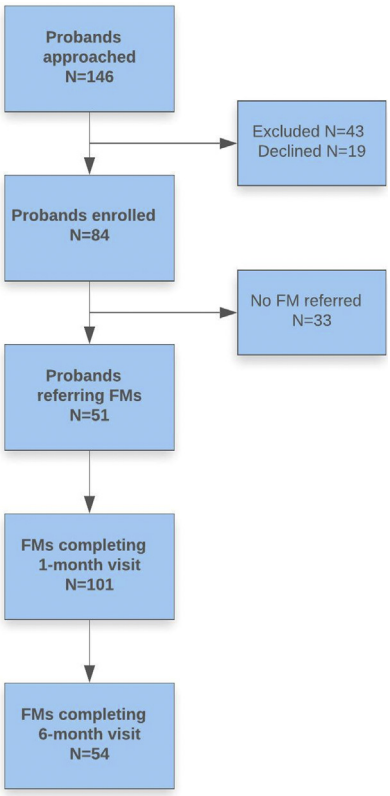

Figure 1. Flow diagram. FM, family or household member.

There were 101 participants who attended the initial screening visit (FMs, n = 62; household members, n = 39). There were 5 FMs who scheduled an appointment but did not show up for the initial screening visit. The mean age of FMs was 44.8 ± 15.3 years, and 65 (64.4%) were female (Table 2). Children (n = 41 of 101; 40.6%) and spouses (n = 27 of 101; 26.7%) were the most common participants. Sixty-one (60.4%) participants had another FM present at their initial visit, and this number ranged from 0 to 6 (median: 2; interquartile range: 1, 2.75). The CV proband was present at one-fifth (n = 20 of 101; 19.4%) of initial visits. At the initial visit, 11 of 101 (10.9%) FMs were already taking statins, and 5 of 101 (5.0%) FMs were initiated on statins. Five (5.0%) of 101 FMs were already taking aspirin. No FMs were initiated on aspirin.

When only participants aged ≥ 30 years were included, 45.2% (38 of 84) of FMs had an intermediate or high risk-modified FRS. The mean modified FRS was 13.6% ± 12.5. One-third (n = 28; 32.1%) of FMs had a new diagnosis of either hypertension, diabetes, or dyslipidemia. For participants without previously diagnosed CV risk factors, there were 7 new diagnoses of hypertension (9.3%), 16 new diagnoses of diabetes (11.8%), and 24 new diagnoses of dyslipidemia (38.1%). Six participants (7.2%) had 2 new CV risk factors, and 1 participant (1.2%) had 3 new risk factors. For FMs aged < 30 years (n = 17), new CV risk factors identified were hypertension (n = 1; 5.8%) and dyslipidemia (n = 4; 23.5%). The 30-year FRS was 3.9% ± 1.2.

There were 51 of 84 (60.7%) FMs aged ≥ 30 years and 3 of 17 (17.6%) FMs aged < 30 years who attended the 6-month follow-up. In FMs aged ≥ 30 years attending the follow-up visit, the mean modified 10-year FRS decreased by an absolute value of 4.6% (from 13.2% ± 12.7 to 8.6% ± 10.0, $P < 0.001$; Table 3). Of the 23 participants with intermediate or high modified FRS at the initial visit who attended the 6-month follow-up, 7 (30.4%) had low modified FRS at follow-up. All 5 participants who were initiated on statins attended the 6-month follow-up. For FMs aged < 30 years (n = 3) attending the 6-month follow-up, the 30-year FRS was 3.8% ± 1.1.

In a sensitivity analysis, when participants aged ≥ 30 years who were initiated on statins (n = 5 of 84; 6.0%) were removed from the analysis, the mean modified 10-year FRS at 6-months was 8.9% ± 10.2 (a decrease of 4.3% from the initial visit).

Discussion

We hypothesized that a patient-initiated screening and intervention program would be able to identify FMs at increased risk of CV disease and improve their long-term CV risk. In this population where the majority of participants did not have a general practitioner, and almost half of participants were from an ethnic minority group, nearly half of referred FMs had an intermediate or high modified FRS, and one-

Table 1. Cardiovascular probands who referred vs did not refer FMs

Characteristic	Cardiovascular probands who referred FMs n = 51	Cardiovascular probands who did not refer FMs n = 33	*P* value
Age, years	57.0 ± 9.4	57.0 ± 9.5	0.97
Female sex	14 (27.5)	8 (24.2)	0.74
Ethnicity			0.15
Caucasian	26 (51.0)	25 (75.8)	
East Asian	9 (17.6)	1 (3.1)	
South Asian	5 (9.8)	4 (12.5)	
African American	1 (2.0)	0 (0.0)	
Latin American	1 (2.0)	0 (0.0)	
Middle Eastern	7 (13.7)	2 (6.1)	
Not identified	2 3.9)	0 (0.0)	
Admission diagnosis			0.56
ACS	45 (88.2)	29 (87.9)	
CABG	6 (11.8)	4 (12.1)	
Hospital length of stay, days	7.0 ± 5.1	8.5 ± 8.0	0.45

Continuous data are presented as mean ± standard deviation. Categorical data are presented as frequency (%).
ACS, acute coronary syndrome; CABG, coronary artery bypass graft; FM, family or household member.

Table 2. Characteristics of FMs at initial screening visit

Characteristic	FMs aged ≥ 30 years (n = 84)	FMs aged 18–29 years (n = 17)
Age, years	49.6 ± 12.3	22.7 ± 3.6
Female sex	56 (66.7)	9 (52.9)
Relation to CV probande		
Child	26 (31.0)	15 (88.2)
Spouse	27 (32.1)	0 (0.0)
Household member	11 (13.1)	1 (5.9)
Parent	4 (4.8)	0 (0.0)
Sibling	16 (19.0)	1 (5.9)
Ethnicity		
Caucasian	36 (42.9)	9 (52.9)
East Asian	13 (15.5)	2 (11.8)
South Asian	8 (9.5)	2 (11.8)
African American	8 (9.5)	1 (5.9)
Latin American	6 (7.1)	0 (0.0)
Middle Eastern	13 (15.5)	3 (17.6)
Family physician	39 (46.4)	3 (17.6)
Previous cardiovascular screening		
Never	53 (63.1)	16 (94.1)
More than 2 years prior	31 (36.9)	1 (5.9)
Pre-existing medical conditions		
Hypertension	26 (30.9)	0 (0.0)
Diabetes mellitus	16 (19.0)	0 (0.0)
Dyslipidemia	38 (45.2)	0 (0.0)
Obstructive sleep apnea	4 (4.8)	0 (0.0)
Chronic renal disease	4 (4.8)	0 (0.0)
Smoker, current	20 (23.8)	0 (0.0)
Physical exam		
Blood pressure, systolic (mm Hg)	123.6 ± 17.1	121.8 ± 15.7
Blood pressure, diastolic (mm Hg)	76.1 ± 13.8	74.0 ± 11.0
Body mass index	27.7 ± 5.0	26.3 ± 5.9
Investigations		
Total cholesterol (μmol/L)	5.1 ± 1.3	4.6 ± 1.1
Low-density lipoprotein (mmol/L)	3.0 ± 1.2	2.6 ± 0.9
High-density lipoprotein (mmol/L)	1.4 ± 0.5	1.4 ± 0.3
Triglycerides (mmol/L)	1.7 ± 1.2	1.5 ± 1.0
Creatinine (mmol/L)	71.8 ± 17.4	66.5 ± 12.0
Hemoglobin Alc (%)	5.0 ± 2.0	4.5 ± 1.7
Glucose, fasting (mmol/L)	5.6 ± 2.0	4.9 ± 0.6

Continuous data are presented as mean ± standard deviation. Categorical data are presented as frequency (%).
CV, cardiovascular; FM, family or household member.

third were newly diagnosed with a CV risk factor. The mean 10-year FRS decreased in participants who attended the 6-month follow-up; indeed, nearly one-third of participants who had an intermediate or high FRS at baseline had a low FRS at follow-up.

Screening family members of patients with CV disease is recommended by major CV professional society guidelines.[5,15] However, there are no specific recommendations for family member referral at the time of a relative's cardiac intensive care unit (ICU) hospitalization. Most prior studies have focused on recruitment strategies by CV healthcare professionals at outpatient clinics.[8,16] Yet motivation is likely greatest for FMs to identify CV risk and change their lifestyle behaviours during or immediately following a

Table 3. Variables on initial and 6-month follow-up visit

Variable	Initial visit (n = 51)	6-month follow-up (n = 51)	*P* value
Blood pressure, systolic (mm Hg)	123.3 ± 16.8	119.1 ±16.0	0.40
Blood pressure, diastolic (mm Hg)	75.8 ± 13.4	70.8 ± 11.6	0.48
Modified 10-year FRS	13.6 ± 12.5	9.0 ± 10.1	0.0004
Total cholesterol (mmol/L)	5.0 ± 1.3	4.8 ± 1.0	0.18
Low-density lipoprotein (mmol/L)	2.9 ± 1.1	2.8 ± 0.9	0.23
High-density lipoprotein (mmol/L)	1.4 ± 0.4	1.5 ± 0.5	0.84
Triglycerides (mmol/L)	1.7 ± 1.2	1.5 ± 1.0	0.27
Creatinine (μmol/L)	70.3 ± 17.4	71.1 ± 21.4	0.76
Hemoglobin Alc (%)	4.9 ± 2.0	5.1 ± 1.5	0.27
Glucose, fasting (mmol/L)	5.4 ± 1.8	5.4 ± 1.0	0.24
Body mass index	27.5 ± 5.1	26.9 ± 4.6	0.50
Smoker, current	12 (23.5)	6 (11.8)	0.01

Continuous data are presented as mean ± standard deviation. Categorical data are presented as frequency (%).
FRS, Framingham risk score.

family member's hospitalization.[6] Direct contact from the CV proband may lead to an even greater motivation to attend an initial screening visit and to make positive lifestyle changes. In our study, the CV proband initiated contact directly with FMs. Furthermore, to encourage a family engagement approach to prevention, the proband and other FMs were invited to attend visits, and an additional FM was present in more than 60% of screening visits. Creating a supportive environment for improvements in lifestyle behaviours may lead to meaningful and enduring changes and decreased CV risk. Using our family-based approach, we found an overall decrease in CV risk scores from baseline to 6 months, and a reduction in the number of people at intermediate or high risk for CV disease. Whether these improvements are sustained is uncertain and requires additional longer-term investigation.

The eligibility criteria for our study were designed to identify a largely underserved population who could benefit from CV risk-factor identification and management. Most of the participants in our study did not have primary care providers and were from ethnic minorities. People from ethnic minorities are more likely to have inadequate access to primary care providers, have undiagnosed and undertreated CV risk factors, and have poor health outcomes.[17,18] Referral of a relative at the time of hospitalization in the cardiac ICU may help to identify and prioritize screening of underserved populations who may stand to benefit the most from CV screening and treatment programs.

The optimal timing for screening and management strategy in young offspring of CV probands is uncertain. Younger people typically have a very low 10-year FRS, as age contributes a large part of the FRS score, but they may have an elevated 30-year risk.[19] Current evidence for CV risk-factor treatment in young people for the prevention of longer-term CV disease is limited, other than for familial dyslipidemias. Early identification of at-risk younger individuals could allow for earlier initiation of lifestyle measures and even therapeutic strategies. CV professional society guidelines currently provide weak recommendations for 30-year or lifetime CV risk-assessment scores for younger people.[20,21] Given the potential to change lifestyle behaviours and to decrease risk and CV outcomes over a lifetime, further studies are needed to understand the role of early identification of longer-term CV risk and treatment strategies in young offspring of CV probands.

Implementation of a health system—wide screening referral program of FMs at the time of acute care hospitalization could have important public health implications. Targeting family members of CV probands is a cost-effective way to identify CV risk factors and prevent a large proportion of MIs in the population.[3,4] Focusing on individuals from underserved populations is also an efficient method of identifying a considerable portion of a population's CV risk-factor burden.[4] The results of this study could help inform future work for systematic screening of this vulnerable and higher-risk population. Cardiac units can incorporate standardized discharge planning protocols that involve referral of family members to family heart clinics. Approaches to family-based screening may vary by healthcare setting, but they could incorporate cardiovascular specialists, primary care providers, pharmacists, nurse practitioners, or physician assistants.[22] FMs who are already followed by a primary care provider may benefit from a letter to the primary care provider emphasizing the importance of CV risk screening. This letter can emphasize that the incident event in the proband may now place the family member at higher risk of CV disease as someone with a de novo "family history" of CV disease. It is also important to understand reasons for nonreferral. In our study, 33 of the 84 CV probands did not refer any FMs for screening. Understanding the reasons for FM nonparticipation would be helpful to developing an approach for larger-scale program implementation. Further studies are needed to assess the role of patient-initiated referral and family-based CV screening to inform clinical practice.

A family-based approach to smoking cessation could potentially lead to higher rates of smoking cessation for both CV probands and FMs. In our study, the CV proband was present at the visits as a supporting family member, but not in a secondary prevention capacity, although the CV proband may have benefitted from the support of the family care environment. Future study design could consider including the CV proband as an active, medical participant in the CV prevention program. Smoking cessation and medication adherence for secondary prevention are prime examples of how family-based prevention might be a useful intervention for the CV proband.

Reduction in FRS was primarily mediated by a reduction in smoking cessation. Participants who quit smoking were classified as nonsmokers at the 6-month follow-up visit. However, the improved CV risk reduction may require smoking abstinence for several years to realize the benefit from smoking cessation. One study found a 39% reduction in CV disease in heavy smokers after 5 years of smoking cessation.[23] Thus, the reduction in FRS may be overestimated in recent ex-smokers who resume smoking following the study period.

Drop-out is a recognized phenomenon in CV primary prevention studies.[24] We found a differential rate of attrition based on the age of participants. The drop-out rate was 39.3% (33 of 84) in participants aged $\geq$ 30 years and 82.4% (14 of 17) in participants aged $<$ 30 years. Although motivation for FMs of CV probands to attend a screening visit offered shortly after hospitalization of a relative may be high, it is possible that the motivation wanes with time. In addition, younger participants may wish to learn about their long-term CV risk but may feel that a short-term follow-up in a study setting may not have "added benefit" to improving their risk. Primary CV prevention programs that specifically target younger relatives may decrease attrition rates in this population.

Approximately 15% of Canadians overall do not have a primary care provider, although this percentage varies by province (as high as 22% in Quebec) and decreases with age (about 6% in adults aged $\geq$ 65 years).[25] In our study, nearly half of the FMs aged $\geq$ 30 years did not have a primary care provider. Effective referral and management strategies to identify and treat this population are strongly needed. Our referral location source (during cardiovascular ICU admission) represents a novel approach that was able to identify an underserved population with considerable CV risk. Expansion of the eligibility criteria and systematic referral at a larger healthcare-system level could result in a greater absolute number of previously underserved people referred for CV primary prevention screening. In particular, this strategy could be useful in identifying ethnic minorities and those without

regular access to primary care providers, who may have important, untreated CV risk factors. Cascade screening of extended family members from these identified people may further increase the ability to capture at-risk but previously medically neglected populations.

There are limitations to this study. First, this is a single-centre study in the context of a particular healthcare system. Generalizability may be limited in settings where there is a greater proportion of people with primary care providers and access to CV screening. Yet despite "universal health care coverage" in the study region, we identified a group of people who did not have routine access to a primary care provider. Second, there was no control group, and therefore regression to the mean of risk factors and 10-year modified FRS is possible and cannot be accounted for with this study design. Third, participants with primary care providers self-reported that they had not received CV screening in the previous 2 years. This may reflect a lack of awareness from the participants that they had been screened for CV disease. Fourth, the highest possible percentage for the 10-year FRS is $> 30\%$. A number of participants had a 10-year FRS $> 30\%$, so it is likely that the overall mean FRS percentage was higher, and the results may be underestimated. The impact of family member participation on lifestyle behaviours and outcomes of the proband could not be assessed within the confines of this study, but it is possible that there could be a beneficial effect. Fifth, there were 5 FMs who were started on statins in the initial visit. Although statins primarily lower LDL, which is not part of the FRS calculation, they can have a mild high-density lipoprotein—raising effect and lower total cholesterol, which are part of the FRS calculation and could lead to a lower risk score at follow-up. However, our sensitivity analysis showed similar mean modified 10-year FRS when the statin-initiated FMs were removed. Sixth, smoking cessation was assessed by self-report and not by objective assessment (ie, urine cotinine levels). Seventh, the study size of 101 participants was relatively low. Recruitment of CV probands was done by research assistants during usual work hours and not on evenings, weekends, or holidays. It is probable that a systematic referral strategy that could be performed without interruption would result in a greater absolute number of people referred. Expanding the eligibility criteria to a wider circle of participants (ie, second-degree relatives, family of spouses, members of social circles) could also increase the referral rate, although likely at the cost of screening specificity. Finally, the primary endpoint of the study was CV risk, which is a surrogate endpoint for CV events and death. An increased number of study participants and a longer follow-up period would be needed to assess these hard endpoints.

Conclusions

A patient-initiated FM referral strategy at the time of admission for an acute CV event identified an underserved and high CV—risk population. There was improvement in CV risk scores in those who completed the intervention. Systematic screening programs at the time of hospitalization could capitalize on motivation and improve population CV prevention efforts.

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Disclosures

The authors have no conflicts of interest to disclose.

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Supplementary Material

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