



Impact of a patient-centered tool to reduce misconceptions about coronary artery disease and its treatment: The CAD roadmap

Laura D. Scherer^a, Grace A. Lin^b, Vinay Kini^{c,*}

^a University of Colorado Anschutz Medical Campus, Department of Medicine, Aurora, CO, USA

^b University of California San Francisco, Department of Medicine, San Francisco, CA, USA

^c Weill Cornell Medical College, Department of Medicine, New York, NY, USA

ARTICLE INFO

Keywords:

Coronary artery disease
Patient education
Health misinformation

ABSTRACT

Objective: Health misinformation is common and can lead to harmful behaviors such as medication non-adherence. We assessed the impact of a novel patient educational tool focused on overcoming misconceptions among patients with coronary artery disease (CAD).

Methods: We developed the CAD Roadmap, an educational tool aimed at explaining the disease trajectory and overcoming common disease misconceptions (such as that statin medications are not beneficial). We designed a pilot survey to assess patients' 1) CAD-related knowledge, 2) medication-taking behavior, and 3) acceptability of the Roadmap. Survey participants were recruited online. CAD knowledge scores were compared with repeated measures *t*-tests.

Results: Among 114 patients with CAD (mean age 67 years, 63% male), average CAD-related knowledge was 79.0% pre-test and 89.7% after review of the CAD Roadmap ($p < .001$). After review of the Roadmap, 24% indicated they planned to take their medications more regularly, 93% agreed it was helpful in understanding medication benefits, and 77% felt more empowered to participate in medical decisions.

Conclusion: The CAD Roadmap was evaluated positively, improved disease-related knowledge, and has the potential to improve adherence to treatments.

Innovation: Unlike many other interventions, the CAD Roadmap is specifically designed to overcome common misconceptions to improve health behaviors.

1. Introduction

Over 20 million adults in the United States have coronary artery disease (CAD) [1]. Advances in understanding of the disease have led to a multitude of effective treatments for CAD including lifestyle changes, cholesterol-lowering drugs such as statins, and interventions such as stents and coronary artery bypass (CABG) surgery [2,3]. Although CAD is a lifelong disease, these advances have led to improvements in both mortality and quality of life for patients with CAD [1].

However, patient misconceptions about CAD and its treatment are common and can lead to health behaviors that are harmful. For example, some patients believe that they are "cured" after receiving a coronary stent, and no longer need further treatment with medications or lifestyle changes [4,5]. Many patients believe stents alone prevent heart attacks, even after being explicitly told otherwise [6,7]. In a 2021 qualitative study, patients who had recently received a stent for stable coronary

symptoms were told about studies showing the uncertain benefit of stents, and patients' reactions included disbelief and shock (e.g., "I'd be stunned, knowing what I know... it would be disbelief. Yeah, it would be disbelief." (Male, Age 63) [7]. Furthermore, many patients believe CAD medications such as statins are not beneficial and may even be harmful due to misinformation that is abundant on the internet. The proportion of websites with non-credible information about statins has been estimated to be as high as 26%, and misinformation about statins on social media tends to exaggerate side effects and negate benefits [8-10]. Misconceptions about the CAD disease trajectory, the benefit of coronary interventions, and the benefit of CAD medications can lead to low rates of adherence to guideline-recommended treatments [11].

Informing patients can be an uphill battle against patients' intuitions, pre-existing beliefs, and widely circulating misinformation. Most clinicians likely *are* conveying high-quality information to their patients with CAD. However, information provided by clinicians

* Corresponding author at: Weill Cornell Medical College, Division of Cardiology, 520 E 70th St, Starr 433, New York, NY 10021, USA.

E-mail address: vuk9003@med.cornell.edu (V. Kini).

<https://doi.org/10.1016/j.pecinn.2024.100303>

Received 17 January 2024; Received in revised form 4 June 2024; Accepted 5 June 2024

Available online 6 June 2024

2772-6282/© 2024 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

competes with patients' pre-existing beliefs and other informational sources, and clinicians' messages may not be adequately reinforced outside of the clinical encounter. Moreover, perhaps because CAD is so common, some patients may have well-established mental models - defined as an interconnected network of beliefs - about CAD. When people have an established mental model about how something works, new information is interpreted through the lens of that mental model. Information that conflicts with the mental model is often ignored or misunderstood [12].

To overcome CAD misconceptions, accurate information must be repeatedly reinforced and designed to give patients a more accurate mental model about CAD. Although many patient education resources exist to explain what CAD is, many focus on single decision points in the disease process such as the decision to undergo coronary stenting [13-16]. However, given that substantial misconceptions about the disease course and treatments persist, there is a need for materials that are designed to inform patients' broader understanding of CAD, the disease trajectory, and the benefit of different treatments and how those relate to the disease trajectory. Informing patients' broader understanding, or mental model, of what CAD is and how it works, particularly at the beginning of the disease course, could overcome the limitations of existing educational tools [17,18].

Accordingly, we developed and pilot-tested the CAD Roadmap, a patient-facing booklet that was specifically designed to inform patients' mental models of CAD at the time of diagnosis before misconceptions become entrenched. The Roadmap gives patients a long view of their diagnosis and the CAD disease trajectory, and is meant to be used as a reference throughout the disease course. The booklet focuses on medication-taking and lifestyle changes as essential long-term treatment, provides accurate information about the benefits and risks of CAD treatment medications, and in accordance with recent clinical trials, de-emphasizes stents as a preventative intervention [19]. Finally, the CAD Roadmap seeks to activate patients by helping them reflect on their broader healthcare preferences and describing how their preferences might influence care decisions. In this study, we describe a pilot survey of the Roadmap among 114 U.S. patients with CAD to evaluate 1) the acceptability of the CAD Roadmap and 2) its impact on disease-related knowledge and patients' intentions to take CAD medications as prescribed.

2. Methods

2.1. CAD roadmap development process

This study was approved by the Colorado Multiple Institutional Review Board (#20-2030). We conducted an initial needs assessment to inform the content that should be included within a CAD educational tool and to understand the optimal time of its delivery to patients. We spoke with a group of approximately 20 clinical cardiologists who highlighted two main challenges of communication with patients diagnosed with stable CAD in the outpatient setting. First, it can take weeks to obtain an initial consultation with a cardiologist. This is a time of high patient anxiety during which patients often seek out information online or from community members, and that information can vary in its quality. Second, communicating the longer-term implications of a CAD diagnosis can be challenging. It is difficult to respond to patients' immediate questions, discuss next diagnostic and therapeutic steps, and also communicate the long-term implications of a CAD diagnosis and the importance of life-long medications. These physicians requested help communicating these concepts to patients, to prepare patients to have more informed discussions during clinical encounters.

These findings, in addition to convergent efforts among colleagues working in different health contexts [1,2], led our team to conceptualize the idea of a *Patient Roadmap*, which was identified as a novel approach to patient education that could be used to support patients with many types of chronic illnesses [20]. In a conceptual paper, a Patient Roadmap

was defined as a tool that would 1) inform patients about their diagnosis as well as the future implications of that diagnosis, 2) address common misconceptions, 3) help patients form accurate expectations for the future and anticipate future decisions that might be made, and 4) "activate" patients, including showing patients how they can be involved in their care and how their preferences matter [20].

Using this conceptual framework, we developed an initial prototype of the CAD Roadmap that included 1) basic educational material about what CAD is, how it is treated, and the treatment decisions patients face during the disease course; and 2) common misconceptions and misinformation cited in prior research. Our goal was for the Roadmap to be a patient-centered tool that encourages patients to be active participants in their care. Therefore, we first solicited feedback on the prototype from a standing panel of 10-15 diverse patients with various health conditions including CAD [3]. We revised the tool based on the panel's feedback, brought the tool back to the clinical cardiologist group, and made additional changes based on their feedback. We next conducted interviews with patients newly diagnosed with CAD (identified through the electronic health record at one author's institution) to determine whether the CAD Roadmap was acceptable in the target patient population, and received positive feedback about its relevance to the patient, readability, and completeness. We then employed a graphic designer to refine images and layout (sample pages shown in Fig. 1). In the research reported in this article, we evaluated the acceptability of the CAD Roadmap among a larger sample of patients with CAD, and conducted the first quantitative pilot test of the CAD Roadmap's ability to improve CAD-related knowledge and patients' intentions to take CAD medications as prescribed.

2.2. Survey participants

Participants were recruited through Dynata, a company that maintains a survey research panel consisting of millions of individuals worldwide who have agreed to take surveys in exchange for small cash prizes. Individuals were invited to participate via email and the survey was completed online. Invitations were limited to individuals located in the United States who were previously identified by Dynata as having a CAD diagnosis. A screener question at the start of the survey asked participants if they had a CAD diagnosis ("Coronary artery disease is when you have cholesterol plaques in the heart arteries. Some people also call this 'heart disease'. Have you been diagnosed with coronary artery disease?"), and only those indicating they did have CAD were invited to complete the survey.

2.3. Survey design and outcome measures

After confirming they had a prior diagnosis of CAD, participants were invited to complete the full survey. Prior to receiving the CAD Roadmap, each participant responded to 9 CAD knowledge questions adapted from a previously published knowledge questionnaire [21], and a question indicating the perceived importance of taking their CAD medications regularly (1-6 Likert scale, 1 = not important, 6 = very important). Next, all participants read the CAD Roadmap tool, and then answered the same 9 knowledge questions and re-indicated their perceived importance of taking CAD medications.

Next, participants reported the CAD medications they were currently taking by indicating "Yes" "No" or "I don't know" from a list of common medications. Then participants indicated 1) whether they have ever refused a recommended medication (and if yes, which one(s)), 2) whether they ever skip or forget to take medications prescribed for CAD (almost never, sometimes, often, almost always), and 3) whether they intend to change the way they take medications after reading the CAD Roadmap (more regularly, less regularly, will not change).

Next, participants were asked to evaluate the CAD Roadmap: 1) whether it was clear and easy to understand, 2) whether it was helpful in understanding the benefit of medications, 3) if they would recommend it

A Roadmap for Patients with CORONARY ARTERY DISEASE

C · A · D

YOUR HEALTHCARE JOURNEY

In the next weeks, months and years, you may find yourself on different points on this map. All patients end up at the same place, which is long-term management of CAD with medications and lifestyle changes like diet and exercise.

START
Abnormal stress test result

Exit
No CAD (if no plaque seen on test)

High Risk (go to page 6)

Intermediate Risk (go to page 7)

Low Risk (go to page 6)

Angiogram Test

Bypass Surgery **Stents** **No Stent or Surgery**

Medical Therapy & Lifestyle Changes

Medications and lifestyle changes are your main treatment: They will reduce your chance of a heart attack and to help you live a long life!

ALL ROADS LEAD TO THE SAME PLACE: MEDICATIONS AND LIFESTYLE CHANGES

These 4 things are the **BEST** way to reduce your risk of a future heart attack:

- 1 TAKE MEDICATIONS**
Medications to lower cholesterol are very effective at preventing heart attacks. Statins and PCSK9 inhibitors are commonly-prescribed cholesterol-lowering medications. Blood thinners like aspirin help prevent clots in the arteries in your heart. If you have diabetes or high blood pressure, getting these under control with medications is very important too.
- 2 GET MOVING**
Any activity is beneficial. You can get the most benefit from activities that make you breathe faster and your heart beat faster than normal. For example, brisk walking, jogging, dancing, tennis, and biking. Moderate exercise 30 minutes per day, 5 days per week is optimal. Discuss with your doctor what level of activity is safe for you.
- 3 QUIT SMOKING**
Smoking greatly increases your risk of having a heart attack. The good news is if you quit smoking your risk quickly becomes the same as people who have NEVER smoked! Medications and counseling are both effective in helping you to stop smoking. Talk to your doctor to determine the best way for you to stop smoking.
- 4 EAT A HEART-HEALTHY DIET**
A healthy diet, along with exercise and medications, can help. General principles of a heart healthy diet include eating more fruits and vegetables and selecting whole grain foods. For information on a heart healthy diet and recipes, see...

TREATMENT MYTHS VS. FACTS

- 1. Can CAD be cured?**
Unfortunately, there is no "cure" for CAD.
CAD is a chronic condition. Build up of plaque will continue to narrow your coronary arteries and no treatment will make this go away completely. Medications and lifestyle changes are the main way to treat CAD and lower your risk of a heart attack. You may also need more intensive treatment like a stent or bypass surgery at some points in the journey.
With these treatments, people with CAD can live long lives.
- 2. Do stents reduce the chance of a heart attack?**
It depends.
Stents are mainly done for symptom relief. Stenting smaller arteries will **NOT** reduce your chance of a future heart attack and may be used as a last resort for trying to help with your symptoms if medications are not working. If your chest pain symptoms are well controlled with medications, you may not benefit from stent.
Sometimes when there are blockages in larger, more central arteries, stents are thought to reduce the chance of a heart attack. This is different from stenting smaller arteries.
- 3. If I have a stent or bypass surgery, can I stop taking medicines?**
You will need to continue taking life long medications.
Medications are the best way to reduce your risk of having a future heart attack. You may be able to stop taking the medicines that treat your symptoms if your CAD symptoms improve. However, you should continue to take medicines that reduce your risk of a heart attack.

Fig. 1. Sample pages from the CAD Roadmap. Clockwise from upper left: cover page, a visual illustration of the disease roadmap, a page dispelling common CAD misconceptions, and a page describing the most effective CAD treatments.

to others, 4) whether it would help to have better conversations with their doctor, and 5) whether it would help them feel more empowered to participate in medical decisions. All of these questions were answered with a strongly disagree to strongly agree 7-point Likert scale. After these questions, participants were provided with space to write “anything else that you think we should know about your experience reading the CAD Roadmap booklet”.

Finally, the survey asked a number of questions for the purpose of describing the sample: 1) time since CAD diagnosis, 2) prior heart attack, 3) prior stent, 4) prior CABG surgery, 5) frequency seeing a cardiologist, 6) frequency seeing primary care doctor, and 7) standard demographics (age, gender, race, ethnicity, etc.). Embedded in the survey were two simple attention checks (e.g., To show that you are still reading these questions, select “strongly agree”).

2.4. Analyses

CAD knowledge scores were computed as proportion correct and compared with a repeated measures *t*-test. All other survey outcomes were analyzed descriptively (means, standard deviations, range, etc.). Analyses were performed using SPSS.

3. Results

One-hundred forty participants began the survey, and of those, 114 confirmed they had CAD and were eligible to complete the study. Participant characteristics are displayed in Table 1. Age ranged from 34 to 85, there was a balance of gender, the sample was predominantly white and was somewhat more educated than the general U.S. population. Most participants had been diagnosed with CAD >5 years previously. Most participants saw a cardiologist and a primary care doctor once per year or more. Many participants reported a history of heart attack, stent and CABG procedures. Most indicated that they could pay for their medications.

Pre-test and post-test knowledge scores ranged from 0% to 100% accuracy. Average knowledge, calculated as the percentage of CAD-related questions answered correctly, was 79.0% (SD = 15.1) at pre-test, and significantly increased after review of the CAD Roadmap (89.7%, SD = 13.0, $p < .001$). Knowledge questions, answers, and percent correct pre- and post-testing are provided in Table 2.

Perceived importance of taking medications was at ceiling at pre-test (1–5 Likert scale; $M = 4.97$, $SD = 0.15$), limiting our ability to observe whether the tool could improve this outcome at post-test ($M = 4.98$, $SD = 0.13$, $p = .160$). Participants reported high medication adherence: 104 (91%) participants indicated they never or almost never skip or forget to take their medications, 9 (8%) said they sometimes skip or forget, and 1 (1%) reported they almost always skip or forget. Nonetheless, 27 (24%) participants indicated they plan to take their medications more regularly after reading the CAD Roadmap.

Table 3 shows that evaluations of the CAD Roadmap were very positive. A large majority of participants “strongly agreed” or “agreed” that the CAD Roadmap was clear and easy to understand, helpful in understanding the benefit of their medications, and would recommend to others with CAD. >80% of patients reported that they thought the tool would help them have better conversations with their doctor, and >75% felt more empowered to participate in medical decisions after viewing the tool.

Table 4 shows a representative sample of participants’ feedback in response to the open-ended prompt “Please use this space to tell us anything else you think we should know about your experience reading the CAD Roadmap booklet”. Participants were not forced to respond to this prompt, and yet, 85 participants wrote remarks (not including entries such as “no comment” or “none”). The majority of those remarks were positive, with 6 comments that ranged from neutral (e.g., “no new information for me”) to negative (“I thought the roadmap itself was slightly confusing and complex”).

Table 1
Survey participant characteristics.

Participant characteristic (n = 114)	
Age (mean, SD)	67.2 (9.7) years, range 34–85
Gender	
Male	72 (63.2%)
Female	42 (36%)
Transgender/other	0 (0%)
Race and ethnicity	
White	102 (89.5%)
Black / African American	5 (4.4%)
Native American	1 (0.9%)
Asian / Asian American	3 (2.6%)
Hawaiian / Pacific Islander	0 (0%)
Other	5 (4.4%)
Hispanic / Latino/a	4 (3.5%)
Education	
Some high school	2 (1.8%)
High school or GED	23 (20.2%)
Some college or 2-year degree	38 (33.3%)
4-year college graduate	13 (1.7%)
Advanced or professional degree (Master’s, PhD, MD, etc.)	33 (28.9%)
Trouble paying for medications	
Never	82 (71.9%)
Sometimes	25 (21.9%)
Often	5 (4.4%)
Always	3 (2.6%)
Marital status	
Single, never married	7 (6.1%)
Married or living with a partner	68 (59.6%)
Separated or divorced	23 (20.2%)
Widowed	16 (14%)
How often do you see a primary care doctor?	
Never	1 (0.9%)
Less than once per year	5 (4.4%)
Once per year	27 (23.7%)
More than once per year	81 (71.1%)
How often do you see a cardiologist?	
Never	1 (0.9%)
Less than once per year	9 (7.9%)
Once per year	43 (37.7%)
More than once per year	61 (53.5%)
How long ago were you first diagnosed with CAD?	
<1 year	
1–2 years	6 (5.3%)
2–5 years	4 (3.5%)
>5 years	21 (18.4%)
83 (72.8%)	
Have you ever had a heart attack?	
Yes	50 (43.9%)
No	61 (53.5%)
I don’t know	3 (2.6%)
Have you ever had a coronary stent procedure to open a blockage in one or more of your heart arteries?	
Yes	
No	67 (58.8%)
Missing	46 (40.4%)
1 (0.9%)	
Have you ever had coronary artery bypass surgery (CABG)?	
Yes	
No	48 (42.1%)
66 (57.9%)	
Medications reported*	
Statin (atorvastatin, rosuvastatin, etc.)	101 (89.4%)
Ezetimibe	7 (6.1%)
PCSK9 inhibitor (evolocumab, alirocumab)	9 (7.9%)
Fibrate (gemfibrozil, fenofibrate)	11 (9.6%)
Niacin	3 (2.6%)
Red yeast rice	3 (2.6%)
Aspirin	99 (86.8%)
P2Y12 inhibitor (clopidogrel, ticagrelor, etc.)	35 (30.7%)
Beta blocker: (metoprolol, carvedilol, etc.)	71 (62.3%)
Nitroglycerin	37 (32.5%)

* Reported values are for participants answering “yes” they take this medication; all other participants responded with “no” or “I don’t know”.

Table 2
Coronary artery disease knowledge survey questions.

Question	Answer Choices (correct answer underlined)	Percent correct
Q1. True or false: coronary artery disease is a life-long condition.	A. <u>True</u> B. False C. I don't know	Pre: 78.1% Post: 97.4%
Q2. For most people who have coronary artery disease and stable symptoms (who are not having a heart attack), which of the following is the best way to prevent a future heart attack?	A. Getting a stent B. <u>Taking medications</u> C. I don't know	Pre: 77.2% Post: 96.5%
Q3. True or false: If a person gets treated with a stent or bypass surgery, they will be cured of coronary artery disease.	A. True B. <u>False</u> C. Maybe	Pre: 98.2% Post: 99.1%
Q4. True or false: After having a stent or bypass surgery, most people can stop taking medications for coronary artery disease.	A. True B. <u>False</u> C. Maybe	Pre: 99.1% Post: 98.2%
Q5. How long do most people with coronary artery disease have to take medications for?	A. Until they feel better B. Until their cholesterol is lower C. <u>For the rest of their lives</u> D. I don't know	Pre: 93.9% Post: 97.4%
Q6. True or False: Sometimes a person's best testing and/or treatment options for coronary artery disease depend on the person's preferences and values.	A. <u>True</u> B. False C. Maybe	Pre: 36.8% Post: 68.1%
Q7. True or false: All people who have an abnormal stress test need to have a stent or bypass surgery for treatment.	A. True B. <u>False</u> C. Maybe	Pre: 87.7% Post: 96.5%
Q8. Which of the following treatments can relieve symptoms of coronary artery disease?	A. Medications B. Stents C. <u>Both medications and stents</u> D. I don't know	Pre: 93.9% Post: 97.4%
Q9. For most patients with heart disease and stable symptoms (who are not having a heart attack), does getting a stent reduce the risk of a future heart attack?	A. Yes B. No C. <u>It depends</u> D. I don't know	Pre: 46.5% Post: 57.0%

4. Discussion and conclusion

4.1. Discussion

In this study, we report the development and pilot testing of the CAD Roadmap, a novel patient-facing educational tool aimed at educating patients from the beginning of their disease course and overcoming misconceptions about the CAD disease process and treatments. We developed and iteratively refined the CAD Roadmap tool using feedback from patients and clinicians, and then pilot tested the impact of the tool on 1) disease-related knowledge and 2) its potential effect on medication-taking behavior using a survey of 114 patients with CAD. Results showed that the CAD Roadmap had the following effects. First, even in a group of patients who had relatively high knowledge of CAD at baseline, it significantly improved average CAD knowledge scores. Second, although perceived importance of taking medications and reported adherence were high at baseline, nearly one-fourth of participants indicated they planned to take their medications more regularly after reading the CAD Roadmap. Third, the vast majority of patients felt more empowered and informed about their disease, and felt more equipped to have conversations with their healthcare providers. Finally, evaluations of the CAD Roadmap tool were very positive; the vast majority of participants said they would recommend the tool to other people with CAD.

Our results are significant in the context of 1) low rates of adherence to statin medications and 2) mixed results from prior evaluations of educational tools to improve statin adherence. While studies by

Table 3
Participant evaluations of the CAD roadmap.

I found the information in the CAD Roadmap tool clear and easy to understand	
Strongly disagree	
Disagree	2 (1.8%)
Somewhat disagree	0
Neither agree nor disagree	0
Somewhat agree	1 (0.9%)
Agree	2 (1.8%)
Strongly agree	27 (23.7%)
	82 (71.9%)
I found the information helpful in understanding benefit of taking medications for CAD	
Strongly disagree	
Disagree	2 (1.8%)
Somewhat disagree	0
Neither agree nor disagree	0
Somewhat agree	0
Agree	6 (5.3%)
Strongly agree	29 (25.4%)
	77 (67.5%)
I would recommend the CAD Roadmap tool to other people who are diagnosed with CAD	
Strongly disagree	
Disagree	1 (0.9%)
Somewhat disagree	0
Neither agree nor disagree	0
Somewhat agree	2 (1.8%)
Agree	2 (1.8%)
Strongly agree	24 (21.1%)
	84 (73.7%)
This information could help me to have better conversations with my doctor about CAD	
Strongly disagree	
Disagree	1 (0.9%)
Somewhat disagree	1 (0.9%)
Neither agree nor disagree	0
Somewhat agree	9 (7.9%)
Agree	8 (7.0%)
Strongly agree	33 (28.9%)
	62 (54.4%)
This information made me feel more empowered to participate in decisions about my medical care	
Strongly disagree	
Disagree	1 (0.9%)
Somewhat disagree	0
Neither agree nor disagree	0
Somewhat agree	9 (7.9%)
Agree	16 (14.0%)
Strongly agree	33 (28.9%)
	55 (48.2%)

Nieuwkerk et al. and Stacy et al. found modest improvements in statin adherence among patients who received educational interventions compared to controls, other studies by Eussen et al., Schwalm et al., and Ivers et al. showed no difference in adherence rates [22-26]. One reason for these mixed results may be due to widely circulating health misinformation about statins. Golder et al. analyzed nearly 12,000 social media posts about statins, and found that >20% of posts included polarizing personal beliefs or attitudes about statins [10]. Given this and other studies confirming widespread statin misinformation, coupled with a lack of information that explicitly addresses these misconceptions, it is no surprise that many patients are reluctant to take

Table 4

Participant feedback on the CAD roadmap.

-
- This is the best information piece on CAD that I have seen.
 - It's great solid information and easy to understand terms. I believe it could be helpful for anyone having this scary disease.
 - I believe you nailed it!
 - Very informative and well designed!!
 - Good reference guide which explains very well all pertinent facts that anyone with CAD should have access to.
 - I wish I had something like this when I first was diagnosed!
 - I had 6 bypasses 17 years ago and I wish I would have had this booklet available to me then. You tend to forget this information and having this booklet would regularly refresh your memory about this important information.
 - I think this booklet should be given to all heart patients.
 - I found it was well organized and answered some questions I had about CAD. I have had a CABG and some of this info I hadn't heard before.
 - CAD diagnoses can be very frightening. The Roadmap answers many questions/concerns that can lessen the stress of a diagnosis.
 - I was very impressed with the layout and quality of the information. I feel that it will help patients to better understand their concerns and to help them make appropriate decisions along with their doctor's advice.
 - It was very informative and I enjoyed reading it. It gave me ideas of what to discuss with my doctor.
 - I thought it was very easy to understand and I learned a lot that I didn't know
-

statins, particularly long-term [27]. Countering medical misinformation has recently become an issue of national priority, described in an editorial written by the Food and Drug Administration commissioner [28]. Our results suggest that the CAD Roadmap could be a useful tool in combating statin misinformation and improving adherence, potentially in conjunction with other interventions that have shown promise in improving adherence such as medication-taking reminders [29].

4.2. Innovation

Patient misconceptions about CAD and its treatment remain common despite existing educational tools and the availability of information about CAD from reliable sources on the internet such as the American Heart Association and Centers for Disease Control [30-32]. The concept of a Patient Roadmap for chronic illness is a new and innovative paradigm for patient education and patient-centered care [20]. Unlike other tools, the CAD Roadmap gives patients a long view of their diagnosis (including what to expect in the future and can be used as a reference over time), and focuses on medication-taking as an essential long-term treatment. Our CAD Roadmap explicitly addresses common misconceptions about CAD treatment, and continually reinforces the life-long benefits of medication, as well as putting treatments such as stents into context. Additionally, many educational interventions are simply informational. The CAD Roadmap is specifically designed to activate patients to participate in their disease management, clarify their healthcare goals and values, and thereby foster better conversations with clinicians by employing a "flipped exam room" model (i.e., informs patients outside a patient-clinician visit to prepare patients for better future conversations) [33,34]. Finally, many educational interventions are not designed to take place within the context of the daily workflow (i.e., they require substantial additional time / resources / staff). The CAD Roadmap is designed to enhance the daily workflow; it can be delivered directly to patients, does not impose additional time or resource burdens on clinicians, and enhances the quality of the clinical encounter by providing introduction and context to important CAD concepts.

Our study has several limitations. First, we assessed baseline medication adherence using a sample self-reported measure, and assessed only the potential impact of the Roadmap on adherence. Future studies should assess the impact of Roadmaps on adherence using validated measures in clinical trial settings. Second, our survey sample was largely white and well-educated, and therefore the generalizability of our findings may be limited. Third, the participants largely had been diagnosed with CAD >5 years prior to the survey; thus, the level of knowledge and medication adherence may differ from newly diagnosed patients. Fourth, the CAD Roadmap is targeted to patients receiving an initial diagnosis of stable CAD in the outpatient setting. Results may not be generalizable to patients diagnosed with CAD in an acute setting (e.g., myocardial infarction). Fifth, our survey was fielded through a survey

research company that identified a sample of CAD patients willing to take our survey for a small cash incentive; our results may not be generalizable to all CAD patients.

4.3. Conclusion

Misinformation about chronic diseases is common and can lead to adverse health behaviors. The CAD Roadmap is a novel tool designed to educate patients about CAD across the disease course, address common misconceptions about CAD treatments, and activate them to be involved in their care. The tool was evaluated positively by CAD patients and improved disease-related knowledge. Finally, by overcoming misconceptions about CAD treatments, widespread implementation of the CAD Roadmap has the potential to improve adherence to medications such as statins.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or non-for-profit sectors.

CRediT authorship contribution statement

Laura D. Scherer: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Grace A. Lin:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Vinay Kini:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

None.

References

- [1] Tsao CW, Aday AW, Almarzoq ZI, et al. Heart disease and stroke statistics—2022 update: a report from the American Heart Association. *Circulation* 2022;145(8):e153–639.
- [2] Members WC, Lawton JS, Tamis-Holland JE, et al. 2021 ACC/AHA/SCAI guideline for coronary artery revascularization: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol* 2022;79(2):e21–129.
- [3] Smith SC, Benjamin EJ, Bonow RO, et al. AHA/ACCF secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update: a guideline from the American Heart Association and American College of Cardiology Foundation endorsed by the World Heart

- Federation and the Preventive Cardiovascular Nurses Association. *J Am Coll Cardiol* 2011;58(23):2432–46.
- [4] Hirsh BJ, Smilowitz NR, Rosenson RS, Fuster V, Sperling LS. Utilization of and adherence to guideline-recommended lipid-lowering therapy after acute coronary syndrome: opportunities for improvement. *J Am Coll Cardiol* 2015;66(2):184–92.
- [5] Bradley CK, Wang TY, Li S, et al. Patient-reported reasons for declining or discontinuing statin therapy: insights from the PALM registry. *J Am Heart Assoc* 2019;8(7):e011765.
- [6] Rothberg MB, Sivalingam SK, Ashraf J, et al. Patients' and cardiologists' perceptions of the benefits of percutaneous coronary intervention for stable coronary disease. *Ann Intern Med* 2010;153(5):307–13.
- [7] Ingle MP, Lammons W, Guigli R, et al. Patient perspectives on the benefits and risks of percutaneous coronary interventions: a qualitative study. *Patient Prefer Adherence* 2021;7:21–8.
- [8] Kwan JY, Stocco F, Scott DJ, Bailey MA, Coughlin PA. Assessment of internet-based information on statin therapy. *Eur J Cardiovasc Nurs* 2024;23(2):115–21.
- [9] Harrison TN, Derose SF, Cheatham TC, et al. Primary nonadherence to statin therapy: patients' perceptions. *Am J Manag Care* 2013;19(4):e133–9.
- [10] Golder S, O'Connor K, Hennessy S, Gross R, Gonzalez-Hernandez G. Assessment of beliefs and attitudes about statins posted on Twitter: a qualitative study. *JAMA Netw Open* 2020;3(6):e208953.
- [11] Maddox TM, Chan PS, Spertus JA, et al. Variations in coronary artery disease secondary prevention prescriptions among outpatient cardiology practices: insights from the NCDR (National Cardiovascular Data Registry). *J Am Coll Cardiol* 2014; 63(6):539–46.
- [12] Petty RE, Cacioppo JT. Source factors and the elaboration likelihood model of persuasion. *Adv Consumer Res* 1984;11(1):668–72.
- [13] Scherer LD, Fagerlin A. Shared Decision-Making in Revascularization Decisions: Complexities and Challenges Vol 12. *Am Heart Assoc*; 2019. e005446.
- [14] de Melo Ghisi GL, da Silva Chaves GS, Brito RR, Oh P. Health literacy and coronary artery disease: a systematic review. *Patient Educ Couns* 2018;101(2): 177–84.
- [15] Williamson TM, Rouleau CR, Aggarwal SG, Arena R, Hauer T, Campbell TS. The impact of patient education on knowledge, attitudes, and cardiac rehabilitation attendance among patients with coronary artery disease. *Patient Educ Couns* 2021; 104(12):2969–78.
- [16] Peterson JC, Link AR, Jobe JB, Winston GJ, Klimasiewski EM, Allegrante JP. Developing self-management education in coronary artery disease. *Heart Lung* 2014;43(2):133–9.
- [17] Johnson-Laird PN. Mental models and probabilistic thinking. *Cognition* 1994;50 (1–3):189–209.
- [18] Greenfield S, Kaplan SH, Ware JE, Yano EM, Frank HJ. Patients' participation in medical care: effects on blood sugar control and quality of life in diabetes. *J Gen Intern Med* 1988;3:448–57.
- [19] Maron DJ, Hochman JS, Reynolds HR, et al. Initial invasive or conservative strategy for stable coronary disease. *N Engl J Med* 2020;382(15):1395–407.
- [20] Scherer LD, Matlock DD, Allen LA, et al. Patient roadmaps for chronic illness: introducing a new approach for fostering patient-centered care. *MDM Policy Pract* 2021;6(1). 23814683211019947.
- [21] Yuan N, Boscardin C, Lisha NE, Dudley RA, Lin GA. Is better patient knowledge associated with different treatment preferences? A survey of patients with stable coronary artery disease. *Patient Prefer Adherence* 2021:119–26.
- [22] Nieuwkerk PT, Nierman MC, Vissers MN, et al. Intervention to improve adherence to lipid-lowering medication and lipid-levels in patients with an increased cardiovascular risk. *Am J Cardiol* 2012;110:666–72.
- [23] Stacy JN, Schwartz SM, Ershoff D, Shreve MS. Incorporating tailored interactive patient solutions using interactive voice response technology to improve statin adherence: results of a randomized clinical trial in a managed care setting. *Popul Health Manag* 2009;12:241–54.
- [24] Eussen SR, Elst ME, Klungel OH, et al. A pharmaceutical care program to improve adherence to statin therapy: a randomized controlled trial. *Ann Pharmacother* 2010;44:1905–13.
- [25] Schwalm J-D, Ivers NM, Natarajan MK, et al. Cluster randomized controlled trial of delayed educational reminders for long-term medication adherence in ST-elevation myocardial infarction (DERLA-STEMI). *Am Heart J* 2015;170:903–13.
- [26] Ivers NM, Schwalm J-D, Bouck Z, et al. Interventions supporting long term adherence and decreasing cardiovascular events after myocardial infarction (ISLAND): pragmatic randomised controlled trial. *BMJ* 2020;369.
- [27] Naderi SH, Bestwick JP, Wald DS. Adherence to drugs that prevent cardiovascular disease: meta-analysis on 376,162 patients. *Am J Med* 2012;125(882–887):e881.
- [28] Califf RM. The FDA and the clinical community. *JAMA* 2022;328:1043–4.
- [29] Kini V, Ho PM. Interventions to improve medication adherence: a review. *JAMA* 2018;320:2461–73.
- [30] Anderson L, Brown JP, Clark AM, et al. Patient education in the management of coronary heart disease. *Cochrane Database Syst Rev* 2017;6.
- [31] Patient Education Resources for Health Care Professionals. American Heart Association. <https://www.heart.org/en/health-topics/consumer-healthcare/patient-education-resources-for-healthcare-providers>. Accessed 10/19/2023.
- [32] Educational Materials for Patients, Centers for Disease Control and Prevention, Division for Heart Disease and Stroke Prevention. https://www.cdc.gov/dhdsp/materials_for_patients.htm. Accessed 10/19/2023.
- [33] Fagerlin A, Pignone M, Abhyankar P, et al. Clarifying values: an updated review. *BMC Med Inform Decis Mak* 2013;13:1–7.
- [34] Flipping the Doctor's Office. The Health Care Blog. <https://thehealthcareblog.com/blog/2013/07/17/flipping-the-doctors-office>. Accessed 10/19/2023.