CJC Open 5 (2023) 530–536

Original Article

Adherence to Cardiovascular Prevention Guidelines in an Academic Centre

Iness Soltani, MD,[a,‡] Marie-Claude Beaulieu, MD,[a,‡] Maude Sestier, MD,[a] Hao Cheng Shen, MD,[a] Ali Hillani, MD,[a] Alexis Matteau, MD, SM,[a] Samer Mansour, MD,[a] and Brian J. Potter, MDCM, SM[a]

[a] *Centre hospitalier de l'Université de Montréal (CHUM) Research Center and Cardiovascular Centre, Montreal, Québec, Canada*

ABSTRACT

Background: Adherence to guidelines is associated with better patient outcomes. Although studies show suboptimal adherence to cardiovascular prevention guidelines among general practitioners, adherence among specialist physicians is understudied. The aim of this analysis was to identify practice gaps among cardiologists in a tertiary academic centre.

Methods: We retrospectively audited cardiology outpatient clinic notes taken at the Cardiology Clinic at the Centre hospitalier de l'Université de Montréal (CHUM), from the period January 1, 2019 to February 28, 2019. Data were abstracted from hospital medical records. The pri-

RÉSUMÉ

Contexte : Le respect des lignes directrices est associé à de meilleurs résultats pour les patients. Bien que les études montrent que les omnipraticiens adhèrent de façon sous-optimale aux lignes directrices en matière de prévention des événements cardiovasculaires, l'observance chez les médecins spécialistes n'a pas été assez étudiée. Notre analyse a pour objectif de déceler les lacunes dans la pratique des cardiologues exerçant dans des centres universitaires de soins tertiaires.

Méthodologie : Nous avons examiné de manière rétrospective les notes cliniques consignées au dossier des patients du Centre car-

Cardiovascular disease (CVD) has been the leading cause of death in North America for many years.[1,2] The morbidity and mortality levels associated with CVD represent significant costs and burden of care for the healthcare system globally.[3] As the fact that adverse cardiovascular events can be prevented through healthy behaviours and optimal treatment of cardiovascular risk factors is well known,[4] national scientific societies have published evidence-based guidelines for the prevention of CVD events through management of diabetes, lipid disorders, hypertension, heart failure, coronary artery disease (CAD), and peripheral artery disease (PAD), including both pharmacologic and nonpharmacologic interventions.[4-12] The American College of Cardiology (ACC) also recommends a team-based approach to optimize preventive cardiology aspects and minimize the incidence of CVD.[4]

Despite strong evidence that adherence to prevention guidelines is associated with better outcomes for patients,[4,13-16] studies have shown that adherence to these guidelines remains suboptimal.[13,17-22] For example, the adherence rate to individual guideline recommendations was found to range between 5% and 34%, even among patients with prior myocardial infarction.[21] The Million Hearts study also assessed the quality of adherence to preventive cardiology concepts. Antiplatelet prescription, hypertension control, hyperlipidemia control among patients with diabetes, and tobacco use screening and intervention were appropriate, according to guidelines, in 71.9%, 66.6%, 75.8%, and 79.8% of cases, respectively.[18]

Despite the availability of well-developed cardiovascular prevention guidelines, a number of barriers appear to limit their application in clinical practice.[23] However, although guideline adherence has been evaluated among general practitioners,[17-21] data are limited regarding guideline adherence among cardiologists.[24] Better definition of treatment gaps among specialists may shed important light on the nature of these barriers, to help improve real-world prevention and lead to specific interventions.

Methods

This study consisted of a retrospective chart audit of all patients ≥ 18 years of age who were seen by a cardiologist in

Received for publication February 25, 2023. Accepted March 20, 2023.

‡Co-first authors with equal contribution.

Corresponding author: Dr Brian J. Potter, Carrefour de l'innovation et évaluation en santé (CIÉS), Centre de recherche du CHUM (CRCHUM), Cardiology & Interventional Cardiology, CHUM, Pavillon S, S03-334, 850 rue St-Denis, Montréal, Québec H2X 0A9, Canada. Tel.: +1-514-890-8000 x15473; fax: +1-514-412-7212.

E-mail: brian.potter@umontreal.ca

See page 535 for disclosure information.

https://doi.org/10.1016/j.cjco.2023.03.010

mary outcome of interest was the rate of adherence to cardiovascular prevention guidelines. We compared the chart-documented practice at our centre to the Canadian hypertension, lipid, diabetes, antiplatelet, and heart failure guidelines in effect at the time of the audit. We also collected information regarding discussions of smoking, alcohol consumption, physical activity, and diet.

Results: **A total of 2503 patients were included, with a mean age of 65.6 ± 14.5 years. Dyslipidemia occurred in 63% of patients, hypertension in 55%, and coronary artery disease in 41%. Optimal low-density lipoprotein control was documented as having been achieved in just 39% of cases. Blood pressure control was adequate for 65% of patients, and glycemic control was achieved in 47% of patients with diabetes. Heart failure treatment was optimal in 34% of patients. Nearly all patients with coronary artery disease (95%) had appropriate antithrombotic therapy. The incidence of discussion of non-pharmacologic interventions varied, ranging from 91% (smoking) to 16% (diet).**

Conclusions: **Primary and secondary prevention of cardiovascular events was found to be suboptimal in an academic tertiary-care outpatient cardiology clinic and may be representative of similar shortcomings nationwide. Strategies to ensure guideline adherence are needed.**

diovasculaire du Centre hospitalier de l'Université de Montréal (CHUM) et résumé les données issues des consultations ayant eu lieu du 1er janvier au 28 février 2019. Le principal résultat d'intérêt était le taux d'adhésion aux lignes directrices en matière de prévention des événements cardiovasculaires. Nous avons comparé les pratiques enregistrées dans les dossiers de notre centre aux lignes directrices canadiennes sur la prise en charge de l'hypertension, de la lipidémie, du diabète, du traitement antiplaquettaire et de l'insuffisance cardiaque en place au moment de l'évaluation. Nous avons aussi recueilli de l'information sur les discussions entourant le tabagisme, la consommation d'alcool, l'activité physique et l'alimentation.

Résultats : **Les données de 2 503 patients, âgés en moyenne de 65,6 ± 14,5 ans, ont été retenues. De ces patients, 63 % présentaient une dyslipidémie, 55 %, une hypertension et 41 %, une maladie coronarienne. Le taux de lipoprotéines de basse densité n'était maîtrisé de façon optimale que dans 39 % des cas. La normalisation de la pression artérielle était adéquate chez 65 % des patients, et 47 % des patients diabétiques atteignaient les cibles glycémiques. L'insuffisance cardiaque était optimalement traitée chez 34 % des patients. Presque tous les patients atteints de maladie coronarienne (95 %) recevaient un traitement antithrombotique approprié. La fréquence des discussions sur les interventions non pharmacologiques variait, allant de 91 % dans le cas du tabagisme à 16 % dans celui de l'alimentation.**

Conclusions : **La prévention primaire et secondaire des événements cardiovasculaires s'est révélée sous-optimale dans une clinique externe de cardiologie d'un hôpital universitaire et pourrait être représentative de lacunes similaires dans l'ensemble du pays. Des stratégies visant à assurer le respect des lignes directrices sont nécessaires.**

the outpatient Cardiology Clinic at the Centre hospitalier de l'Université de Montréal (CHUM), in the period from January 1, 2019 to February 28, 2019. This period was chosen because it allowed a second follow-up audit of the same period in 2020, prior to when the COVID-19 pandemic reached North America. Cardiologist visits occurring both in general cardiology and specialized cardiology clinics were included.

The CHUM is a large Canadian tertiary-care academic centre that uses the open architecture clinical information system (Oacis) electronic medical record (EMR) system (Telus Santé, Montréal, Québec, Canada). Outpatient cardiology notes can be made using either a structured digital format or a handwritten note (subsequently scanned into the EMR), according to individual physician preference. The primary outcome of interest was adherence to cardiovascular prevention guidelines in an outpatient setting. We compared the documented practice used at our centre to that specified in the most recent Canadian diabetes, lipids, antiplatelets, hypertension, and heart failure guidelines published at the time of the patient visits.[4-12]

Patients who consulted the cardiology service more than once during the study period were analyzed based on their more recent visit. Visit notes by noncardiologist health professionals were not audited (the vast majority of patients were seen by only their cardiologist during the period of study). All data were abstracted from the EMR.

For hypertension, we compared charted practice to the 2018 Hypertension Canada guidelines.[8] Treatment was analyzed for each patient first by collecting a record of medications that were initiated (angiotensin-converting enzyme inhibitor [ACEi], angiotensin receptor neprilysin inhibitor (ANRI), beta-blocker [BB], calcium-channel blocker (CCB), diuretics, mineralocorticoid antagonist (MRA), thiazides, and angiotensin receptor blocker [ARB]). Blood pressure targets were $< 130/80$ mm Hg for patients with diabetes, and $< 140/90$ mm Hg for others, needing to reach both systolic and diastolic values to be considered on target.

Regarding dyslipidemia, we used the 2016 Canadian Cardiovascular Society (CCS) dyslipidemia guidelines and the 2018 CCS familial hypercholesterolemia update.[6,7] We looked at the rate of lipid treatment-target achievement (low-density lipoprotein [LDL] < 2 mmol/L or reduction of 50% of LDL level compared to baseline values), adequacy of screening, and the types of lipid-lowering therapy prescribed to patients with indication of treatment.

We used the 2018 Canadian Diabetes Association guidelines[5] to assess adherence to diabetes recommendations. Outcomes of interest included the rate of diabetes screening among cardiology patients without diabetes aged > 40 years or without risk factors for diabetes, as well as the rate of glycosylated hemoglobin (HbA1C) evaluation and adequate glycemic control (HbA1C $\leq 7.0\%$) among patients with diabetes. We also assessed the use of sodium-glucose cotransporter 2 inhibitors (SGLT2i's) and glucagon-like peptide 1 receptor agonists (GLP1RA's), which are antidiabetic agents with known cardiac benefit.

The 2018 CCS antiplatelet therapy guidelines, the 2016 American Heart Association (AHA)/ACC guideline on lower-extremity PAD and the 2018 AHA/American Stroke Association guidelines for management of ischemic stroke[10-12] were all used to assess the adequacy of antiplatelet therapy among CAD and PAD patients. Appropriateness of prescription was defined as prescription of aspirin when it was indicated or omission of prescription when it was not indicated. For example, for patients with stable CAD with an indication for anticoagulation, omission of aspirin prescription was judged to be appropriate. We also assessed whether gastroprotective therapy was prescribed according to the 2008 ACC Foundation, American College of Gastroenterology, and AHA expert consensus recommendations.[25] Indications for gastroprotective therapy included the need of aspirin therapy and history of ulcer disease, gastrointestinal bleeding, dual antiplatelet therapy (DAPT), or concomitant anticoagulant therapy. Gastroprotective therapy was also indicated if more than one of the following risk factors was met: age $>$ 60 years, corticosteroid use, dyspepsia, or gastroesophageal reflux symptoms. The criterion regarding gastrointestinal symptoms was not taken into account, because of the anticipated likelihood that such data might be missing from a cardiologist's visit documentation. We also screened the cohort to determine the proportion of patient who would be eligible for dual pathway inhibition (low-dose rivaroxaban plus aspirin) based on the Rivaroxaban with or without Aspirin in stable Cardiovascular Disease (COMPASS) trial[26] that was already published at the time, but was not yet incorporated into guidelines and Régis de l'assurance maladie du Québec (RAMQ) reimbursement criteria (coexistence of CAD and PAD).

We referred to the 2017 CCS heart failure guidelines to assess treatment of patients with heart failure.[9] We collected the left ventricular ejection fraction (LVEF) for all patients. We considered patients with an LVEF $\leq$ 40% as having heart failure with reduced ejection fraction (HFrEF), for whom optimal medical therapy consisted of at least triple therapy with a BB, an MRA, and an ACEi/ARB/ARNI. Patients in sinus rhythm with a resting heart rate more than 70 beats per minute despite adequate treatment with a BB were expected to receive ivabradine. Treatment with SGLT2i's was not included in the heart failure guidelines at the time of the chart audit. If LVEF was $<$ 35% after 3 months of optimal medical therapy, patients were expected to be offered an implantable cardioverter-defibrillator (ICD), plus cardiac resynchronization therapy if they were in sinus rhythm with a QRS that was more than 130 ms (left bundle branch pattern).

For all patients, we also collected any documented information regarding their lifestyle, including smoking, alcohol consumption, physical activity and nutrition. For patients drinking more than the recommended amount of alcohol ($>$ 14 drinks per week for men; $>$ 11 drinks per week for women),[27] we took note of whether the cardiologist addressed this aspect during the patient visit. For active smokers, we verified whether a smoking-cessation therapy had been prescribed or discussed. We also evaluated whether a discussion took place about physical activity and nutrition, or referral to a nutritionist. We also recorded whether the body mass index was documented or available in the EMR.

Table 1. Characteristics of the total cohort

Characteristic	Total cohort (N = 2503)
Age, y	66 ± 15
Age > 40 y	2346 (94)
Male	1506 (60)
Weight, kg	79 ± 20
BMI ≥ 30	339 (14)
Missing data	1468 (59)
NYHA functional class	2 (1−2)
Missing data	1513 (60)
≥ 2 heart failure hospitalizations in past y	45 (2)
Comorbidities	
Diabetes	644 (26)
Dyslipidemia	1567 (63)
CAD	1032 (41)
PAD	318 (13)
HFrEF	184 (7)
Hypertension	1378 (55)
CKD	438 (18)
Lifestyle habits	
Active smoking	188 (8)
Alcohol more than recommendations*	40 (2)
Physical activity > 150 min/ wk	83 (3)

Values are n (%), mean ± standard deviation, or median (interquartile range). Chronic kidney disease (CKD) is defined as an estimated glomerular filtration rate $<$ 60 ml/min per m^2.

BMI, body mass index; CAD, coronary artery disease; HFrEF, heart failure with reduced ejection fraction; NYHA, New York Heart Association; PAD, peripheral artery disease.

*Women > 11 drinks per week; men > 14 drinks per week.[27]

Continuous data are reported as means and standard deviations, or medians and interquartile ranges (IQR), as appropriate, and categorical/binary data are reported as counts and percent proportions. The study protocol was consistent with the ethical guidelines of the 1975 Declaration of Helsinki and was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[28] The CHUM Research Centre institutional ethics board approved the study and provided a waiver for informed consent.

Results

We included 2503 patients seen at the CHUM cardiology clinic from January 1, 2019 to February 28, 2019. The mean age was 66 ± 15 years, with 94% of patients being over 40 years old. Sixty percent of patients were men. The most prevalent comorbidities were dyslipidemia (63%), followed by hypertension (55%) and CAD (41%). Active smokers represented 8% of our population (Table 1).

Management of hypertension

More than half of patients (55%) suffered from hypertension. Of them, 311 (64%) also had diabetes. Optimal blood pressure control was achieved for 62% of all hypertensive patients, and for 66% of patients with diabetes (Table 2). The most frequent medications used were a BB (62% for all; 67% for patients with diabetes) followed by a calcium-channel blocker (43% for all; 43% for patients with diabetes) and an ACEi (36% for all; 39% for patients with diabetes). The level of use of an ARNI in the whole cohort

Table 2. Adherence to prevention guidelines in a cardiology clinic

Risk factor	Optimal adherence to respective guidelines
Diabetes	
Glycemic control	300 (47)
Dyslipidemia N = 1567	
LDL control	608 (39)
Vascular disease	
Accurate aspirin therapy	
CAD	782 (95)
PAD	160 (92)
HFrEF	
Triple therapy	62 (34)
Hypertension	
BP control	899 (65)
Smoking discussion	172 (91)
Alcohol discussion	36 (90)
Obesity	
Physical activity discussion	93 (27)
Diet discussion	45 (11)

Values are n (%).

BP, blood pressure; CAD, coronary artery disease; HFrEF, heart failure with reduced ejection fraction; LDL, low-density lipoprotein; PAD, peripheral artery disease.

was low (2%) but higher (17%) for patients with HFrEF (Supplemental Tables S1 and S2).

Management of dyslipidemia

A total of 1567 patients (63%) had dyslipidemia (Table 1). Lipid treatment was at target dose in 608 patients with dyslipidemia (39%; Table 2). Adequate LDL control was reached in 46% of patients with CAD. Thirty-five patients (3%) with CAD had an LDL level above target without any lipid-lowering therapy. Assessment of lipid levels was documented at least once in the last 5 years in 66% of patients with known CAD, 52% with PAD, 62% with diabetes over the age of 40 years, and 59% of patients with chronic kidney disease over the age of 50 years. The level of prescription of proprotein convertase subtilisin/kexin type 9 (PCSK9) inhibitors was low (1%; Supplemental Table S3).

Management of diabetes

Among the entire cohort, 644 patients had diabetes (26%; Table 1). Documentation of HbA1C was found in 37% of patients without diabetes, compared to 75% of patients with diabetes within the previous 5 years. Among patients with diabetes, target HbA1C ($\leq$ 7.0%) was achieved in 47% of cases (Table 2). GLP1RA and SGLT2i were used in 2.0% and 7.0% of patients with diabetes, respectively, and neither was prescribed to patients without diabetes. In CAD or PAD patients with diabetes, SGLT2i's were prescribed in 7% and 9% of cases, respectively. GLP1RAs were prescribed to 4% of patients with diabetes with body mass index $\geq$ 30 (Supplemental Table S4).

Management of CAD/PAD

Forty-six percent of patients suffered from either CAD and/or PAD. Among the 1032 patients with CAD, 989 (96%) were on antithrombotic or anticoagulant therapy. Of the 821 patients with CAD and an aspirin indication, 782 (95%) had an appropriate prescription. Among the 318 patients with PAD, 296 (93%) were on an antithrombotic or anticoagulant. Of the 173 patients with PAD and an indication for aspirin, 160 (92%) had an appropriate prescription (Table 2). Ninety-six patients in our cohort (4%) were taking aspirin without a guideline-approved indication.

A total of 1665 patients were taking an antiplatelet or anticoagulant. In this population, 828 (50%) were on single antiplatelet therapy (SAPT), 163 (10%) were on DAPT, 584 (35%) were on anticoagulation therapy alone, 80 (5%) were on SAPT plus an anticoagulant, and 10 ($<$ 1%) were on triple therapy (DAPT plus anticoagulant). Among DAPT patients, 101 (62%) were also prescribed a gastroprotective medication, compared to 36 patients (45%) receiving SAPT plus an anticoagulant. All 10 patients on triple therapy had gastroprotective medication.

Among the 1172 patients that suffered from either CAD or PAD in our study, 616 were on aspirin alone, who could potentially benefit from the addition of low-dose rivaroxaban, as per the COMPASS study[29] (Supplemental Tables S5 and S6).

Management of heart failure

Seven percent of patients had HFrEF (Table 1). Of them, 40% had a New York Heart Association functional class $>$ 1. Fifty-seven percent of patients had an LVEF $\leq$ 35%. Treatment with a BB was frequent (88%). A renin-angiotensin modulator (ACEi or ARB or ARNI) was part of the treatment in 73% of cases. Only 40% of patients were on an MRA, however. Overall, therefore, only 62 patients (34%) were optimal medical therapy defined as triple therapy (BB + renin-angiotensin modulator + MRA; Table 2). This percentage increased to 49% in patients followed at the specialized heart failure clinic, suggesting that the low overall proportion might have been due to legitimate limiting factors such as low blood pressure or marginal renal function. Forty seven percent of patients with LVEF $\leq$ 35% either had an ICD or had documentation that an ICD had been discussed. Cardiac resynchronization therapy devices were implanted in 28% of eligible patients with a large QRS and LVEF $\leq$ 35%. About a quarter of HFrEF patients (27%) were followed in a specialized heart failure clinic (Supplemental Table S2).

Nonpharmacologic prevention

A minority of patients were active smokers (8%; Table 1), of whom 91% had a documented discussion or intervention. Of 40 patients with documented excessive alcohol consumption, 36 (90%) had their alcohol consumption addressed by their cardiologist. In contrast, physical activity was discussed with 650 patients (26%), and diet was discussed with 223 patients (16%). Similarly, when considering only obese patients, 27% and 11% received physical activity advice and nutrition advice, respectively. For patients referred to the specialized preventive cardiology clinic, documentation of physical activity and diet discussions increased to 86% and 57%, respectively (Supplemental Table S7).

Discussion

Our study evaluated adherence to CVD prevention guidelines among cardiologists in a Canadian tertiary-care academic centre. We demonstrated that application of many

aspects of the guidelines appears to be suboptimal, even by academic cardiovascular specialists, based on available EMRs.

Treatment to target of blood pressure, HbA1C, and LDL levels was disappointing overall. Regarding dyslipidemia, particularly, a noteworthy point is that, despite low rates of achieving target LDL level in our cohort, add-on molecules to statin therapy, such as PCSK-9 inhibitors, were rarely prescribed. This low rate may be partially explained by the administrative hurdles to obtaining PCSK-9 reimbursement in Québec.

Rates of appropriate aspirin prescription were encouraging overall. However, prescription of gastroprotection, particularly among patients receiving SAPT plus an anticoagulant, requires improvement. Diabetes treatments with known cardiac benefits, such as SGLT2i's and GLP1RAs,[30,31] were rarely prescribed, but they also were not included in the guidelines in force at the time of the audited visits. Similarly, studies showing benefits of SGLT2i's for heart failure patients[32-35] were not published at the time.

The results of our study are consistent with findings of other studies regarding CVD prevention among nonspecialist practitioners. In the Million Hearts study,[18] which included more than 100 000 patients in the US, hypertension control ranged from 49% to 75%, compared with a rate of 65% in our study. The level of dyslipidemia control among patients with diabetes was, in contrast, higher than that in our population. Although a reason for this is not immediately clear, one hypothesis is that the CHUM serves a downtown population that frequently does not benefit from having an identified primary care physician. A large European registry of patients with CAD also showed similarly that less than 60% of patients had good risk-factor control in a population cared for by both primary care physicians and specialists.[13] Although CHUM patients frequently do not have primary care physicians, patients with diabetes and those with chronic renal failure frequently benefit from concurrent specialist follow-up in those areas.

Although discussions of smoking cessation and alcohol consumption were frequently documented, discussion of exercise and diet appeared to occur infrequently, unless patients were also followed at our specialized prevention cardiology clinic. This finding may be explained partially by the fact that physicians who refer their patients to a preventive clinic might be more likely to document these discussions. Similarly, the level of HFrEF treatment appeared to be slightly better among patients followed at our heart failure clinic, but it was still limited, possibly owing to low blood pressure and poor renal function limiting treatment options. Data regarding contraindication to or side effects due to specific treatments were not analyzed because these were documented too inconsistently in the medical chart. Although such contraindication would justify the absence of some treatments for some patients, it would be unlikely to explain the extent of nonadherence we have observed.

Taken together, these observations would seem to support the ACC recommendation for a team-based approach to optimize prevention.[4] In line with this, an Iranian study found better adherence rates than those we observed among academic specialists in an inpatient setting,[24] where patients benefit from multidisciplinary care and relatively prolonged or repeated contact with the treating team. Multidisciplinary care also may be a means of compensating for the time pressures of a busy outpatient clinic and may allow for more complete assessment of the full spectrum of prevention in cardiology. Despite the potential benefit of lifestyle modifications,[36] patients were counselled on physical activity and diet in only a minority of patient visits (26% and 16%, respectively), whether the patient was obese or not, in our cohort. The incidence of such counselling might be underestimated, as these topics might have been discussed but not reported in the medical chart. Another possibility is that physicians do not have the time to adequately address these issues during a patient visit. A survey of physicians from diverse specialties, including cardiologists, revealed that less than two thirds of physicians were likely to give nutritional or physical activity advice to their patients. However, this likelihood was influenced by their perception of a patient's risk.[37] In either case, increasing access to multidisciplinary follow-up care could lead to substantial improvement in outcomes.

Some limitations of the present study should be acknowledged. First, this study is a single-centre analysis, which may limit its generalizability. However, our results are consistent with those of similar studies in the literature and extend the findings to specialized cardiology centres. We therefore believe that they are likely indicative of practice in other academic centres. Second, guideline adherence may have been underestimated, and instead, we may have captured poor documentation of adherence. We unfortunately do not have data allowing comparison between handwritten and digital medical notes. However, given the very low rates of documentation of certain interventions, documentation shortcomings appear unlikely to explain the entirety of the adherence gaps we have identified. Third, whether a patient is also followed by a family doctor or another specialist is known to be documented inconsistently in the cardiology clinic chart. A possibility, therefore, is that the level of overall adherence across providers is better than the level reported here. On the other hand, given that our population included patients followed in specialized clinics, such as the heart failure clinic, the rate of guideline adherence might have been lower if the number of patients followed exclusively in general cardiology clinics had been lower than the number we observed. Finally, reimbursement criteria for medications vary from province to province, and such differences could lead to variations in adherence to certain prevention recommendations.

Bearing in mind these limitations, an opportunity clearly exists for quality improvement. In addition to continuing medical education initiatives for both patients and physicians, given typical time pressures and the complexity of patients who consult in academic centres, system-level interventions are likely necessary. The most obvious intervention at this level is to broaden the availability and use of multidisciplinary care in the outpatient setting, based on both our findings and guideline recommendations.[23] In addition, the randomized Effectiveness of Brazilian Intervention to Increase Evidence Usage (BRIDGE) Cardiovascular Prevention study[20] showed that a combination of case management, feedback reports, and educational materials for physicians and patients leads to increased use of evidence-based therapies. Several current technologies also have capability to provide real-time checklists and decision aids to

providers and aid in the proper documentation of important prevention interventions.

Conclusions

Prevention of CVD through lifestyle behavior modification and optimization of cardiovascular risk factors is essential. Our study reveals that despite appropriate guidance and continued medical education efforts, adherence to prevention recommendations remains suboptimal, even in an academic cardiology clinic. The combination of a multidisciplinary approach with standardized updated algorithms and technology that facilitate both the documentation process and the patient encounter appears well positioned to improve patient CVD outcomes.

Ethics Statement

The study protocol was consistent with the ethical guidelines of the 1975 Declaration of Helsinki and was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The CHUM Research Centre institutional ethics board approved the study and provided a waiver for informed consent.

Funding Sources

This study was funded in part by unrestricted research grants from Bayer Canada and Boehringer-Ingelheim Canada, and an unrestricted educational grant from Novartis Canada. B.J.P. is supported by a Fonds de recherche du Québec-Santé career award (267436). The other authors have no funding sources to declare.

Disclosures

B.J.P. has received research funding from Bayer Canada, Boehringer-Ingelheim Canada, and Novartis Canada. The other authors have no conflicts of interest to disclose.

References

1. Kochanek KD, Xu J, Arias E. Mortality in the United States, 2019. NCHS Data Brief 2020;(395):1-8.
2. Tarride JE, Lim M, DesMeules M, et al. A review of the cost of cardiovascular disease. Can J Cardiol 2009;25:e195-202.
3. Virani SS, Alonso A, Benjamin EJ, et al. Heart disease and stroke statistics-2020 update: a report from the American Heart Association. Circulation 2020;141:e139-596.
4. Arnett DK, Blumenthal RS, Albert MA, et al. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation 2019;140:e596-646.
5. Ivers NM, Jiang M, Alloo J, et al. Diabetes Canada 2018 clinical practice guidelines: key messages for family physicians caring for patients living with type 2 diabetes. Can Fam Phys 2019;65:14-24.
6. Anderson TJ, Gregoire J, Pearson GJ, et al. 2016 Canadian Cardiovascular Society guidelines for the management of dyslipidemia for the prevention of cardiovascular disease in the adult. Can J Cardiol 2016;32:1263-82.
7. Brunham LR, Ruel I, Aljenedil S, et al. Canadian Cardiovascular Society position statement on familial hypercholesterolemia: update 2018. Can J Cardiol 2018;34:1553-63.
8. Nerenberg KA, Zarnke KB, Leung AA, et al. Hypertension Canada's 2018 guidelines for diagnosis, risk assessment, prevention, and treatment of hypertension in adults and children. Can J Cardiol 2018;34:506-25.
9. Ezekowitz JA, O'Meara E, McDonald MA, et al. 2017 comprehensive update of the Canadian Cardiovascular Society guidelines for the management of heart failure. Can J Cardiol 2017;33:1342-433.
10. Mehta SR, Bainey KR, Cantor WJ, et al. 2018 Canadian Cardiovascular Society/Canadian Association of Interventional Cardiology focused update of the guidelines for the use of antiplatelet therapy. Can J Cardiol 2018;34:214-33.
11. Brass EP, Hiatt WR. Aspirin monotherapy should not be recommended for cardioprotection in patients with symptomatic peripheral artery disease. Circulation 2017;136:785-6.
12. Powers WJ, Rabinstein AA, Ackerson T, et al. 2018 Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2018;49:e46-110.
13. Cacoub PP, Zeymer U, Limbourg T, et al. Effects of adherence to guidelines for the control of major cardiovascular risk factors on outcomes in the REduction of Atherothrombosis for Continued Health (REACH) Registry Europe. Heart 2011;97:660-7.
14. Komajda M, Cowie MR, Tavazzi L, et al. Physicians' guideline adherence is associated with better prognosis in outpatients with heart failure with reduced ejection fraction: the QUALIFY international registry. Eur J Heart Fail 2017;19:1414-23.
15. Nguyen T, Le KK, Cao HTK, et al. Association between in-hospital guideline adherence and postdischarge major adverse outcomes of patients with acute coronary syndrome in Vietnam: a prospective cohort study. BMJ Open 2017;7:e017008.
16. Shah BR, O'Brien EC, Roe MT, Chen AY, Peterson ED. The association of in-hospital guideline adherence and longitudinal postdischarge mortality in older patients with non-ST-segment elevation myocardial infarction. Am Heart J 2015;170:273-280.e1.
17. Avezum A, Oliveira GBF, Lanas F, et al. Secondary CV prevention in South America in a community setting: the PURE study. Glob Heart 2017;12:305-13.
18. Eapen ZJ, Liang L, Shubrook JH, et al. Current quality of cardiovascular prevention for Million Hearts: an analysis of 147,038 outpatients from The Guideline Advantage. Am Heart J 2014;168:398-404.
19. Farkouh ME, Boden WE, Bittner V, et al. Risk factor control for coronary artery disease secondary prevention in large randomized trials. J Am Coll Cardiol 2013;61:1607-15.
20. Machline-Carrion MJ, Soares RM, Damiani LP, et al. Rationale and design for a cluster randomized quality-improvement trial to increase the uptake of evidence-based therapies for patients at high cardiovascular risk: the BRIDGE-Cardiovascular Prevention Trial. Am Heart J 2019;207:40-8.
21. Solomon MD, Leong TK, Levin E, et al. Cumulative adherence to secondary prevention guidelines and mortality after acute myocardial infarction. J Am Heart Assoc 2020;9:e014415.
22. Chow CK, Teo KK, Rangarajan S, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. JAMA 2013;310:959-68.

23. Schwalm JD, McCready T, Lear SA, et al. Exploring new models for cardiovascular risk reduction: the Heart Outcomes Prevention and Evaluation 4 (HOPE 4) Canada pilot study. CJC Open 2021;3:267-75.

24. Hosseinzadeh-Shanjani Z, Hoveidamanesh S, Ramezani M, Davoudi F, Nojomi M. Adherence of cardiologist physicians to the American Heart Association guideline in approach to risk factors of cardiovascular diseases: an experience from a teaching hospital. ARYA Atheroscler 2019;15:38-43.

25. Bhatt DL, Scheiman J, Abraham NS, et al. ACCF/ACG/AHA 2008 expert consensus document on reducing the gastrointestinal risks of antiplatelet therapy and NSAID use: a report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus Documents. Circulation 2008;118:1894-909.

26. Eikelboom JW, Connolly SJ, Bosch J, et al. Rivaroxaban with or without aspirin in stable cardiovascular disease. N Engl J Med 2017;377:1319-30.

27. Hobin E, Shokar S, Vallance K, et al. Communicating risks to drinkers: testing alcohol labels with a cancer warning and national drinking guidelines in Canada. Can J Public Health 2020;111:716-25.

28. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Int J Surg 2014;12:1495-9.

29. Bosch J, Eikelboom JW, Connolly SJ, et al. Rationale, Design and Baseline Characteristics of Participants in the Cardiovascular Outcomes for People Using Anticoagulation Strategies (COMPASS) trial. Can J Cardiol 2017;33:1027-35.

30. Marso SP, Daniels GH, Brown-Frandsen K, et al. Liraglutide and cardiovascular outcomes in type 2 diabetes. N Engl J Med 2016;375:311-22.

31. Neal B, Perkovic V, Mahaffey KW, et al. Canagliflozin and cardiovascular and renal events in type 2 diabetes. N Engl J Med 2017;377:644-57.

32. Anker SD, Butler J, Filippatos G, et al. Empagliflozin in heart failure with a preserved ejection fraction. N Engl J Med 2021;385:1451-61.

33. Anker SD, Butler J, Filippatos GS, et al. Evaluation of the effects of sodium-glucose co-transporter 2 inhibition with empagliflozin on morbidity and mortality in patients with chronic heart failure and a preserved ejection fraction: rationale for and design of the EMPEROR-Preserved trial. Eur J Heart Fail 2019;21:1279-87.

34. McMurray JJV, Docherty KF, Jhund PS. Dapagliflozin in patients with heart failure and reduced ejection fraction. Reply. N Engl J Med 2020;382:973.

35. Packer M, Anker SD, Butler J, et al. Cardiovascular and renal outcomes with empagliflozin in heart failure. N Engl J Med 2020;383:1413-24.

36. Perk J, De Backer G, Gohlke H, et al. European guidelines on cardiovascular disease prevention in clinical practice (version 2012). The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts). Eur Heart J 2012;33:1635-701.

37. Mosca L, Linfante AH, Benjamin EJ, et al. National study of physician awareness and adherence to cardiovascular disease prevention guidelines. Circulation 2005;111:499-510.

Supplementary Material

To access the supplementary material accompanying this article, visit *CJC Open* at https://www.cjcopen.ca/ and at https://doi.org/10.1016/j.cjco.2023.03.010.