

Cardiovascular prevention in general practice : development and validation of an algorithm

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Abstract

Objective. General Practice visits are a unique opportunity to identify and treat individuals at high cardiovascular (CV) risk. However, a case-finding strategy suited to the daily general practice is not provided in the CV prevention guidelines. We wanted to create, validate and test an algorithm for global CV risk assessment and management.

Methods. The algorithm was 1) developed based on evidence from epidemiological studies and clinical trials, 2) validated in a population-based cohort and 3) tested by randomly selected general practitioners (GPs) who rated its usefulness and applicability.

Results. 1) Screening for seven clinical risk factors (RF) allowed a quick classification of patients in four CV risk typologies: obvious high risk (previous CV event or/and type 2 diabetes) in 17%, obvious low risk (no RF) in 14%, smoking-related risk (single RF) in 6%, or undetermined risk (any other RF) to further evaluate in 63% patients. Inter-physician reproducibility for risk prediction was excellent. Overall, predicted risk was high, moderate and low in 25, 17 and 58% of the patients, respectively. 2) These risk predictions were validated in a cohort of 962 men followed over 10 years. 3) Most GPs reported that the algorithm was applicable and useful, while half of them started using it frequently in their daily practice.

Conclusion. This algorithm is a new, pragmatic and evidence-based strategy for systematic and global CV risk management. It was validated at the population level, and shown to be applicable and useful in the daily general practice.

Introduction

Cardiovascular (CV) ischaemic attacks remain a major cause of adult mortality and morbidity in most industrialised countries. The majority of CV attacks occur in apparently healthy individuals.^{1,2} Because a large majority of the adult population is yearly seeking medical advice in the General Practice, the latter offers a unique opportunity for CV risk prevention.

High CV risk meets the main WHO criteria for screening/case-finding as this severe and frequent condition may be detected early and treated effectively. High CV risk is the main focus of the recent third Joint European guidelines for CV prevention released in 2003.³ In these guidelines, the identification of high risk in CAD-free patients requires the measurement of serum lipids and the use of a risk chart in all patients. This is a time- and cost-consuming approach. Moreover, many clinicians do not systematically screen their adult patients for CV risk factors - which are often not reported in the medical record⁴ – and still focus more on individual CV risk factor(s) than on global CV risk.

Recent studies have pointed to important failures in the implementation of CV prevention.^{5,6} These failures relate to multiple causes, which are internal and external to the physicians. In a survey on CV prevention conducted among Belgian GPs in 2000, we observed inappropriate management as far as the diagnosis (e.g. under-use of a global CV risk approach) and the treatment of CV risk (over-treatment in low risk and under-treatment in high risk patients) were concerned.⁷

The purpose of this research was to develop, validate and test a clinical algorithm to help GPs in the management of CV risk. This strategy had to be evidence-based, simple, fast and useful in a busy GP's daily medical practice.

Methods

DEVELOPMENT OF THE CV RISK ALGORITHM

In the algorithm, the clinical risk assessment and the risk-driven therapeutic targets were defined according to, respectively, epidemiological and clinical trials evidence. The algorithm was constructed in three successive steps, namely the screening of the clinical CV risk factors, the assessment of the patient's CV risk level, and the risk-related therapeutic targets.

1. The screening included the main clinical risk factors readily available in the primary care setting⁸: age, sex, personal and familial history of ischaemic CV disease, smoking, high blood pressure, diabetes and history of dyslipidaemia. These risk factors were defined according to the European guidelines for CV prevention³ and the international guidelines for hypertension management⁹.

2. To help GPs quickly assess the patient's CV risk level, we defined risk typologies according to epidemiological evidence from the Framingham, Monica and Procam population-based projects.¹⁰⁻¹² Patients at undetermined risk after this clinical evaluation had a lipid testing and a risk assessment using a risk chart, e.g. the Joint British CAD risk assessment chart¹³ shown to be the most accurate tool in General Practice.¹⁴ This latter chart relies on values of the total Cholesterol/HDL-C ratio and of the systolic blood pressure, both

on continuous axes, thereby making it possible to locate very precisely (1 mm²) an individual on one curve of the table. With authorisation from Prof. Durrington (Birmingham, UK), we adapted the British chart according to the classical definitions of the 10-year CAD risk levels (low risk : <10% ; medium risk : 10-20% ; high risk : >20%).

3. Evidence for effective therapeutic interventions for CV prevention in high risk patients was searched in the medical literature. We reviewed the original clinical trials and systematic reviews addressing the effectiveness of life-style or drug interventions, using Medline, Clinical Evidence, and the Cochrane Collaboration. The algorithm was discussed and reviewed with national experts in the fields of General Practice, Preventive Cardiology, Lipidology and Atherosclerosis, Diabetes mellitus, Hypertension and Public Health.

VALIDATION OF THE ALGORITHM.

Risk discrimination. The algorithm's ability to classify patients in distinct CV risk groups was tested by asking GPs - who had participated in a continuous medical education meeting on CV prevention - to use the algorithm in 20 consecutive patients aged 30 to 70 years. Fourteen GPs recruited 280 patients whom they classified using the algorithm into the various CV risk typologies.

Reproducibility. Eight other GPs used the algorithm to assess the CV risk level of the same 100 cases selected among the 280 above mentioned patients. These GPs were provided with the patient's risk factors, as well as lipid values when useful (undetermined risk group). Inter-physician reproducibility was analysed using weighted kappa statistics for multiple ratings for subject.¹⁵

Predictive value. For the sake of external validation, we applied the algorithm to the population-based prospective cohort of the 962 CAD-free men aged 35-64 years from the Bel-Lux centre of the WHO-MONICA Project, followed since 1984 by the register of major acute coronary events (MACE, i.e. non-fatal myocardial infarctions, coronary deaths, coronary revascularisation).¹⁶ According to their baseline characteristics, these men were classified into the four risk typologies of the algorithm. The actual numbers and the incidence of MACE over a 10 year period was calculated in each CV risk level.

APPLICABILITY OF THE ALGORITHM.

To test the feasibility of this CV risk algorithm in the daily GP's practice, we randomly selected seven groups of continued medical education (namely dodecagroups) affiliated to the French-speaking Scientific Society of General Practice. This research was approved by our Ethics Committee. Ninety-nine GPs were taught to use the algorithm during a 2 hour training session, and invited to use it in their daily practice. Four months after the training, GPs were invited to respond to a survey and scored three features of the algorithm (usefulness, applicability and actual use) on a 100 mm visual analogue scale. For each feature, the median score was calculated as well as the proportion of GPs scoring 70 mm or more.

Results

DEVELOPMENT OF THE CV RISK ALGORITHM

The algorithm flows in three steps, suited to the daily general practice.

The clinical screening of CV risk factors (Figure, step 1). A systematic and quick (~ 1 minute) screening of seven clinical CV risk factors is proposed in all patients 30-70 years of age. This screening is clinical as it relies only on medical history and blood pressure measurements. Table 1 shows the definition of each clinical risk factor, namely age/gender [A], blood pressure [B], cigarette smoking [C], history of dyslipidaemia [D], personal ischaemic event [E], familial ischaemic event [F] and of high glucose/diabetes [G]. Dyslipidaemia was defined by medical history because lipid values are not needed in all patients to assess CV risk and are moreover not always available at the time of the medical visit.

Table 1. List and definitions of clinical CV risk factors (ABCDEFGF)

	Clinical CV risk factor definitions
A	Age \geq 45 years in men, and \geq 50 years in women
B	Blood pressure: high values (\geq 140/90 mmHg) or drug use
C	Cigarettes \geq 1 daily
D	Dyslipidaemia : history or use of lipid-lowering medication
E	Event * in the personal history
F	Familial CV event *, first degree relative < age 60 years
G	Glycaemia/diabetes: history (\geq 126mg/dl) or drug use

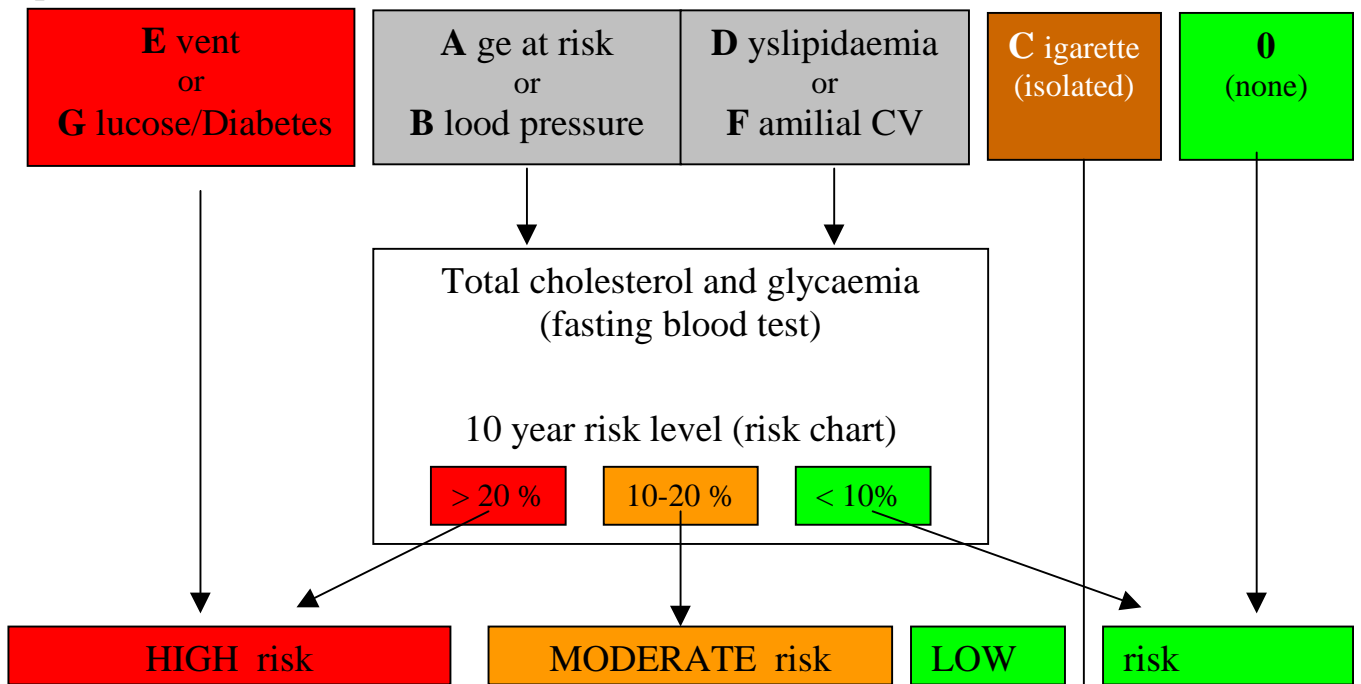
* Event (cardiovascular): myocardial infarction, angina pectoris, coronary revascularisation, stroke, transient ischaemic attack, carotid surgery, leg claudicatio, aorto-femoral revascularisation.

Figure. Three step algorithm for cardiovascular (CV) risk management

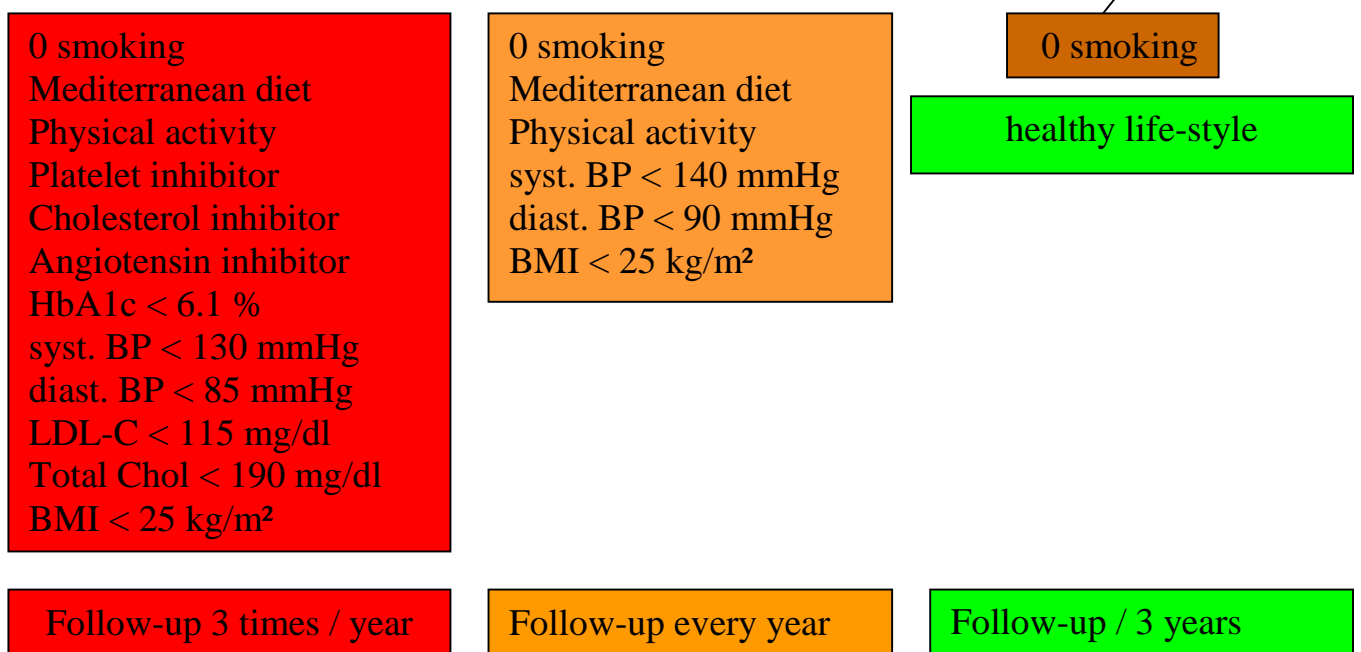
Step 1. SCREENING OF CLINICAL CV RISK FACTORS #

Medical history (A C D E F G) and blood pressure measurements (B)

Step 2. ASSESSMENT OF CV RISK LEVEL #



Step 3. CV TREATMENT TARGETS



: Risk factors (ABCDEFG): see definitions in Table 1

The CV Risk assessment (Figure, step 2). Using these seven clinical risk factors, the algorithm allows a quick triage of the patients in one of the four following CV risk typologies: obvious high risk (*red colour*) for patients with a previous CV event [E] and/or those with known type 2 diabetes [G]; obvious low risk (*green colour*) for patients with no clinical risk factor; smoking-related CV risk (*brown colour*) for patients with cigarette smoking [C] and no other risk factor; and undetermined CV risk (*grey colour*) for patients with any other clinical risk factor(s) [A,B,D,F]. In this latter group, risk is further evaluated by using a global risk assessment chart and fasting blood results (cholesterol and glucose). All patients are thus eventually classified into low (*green*), moderate (*orange*) or high (*red*) 10-year risk.

Table 2. Therapeutic targets in high CV risk patients

Targets	Reference	EBM level *
No smoking	20	II
Mediterranean-type healthy diet	21	I b
Physical activity, 3x30 min/week	22	II
Platelet inhibition (aspirin, ...)	23	I a
Cholesterol inhibition (statin, ...)	24	I a
Angiotensin inhibition (ACE inhibitor, ...)	25	I b
Optimal glucose control, < 6.1 % HbA ₁ C	26	II
Optimal systolic blood pressure, < 130 mmHg	27	IV
Optimal diastolic blood pressure, < 85 mmHg	27	IV
Optimal LDL-cholesterol, < 115 mg/dl	28	IV
Optimal total cholesterol, < 190 mg/dl	28	IV
Optimal BMI, < 25 kg/m ²	29	IV

* Levels of scientific evidence: meta-analyses or multiple RCTs (Ia), single RCT (Ib), observational studies (II), case-control studies (III), expert opinions (IV).

The CV therapeutic targets (Figure, step 3). Treatments are driven by the patient's CV risk level. In low risk patients (*green*), a healthy life-style is recommended. In all smokers, the algorithm focuses on smoking cessation, which results in low CV risk in patients with cigarette smoking as single risk factor (*brown*). For patients at moderate risk (*orange*), six targets are defined: no smoking, Mediterranean diet, regular physical activity, normal weight and normal blood pressure values. In the high risk patients (*red*), global CV risk management involves 12 items (Table 2), each supported by at least one clinical study conducted in high CV risk patients. For the sake of simplicity, each therapeutic target received a single definition.

VALIDATION OF THE ALGORITHM

Risk discrimination. In 280 consecutive patients aged 30-70 years (mean age 51.1 ± 11.5 years; 51% male) visiting a GP, the distribution of the clinically defined risk typologies (see Figure, step 2) was as follows: "obviously high" [red] in 48 (17%), "undetermined" [grey] in 176 (63%), "cigarette-related" [brown] in 17 (6%), and "obviously low" [green] in 39 (14%) patients. No further risk evaluation was needed in these 104 patients (37%). In the 176 patients (63%) at "undetermined risk", further evaluation using a risk chart (after cholesterol testing) showed that risk was low (n=106), moderate (n=47) and high (n=23). Thus, the final CV risk of these 280 patients was low [green] in 52 % (n=39+106), smoking-related [brown] in 6% (n=17), moderate [orange] in 17 % (n=47) and high [red] in 25% (n=48+23).

Reproducibility. Using the algorithm to assess the CV risk in the same 100 patients (figure, step 2), eight GPs reached identical conclusion in 96 cases (weighted kappa 0.98, $p < 0.001$) for the initial clinical risk classification into the four CV risk typologies (i.e. red, grey, brown,

green) and in 78 cases (weighted kappa 0.85, $p < 0.001$) for the three final CV risk levels (high, moderate, low).

Predictive value. Risk prediction in each clinical typology was validated in a prospective population-based male cohort of CAD-free men.¹⁶ Over 10 years, 77 of the 962 men suffered a first major acute coronary event (MACE), giving a 8% cumulative incidence. The 10-year MACE incidence was 29% in the “obvious high risk” group (5/17), 9% in the “undetermined risk” group (68/754), 3% (3/96) in the “cigarette-related risk” group, and 1% (1/96) in the “obvious low risk”. Low risk (< 10% at 10 years) was confirmed in all the latter 96 subjects by risk calculation using the cholesterol values. Further risk evaluation with the algorithm of the heterogeneous “undetermined risk” group showed that risk was high in 256 (34%), moderate in 324 (43%) and low in 174 (23%) individuals. In this population-based cohort, 268 of the 962 men (28%) were at high predicted risk (>20% at 10 years) and suffered 45 of the 77 MACE (58%), with a MACE rate of 17.8/1.000 person-years. Table 3 shows the MACE rate in the other CV risk groups.

Table 3. Rates of first major acute coronary events (MACE) in a cohort of 962 men followed over ten years, by risk level according to the algorithm

Algorithm risk groups	First MACE n=77 (100%)	Observed rate, person-years	Observed 10 year risk	Predicted 10 year risk
Low risk, n=274	N=7 (9%)	2.4 / 1.000	~ 2.4 %	< 10 %
Cigarette-related, n=96	N=3 (4%)	2.9 / 1.000	~ 2.9 %	< 10 %
Moderate risk , n=326	n=22 (29%)	6.6 / 1.000	~ 6.6 %	10 - 20 %
High risk, n=268	n=45 (58%)	17.8 / 1.000	~ 17.8 %	> 20 %

APPLICABILITY OF THE ALGORITHM.

Fifty-five of the 99 GPs (mean age 42 ± 10 years; 76% male; 76% urban practice and 78% single practice) answered four months after the training session a survey on the algorithm's usefulness, applicability and use (rating on a 0-100 mm scale). A large majority of these GPs reported that the algorithm was useful and applicable, while 46% of them had started using it in their daily practice (Table 4).

Table 4. GP's ratings (0-100 mm visual analogue scale) of three features of the CV prevention algorithm, four months after the training

	Median	Rating > 70 mm
Usefulness	83 mm	82 %
Applicability	81 mm	75 %
Regular use	64 mm	46 %

Discussion

In order to be more frequently implemented in the daily medical practice, the CV risk evaluation must be fast and valid. We present here a CV risk algorithm able to help clinicians quickly (~ 1 minute) sort the patients into four CV typologies and manage them accordingly. Our results indicate that this algorithm was found interesting and feasible in the general practice. Four months after the training, GPs reported high adherence rates regarding the algorithm's usefulness and applicability, and half of them used it regularly. Facilitators (e.g. electronic version of the algorithm, reminders, feed-back, discussion with peers, ...) might increase the proportion of GPs implementing this strategy in their daily practice.

The three step strategy goes from case-finding to treatment. The first step of the algorithm is the screening of risk factors in all patients aged 30 years or more. One fourth of all first myocardial infarctions occur in men aged 30 to 55 years.¹⁷ The screening is clinical in order to be easy and fast, and therefore applicable to any patient. It relies on seven items obtained by focused medical history and blood pressure measurements. It does not include lipid results which do not modify the risk assessment in patients at obviously high risk (CAD or diabetes) or low risk (no clinical risk factor). Obesity was not included in the clinical screening because weight (or BMI) is not used for CV risk calculation in the Framingham and in the SCORE³ equations. The age of 45 years is also the threshold for screening of diabetes mellitus.

The second step of the algorithm is based on CV risk typology, an approach suited to the general practice. Ten-year risk level assessment does not require a cholesterol value nor a risk chart in one third of the patients. Risk is always high in patients with CAD, other atherosclerosis related manifestations, or diabetes.³ However, even when hypercholesterolemia is present¹⁸, risk is always low in individuals free of clinical risk factor (including age of 45 years or more). In the latter individuals, we confirmed that lipid results do not modify the clinical-based assessment of low risk, and we observed a very low incidence (~1%) of acute coronary events over ten years. The actual risk observed in each group of the Bel-Lux MONICA cohort (see table 3) was lower than risk expected using the Framingham equation, which is known to overestimate risk prediction in European countries.¹⁹ The discrepancy between predicted and actual risk in the Bel-Lux cohort was not due to the MACE definition as non-infarction myocardial ischaemia was included both in the Framingham study (angina pectoris) and in the Bel-Lux study (coronary revascularisations). If the SCORE equation proves to be accurate in CV risk prediction in the general population, it should be used for risk determination. We believe that a risk chart is useful only in the

“undetermined risk” [grey] typology, in which it may modify the pre-test probability based on the clinical approach. Restricting the use of a risk chart to the “undetermined risk” group is time-saving and safe in the daily practice. Our results showed that this typological approach allowed a useful risk discrimination among consecutive patients presenting to a GP. Moreover, inter-physician reproducibility in the evaluation of patient’s CV risk level through the algorithm was high.

The third step of the algorithm relates to treatments. Rather than reminding GPs about recommendations on life-style and drug treatments, the algorithm provides a list of pragmatic therapeutic targets. Targets are an effective mean for the implementation of CV prevention in the clinical practice. For the sake of applicability, we gave each target one single definition. Both for moderate and high risk, the first targets relate to life-style.²⁰⁻²² Patients at moderate risk (10-20% at 10 years) are not considered as a distinct risk group by the European guidelines³, although our results show that this group represents about one-third of all first CV attacks at the population level. In high risk patients, the target list of our algorithm includes the use of an anti-platelet agent, a statin and an ACE-inhibitor, according to the clinical evidence from recent clinical trials.²³⁻²⁵ We believe that the use of these drugs itself is a more validated target than the absolute values of blood pressure or serum cholesterol concentrations, for which our review of the literature found no strong scientific evidence.

This algorithm for CV prevention has some limitations. It requires a training session which allows a change in the physicians’ behaviour. Its testing was limited in size (99 GPs), and is currently extended to another one hundred GPs. The screening of risk factors did not include new ones, such as C-reactive protein or homocystein which can not currently be included in a quantitative CV risk assessment. Risk evaluation, based on clinical typology, allowed to

classify 37% of the patients without the use of a risk chart; the other patients, i.e. those at undetermined risk, need to undergo a blood analysis and a formal risk assessment through a risk chart. The chart used in our validation study, namely the British chart published in 2000, is not the one proposed by the European guidelines. We believe that the choice of the risk chart is of secondary importance, whether it is based on Framingham or on Score, or whether it relies on total cholesterol or on TC/HDL-C ratio. As far as the therapeutic targets are concerned, no specific advice is given for behavioural change or for drug prescription. In our view, the main need of GPs is a short list of validated targets, each with one single definition.

Conclusion

This algorithm offers three main advantages completing the current CV prevention guidelines. It helps GPs to systematically screen for CV risk factors (namely ABCDEFG), to quickly assess (~1 minute) the CV risk level in about 40% of all patients without use of a risk chart, and to aim at a list of evidence-based therapeutic targets according to the patient's CV risk level. This algorithm is a simple, validated, discriminating and reproducible strategy. GPs found it applicable and useful in their daily practice. If adopted by most GPs, it should improve the CV prevention at the population level. The implementation of this CV prevention algorithm is currently prospectively studied in the daily practice of one hundred GPs.

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Conflict of interest : none

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