Predicted Risk of Secondary Attacks among Ischaemic Heart Diseases Patients after A Rehabilitative Program in Ismailia Governorate

Mohamed A. Abdel Hamid[1], Sobhy A. Sobhy[1], Hesham H. Aly[2], Issam E. Barrimah[1], Hussein A. Awaad[1]

Community[1] Medicine and Cardiology[2] Departments, Faculty of Medicine, Suez Canal University, Ismailia, Egypt

Corresponding author: Mohamed A. Abdel Hamid, Community Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia 41522, Egypt, Tel: +201220617327, Fax: none, E-mail: mohamed_alaa@med.suez.edu.eg

Order	Name	Email Address	Phone	Affiliation
1	Mohamed Alaaeldin AbdelHamid	mohamed_alaa@med.suez.edu.eg	+201220617327	Community Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt
2	Sobhy Ahmed Sobhy	sobhy_ahmed@med.suez.edu.eg	+201284010410	Community Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt
3	Hesham Hegazy Aly	dochegazy@yahoo.com	+201200178026	Cardiology department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt
4	Issam ElsaedBarrimah	essam_barima@med.suez.edu.eg	01287008188	Community Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt
5	Hussein Aamer Awaad	hussein_aamer@med.suez.edu.eg	01002341032	Community Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt

Abstract

Background: The problem of ischaemic heart diseases (IHD) is still raising concern on more than one aspect: epidemiological, social, and clinical. Risk prediction using simplified tools can aid in risk quantification and stratification. Secondary attacks of IHD can be prevented, or at least predicted for proper control.

Aim: Improvement of the quality of life of IHD patients and reduce related morbidities and complications, through estimation of secondary attacks risk, and vascular death.

Methods: SMART risk score and SMART-REACH risk model calculators were used to assess 10-year risks of IHD recurrence.

Results: Improvements were noticed for each patient individually, even if there were trials to manage only one risk factor. Collectively, improvement figures were not as good when averages were calculated.

Conclusion: Secondary IHD attack risk calculation and stratification are both essential as parts and parcels in IHD patient care and management.

Keywords: secondary attack, cardiovascular disease/s, ischaemic heart diseases, SMART risk score, SMART-REACH risk model.

DOI Number: 10.48047/nq.2023.21.6.nq23186 **NeuroQuantology2023;21(6): 1863-1871**

Introduction

Disorders of the heart, with its forming structures, arteries, arterioles, blood capillaries, venules, and veins, in addition to cerebrovascular, coronary and rheumatic heart, and pulmonary vessels' diseases are collectively called cardiovascular diseases **(Mendis et al., 2011; World Health Organization, 2018a)**.

Deaths due to ischaemic heart diseases comprise almost a third of all world deaths (31%), that is congruent with a number of people of nearly 17.7 million. More than half of deaths (54%) due to non-communicable diseases in the Eastern Mediterranean Region (EMR) of the World Health Organization classification are caused by ischaemic heart diseases**(World Health Organization, 2018b)**.

It is toworth mention that the risk factors that increase the probability of ischaemic heart diseases' occurrence, either primary or secondary attacks, includingnon-modifiable, modifiable and novel ones. Non-modifiable factors include age, family history, race and gender**(World Health Organization, 2017; World Heart Federation, 2017)**.

Statistics performed recently by the **Institute for Health Metrics and Evaluation** indicate that the prevalence of circulatory and ischaemic heart diseases for all age groups that become affected with CHDs in Egypt was 2.24% in 1990. This proportion was raised to 2.93% in 2016. Ischaemic heart diseases' mortalityin 1990 was 19.5% which increased to reach 28.01% **(Institute for Health Metrics and Evaluation, 2021)**.

Bonaccio and others in 2018 concluded that the main objective of combating ischaemic heart diseases must be the prevention, but NOT control of them. This will lead to the improvement of the patients' health-related quality of life.

Risk stratification and quantification tools have been developed and are increasing in number over time. They include, but are not limited to the following:Cardiovascular Risk Assessment Questionnaire **(Metagenics, 2010)**, Framingham Coronary Heart Disease Risk Scoreand Framingham Risk Models **(Framingham Heart Study (FHS) and National Heart Lung and Blood Institute (NHLBI), 2018)**.

For the prediction of secondary attacks risk score of SMART**(Dorresteijn et al., 2013)**estimates the residual risk for recurrence of an IHD-related event.SMART-REACH**(Kaasenbrood et al., 2018)** model estimates the residual 10-year risk and lifetime risk for recurrence of an IHD-related event.

Cardiac rehabilitation (CR) is an effective way in the secondary prevention of the occurrence of secondary attacks of IHDs. It is a program, supervised medically, with a main objective of the improvement of a patient's health of their cardiovascular system. This is after the occurrence of the first IHD attack with or without its proper management. Healthy-heart living, health education and counselling for exercise, training and stress management are the axes of the program, and their importance is equal **(American Heart Association, 2018)**.

Neither SMART risk score, norSMART-REACH risk model wasput to question or validation in an Egyptian cohort. This study would predict the risk of secondary attacks of ischaemic heart diseases before and after the cardiac rehabilitation program that will be carefully designed, applied and customized per case.

This study aimed towards reduction of morbidities and mortalities, and improvement of quality of life of ischaemic heart disease patients.

Patients and Methods

The study quasi-experimentalstudy was conducted at the department of Cardiology in Suez Canal University Hospitalson 57 patients recruited by simple random sampling from IHD patients who were diagnosed either urgently or electively undergoing diagnostic/therapeutic percutaneous coronary intervention (PCI).

Urgent diagnosis indicates that the patient felt sudden chest pain that led them to undergo PCI. Elective diagnosis means that the patient was feeling chronic chest pain of any nature, and undergoing PCI revealed a coronary pathology that led to IHD due to whatever underlying cause. Patients with incomplete data, or those who had terminal malignancy or auto-immune disease/s were excluded.

Study participants underwent thorough history taking, examination and baseline investigations.Risk of secondary attacks was calculationed using SMART and SMART-REACH models. Participant underwent cardiac rehabilitation programs.One-year of continuous monitoring of adherence to CR programs passed. Risk of secondary attacks was re-calculated. Then the scores before and after the one-year CR program were compared.

Risk calculations were done using SMART and SMART-REACH models. The values of the input data were entered into the electronic web-based calculators on the website www.u-prevent.com.

SMART risk score calculates individual residual risk for (recurrent) myocardial infarction, stroke or vascular death in the next 10 years if standard care (as per protocols of hospital/cardiac centre/etc.) is provided.SMART-REACH riskmodel calculates individual residual 10-year risk and lifetime risk (i.e., risk until the age of 90 years) for (recurrent) myocardial infarction, stroke or vascular death. It also calculates recurrent event-free life-expectancy if standard care is provided (as per protocols of hospital/cardiac centre/etc.).

The cardiac rehabilitation program instructions were delivered to the patient through the first interview with the researcher before the start of the rehabilitation program. Moreover, adherence was checked periodically.For each patient, rehabilitation, treatment and management was targeted against the modifiable risk factors the patient already did have.The program continued for one-year for each patient since the diagnosis of IHD.It consisted of one or more of the following items.

Table1: Cardiacrehabilitationprogrambroad lines

Item		Details
Lifestyle	Sleep	Daily uninterrupted 8-hour in a comfortable position, or 6-hour night and 2-hour afternoon
	Hygiene	Follow hygienic procedures whenever wherever needed

Table1: Cardiacrehabilitationprogrambroad lines

Item		Details
	Food and its related habits	Reduce carbohydrate intake Cut-down fat intake Increase number of fruits and vegetables in taken during the day to at least 3 per day Daily water intake should bet at least 2 liters Total amount of food should be divided upon 5 small meals daily
	Smoking	To be terminated in any form
	Exercise	Daily brisk walking for 30-45 minutes started gradually from normal-paced walking 5-10 minutes a day, or Any form of regular aerobic exercise
Diseases or risk factors	Menopause	Hormone-replacement therapy may be resorted to.
	Diabetes	Adherence to healthy dieting and strict adherence to medication regimens in addition to exercising and healthy lifestyle with reduction of sedentary life attitudes.
	Hypertension	
	Obesity	
	Dyslipidaemia	
	Kidney disease	
	Physical inactivity	Exercising for more than half an hour 3 days a week is a minimum, e.g., brisk walking.
	Stress	Stress and anger-management, in addition to exercising and removing stressors if applicable.
(Kahn et al., 2008; Piepoli et al., 2016)		

Validity and reliability were assessed for both SMART risk score and SMART-REACH model upon the study population. These were checked by the calculation of Cronbach's Alpha, and through calculation of correlations between pre-intervention and post-intervention variables.

Statistical analysis

After data entry into Microsoft Excel 2016 (Microsoft Office, Microsoft Corporation, Redmond, Washington State, United States of America) and analysed using IBM SPSS (Statistical Package for Social SciencesOf IBM Corporation, Chicago, Illinois State, United States of America), normality of data was checked using Kolomogrov-Smirnov test.

Quantitative data weredisplayed in the form of mean ± standard deviation (SD), with medians and first and third quartiles. Qualitative data weredemonstrated through figures of frequency and percentage.

Statistically significant difference between two groups was calculated using Independent Samples t-test for parametric variables and Mann-Whitney U test for non-parametric variables. Between groups of qualitative data, chi-squared-test (χ^2) was used.Statistical differences between data before and after intervention was calculated using Paired samples t-test for parametric data and Wilcoxon Signed-Rank test for non-parametric variables.

Results

This study was inclusive of 57 patients at its start, 14 of which had secondary attacks/episodes of recurrent IHDs. Only 9 of the patients died due to cardiovascular or other causes.Thirty-three of the study's participants were males.

Figure 1shows the frequencies of modalities of cardiac rehabilitation that weremanaged or treated and adhered to by the patients. The most frequent modality managed/treated was using anticoagulant medications and the least was using statin medications.

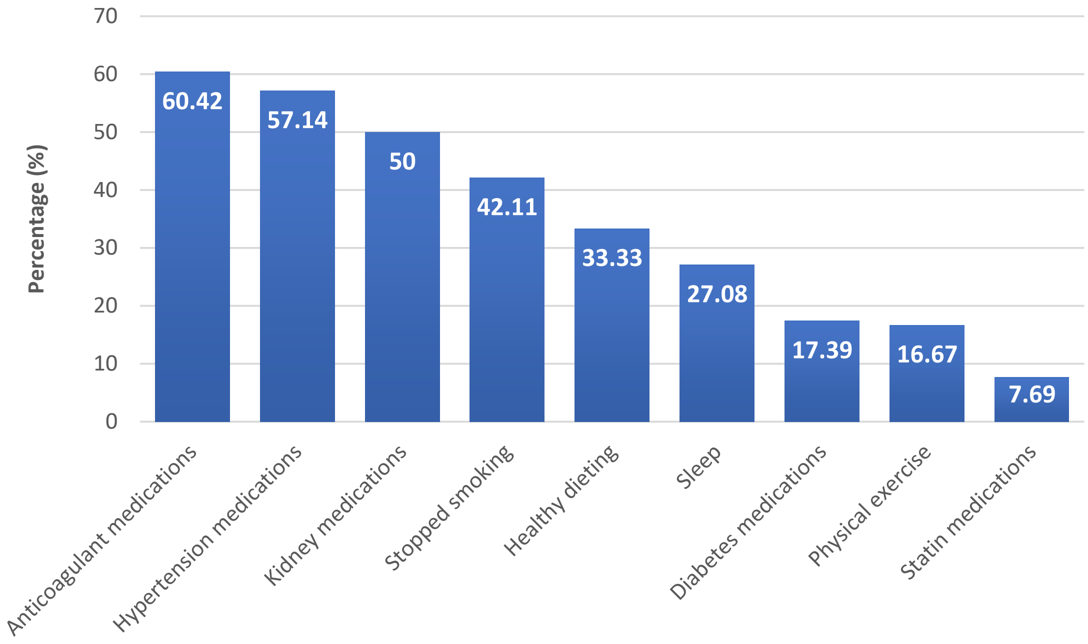

Figure1:Riskfactormanagement and adherence

Table 2:ComparisonofmeasurementsbeforeandafterCRprogram

Variable	PRE	POST	Test	p-value
Systolic blood pressure (mmHg)	135.53 ± 22.69	133.81 ± 14.97	W	0.196
Diastolic blood pressure (mmHg)	87.28 ± 15.81	79.38 ± 13.83	W	0.001
Mean arterial blood pressure (mmHg)	103.21 ± 16.73	97.5 ± 13.36	W	0.009
Hemoglobin (g/dl)	12.34 ± 1.44	12.56 ± 1.34	t	0.262
Hematocrit (%)	43.14 ± 3.71	39.73 ± 3.15	W	<0.001
Platelets (1000/mm3)	255.93 ± 65.33	278 ± 72.94	t	0.077
White blood cells (/mm3)	7870.88 ± 1921.88	7493.13 ± 2088.85	t	0.137
AST (U/l)	64.61 ± 9.25	35.94 ± 7.19	W	<0.001
ALT (U/l)	34.23 ± 25.41	34.75 ± 6.52	W	0.144
Creatinine (mg/dl)	1.12 ± 0.35	1.08 ± 0.47	W	0.531
C-reactive protein (mg/l)	9.93 ± 2.89	7.27 ± 2.76	W	<0.001
glycosylated hemoglobin (%)	6.89 ± 2.04	7.23 ± 1.92	W	0.026

● ^{W}Wilcoxon signed-rank test. ● p-value significant if less than 0.05.

Table 2 shows that there were statistically significant differences between blood pressure measurements before and after the CR programregarding diastolic and mean arterial, but not for systolic blood pressure measurements. There was a statistically significant difference between pre and post hematocrit levels. This was not true for hemoglobin,platelet and white blood cell count.The levels of AST and C-reactive protein showed statistically significant differences between the measurements before and after the CR program. It is notable that AST is specific for the heart. Moreover, a high level of C-reactive protein is a risk factor for IHDs. ALT and creatinine levels before and after the CR program did not show statistically significant differences. There was a statistically significant difference between glycosylated hemoglobin measurements before and after the CR program. All of the aforementioned information is mentioned in table 6.

Table3:SMARTriskscorecomparisonbeforeandafterCRprogram

Variable	PRE	POST	Test	p-value
Current 10-year recurrence risk	30.88 ± 14	26.44 ± 10.92	W	0.002
Reduction in current 10-year recurrence risk using treatment	7.82 ± 9.04	1.17 ± 2.33	W	<0.001
Number needed to treat	19.24 ± 31.12	14.47 ± 42.9	W	0.078
Net 10-year risk after treatment	22.92 ± 13.38	25.26 ± 10.59	W	0.502
● [W]Wilcoxon signed-rank test. ● p-value significant if less than 0.05.				

Table 4 shows the scores that were products of the SMART risk score, when applied to the patients before and after the CR program. It is seen that there were statistically significant differences regarding current 10-year recurrence risk and reduction in current 10-year recurrence risk using treatment between scores before and after the CR program. The number needed to treat and the net 10-year risk after treatment did not show statistically significant differences.

Table4:SMART-REACHmodelcomparisonbeforeandafterCRprogram

Variable	PRE	POST	Test	p-value
CVD-free life expectancy	70.47 ± 10.8	73.32 ± 5.54	W	0.025
CVD-free years gained	0.24 ± 0.71	0.02 ± 0.16	W	0.066
10-year current risk	40.73 ± 53.66	30.71 ± 11.75	W	0.004
Reduction with treatment	0.7 ± 2.11	0.05 ± 0.33	W	0.068
10-years NNT	32.41 ± 28.14	5022 ± 7039.96	W	0.180
Lifetime current risk	70.06 ± 14.29	65.29 ± 14.13	W	0.006
Reduction with treatment	0.73 ± 2.25	0.05 ± 0.35	W	0.068
Lifetime NNT	25.43 ± 21.02	41	-----	-----
●[W]Wilcoxon signed-rank test. ● p-value significant if less than 0.05.				

Table 8 shows the scores that were products of the SMART-REACH model, when applied to the patients before and after the CR program. It is seen that there were statistically significant differences between scores before and after the CR program regarding CVD-free life expectancy, 10-year current risk, and lifetime current risk. The CVD-free years gained, and its reduction with treatment, in addition to the 10-years number needed to treat and its reduction with treatment, all did not show statistically significant differences.

Discussion

The present study was a longitudinal quasi-experimental study. The number of treatment options and treatment goals in CVD prevention are increasing, which is exciting but on the other hand makes it increasingly difficult to make treatment decisions for individual patients. **(De Vries and Visseren, 2021)**.

The SMART risk score and SMART-REACH model were used for more than one reason. Both were validated externally. They had a wide base of patients to be validated upon. They were easy to be applied and they do not need lots of clinical information. The figures that are needed to be used in calculations are easily obtainable and accessible for all patients. Both are available for public use by medical and non-medical personnel on the website www.u-prevent.com. The website contains step-by-step instructions for both types of personnel so as maximal benefits can be attained.

The importance of a simple, yet, informative tool that can provide one or more pieces of information that can guide the clinical decision-making process. Tools which can calculate added benefit of therapy, predict lifelong risk of recurrence/s and quantify and stratify risk with as limited output figures as possible are always welcome in the clinical field. Either of the used models can fulfill one or more of those purposes.

Moreover, these tools can predict benefit or harm that can be attained for the patient with or without treatment. It can play a role in determining the cost effectiveness and cost-benefit of different modules of therapy.

The presence of risk stratification tools that are cheap, easy-to-use and apply, easily accessible, and would also reduce non-necessary treatment costs had become a necessity in the field of all-increasing wants and needs and resources that are still limited and may be even decreasing.

A unique aspect of SMART and SMART-REACH models is the option to include treatment options or lifestyle changes that alter your long-term risk for ischemic events. A visual assessment of the risk is made using graphs, making it accessible to the patient and is most suitable for shared clinical decision-making**(Yin et al., 2020)**.

Estimation of individual lifetime benefit of lifestyle changes and risk factor treatment, expressed as gain in CVD-free life, is a new development that may support the process of shared decision-making and may increase patient motivation to adhere to lifestyle changes and medication use. The most-used CVD risk algorithms are freely available as online risk tools **(De Vries and Visseren, 2021)**.

The results of the study generally showed improvement of the scores for almost all patients, except for a few who showed that additional treatment would cause harm and not cause benefit to those patients. However, this is not apparent on amalgamating all of the scores into descriptive statistics and when comparing and analyzing scores that resulted pre-CR and post-CR.

This study was a trial at applying the SMART risk score and SMART-REACH model on the Egyptian population, so as to be a nucleus for further risk estimation and stratification for IHD patients. Validation of the risk score models using the aforementioned models as examples will help in the construction of a model that is applicable and specific for the Egyptian population, although, SMART-REACH model can be used on European and North American population.

Setting the results of the current study against the results of **VanTrierandothersin2021** shows the following. In the current study, the figures for a high blood pressure were 52.63% for the current study against 40%. For those who were to use medications for their risk factors or comorbid conditions; this study 57.14% used anti-hypertensive medications and that study showed a figure of 86%. Anticoagulant medication use figures were 60.42% and 87%. Lipid lowering medication usage was calculated tobe 7.69% and 85% in the other study. Applying the SMART-REACH model showed the mean of residual lifetime risk for cardiovascular events to decrease from a mean of 70.06% to 65.29%(with a median of one year and first and third quartile figures of minus one and 3)versus a decrease from 54 to 26% (with a median of 7.4 years and first and third quartile figures of 5.2 and 10.6 of event-free years)**(Van Trier et al., 2021)**.

Patients with established cardiovascular disease are considered very high risk by guidelines, for recurrence attacks.However, the distribution of predicted 10-year risk of recurrent CVD is widespread and a risk prediction models are available for these patients **(van’t Klooster et al., 2020)**. This confers with the current study.

Any disparity in the current study's result was due to the small sample size and the relatively many points of data to be collected, in addition to poor overall compliance of the study population.

Of the strengths of the current study are more than one point. First of all, the sample, although being heterogenous, it included relevant population, all of whom underwent CR programs all of which sharing the same principle.

Moreover, the usage and utility of SMART and SMART-REACH models in risk estimation pre- and post-CR programs in estimation of the risk of recurrence of IHD attacks in Egyptian population.

The study, being longitudinal with a prospective design and having the same initial population, reflected clinical practice trends. Moreover, follow-up of the same population was feasible. Data and statistical analyses were based on actual models, not theoretical ones.

Data and depth of details collected were abbreviated to the point of aiding calculation of different statistics that could be available using the two models applied in the study. Finally, this was the first study validating the SMART and SMART-REACH models on the Egyptian population.

In spite of the study having several strength points, however, the limitations must be mentioned and simply put.

The study did not have a control group. Moreover, the sample size is relatively small if compared to the cohorts that were used to validate SMART and SMART-REACH models when they were being modulated. Statistical correction and C-statistics were not used and would have been rather inaccurate if used upon the study's sample with its size.

The CR program was not unified, although this did not interfere with the accomplishment of the study's objectives, but it was based upon the presence or lack of risk factors in the cohort of the study; which led to affection of the internal homogeneity of the sample size.

Conclusions

The current study showed that risk stratification and estimation are parts and parcel of personalized medical care of IHD patients aiding in decision making processes for both of the clinical decision maker and the patient. Both of them can take role in the process with full understanding and insight into any consequent estimated risk and corresponding measures to be taken and making urgent and emergent measures ready in case of any IHD-related incident arising.Moreover, the study concluded that the availability of risk calculators online and the step-by-step instructions on the website will make it very easy identifying the benefits of CR and their consequent additions to the health of IHD patients. Moreover, this can aid the development of personalized CR programs with the highest benefit available to the patient, according to the physical state of each patient, as prediction of benefit would be easily and readily available.

It can be deducted, from the study also, that strict compliance to the CR programs will inevitably be beneficial to the IHD patients. What is encouraging also is that most of the aspects of the CR programs does not cost money, and even can save money, as in the case of stopping smoking. The current study showed that risk factor management results in treatment effects that can be predicted so as to help in the process of clinical decision making, but, per individual, and not a cohort. Prediction of cardiovascular disease recurrence will help in the selection of a right treatment plan for the right patient in the right time (increasing the quality of care).

Methodologically, replication of the study with larger sample sizes and longer follow-up periods to produce models in parallel to SMART and SMART-REACH models with high accuracy in prediction of cardiovascular risk, at all of its levels.

The culture of risk stratification and estimation should be emphasized in the field of clinical practice. Figures obtained from risk estimation will aid in the process of clinical decision making by both the physician and the patient, who is to have care provided-to, accordingly.

The national direction towards national universal health insurance would be of great assistance to spreading the culture and use of CR programs, as it is cost-effective and efficient.

References

American Heart Association, 2018.*Cardiac rehab: What is cardiac rehabilitation?*

Bonaccio, M., Di Castelnuovo, A., Costanzo, S., Persichillo, M., De Curtis, A., Cerletti, C., et al., 2018. Health-related quality of life and risk of composite coronary heart disease and cerebrovascular events in the Moli-sani study cohort, *European Journal of Preventive Cardiology*, 25(3), pp. 287–297.

Dorresteijn, J.A.N., Visseren, F.L.J., Wassink, A.M.J., Gondrie, M.J.A., Steyerberg, E.W.,

Ridker, P.M., et al., 2013. Development and validation of a prediction rule for recurrent vascular events based on a cohort study of patients with arterial disease: The SMART risk score, *Heart*, 99(12), pp. 866–872.

Framingham Heart Study (FHS) and National Heart Lung and Blood Institute (NHLBI), 2018. Different cardiovascular risk models.

Institute for Health Metrics and Evaluation, 2021.*Global Burden of Disease: Egypt Datasets*. University of Washington, Seattle, WA, USA.

Kaasenbrood, L., Bhatt, D.L., Dorresteijn, J.A.N., Wilson, P.W.F., D'Agostino, R.B., Massaro, J.M., et al., 2018. Estimated life expectancy without recurrent cardiovascular events in patients with vascular disease: The SMART-REACH model, *Journal of the American Heart Association*, 7(16), p. e009217.

Kahn, R., Robertson, R.M., Smith, R. and Eddy, D., 2008. The Impact of Prevention on Reducing the Burden of Cardiovascular Disease, *Circulation*, 118(5), pp. 576–585.

Mendis, S., Puska, P., Norrving, B. and Organization, W.H., 2011.*Global atlas on cardiovascular disease prevention and control*. Geneva: World Health Organization.

Metagenics, 2010. Cardiovascular Risk Assessment Questionnaire. North Shore City, New Zealand: Metagenics.

Piepoli, M.F., Hoes, A.W., Agewall, S., Albus, C., Brotons, C., Catapano, A.L., et al., 2016. 2016 European Guidelines on cardiovascular disease prevention in clinical practice, *European Heart Journal*, 37(29), pp. 2315–2381.

Van Trier, T.J., Snaterse, M., Ter Hoeve, N., Sunamura, M., Moll Van Charante, E.P., Galenkamp, H., et al., 2021. Modifiable lifetime risk for recurrent major cardiovascular events: observations in a contemporary pooled cohort, *European Heart Journal*, 42(Supplement_1), pp. ehab724-2553.

van't Klooster, C.C., Nathoe, H.M., Hjortnaes, J., Bots, M.L., Isgum, I., Lessmann, N., et al., 2020. Multifocal cardiovascular calcification in patients with established cardiovascular disease; prevalence, risk factors, and relation with recurrent cardiovascular disease, *IJC Heart & Vasculature*, 27, p. 100499.

De Vries, T.I. and Visseren, F.L.J.J., 2021. Cardiovascular risk prediction tools made relevant for GPs and patients, *Heart*, 107(4), pp. 332–340.

World Health Organization, 2017.*World Heart Day 2017*.

World Health Organization, 2018a.*Cardiovascular diseases in EMRO Region*.

World Health Organization, 2018b. International Classification of Diseases 11 (ICD-11). Geneva, Switzerland: World Health Organization.

World Heart Federation, 2017. Fact sheet: Risk factors.

Yin, C.P., Azzahhafi, J., James, S., Yin, D.C.P., Azzahhafi, J. and James, S., 2020. Risk Assessment Using Risk Scores in Patients with Acute Coronary Syndrome, *Journal of Clinical Medicine*, 9(9), pp. 1–16.