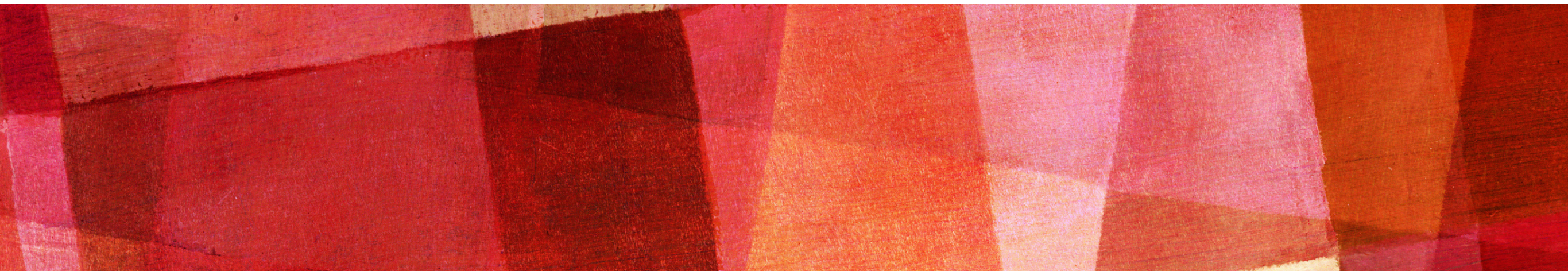


CARDIAC REHAB AND THE STROKE POPULATION

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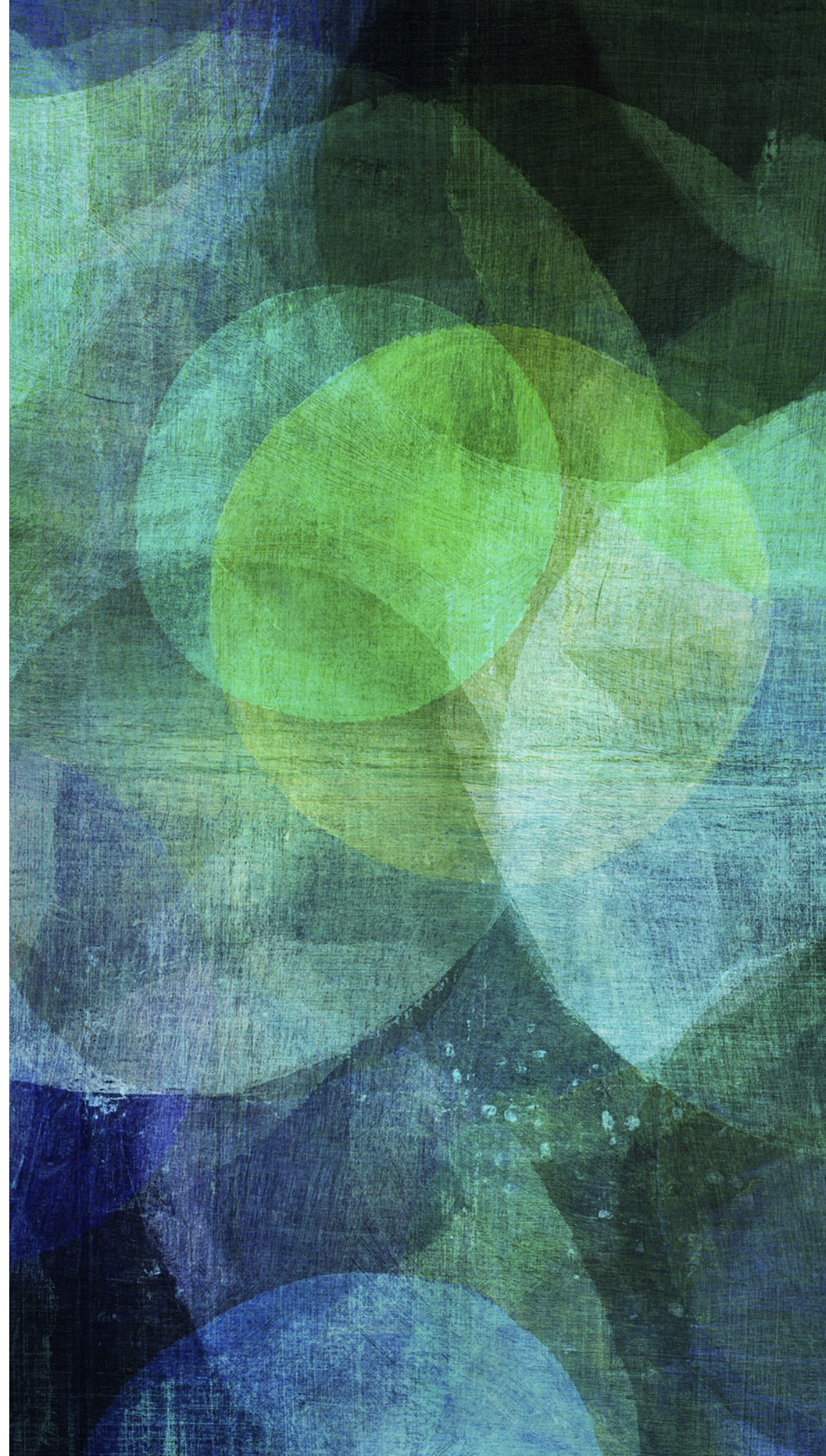


OVERVIEW

- Mutual Goals
- Pathophysiology
- Cardiac Risk in Stroke Patients
- Services of Cardiac Rehabilitation
- Safety of Exercise
- Cardiac Rehab Specifics for Stroke Patients
- Brief Overview of Cardiac Rehab Interventions



WHAT BRINGS STROKE AND CARDIAC REHAB TOGETHER?



MUTUAL GOALS

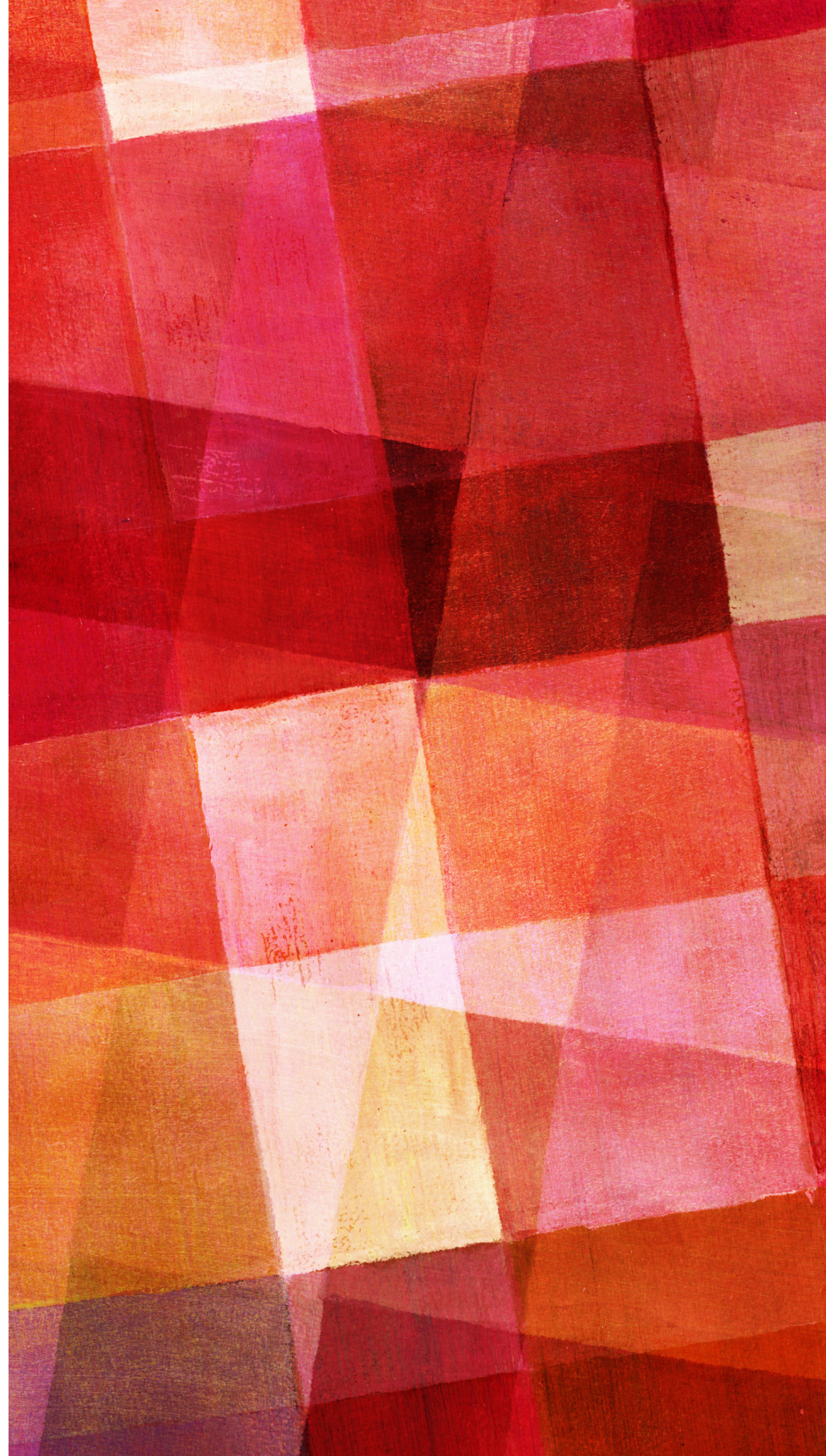
- Prevention and risk-reduction of cardiovascular-related morbidity and mortality
- Promotion of exercise and function
- Promotion of healthy lifestyle changes

STROKE AND CARDIAC MODIFIABLE RISK FACTORS

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| Stroke | Cardiac |
|---------------------------------------|---------------------|
| Hypertension | Hypertension |
| Tobacco use | Tobacco use |
| Physical inactivity | Physical inactivity |
| Diabetes | Diabetes |
| Diet | Diet |
| Dyslipidemia | Dyslipidemia |
| Elevated BMI | Elevated BMI |
| Atrial fibrillation | |
| Carotid stenosis | |
| Structural heart disease (valve, ASD) | |

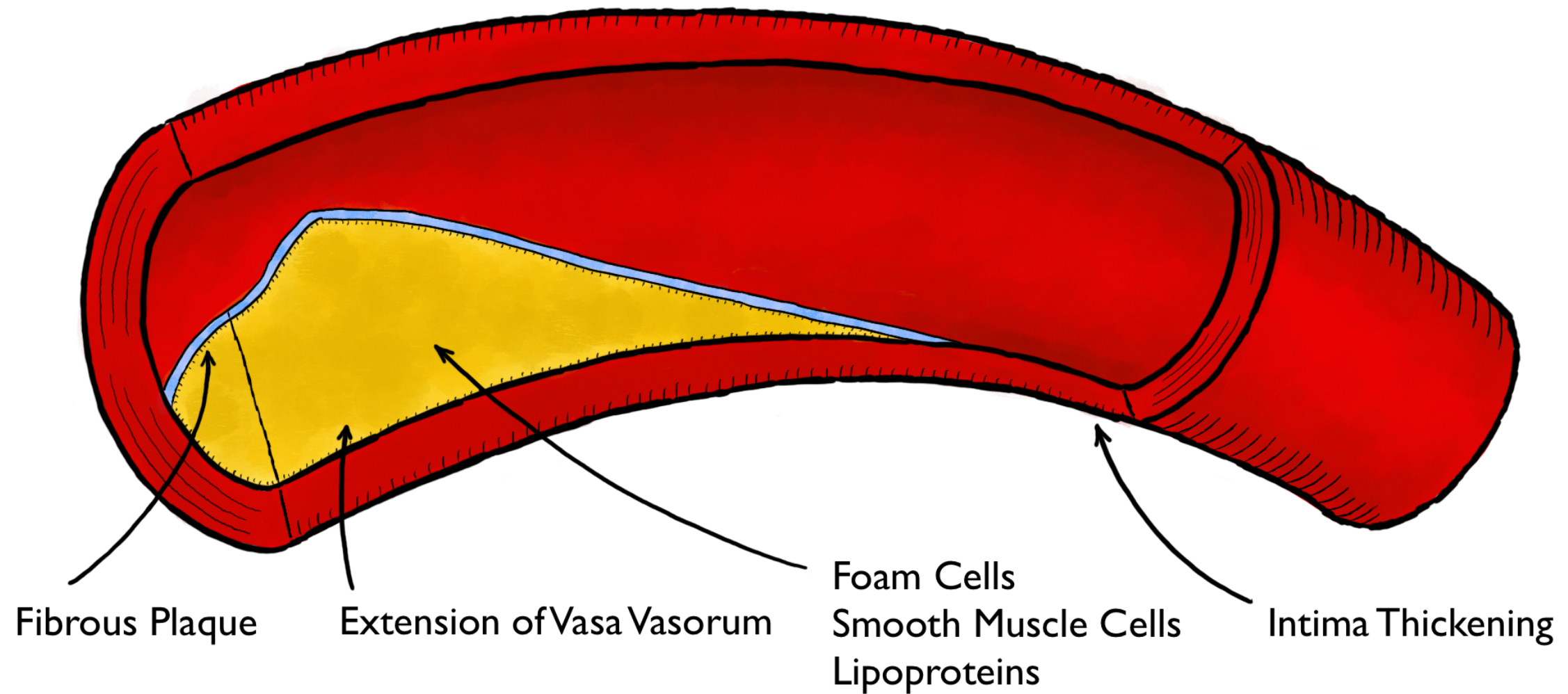
PATHO- PHYSIOLOGY



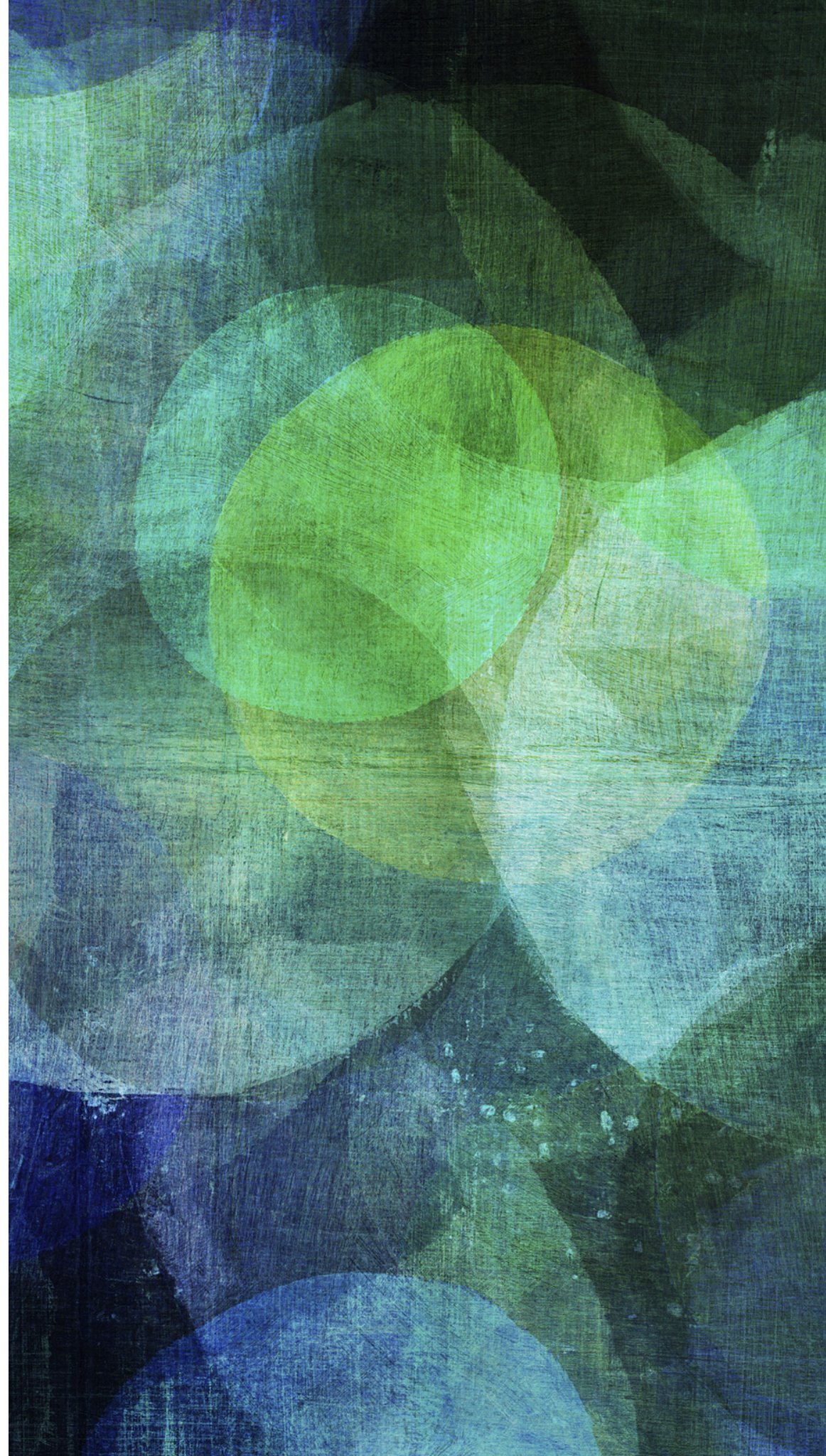
STROKE CLASSIFICATION

- Ischemic stroke
 - Thrombosis or embolism associated with large vessel atherosclerosis.
 - Embolism of cardiac origin (cardioembolic stroke).
 - Small vessel occlusion (lacunar stroke).
 - Other determined cause
 - Undetermined (cryptogenic) cause
- Hemorrhagic
 - Intracerebral
 - Subarachnoid

ATHEROSCLEROSIS PROGRESSION



CARDIAC RISK IN STROKE PATIENTS



STROKE RISK IN CARDIAC PATIENTS

- Extent of CAD associated with increased ischemic stroke risk in patients without Afib ¹⁶
- Patients with 0VD had the lowest 7-year cumulated risk of ischemic stroke (2-33%) and the highest risk patient were those with diffuse CAD (4-47%) and 3VD (5-15%) ¹⁵
- Rate ratio for ischemic stroke was also highest for patients with diffuse CAD and 3VD and were equivalent ¹⁵

CUMULATED 7 YEAR RISK OF ALL-CAUSE DEATH

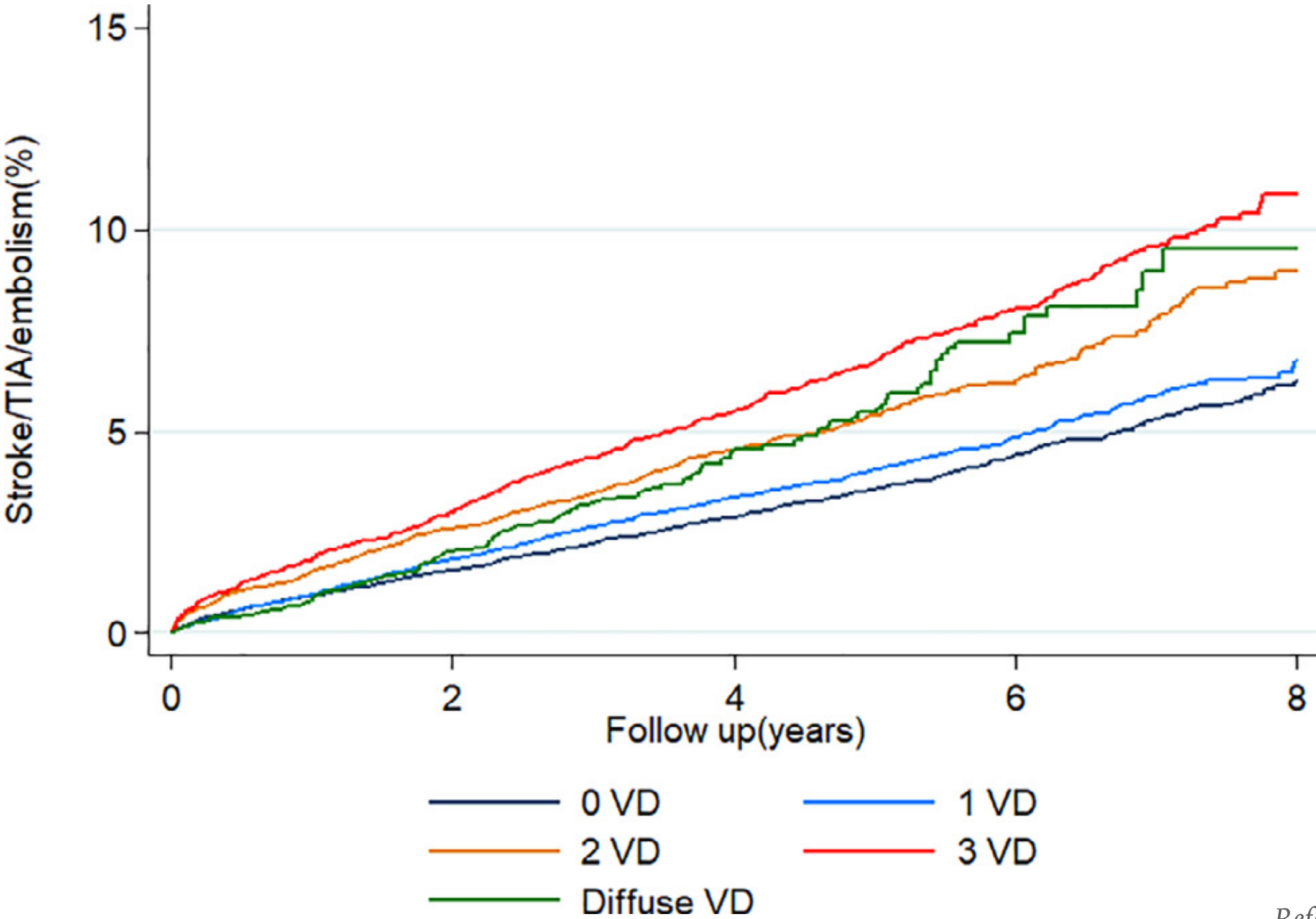
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| | All-cause death (95% CI ^a) | Cardiac death (95% CI) | Myocardial infarction (95% CI) | Ischaemic stroke (95% CI) |
|-------------------|---|---------------------------|--------------------------------------|------------------------------|
| 0 VD ^b | 14.59% (14.0–15.2) | 1.87% (1.6–2.1) | 2.06% (1.8–2.3) | 2.33% (2.1–2.6) |
| Diffuse VD | 21.68% (19.5–23.9) | 2.93% (2.1–4.0) | 5.69% (4.3–7.3) | 4.47% (3.4–5.7) |
| 1 VD | 18.90% (18.1–19.7) | 4.93% (4.5–5.4) | 7.42% (6.9–8.0) | 2.95% (2.6–3.3) |
| 2 VD | 24.43% (23.3–25.6) | 8.02% (7.3–8.8) | 8.92% (8.2–9.7) | 3.92% (3.4–4.5) |
| 3 VD | 32.40% (31.1–33.7) | 14.41 (13.4–15.5) | 11.94% (11.0–12.9) | 5.15% (4.5–5.9) |

7 YEAR RATE RATIO (RR) OF ALL-CAUSE DEATH

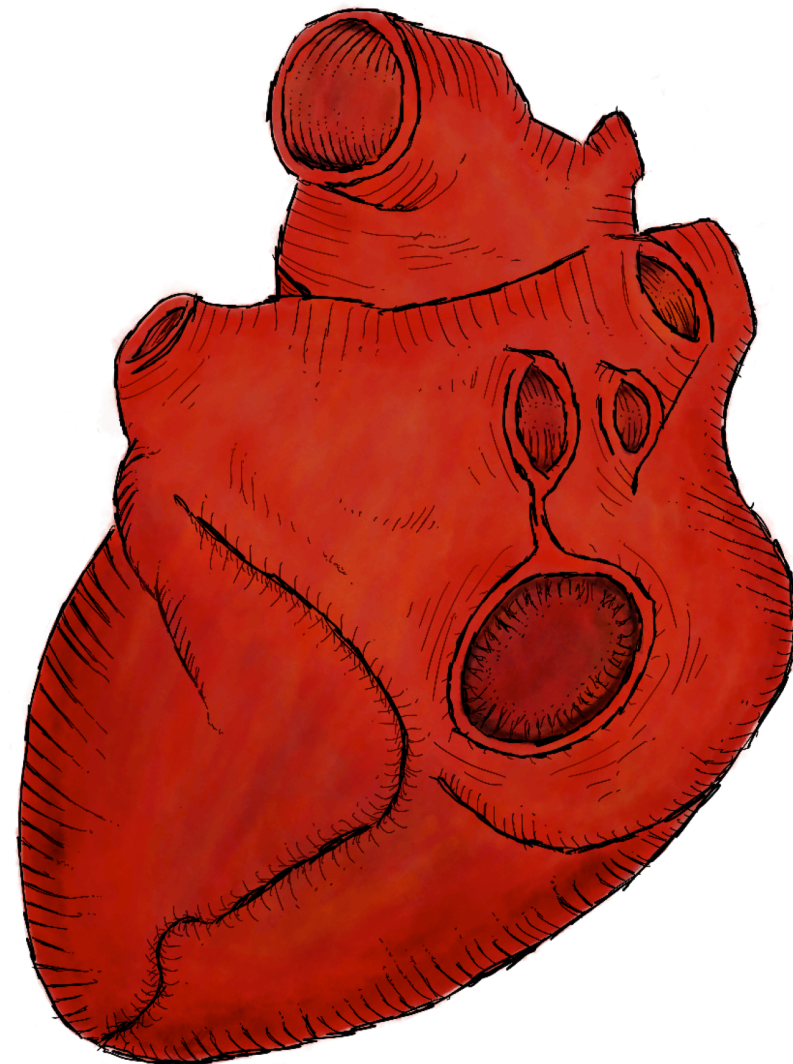
| | Unadjusted RR | P-value |
|------------------|------------------|---------|
| 0 Vessel Disease | 1 | <0.001 |
| Diffuse Disease | 1.92 (1.56-2.37) | <0.001 |
| 1 Vessel Disease | 1.34 (1.17-1.55) | <0.001 |
| 2 Vessel Disease | 1.73 (1.48-2.02) | <0.001 |
| 3 Vessel Disease | 1.92 (1.56-2.37) | <0.001 |

CUMULATIVE INCIDENCE OF ISCHEMIC STROKE, TIA, AND SYSTEMIC EMBOLISM ACCORDING TO EXTENT OF CAD



STROKE-SPECIFIC CARDIAC RISK FACTORS

- Ischemic stroke without carotid artery disease is a coronary heart disease risk factor
- Atherosclerotic stroke considered high risk for future atherosclerotic coronary events
- Carotid artery disease



OVERLAPPING RISK FACTORS

- CAD and ischemic stroke share overlapping CHADS2/CHA2DS2VASc risk factors, in particular atherosclerosis, advanced age, HTN, and diabetes ¹⁵
- CHADS2/CHA2DS2VASc has been described for predicting outcomes for non-Afib patients for stroke after ACS ¹³
- Association strengths for HTN, age, gender, and diabetes are similar between lacunar, large artery thrombotic, and cardioembolic stroke ¹³
- Large cardiovascular trials demonstrated reduced risk for major adverse cardiovascular and cerebrovascular events ¹⁶

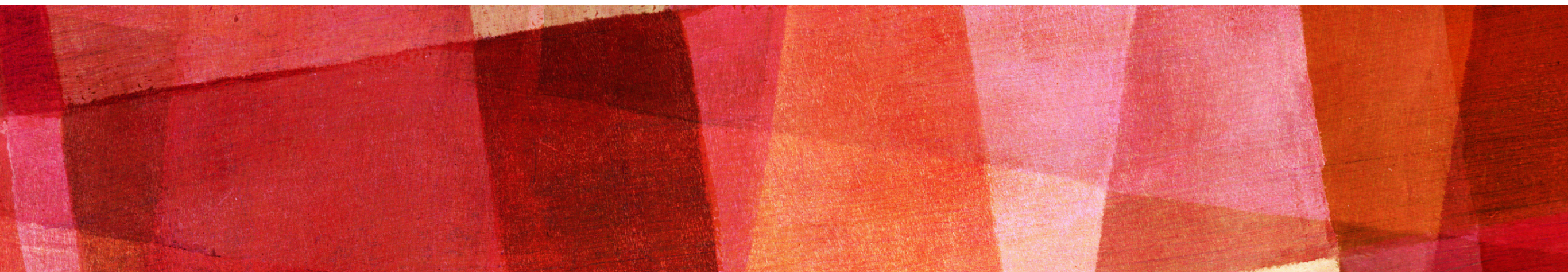
CAD PREVALENCE AND RISK IN STROKE PATIENTS

- Via angiography, any coronary plaques was present at 61.9% of patients and coronary stenoses $\geq 50\%$ in at least 1 vessel occurred in 25.7% ¹
 - 14.9% of patients had at least 1 coronary stenosis $\geq 70\%$ ¹
- Prevalence of CAD by coronary computed tomography angiography (CCTA) was 48% in ischemic stroke patients with cardiac risk factors who had no previously known cardiac disease ⁸
- Nearly 80% of ischemic stroke patients had CAD detected by cardiac calcium score (CCS) compared to 50% of non-stroke patients ⁹
 - 24.5% of ischemic stroke patients were in the high-risk category compared to 9.3% with non-stroke patients ⁹

CAD PREVALENCE AND RISK IN STROKE PATIENTS

- Meta-analysis demonstrated 52% of asymptomatic CAD in ischemic stroke patients without known CAD and 1/3 had an occlusion $\geq 50\%$ ⁷
- The prevalence of coronary plaque and coronary stenosis $\geq 50\%$ were markedly increased when plaques were present in both the carotid and femoral arteries of stroke patients ¹
- 3% of ischemic stroke patient experience an MI within one year of the stroke event ⁷

Reference - 7, 1



PREVALENCE OF ASYMPTOMATIC CAD

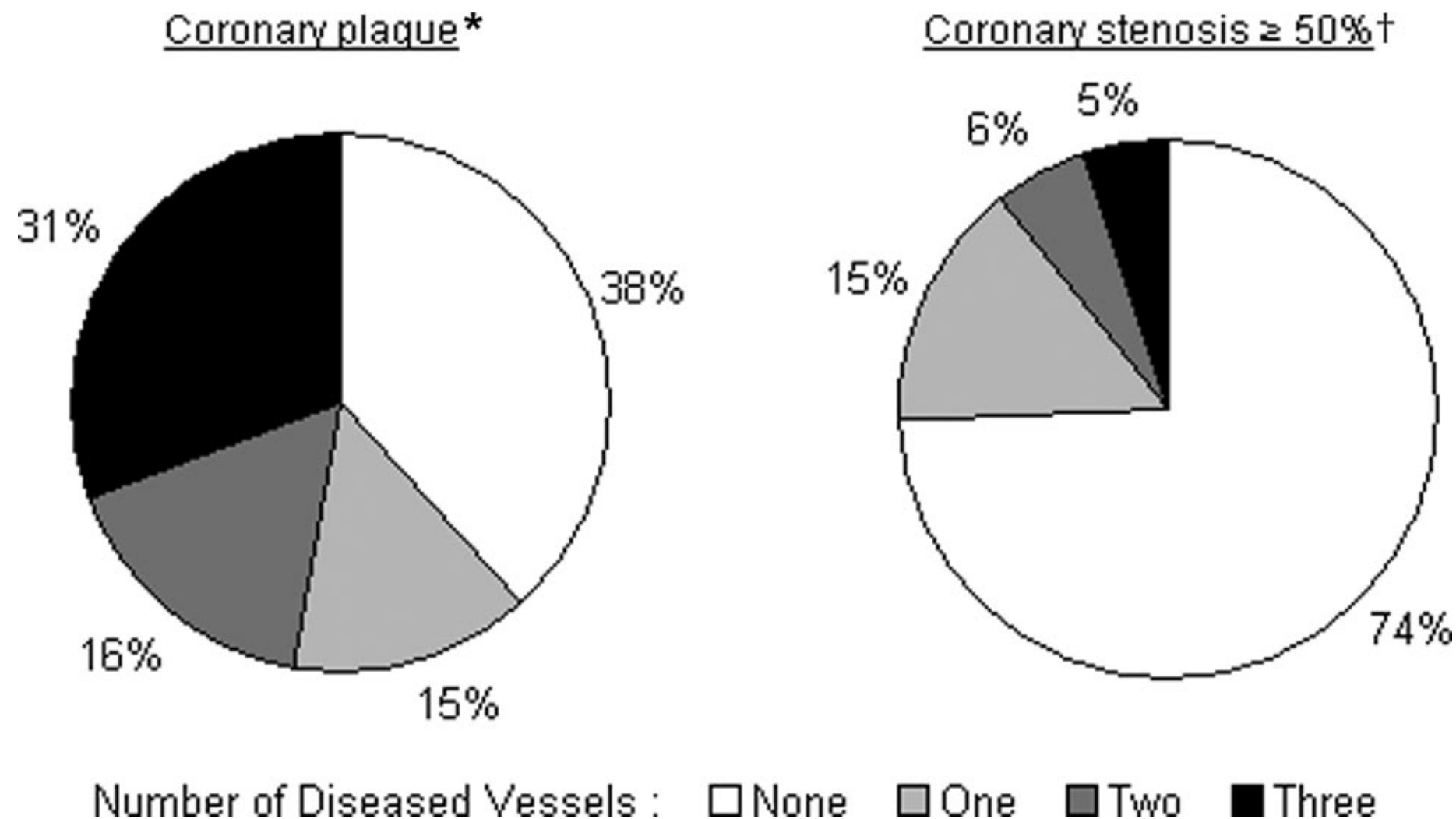


Figure 1. Prevalence of asymptomatic coronary artery disease by number of diseased vessels among 315 patients with no history of coronary heart disease. *Regardless of stenosis severity. †Plaque with arterial lumen reduction $\geq 50\%$ in diameter.

CAD ACCORDING TO NUMBER OF ARTERIAL TERRITORIES WITH PLAQUES

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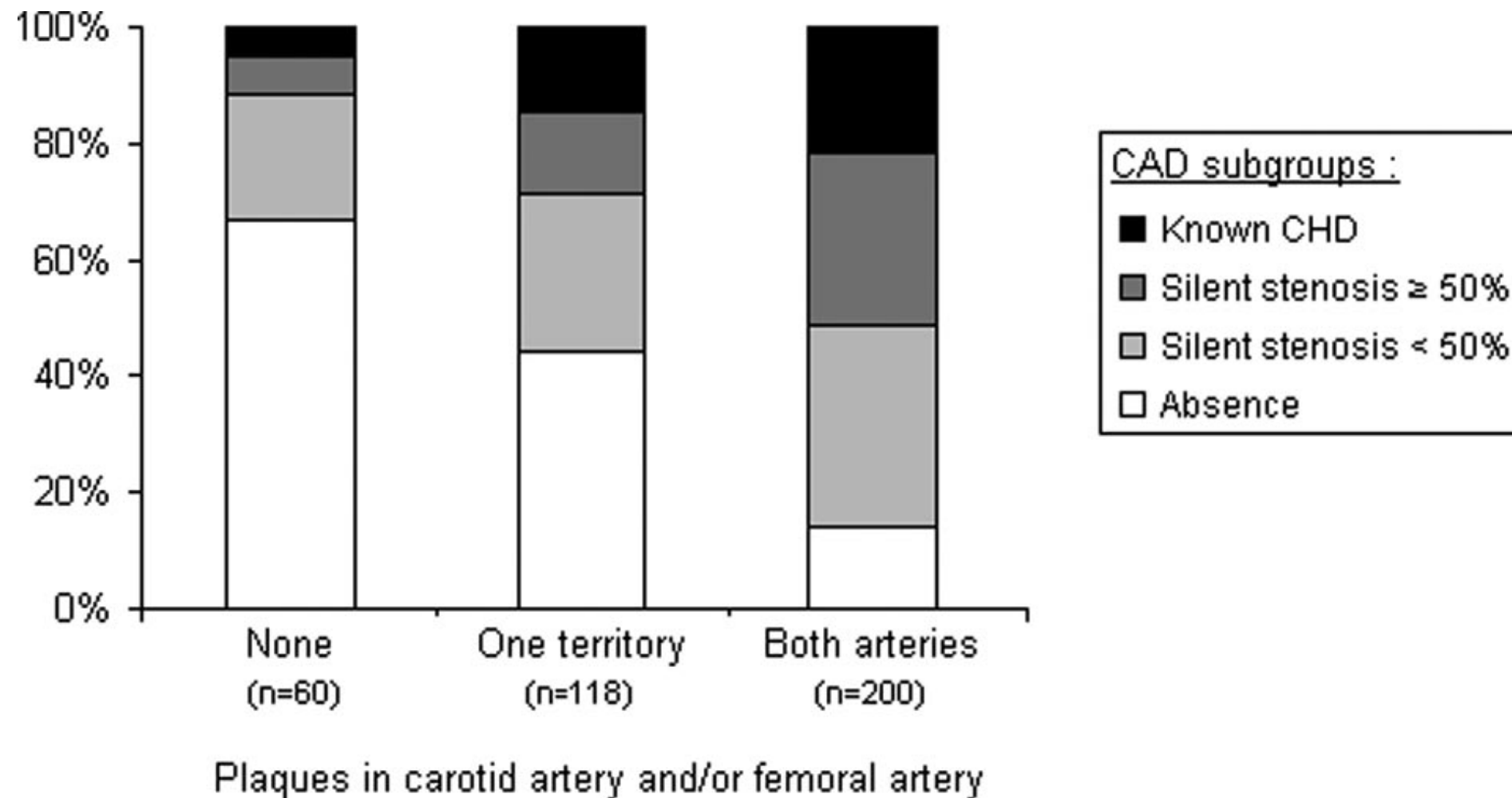
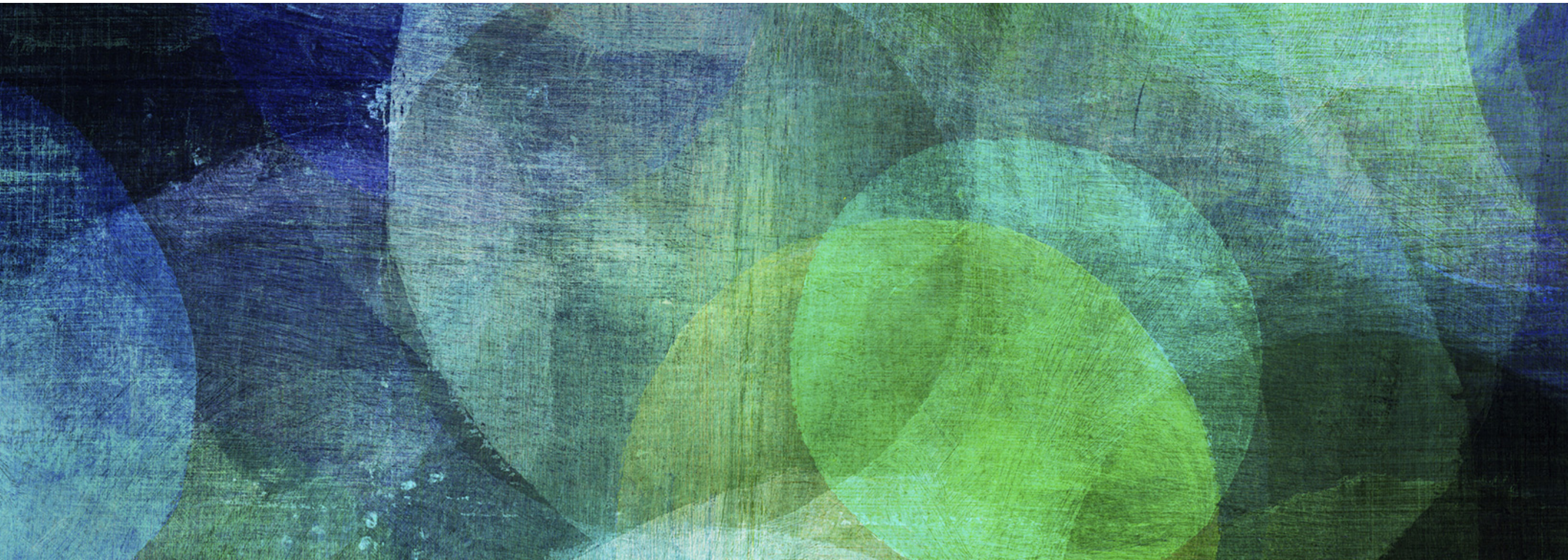


Figure 4. Distribution of coronary artery disease subgroups according to number of arterial territories with plaques (including carotid and femoral arteries). CHD, coronary heart disease.

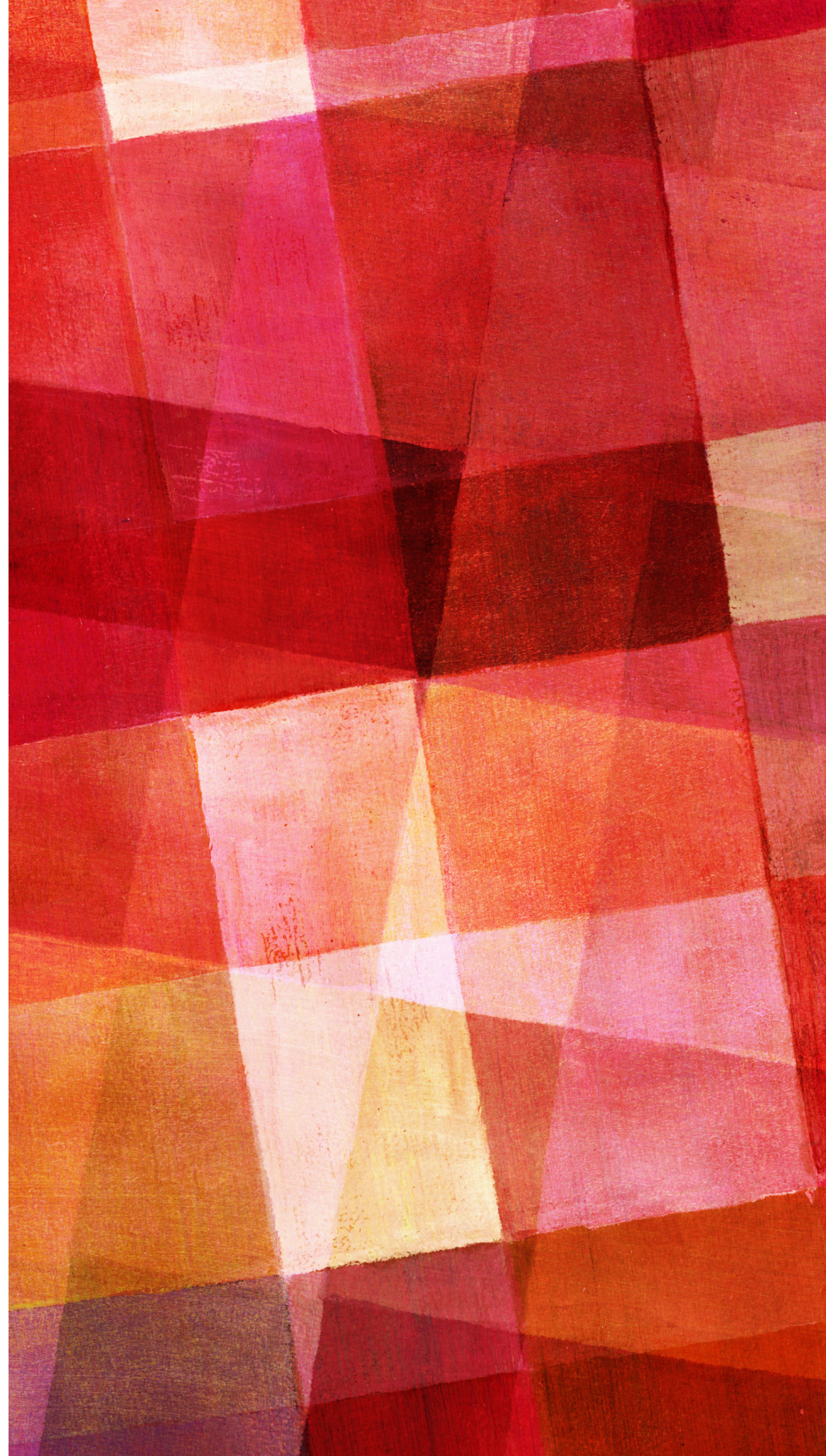
HEMORRHAGIC STROKE

- Compared to ischemic stroke, hemorrhagic stroke patients are typically younger with less cardiac risk factors
- For hemorrhagic stroke 8.95% passed away from an MI compared to 22.07% for ischemic strokes

Reference - 3



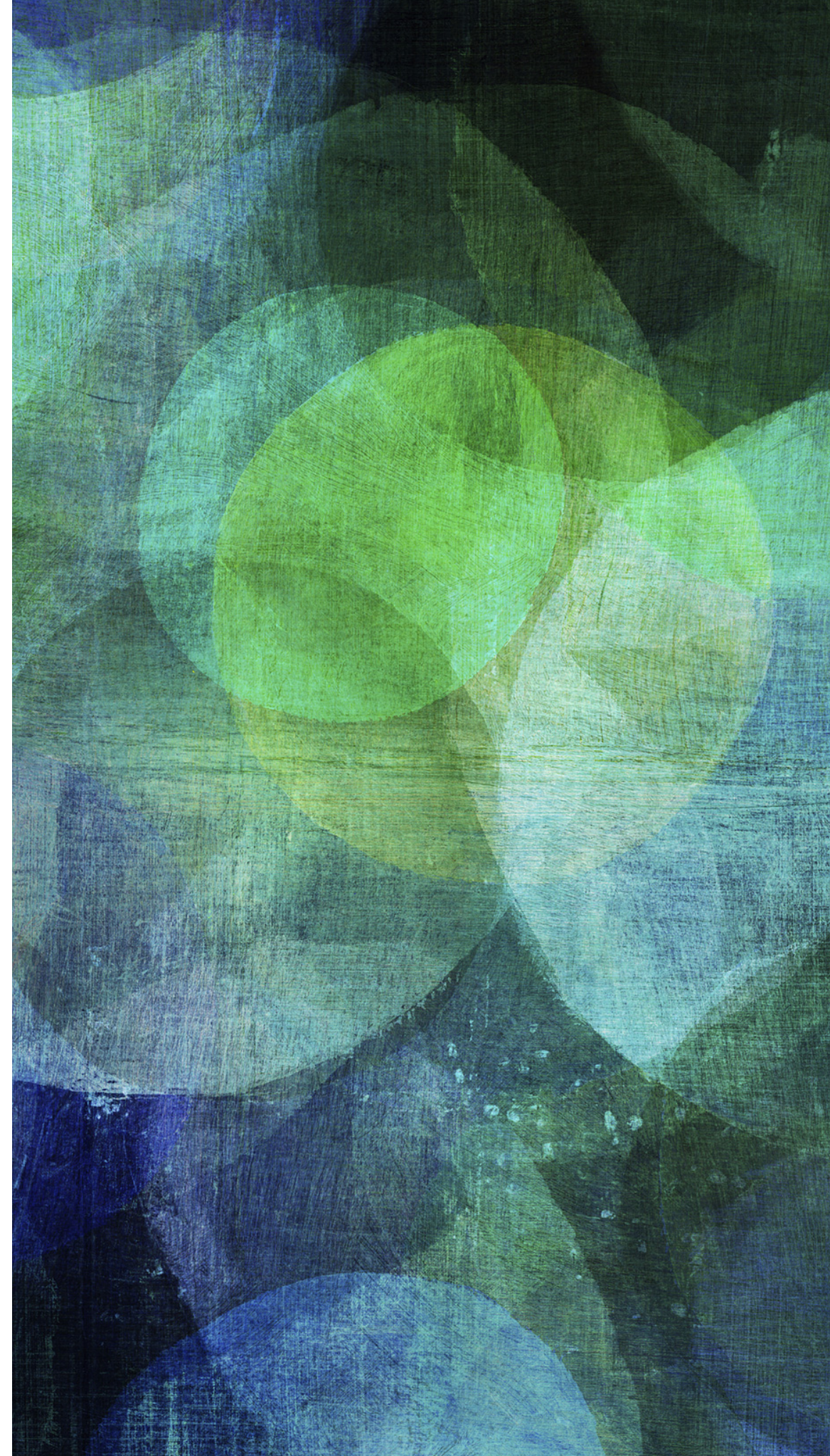
HOW CAN CARDIAC REHAB HELP?



SERVICES OF CARDIAC REHAB

- Screening for cardiovascular risk factors
- Exercise testing
- Exercise prescription
- Patient education
- Dietician
- Social work
- Smoking cessation

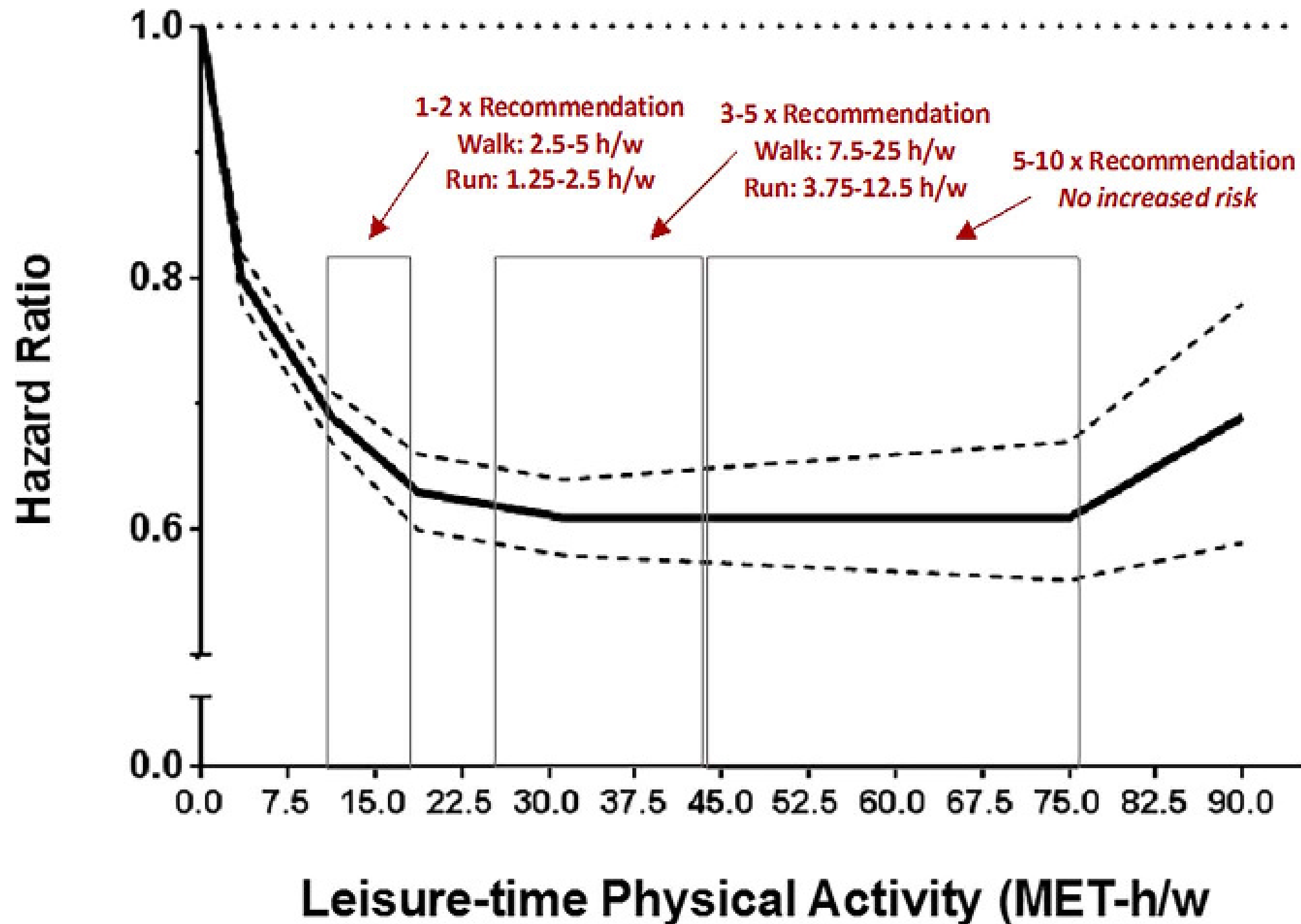
EXERCISE



EXERCISE SAFETY

- Exercise training post stroke has a strong safety profile and improves walking speed and balance ¹⁷
- Low adverse event rate and similarity in adverse event rates between case and control groups from mixed methods systematic review and meta-analysis of non-ambulatory stroke patients ¹⁰
- Beneficial effect of exercise has no lowest threshold and the steepest slope for provision of benefits is in the early stages ¹²
- Roughly 70% of the population all-cause mortality benefit occurs at 8.25 MET-hrs/week or 150 min/week of mod-vigorous exercise ¹²
- Activity volumes up to 4 times the recommended exercise do not demonstrate evidence of increased mortality risk ¹²
- Activity volumes ≥ 10 times the recommended exercise do show an increasing mortality risk, though did not reach statistical significance ¹²

RELATIONSHIP OF MOD-VIGOROUS PHYSICAL ACTIVITY TO ALL-CAUSE MORTALITY



POST-STROKE EXERCISE RECOMMENDATIONS

- Exercise: Participating in moderate dynamic exercise such as walking (ideally brisk walking), jogging, cycling, swimming or other dynamic exercise four- to seven-days each week in addition to routine activities of daily living (Evidence Level A).
- Patients should be counseled to achieve an accumulation of at least 150 mins of moderate to vigorous activity per week, in episodes of 10 mins or more (Refer to the CSEP Canadian Physical Activity Guidelines 2011 for additional information) (Evidence Level B).
- Most stroke patients should be encouraged to start a regular exercise program. Supervision by a health-care professional (such as a physiotherapist) at exercise initiation should be considered in individuals with stroke at risk of falls or injury, or in individuals with other comorbid disease (such as cardiac disease), which may place them at higher risk of medical complications (Evidence Level C).

WHEN TO START EXERCISE

- Within six months of the index event ¹⁷
- Aerobic exercise has been initiated from 1 week to 6 months post stroke ¹⁴
- Stable stroke deficits



EXERCISE TESTING

- When possible, prescribe exercise using a peak effort symptom-limited exercise stress test with electrocardiography (ECG), blood pressure (BP), heart rate (HR), and rate of perceived exertion (RPE)
- If low-intensity exercise training program is planned (<45% of predicted HR reserve), then a submaximal testing such as the 6-minute walk test (6MWT) or Shuttle Walk Test, is an option for individuals who are asymptomatic with no known cardiovascular disease and normal resting ECG
- With patients with mobility deficits, the 6MWT peak HR is not interchangeable with the target training HR at the anaerobic threshold determined by a cardiopulmonary exercise test and so there is limited utility of this test for exercise prescription

ABSOLUTE CONTRAINDICATIONS TO EXERCISE TESTING

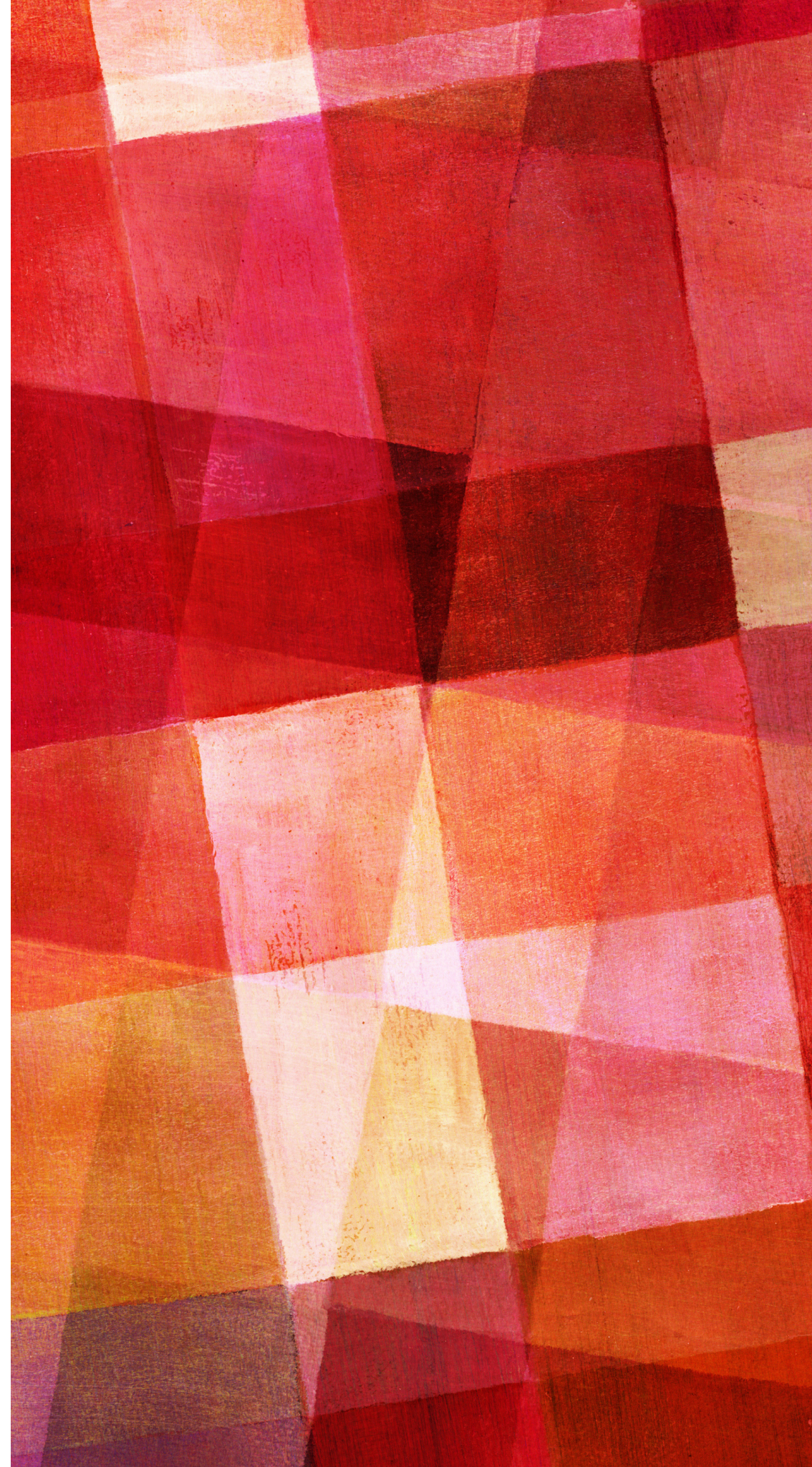
- A recent significant change in the resting electrocardiogram suggesting significant ischemia, recent myocardial infarction (within 2 days), or other acute cardiac event
- Unstable angina
- Uncontrolled cardiac dysrhythmias causing symptoms or hemodynamic compromise
- Symptomatic, severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute myocarditis or pericarditis
- Suspected or known dissecting aneurysm
- Acute systemic infection accompanied by fever, body aches, or swollen lymph glands

RELATIVE CONTRAINDICATIONS TO EXERCISE TESTING

- Left main coronary stenosis
- Moderate stenotic valvular heart disease
- Electrolyte abnormalities
- Severe arterial hypertension (i.e., systolic blood pressure >200 mm Hg and/or a diastolic blood pressure >110 mm Hg) at rest
- Tachydysrhythmia or bradydysrhythmia
- Hypertrophic cardiomyopathy and other forms of outflow tract obstruction
- Neuromuscular, musculoskeletal, or rheumatoid disorders that are exacerbated by exercise
- High-degree atrioventricular block
- Ventricular aneurysm
- Uncontrolled metabolic disease (i.e., diabetes, thyrotoxicosis, or myxedema)
- Chronic infectious disease (i.e., mononucleosis, hepatitis, acquired immunodeficiency syndrome)
- Mental or physical impairment leading to inability to exercise adequately

EXERCISE MODALITIES

- Walking
- Therapist-assisted
- Cycle ergometer
- Body weight supported treadmill
- Arm ergometer
- Robotics
- Stair climbing
- Modified jump training
- Pilates



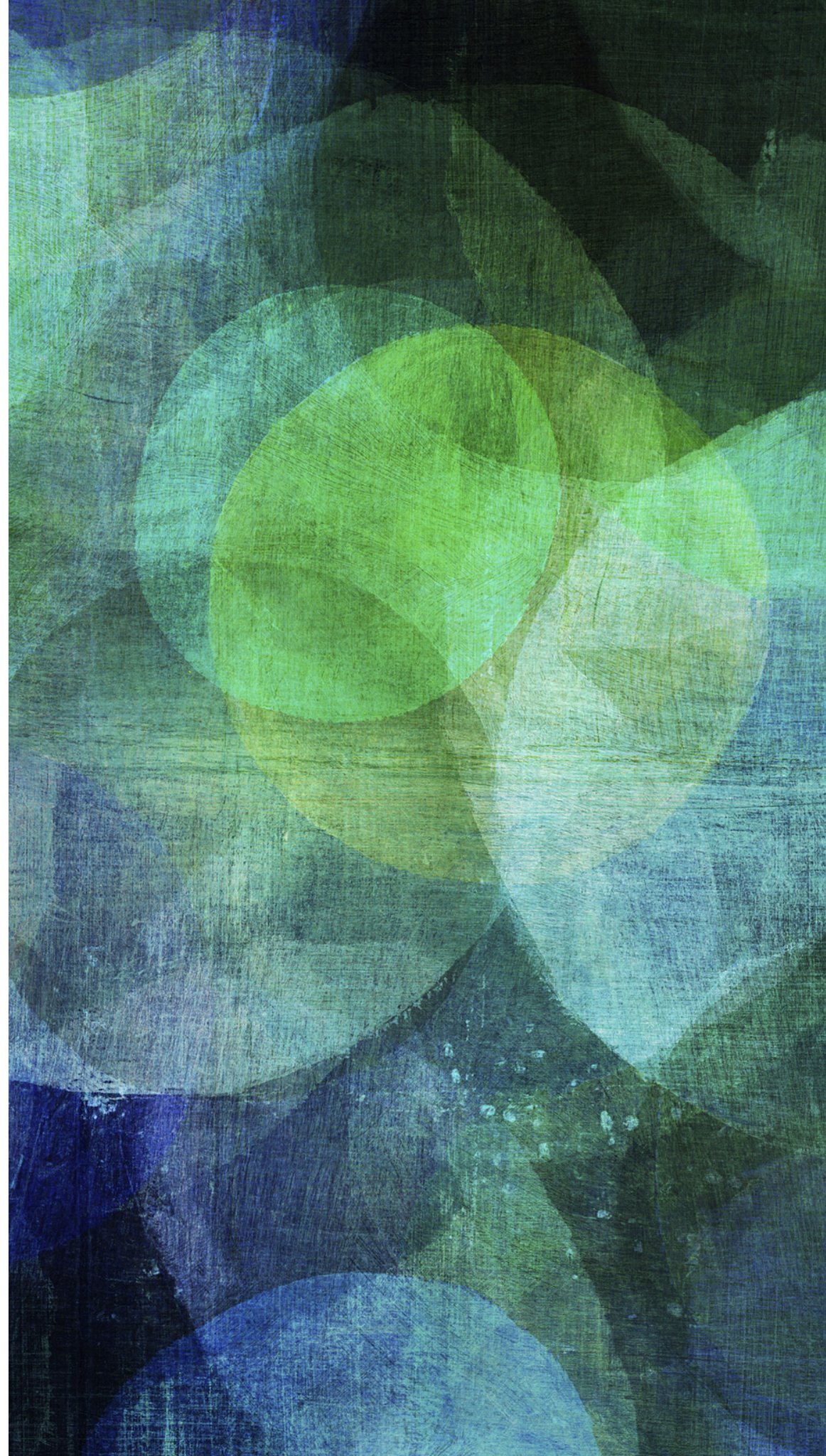
RESISTANCE TRAINING ABSOLUTE CONTRAINDICATIONS

- Unstable CAD
- Unstable CHF
- Uncontrolled arrhythmias
- Severe pulmonary HTN
- Severe symptomatic aortic stenosis
- Acute pericarditis, endocarditis, myocarditis
- Severe vascular disease
- Uncontrolled HTN (>180/110)
- Aortic dissection
- Marfan syndrome
- High intensive RT with active proliferative retinopathy or moderate or worse nonproliferative diabetic retinopathy

RESISTANCE TRAINING RELATIVE CONTRAINDICATIONS

- Major risks for CAD
- Diabetes
- Uncontrolled HTN ($>160/100$)
- Low functional capacity (<4 METS)
- Relevant MSK limitations
- Patient with implanted pacemaker or defibrillator

CARDIAC REHAB SPECIFICS FOR STROKE PATIENTS

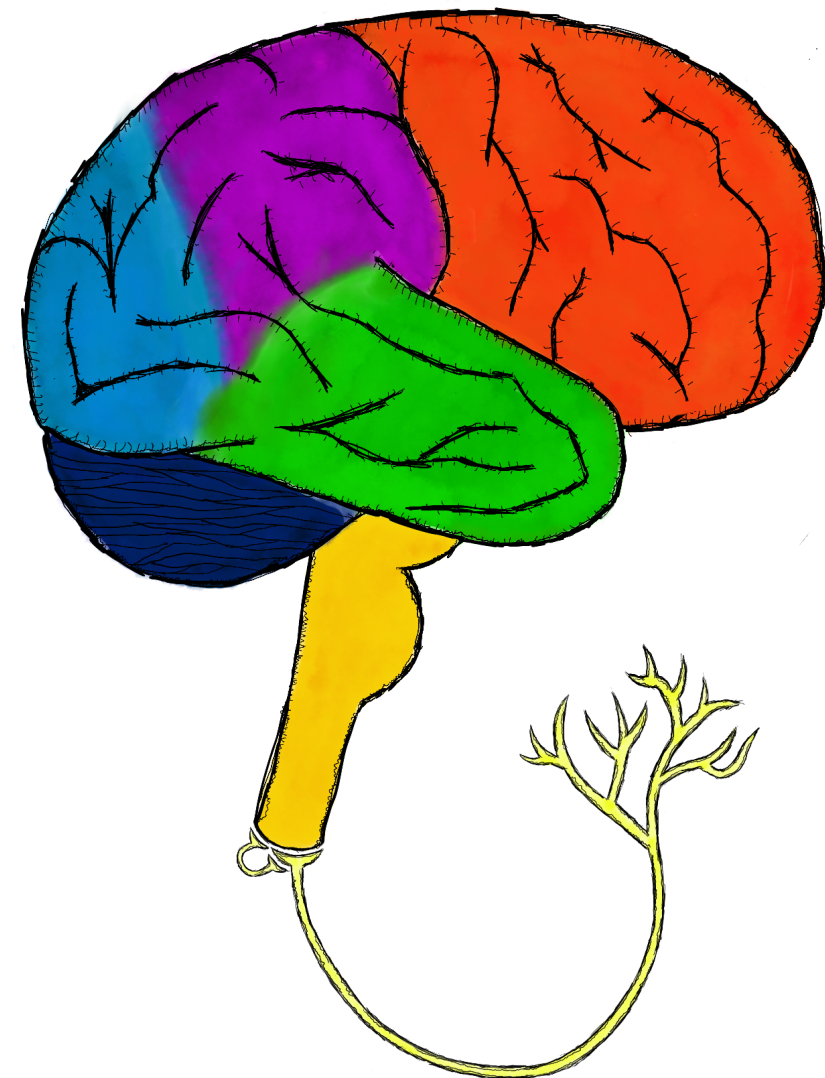


PARTICIPATION REQUIREMENTS

- Ability to follow commands and retain information
- Motivated to participate in exercise and lifestyle modification
- Able to walk a minimum of 10 minutes at a time with or without gait support
- Able to learn/exercise in a group setting
- Stable stroke deficits
- Any stroke deficits are adequately compensated for such that the patient can exercise safely

HELPFUL FOR CARDIAC REHAB STAFF

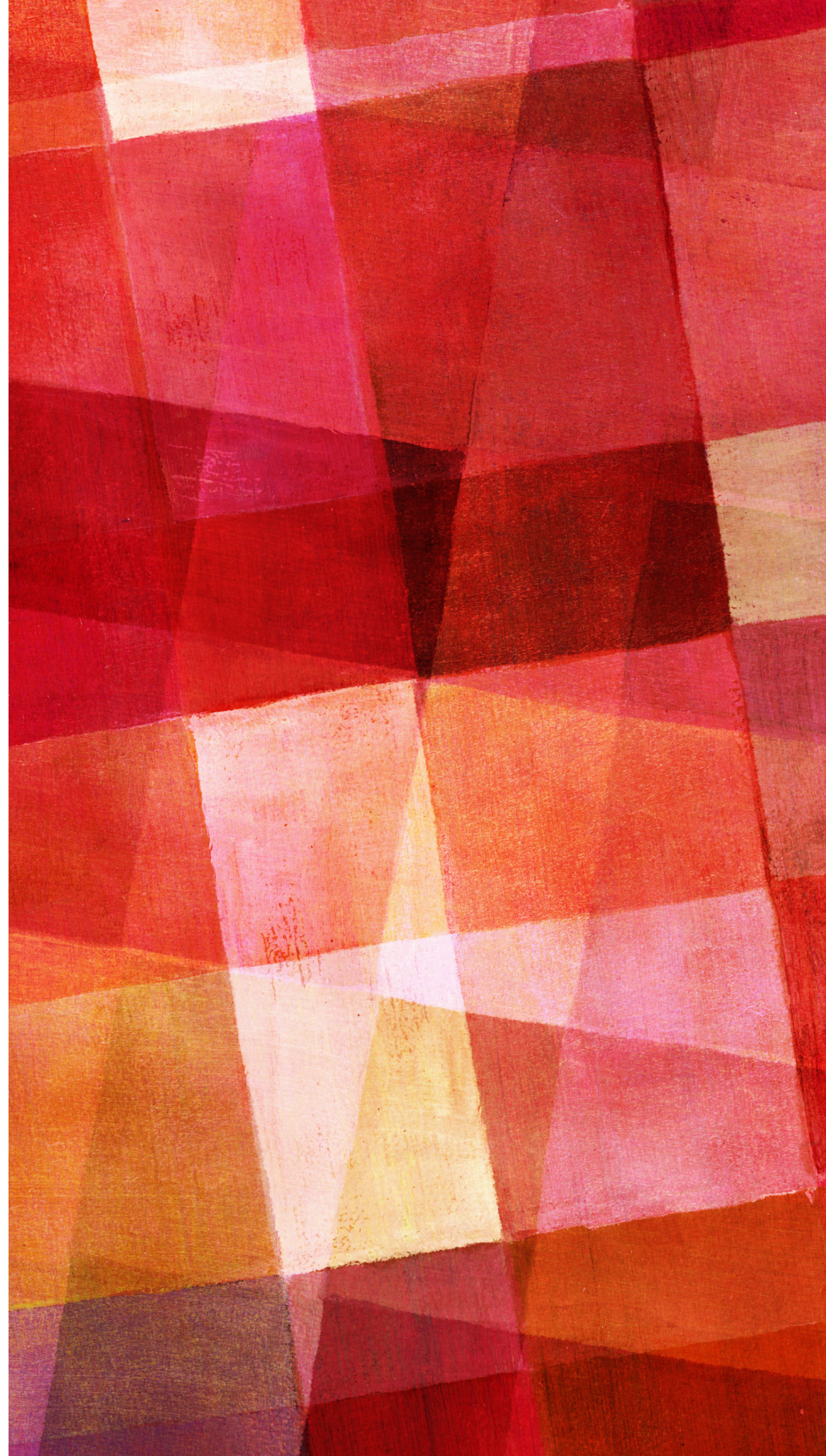
- Clearly documented baseline neurological exam and deficits as other health practitioners and allied staff are not as familiar with the spectrum of stroke patients
- Pharmacologic therapy optimized
- Any heart rate modulating medications on a stable dose



STROKE PATIENT WHO MAY REQUIRE MORE SUPPORT

- Executive dysfunction - if significant this may limit the patient's participation unless 1:1 support can be arranged
- Aphasia - depending on the severity and type, extra support may be required to ensure clear communication with the patient
- Neglect - start of a cardiac rehab program may have to be delayed until appropriate compensatory strategies are attained
- Agnosia
- Apraxia
- Infarct associated movement disorders

BRIEF OVERVIEW OF CARDIAC REHAB INTERVENTIONS



HYPERTENSION

- Hypertension is the most significant modifiable risk factor for stroke
- Cardiac rehabilitation reduces blood pressure, cardiovascular mortality, overall mortality in in patients with cardiac disease
- Exercise can reduce SBP by 4.3 mmHg and DBP by 2.5 mmHg which is comparable to the clinically meaningful effects of pharmacologic therapy at 5.1 and 2.5 mmHg for SBP and DBP respectively
- The most significant reduction in BP was noted when exercise was started within 6 months of the stroke event

ATRIAL FIBRILLATION

- Due to loss of a normal atrial contraction and an associated reduction in cardiac output, exercise capacity in patients with Afib can be 15-20% below that of people in sinus rhythm
- Heart rate at rest, during submaximal exercise, and at peak exercise can be higher in patients with Afib than patients in sinus rhythm
- Protective effects appear to occur at the recommended exercises guidelines (150 min/week), but increased risk may be present with high intensity or high volume activity
- Exercise testing has a low risk for test-related complications

ATRIAL FIBRILLATION

- Improvement in exercise capacity
- Reduced time in atrial fibrillation
- Lower overall heart rate
- Improved quality of life

Reference - 11



HYPERLIPIDEMIA AND DIABETES

- Exercise may improve lipid profiles in post-stroke patients, however the data is heterogenous ¹⁷
- Exercise improves glycemic control ¹⁹
- Cardiac rehab at the Hamilton General offers a free diabetes education class

Reference - 17, 19



DIET

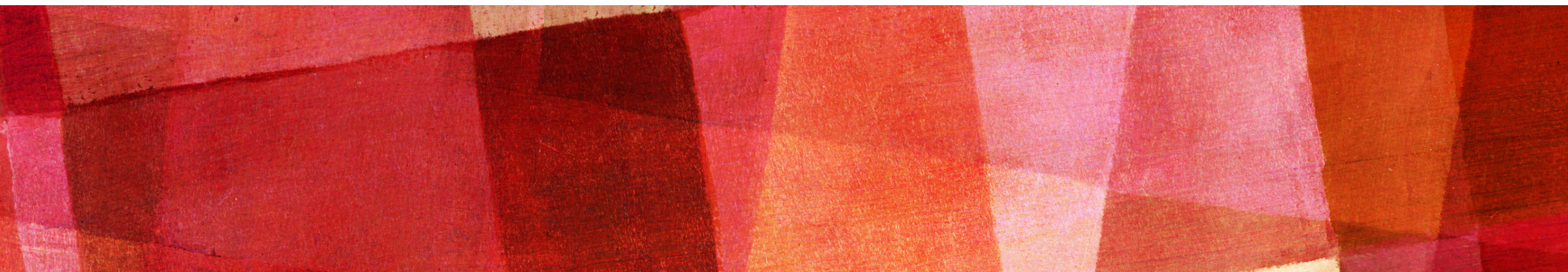
- Counsel and educate individuals with stroke to eat a diet high in fruits, vegetables, low-fat dairy products, dietary and soluble fibre, whole grains and protein from plant sources and low in saturated and trans fats, low in cholesterol (<200 mg daily for patients at increased vascular risk) and low in sodium, in accordance with Canada's Food Guide (Evidence Level B).
- Counsel and educate individuals with stroke about following a Mediterranean-type diet, which is high in vegetables, fruits, whole grains, fish, nuts and olive oil (Evidence Level B).
- Sodium Intake: Counsel and educate individuals with stroke and high blood pressure to have a daily sodium intake from all sources to less than 2000 mg per day (Evidence Level A).
- Patients can make an appointment with the cardiac rehab dietitian

SMOKING

- Provide unambiguous, nonjudgmental, and patient- specific advice regarding the importance of cessation to all smokers (Evidence Level B) and others who reside with the patient.
- Offer assistance with the initiation of a smoking cessation attempt – either directly or through referral to appropriate resources (Evidence Level A).
- People who are not ready to quit should be offered a motivational intervention to help enhance their readiness to quit (Evidence Level B).
- A combination of pharmacological therapy and behavioral therapy should be considered in all smoking cessation programs and interventions (Evidence Level A).
- Cardiac rehab at the Hamilton General Hospital offers free nicotine replacement therapy through the Hamilton STOP Program

TAKE HOME

- Ischemic stroke patients are more likely to have asymptomatic CAD
- Stroke patients should be considered for cardiac evaluation based on their cardiovascular risk factor profile ⁷
- Cardiac rehabilitation can be a helpful therapeutic option for selected stroke patients who could benefit from a number of interventions including exercise prescription, risk factor modification, and lifestyle changes



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QUESTIONS

