



# Coronary Artery Calcium Heart CT Screening for Early Detection of Atherosclerotic Plaque: Measuring Heart Attack Risk to Determine Need for Preventive Medication

Right Care Initiative Project Brief as of May 2019



California CHAPTER

## Cardiovascular Disease Indicator: Coronary Artery Calcium is an Effective & Personalized Predictor of Cardiovascular Events

Heart attacks and strokes, the leading cause of death in the United States, strike without warning in approximately 50% of cases.<sup>1,2</sup> They are often caused by plaque buildup in the walls of the arteries. The plaque usually includes calcium, which makes it visible on a CT scan. For this reason, it is possible to identify if plaque is present in the heart (coronary) arteries long before a heart attack strikes. Therefore, a CT scan of the coronary arteries is a means of screening for patients without symptoms who may be at high risk for a heart attack, refining clinical risk prediction and informing treatment decision-making to obtain better health outcomes and reduce costs. The presence of coronary artery calcification (CAC) increases the likelihood of having deposits in other arteries, including those that supply the brain. Therefore, finding coronary artery calcium may indicate an increased risk of stroke as well as heart attack. The 2018 joint guidelines issued by the American Heart Association (AHA) with the American College of Cardiology (ACC); and UK National Health Service guidelines, endorse this test to improve cardiovascular disease (CVD) risk classification and identify a group of individuals who receive major benefit from statins.<sup>3,4</sup> Conventional risk factors of vascular disease that guide early detection include: family history, diabetes, elevated LDL cholesterol, low HDL cholesterol, tobacco use, hypertension, obesity/physical inactivity and stress. Measuring coronary artery calcium is a specific indicator of an individual's mortality risk that has proven to be a very effective predictor of risk, highly motivating for patients to be adherent to preventive medications & lifestyle changes, while being also cost-effective.<sup>5,6,7</sup> Higher CAC scores are associated with higher risk and need for more intensive preventive intervention.<sup>8</sup>

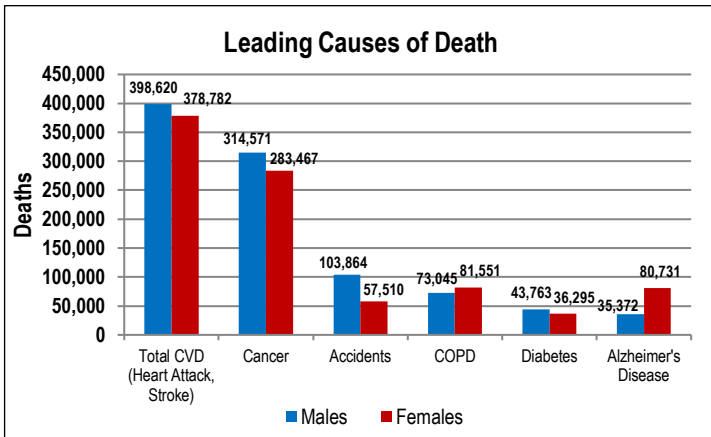


Figure 1: Leading Causes of Death for All Males and Females in the United States (2016)  
Source: Health, United States, 2017. Centers for Disease Control and Prevention, National Center for Health Statistics. US Department of Health and Human Services<sup>9</sup>

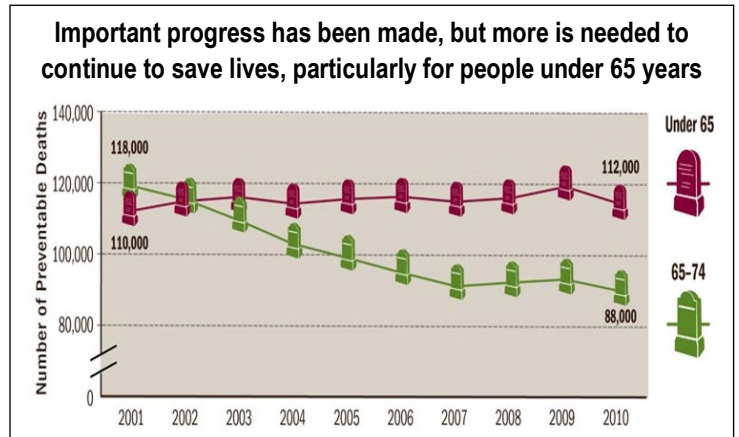


Figure 2: Preventable Cerebrovascular Deaths in the U.S. (2001-2010)  
Source: National Vital Statistics System, US Census Bureau, 2001-2010<sup>10</sup>

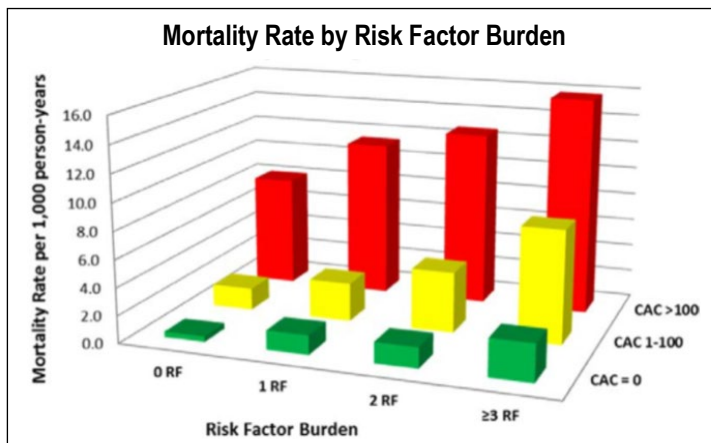


Figure 3: Mortality Rate by Risk Factor Burden and CAC Score  
Source: Nasir, et al. Circulation Cardiovascular Imaging, 2012<sup>11</sup>

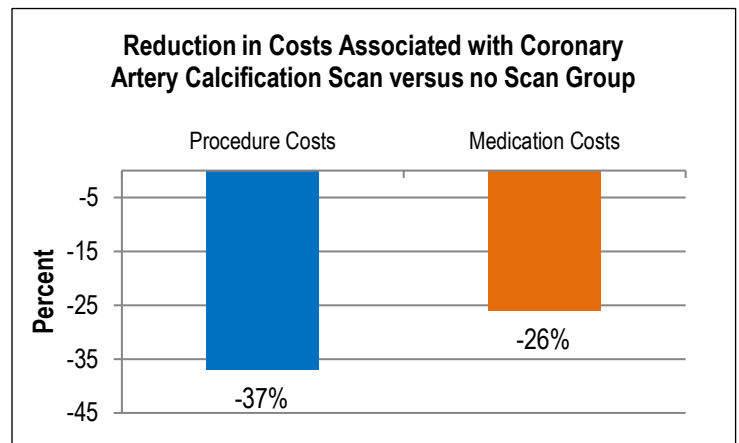


Figure 4: Reduction in Costs Associated with Coronary Artery Calcification Scan Versus No Scan Group  
Source: Rozanski, et al. Journal of the American College of Cardiology 2011<sup>12</sup>

Notes:  $p < 0.005$  for both measures

# Coronary Artery Calcium is a Cost-Effective and Reliable Indicator of Cardiovascular Risk and Mortality

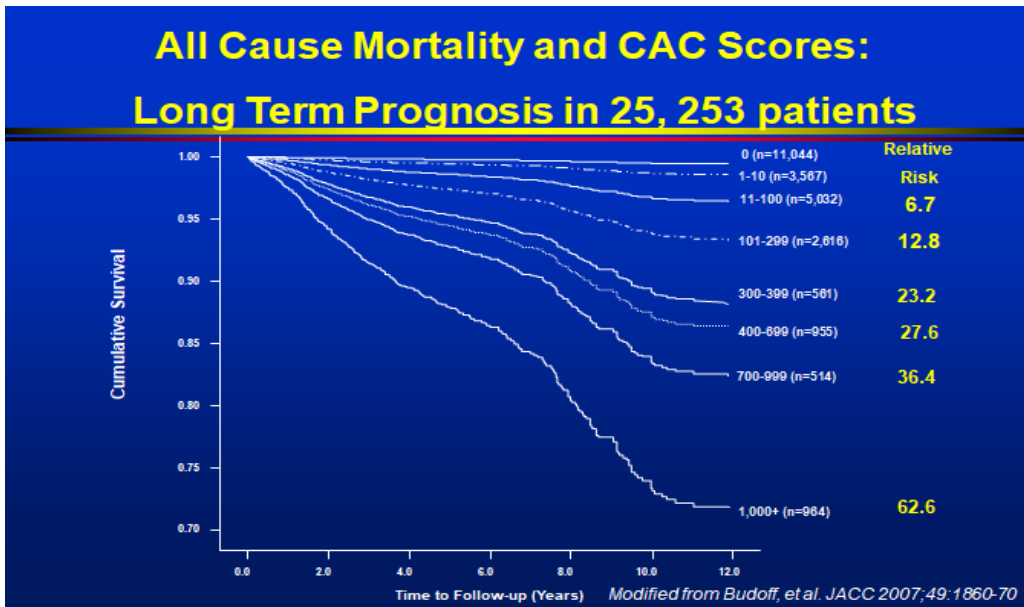


Figure 5: All-Cause Mortality and Coronary Artery Calcification Scores: Long Term Prognosis in 25,253 patients

Source: Budoff, et al. Journal of the American College of Cardiology, 2007<sup>5</sup>

Notes: With greater CAC score, cumulative survival decreases. Relative risk calculation uses those with 0 CAC score to compare.

\*Kaplan-Meier Survival Estimate shows 99.6% survival for people with CAC = 0 without family history of CHD and 99.3% survival for people with CAC = 0 and family history of CHD<sup>13</sup>

## Coronary Artery Calcium Scanning Improves Outcomes by Increasing Initiation and Continuation of Pharmacological and Lifestyle Preventive Therapies for People with Non-zero CAC Scores

Parameters	Odds Ratio	95% CI	p value
Aspirin Initiation	2.61	[1.81,3.78]	<0.0001
Lipid Lowering Medication Initiation	2.86	[1.85,4.41]	<0.0001
Blood Pressure Lowering Medication Initiation	1.94	[1.61,2.33]	<0.0001
Lipid Lowering Medication Continuation	2.26	[1.56, 3.28]	<0.0001
Increased Exercise	1.84	[1.41, 2.41]	<0.0001
Dietary Change	1.94	[1.52, 2.49]	<0.0001

Table 1: Pharmacological Initiation and Continuation Improved by Coronary Artery Calcium Scanning

Source: Gupta et al. Journal of the American College of Cardiology: Cardiovascular Imaging, 2017<sup>7</sup>

Notes: The data above shows that non-zero CAC score significantly increases the likelihood of initiation or continuation of pharmacological and lifestyle therapies for the prevention of cardiovascular disease.

## Primary Prevention Patients with Coronary Artery Calcium Scores $\geq 1000$ have CVD Mortality Rates that Exceed High-Risk Secondary Prevention Patients

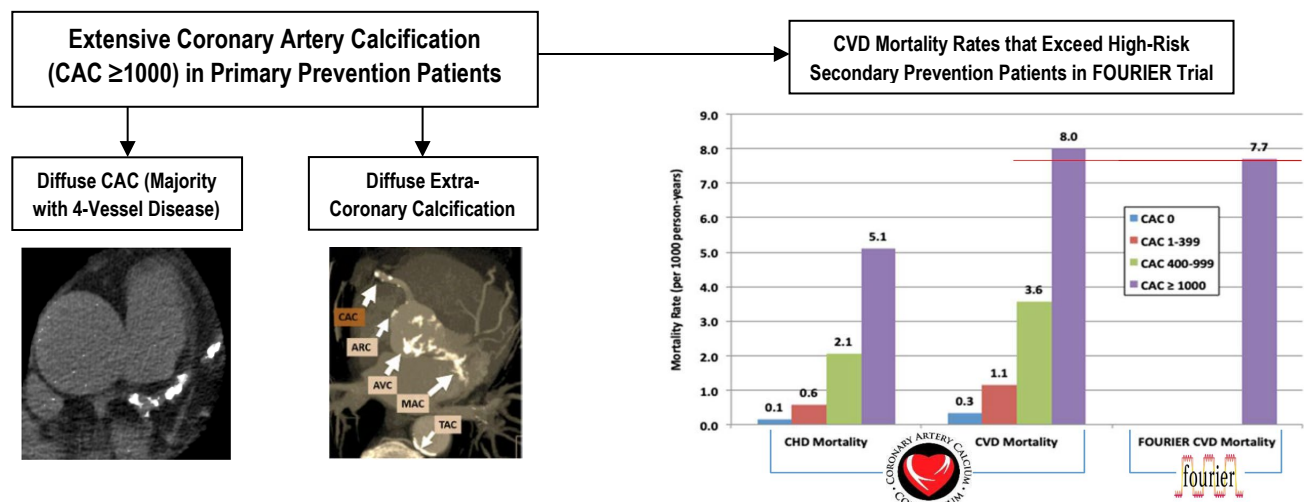


Figure 6: Understanding Extensive CAC (CAC Score  $\geq 1,000$ ) in Primary Prevention Patients

Source: Results from the Coronary Artery Calcium Consortium; Peng et al. Journal of the American College of Cardiology: Cardiovascular Imaging, 2019<sup>8</sup>

## Coronary Artery Calcium's Role in Predicting Mortality and Identifying Groups for Statin Medication

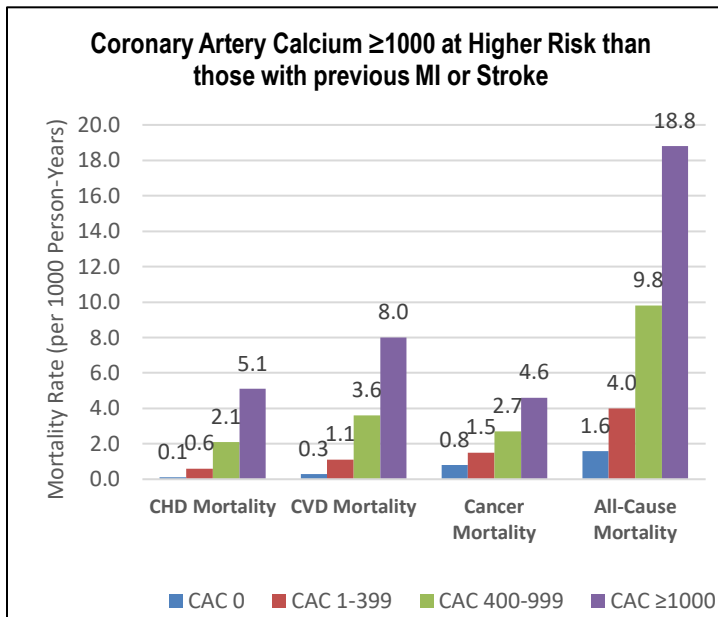


Figure 7: Mortality Rate Per 1,000 Person-Years for CVD, CHD, Cancer, and All-Cause Mortality by CAC Score Group

Source: Results from the Coronary Artery Calcium Consortium; Peng et al. Journal of the American College of Cardiology: Cardiovascular Imaging, 2019<sup>8</sup>

Notes: CAC = coronary artery calcium; CHD = coronary heart disease; CVD = cardiovascular disease

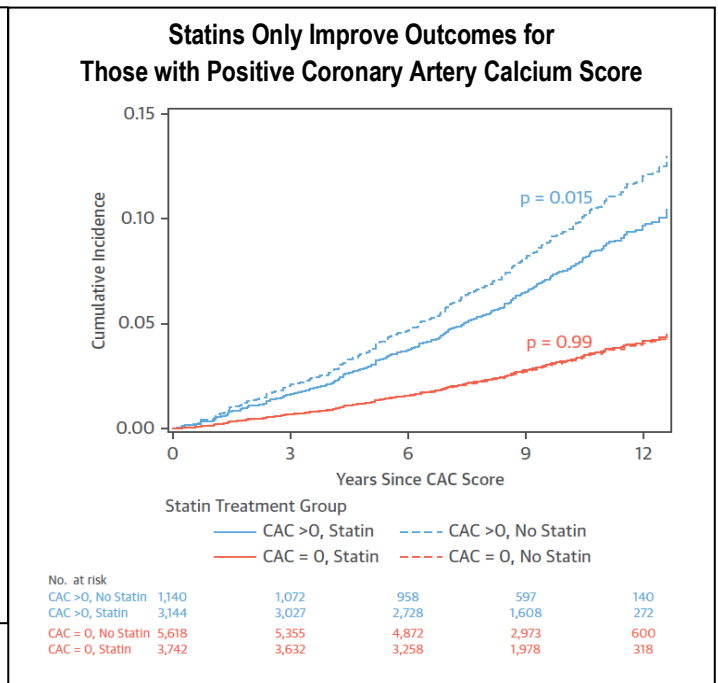


Figure 8: Cumulative Incidence of Major Adverse Cardiovascular Event (MACE) Stratified by Statin Treatment and CAC Presence

Source: Mitchell et al. Journal of the American College of Cardiology 2018<sup>14</sup>

Notes: In a 10-year observational study of 13,644 Military Personnel at Walter Reed Medical Center (mean age 50 years), no statin benefit was found among those with CAC scores of zero.

## Changing the Trajectory of the Outsized Cost of CVD Through Targeted Preventive Therapy

Condition	Total Direct Cost (in Billions)
<b>Heart Disease</b>	<b>\$113.4</b>
COPD, Asthma	\$78.5
<b>Hypertension</b>	<b>\$52.2</b>
<b>Hyperlipidemia</b>	<b>\$35.2</b>
Pneumonia	\$30.5
<b>Stroke</b>	<b>\$27.5</b>
Other Circulatory Conditions	\$25.1
Anemias	\$4.8

Table 2: Direct Economic Cost for Selected Conditions, U.S., 2015

Source: Center for Financing, Access and Cost Trends, Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey, 2015<sup>15</sup>

Notes: CVD conditions are bolded

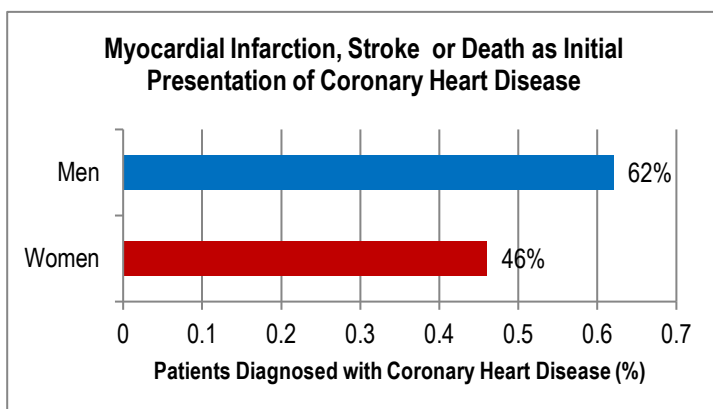
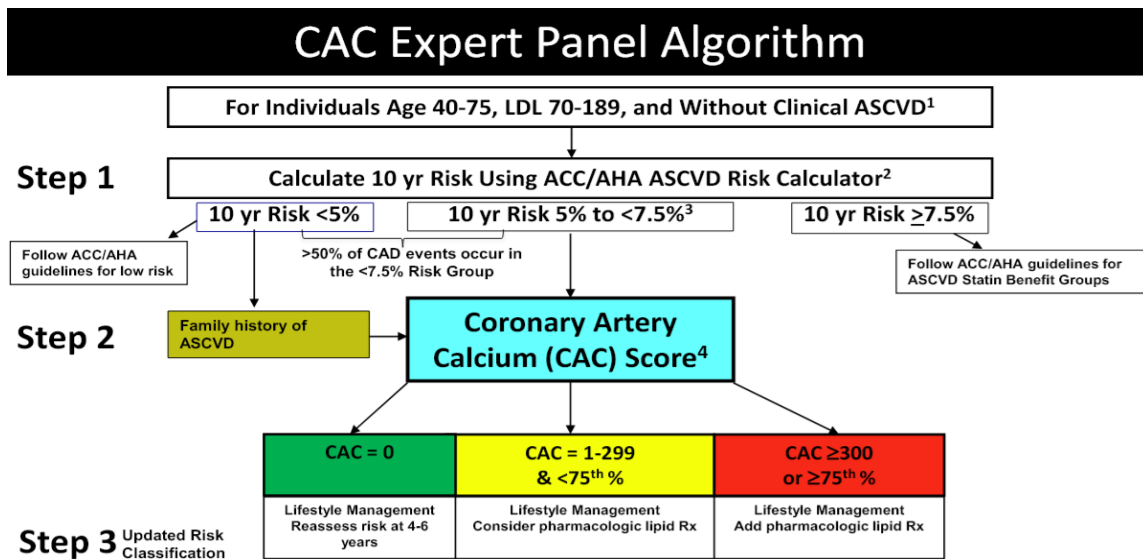


Figure 9: Myocardial Infarction (MI), Stroke or Death as Initial Presentation of Coronary Heart Disease

Source: Murabito, et al. Circulation, 1993<sup>2</sup>



<sup>1</sup> ASCVD = atherosclerotic cardiovascular disease

<sup>2</sup> <http://tools.cardiosource.org/ASCVD-Risk-Estimator/>

<sup>3</sup>ACC/AHA 2013 Cholesterol Guidelines state "for those with a 5% to <7.5% estimated 10-year ASCVD risk, the potential for adverse effects may outweigh the potential for ASCVD risk reduction benefit when high-intensity statin therapy is used in this risk group. However, for moderate-intensity statin therapy the ASCVD risk reduction clearly exceeds the potential for adverse effects."

<sup>4</sup>ACC/AHA 2013 Cholesterol Guidelines state "Before initiating statin therapy, the clinician and patient discussion should include consideration of the potential for ASCVD risk reduction benefits, adverse effects, and drug-drug interactions. Additional factors may also be considered to inform treatment decision making in selected individuals. Factors that may contribute to assessment of ASCVD risk include...coronary artery calcium score ≥300 Agatston units or ≥75 percentile for age, sex, and ethnicity." For additional information, see <http://www.mesa-nhibi.org/CACReference.aspx>.

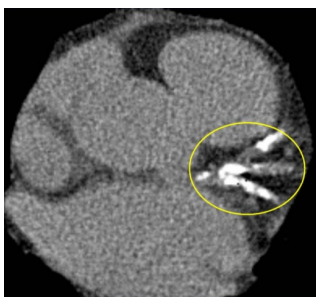
### Coronary Artery Calcification CT Scan Priority Scanning Groups

*American College of Cardiology and American Heart Association Cholesterol Clinical Practice Guidelines, 2018 (Grundy SM, et al.)<sup>3</sup>*

- In adults 40 to 75 years of age without diabetes mellitus and with LDL-C levels ≥70 mg/dl (≥1.8 mmol/L), at a 10-year ASCVD risk of ≥7.5%, start a moderate-intensity statin if a discussion of treatment options favors statin therapy. Risk-enhancing factors favor statin therapy. **If risk status is uncertain, consider using CAC to improve specificity.** If statins are indicated, reduce LDL-C levels by ≥30%, and if 10-year risk is ≥20%, reduce LDL-C levels by ≥50%.
- In adults 40 to 75 years of age without diabetes mellitus and with LDL-C levels ≥70 mg/dl-89 mg/dl (≥1.8-4.9 mmol/L), at a 10-year ASCVD risk of ≥7.5%-19.9%, **if a decision about statin therapy is uncertain, consider measuring CAC. If the CAC score is zero, treatment with statin therapy may be withheld or delayed**, except in cigarette smokers, those with diabetes mellitus, and those with a strong family history of premature ASCVD. A CAC score of 1-99 favors statin therapy, especially in those >55 years of age. **For any patient, if the CAC score is ≥100 Agatston units or ≥75<sup>th</sup> percentile, statin therapy is indicated** unless otherwise deferred by the outcome of clinician-patient risk discussion.

*United Kingdom's National Health Service Guidelines for Chest Pain Recommend Heart CT Scan for Chest Pain<sup>4</sup>*

- Updates to United Kingdom's national guidelines for chest pain involve recommendations that "**cardiac CT is the first-line investigation for patients presenting with new-onset chest pain due to suspected coronary artery disease because of the diagnostic accuracy and cost effectiveness**"<sup>16</sup>
- "If a patient's pre-test likelihood of significant cardiovascular disease was low (10-29%), **a coronary artery calcium score was the recommended first-line investigation** with subsequent CT coronary angiography if the calcium score was between 1 and 400 Agatston Units"<sup>16</sup>



### The Importance of Coronary Artery Calcification Screening: Case Study

An asymptomatic 55-year-old white with unremarkable cardiovascular risk factors (no hypertension, no smoking, no diabetes, lipids: TC:222; TG:122; HDL:42; LDL:156, family history: father is alive at 78; had a myocardial infarction at 50 and 55; had CAB; athletic) presents a 10-year atherosclerotic cardiovascular disease (ASCVD) risk score of 6.6%. With this ASCVD risk score, providers may consider prescribing a statin or aspirin and discuss lifestyle management, however a coronary artery calcification scan shows a calcium score of 1153 (shown left). The risk factors described, taken with the calcium score, indicate that the patient is at high risk for cardiovascular disease and it is recommended that a statin and aspirin are prescribed along with intensifying lifestyle management.

## Take Action

**Stanford Health Care, LA BioMed in Los Angeles, UC Davis Health Preventive Cardiology and Gundersen Health System are lowering the barrier to receiving the coronary artery calcium scan as a preventive screening test by offering it to patients for a cash price of \$150 to receive this precision prevention information for understanding patients' actual risk profile.**

### Occupational Use of Coronary Artery Calcification CT Scan

This scan is used as a tool in determining fitness for duty by predicting cardiovascular risk and yielding actionable information to prevent heart attacks and strokes.

- **The President of the United States**
  - After President Clinton's heart attack, **the Coronary Calcium CT Scan was added to presidential physicals to enable a more preventive approach to protecting the President's health. This test enables greater clarity on whether cardiovascular medications are needed, and at what dose, as well as needed lifestyle modifications.**
- **Astronauts**
  - Astronauts' medical assessments include calculating a 10-year cardiovascular Framingham Risk Score, measuring high-sensitivity C-reactive protein levels and **using coronary artery calcium scores** to screen for cardiovascular disease and decrease the likelihood of a crewmember experiencing a cardiac event during spaceflight.<sup>17</sup>
  - The 2014 NASA Human Research Program Investigators' Workshop developed a tool **using CAC scores** along with other risk factors to calculate astronaut cardiovascular health and risk.<sup>18</sup>
- **Firefighters**
  - Cardiovascular disease contributes to 45% of on-duty fatalities and is the leading cause of on-duty death among firefighters.<sup>16</sup>
  - Forward leading fire departments across the country, such as Los Angeles, CA and Gwinnett County, GA have determined this scan to **be useful for preventing cardiovascular events and are also cost saving.**<sup>19,20</sup>

### Coronary Artery Calcification Screening Additional Materials

- 1) Precision Medicine for Early Detection and Treatment of Coronary Artery Disease for People without Symptoms – Preventive Cardiology Expert Panel
  - Right Care Initiative Leadership Summit [Presentation: https://rightcare.berkeley.edu/wp-content/uploads/2015/11/6.-M.-Expert-Panel-Maron-ARS.pdf](https://rightcare.berkeley.edu/wp-content/uploads/2015/11/6.-M.-Expert-Panel-Maron-ARS.pdf)
  - Video: [Part 1: https://www.youtube.com/watch?v=Lx3w\\_kc7BNY](https://www.youtube.com/watch?v=Lx3w_kc7BNY)
  - [Part 2: https://www.youtube.com/watch?v=\\_cjpYbADJ9c](https://www.youtube.com/watch?v=_cjpYbADJ9c)
  - [Part 3: https://www.youtube.com/watch?v=znvbrFeWFYs](https://www.youtube.com/watch?v=znvbrFeWFYs)
- 2) Studies Featured/ Further Readings
  - [The Multi-Ethnic Study of Atherosclerosis \(MESA\)](#) (MESA is a medical research study involving more than 6,000 men and women from six communities in the United States. MESA is sponsored by the National Heart Lung and Blood Institute of the National Institutes of Health)
  - [Coronary Artery Risk Development in Young Adults \(CARDIA\)](#) (1985-Present) is a prospective community-based study examining the development and determinants of clinical and subclinical cardiovascular disease and their risk factors. CARDIA includes over 5,000 black and white participants aged 18 to 30 years from multiple national sites including Kaiser.
    - [Association of Coronary Artery Calcium in Adults Aged 32 to 46 Years with Incident Coronary Heart Disease and Death \(Jama Cardiology 2017\)](#) is one example of an article utilizing the CARDIA Study.
  - [The St. Francis Heart Study](#) (Treatment of Asymptomatic Adults with Elevated Coronary Calcium Scores with Atorvastatin, Vitamin C, and Vitamin E)
  - [The EISNER Study](#) (Early Identification of Subclinical Atherosclerosis by Noninvasive Imaging Research)
  - [The COURAGE Trial](#) (Optimal Medical Therapy with or without percutaneous coronary intervention (PCI) for Stable Coronary Disease)
  - [2018 ACC/AHA Guideline on the Management of Blood Cholesterol](#)
  - [2010 ACCF/AHA Guideline for Assessment of Cardiovascular Risk in Asymptomatic Adults](#)
  - [2013 European Society of Cardiology Guidelines on the Management of Stable Coronary Artery Disease](#)
- 3) Irish Heart Disease Awareness' video Widomaker (discusses evidence-base for using the CAC scan for proactive screening similar to a mammogram for the heart, but with much less frequency): [Irish Heart Disease Awareness – Heart Attacks, The Facts](#)

## About the Right Care Initiative

Since 2007 The Right Care Initiative's goal has been to apply scientific evidence and outcomes improvement strategies to reduce cardiovascular and diabetes morbidity and mortality through a collaborative focus on achieving measurable quality goals where performance metrics indicate that evidence-based, life-saving practices are not fully deployed. 2017 data from the California Office of Statewide Health Planning and Development indicate that annually approximately 298,000 Californians are hospitalized for heart attacks and strokes, approximately 100,000 of them younger than age 65. Many of these could be prevented with evidence-based preventive patient management, clinical quality improvement and adoption of best practices to implement best medical knowledge. Our work is focused in these high-leverage areas of better management of cardiovascular disease and diabetes, with particular emphasis on control of blood pressure, cholesterol and blood sugar, and is informed by data from Integrated Health Care Association, the National Committee for Quality Assurance, the federal Agency for Health Care Quality and Research, the Commonwealth Foundation, CMS, and the US Centers for Disease Control and the NIH.

The Right Care Initiative, operated by the UC Berkeley School of Public Health, was publicly launched with the Department of Managed Health Care, NCQA and the Deans of UC Berkeley and UCLA Schools of Public Health in March 2008 at the 1st annual Clinical Quality Improvement Leadership Summit. Since the first leadership summit, more than a dozen Right Care summits have been held around the state, along with over 150 monthly University of Best Practices. Each Right Care gathering is a collaborative effort to close the gap between science and practice to improve patient outcomes working with medical directors, pharmacy and quality improvement directors, as well as thought leaders in evidence-based medicine.

More information on The Right Care Initiative can be found at: <https://RightCare.Berkeley.edu/>

## References

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