Introduction

Twenty-two years – it is staggering. The average life expectancy of a police officer in the United States is twenty-two years less than their civilian counterparts.[1] As a police officer, life expectancy is only 57 years, compared to 69 years in the civilian sector. This, however, is just the tip of the iceberg.[2]

A newly sworn officer who has just graduated the police academy is most often in the best physical shape of his or her life. The tragedy is that over the next twenty to twenty five years of their careers, these officers will suffer physical illness and emotional trauma with devastating consequence. When compared to their civilian counterparts, law enforcement officers not only have a shorter life expectancy, but higher rates of heart disease, hypertension, diabetes and obesity.

Because of disparity of physical and mental health issues that is seen in law enforcement officers nationwide, it is the absolute duty of command staff to ensure that the officers under their watch not only go home at the end of their shift, but also stay physically and medically healthy. A young officer in the early stages of his or her career is a phenomenal "raw material". The protection of these individuals goes well beyond policy directives regarding items such as the wearing body armor and reflective vests etc. It requires a comprehensive approach to wellness, allowing them a productive and fulfilling career and the ability to enjoy the retirement for which they have worked so hard.

[1] John M. Violanti et al., "Life Expectancy in Police Officers: A Comparison with the U.S. General Population," *International Journal of Emergency Mental Health* 15, no. 4 (2013): 217–28.
[2] Violanti et al.

Sigma Tactical Wellness Cardiac Screening Initiative

Background:

There is no question that one of the top killers of men and women in uniform is heart disease. Although death from heart attack is consistently ranked as the number two or three cause of death by tracking organizations such as the Officer Down Memorial Page (ODMP)[3], or the National Law Enforcement Officer Memorial Fund (NLEOMF)[4], these rankings do not include heart attack deaths that occur after the individual officer finishes the duty shift. When these numbers are extrapolated for a twenty-four-hour day, heart attack easily becomes the number one killer of men and women in uniform. Furthermore, it is well known that less than 3% of heart attacks are fatal [5], meaning the published data doesn't capture and recognize literally the thousands of heart attacks that result in significant officer disability but do not result in death. Besides the toll on human life, heart attacks are one of the leading medical expenses that police agencies must face. According to The Commission on Accreditation for Law Enforcement Agencies (CALEA), the cost to the taxpayers of an in service heart attack ranges from $450k to $750k *per incident.*

According to data published the average age of a US police officer who suffers a heart attack is 46 year, while the average age of a civilian is 65 years[6]. More striking is that a civilian who is between the ages of 55 and 59 has only 1.5 % chance of dying from a heart attack, while police officers in the same age range have a chance of over 56%[7] More frequent heart attacks which occur at younger ages contribute to that horrific statistic of police officers having life expectancy that is 22 years less than their civilian counterparts. Despite the fact that police

[3] "The Officer Down Memorial Page (ODMP)," accessed December 21, 2020, https://www.odmp.org/.
[4] "Https://Nleomf.Org/," National Law Enforcement Officers Memorial Fund, accessed December 21, 2020, https://nleomf.org/.
[5] Harvard Health Publishing, "Surviving a Heart Attack: A Success Story," Harvard Health, accessed December 21, 2020, https://www.health.harvard.edu/heart-health/surviving-a-heart-attack-a-success-story.
[6] Violanti et al., "Life Expectancy in Police Officers."
[7] Violanti et al.

officers are twenty-five times more likely to die from a cardiovascular event (i.e. heart attack or stroke) than be killed by the violent action of a suspect, little information regarding this significant problem has been adequately disseminated to executive leadership and to line officers as well[8].

The cause of increased cardiac risk in policing remains elusive but is likely related not only to an increased prevalence of known classic risk factors (hypertension, high cholesterol, diabetes etc.) but also to factors such as mental stress induced by work schedules, shift work, hypervigilance and psychological trauma.

Law enforcement is certainly a stressful profession, but it is not unique in this regard. Stress is absolutely ubiquitous in our society. However, police officers are known to have a stress pattern which is unique and very different than what is seen in individuals in the civilian sector. In data from more than 4,500 US LEOs from 1984 to 2010, it was found risk of sudden cardiac death was 34-69 times higher during restraints and altercations, 32-51 times higher during pursuits, 20-23 times higher during physical training, and 6-9 times higher during medical/rescue operations." [9]

The inherent nature of policing consists of long periods of routine and sometimes mundane patrol or investigation punctuated by short periods intense excitement which results in accelerated adrenaline release. This is the so-called pattern of policing which is often described as "98% boredom and 2% sheer terror". This unexpected and rapid secretion in adrenaline results in several rapid physiological changes. Initially, there is a sudden increase in heart rate and blood pressure. There is repeated Valsalva maneuver (increased intrathoracic pressure from breath holding and bearing down), as well as activation of both the left and right hemispheres of the brain as the officer use both sides of his or her upper and lower body in

[8] Tom Tracy, "Fit for Duty: Demand It.," *Police*, March 1993, 18.
[9] Vasileia Varvarigou et al., "Law Enforcement Duties and Sudden Cardiac Death among Police Officers in United States: Case Distribution Study," *BMJ (Clinical Research Ed.)* 349 (November 18, 2014): g6534, https://doi.org/10.1136/bmj.g6534.

offensive and defensive threat mitigation. These intense episodes may go on for several minutes, and in many cases when officers are "fighting for their lives" they will rapidly convert from aerobic to anaerobic metabolism.[10]

It is also known that heart attacks resulting from these described changes in physiology, will often happen hours after the instigating event. Several states recognize this delay and therefore presumptively consider any law enforcement officer who suffers a cardiac issue while off duty to have developed the initial stages of their event while on duty.

A strategy to prevent heart attacks requires understanding of the simple pathophysiology of how these events occur. A heart attack, or myocardial infarction (MI) occurs when one of the coronary arteries that supplies the heart is blocked. A blocked coronary artery *does not* occur from a gradual narrowing of the blood vessel. In other words, a blocked or occluded artery does not block slowly over time.

When plaque or blockage begins to form in an artery, it does not form in the interior or what is known as lumen of the artery such as scale would in a pipe. Instead, plaque accumulates in the actual wall of the blood vessel (figure 2). As the plaque begins to accumulate inside the arterial wall, the artery will become inflamed. This inflammation will eventually become so severe, that the plaque in the artery will burst or rupture causing the plaque to spill out from the wall of the blood vessel into the opening of the artery. This plaque rupture causes the clotting system to activate forming a clot within the artery. This clot immediately blocks blood flow. (figure 3). Current thought is that the unique stress pattern seen in law enforcement can potentially accelerate plaque rupture which results in the increase frequency of heart attacks.

Because of advanced understanding of the pathophysiology of heart attacks, the concept that heart attacks occur without warning is truly antiquated. There are specific tests that can detect

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[10] Michael E. Andrew et al., "Police Work Stressors and Cardiac Vagal Control," *American Journal of Human Biology : The Official Journal of the Human Biology Council* 29, no. 5 (September 10, 2017), https://doi.org/10.1002/ajhb.22996.

the presence of blockages or coronary artery disease (CAD), years before these blockages cause symptoms. Standard stress testing, such as exercise treadmill testing, or bicycle stress testing will only detect blockages which are already significant enough to obstruct blood flow. This testing will *not* detect mild plaque or blockages in their very early stages. For this, more advanced yet simple alternative tests are needed.

When the early stages of plaque forms within the artery wall, several things occur that can be detected *before* plaque ruptures and a heart attack occurs. A very low dose radiation computed tomography (CT or CAT) scan known as a coronary artery calcium (CAC) scan is able to detect little "flecks" of calcium which develop within the coronary arteries (figures 4 and 5). This scan typically costs less than $200, uses a low dose of radiation (0.7 mSv) and can be done in a matter of minutes. More predictive than coronary calcium scoring, is the ability to detect inflammatory changes within the artery by measuring certain biomarkers seen on specific blood tests. Markers such as oxidized LDL (OXLDL), myeloperoxidase (MPO), asymmetric dimethyl arginine (ADMA) and lipoprotein associated phospholipase A_2 (Lp-Pla_2) can identify inflamed plaque and provide evidence that the plaque is prone to rupture. Of these markers, the most studied and most predictive is Lp-Pla_2. When this specific marker is elevated, the risk of that individual having plaque rupture and therefore a heart attack is approximately 15-20% over a 4 year period of time[11].

From a pragmatic standpoint, the combination calcium scoring and Lp-PLA_2 detection is extremely useful in detecting coronary disease *years before* a heart attack occurs. After studying over 3800 police officers without any symptoms of heart disease, 31% were found to have a positive calcium score, 26% were found to have an elevation of Lp-Pla_2, but only 7% had both markers – making the need to evaluate both these tests invaluable. Shockingly, this data clearly demonstrates that of the 3836 officers screened, 64% had evidence of undiagnosed

[11] Emmanouil S. Brilakis et al., "Association of Lipoprotein-Associated Phospholipase A2 Levels with Coronary Artery Disease Risk Factors, Angiographic Coronary Artery Disease, and Major Adverse Events at Follow-Up," *European Heart Journal* 26, no. 2 (January 1, 2005): 137–44, https://doi.org/10.1093/eurheartj/ehi010.

coronary artery disease.[12] Disease that can be identified and successfully treated resulting in fewer officers succumbing to heart attacks and becoming statistics.

Once detected, coronary disease can be mitigated, and risk of heart attack can be significantly reduced. There is a well identified three pronged approach to reducing risk. First, certain cholesterol medications, particularly the HMG co-reductase inhibitors or "statins" have been definitively proven to cause plaque to regress and to reduce coronary inflammation.[13] Secondly, changes in lifestyle, specifically changes in diet and exercise patterns have also been shown to not only reduce coronary disease, but to prolong life and reduce metabolic issues such as obesity, hypertension and diabetes. Finally, the use of certain nutritional supplements has also been shown to reduce risk in specific populations. For example, in those individuals who have an elevation of Lp-Pla_2, one of the components of fish oil, known as icosapent ethyl, or EPA has been successfully shown to significantly reduce inflammation.[14] Heart attack is preventable and does not have to be one of the top killers of men and women in uniform. It can be detected early, and once identified; it can be successfully treated.

Physical Fitness:

There is no question that being a police officer requires a level of fitness that is not needed in other professions. It has been proven time and again, that individuals who exercise live longer than those that do not.[15] High density lipoprotein (HDL) or "good cholesterol" is the cholesterol molecule that is responsible for reverse cholesterol transport, that is, it is the molecule that effectively absorbs plaque from the arterial wall and returns it to the liver for destruction.

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[12] Jonathan Sheinberg, "The Presence of Early Markers of Coroanry Artery Disease in an Asymptomatic Population of Law Enforcement Officers" (June 2020).
[13] Lima João A.C. et al., "Statin-Induced Cholesterol Lowering and Plaque Regression After 6 Months of Magnetic Resonance Imaging–Monitored Therapy," *Circulation* 110, no. 16 (October 19, 2004): 2336–41, https://doi.org/10.1161/01.CIR.0000145170.22652.51.
[14] Mitsuhiro Yokoyama et al., "Effects of Eicosapentaenoic Acid on Major Coronary Events in Hypercholesterolaemic Patients (JELIS): A Randomised Open-Label, Blinded Endpoint Analysis," *The Lancet* 369, no. 9567 (March 31, 2007): 1090–98, https://doi.org/10.1016/S0140-6736(07)60527-3.
[15] Peter Kokkinos, "Physical Activity, Health Benefits, and Mortality Risk," *ISRN Cardiology* 2012 (October 30, 2012): 1–14, https://doi.org/10.5402/2012/718789.

Aerobic exercise has been shown not only to increase the amount of HDL in the blood, but exercise also increases the HDL size and improves its ability to clear plaque.[16]

Police officers have also been shown to have potential exposure to excessive liability if they are not fit. At times, an unfit police officer does not have the ability to go "hands on" with an assailant and may have a higher likelihood to resort to lethal force. In a landmark trial, Parker v District of Columbia, a Metropolitan police officer was found that due to his physical condition, "…it is not hard to fathom that his most effective method for subduing the objects of his pursuits would be the use of a firearm as opposed to the application of physical force…" Furthermore, the District was found liable as, "...Officer Hayes simply was not in adequate physical shape. This condition posed a foreseeable risk of harm to others. We are persuaded that a fair-minded jury could have concluded that Officer Hayes' conduct was the result of deliberate indifference on the part of the District with respect to the physical training of its police officers…"[17].

Finally, the Federal Bureau of Investigation Behavioral Science Unit found that officers who appeared unfit were more likely to face physical resistance and assault than officers who appeared fit[18]. This information was so compelling, it has resulted in the Texas Department of Public Safety to develop the Command Presence Directive requiring both male and female officers to have acceptable waist circumference measurements.

Nutrition and maintenance of a healthy weight:

Obesity and its consequences are also a tremendous problem among the men and women who wear the uniform. According to published data, over 80% of law enforcement officers are

[16] Jonathan J. Ruiz-Ramie, Jacob L. Barber, and Mark A. Sarzynski, "Effects of Exercise on HDL Functionality," *Current Opinion in Lipidology* 30, no. 1 (February 2019): 16–23, https://doi.org/10.1097/MOL.0000000000000568.
[17] "Parker v. District of Columbia, 850 F.2d 708 | Casetext Search + Citator," accessed December 24, 2020, https://casetext.com/case/parker-v-district-of-columbia-2.
[18] Anthony Pinizzotto, Edward Davis, and Charles Miller III, "The Deadly Mix. Officers, Offenders and the Circumstances That Bring Them Together.," *The FBI Law Enforcement Bulletin*, January 2007.

overweight and 40% are clinically obese[19]. In data collected by the Public Safety Cardiac Foundation, over 80% of police officers in central Texas were found to be obese[20] by body fat measurement.

Obesity often results in a myriad of comorbidities including increased rates of hypertension, diabetes as well as the development of more frequent musculoskeletal injuries. Overweight police officers can also be less effective at their jobs and may the focus of more physical resistance and potential assault. It is therefore absolutely vital that there is an expectation not only for officers to remain physically fit, but to have effective command presence.

It has been well documented through many published studies that weight loss and the maintenance of a healthy body mass cannot be achieved by exercise alone.[21] [22] [23]

There are several different diets that have been popularized over the last twenty years. Regardless of the diet, most nutrition plans will fit into one of three categories: reduced fat, reduced carbohydrate and reduced calorie. When these different approaches are comparatively studied, they all seem to be equally effective for weight reduction. [24]

From a cardiovascular standpoint, a diet that limits carbohydrates and eliminates sugar has been shown to be highly effective at reducing heart attack risk as it reduces the most destructive cholesterol particles. Low density lipoprotein (LDL) or "bad" cholesterol is the cholesterol molecule that is responsible for causing plaque formation within the artery wall.

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[19] Daniel Shell, "The Police Executive Leadership Program Class Exercise and Nutrition Questionnaire, Division of Public Safety Leadership" (Johns Hopkins University, October 2003).
[20] Sheinberg, "The Presence of Early Markers of Coroanry Artery Disease in an Asymptomatic Population of Law Enforcement Officers."
[21] Herman Pontzer et al., "Constrained Total Energy Expenditure and Metabolic Adaptation to Physical Activity in Adult Humans," *Current Biology* 26, no. 3 (February 8, 2016): 410–17, https://doi.org/10.1016/j.cub.2015.12.046.
[22] Damon L. Swift et al., "The Role of Exercise and Physical Activity in Weight Loss and Maintenance," *Progress in Cardiovascular Diseases* 56, no. 4 (2014): 441–47, https://doi.org/10.1016/j.pcad.2013.09.012.
[23] Swift et al.
[24] Frank M. Sacks et al., "Comparison of Weight-Loss Diets with Different Compositions of Fat, Protein, and Carbohydrates," *New England Journal of Medicine* 360, no. 9 (February 26, 2009): 859–73, https://doi.org/10.1056/NEJMoa0804748.

LDL exists in several sizes and densities from small dense particle to large fluffy and buoyant particles (think golf balls to beach balls) (figure 6). The small dense particles have the ability to burrow into the blood vessel wall at a much higher frequency than the large buoyant particles. When a diet which is high in carbohydrates and sugar is consumed, the liver forms more of the smaller and denser LDL particles which in turn lead to more plaque deposition. When a diet higher in fat is consumed, the liver forms larger and more buoyant particles which do not contribute to plaque formation as easily as the larger and less dense particles cannot cross the lining of the blood vessel wall.

In the 1970's the McGovern Commission postulated that dietary fat increases LDL, LDL causes heart disease therefore dietary fat causes heart disease.[25] This has been proven inaccurate; however, the contrapositive is correct. The concept of a low fat diet being a "heart healthy" diet was very prevalent in the 1980's 90's. The low fat guidelines were in fact fraught with paradoxical medical outcomes. By avoiding dietary fat, Americans began to consume increasing amounts of carbohydrates. In doing so, the US entered into an obesity epidemic which resulted in increased rate of diabetes and hypertension. More concerning is the fact that the rate of cardiovascular disease did not drop, it actually increased. [26]

The diet which seems to be the most effective at minimizing heart disease and keeping obesity at bay is a diet of fresh fruits, vegetable and meat. The reduction of carbohydrates and the elimination of sugars is absolutely vital to keeping the men and women in law enforcement and the general population healthy.

To reinforce these ideals, Sigma incorporates the proprietary use of indirect calorimetry to determine individual metabolic status. For convenience, this test is conducted simultaneously with the 12-lead stress test.

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[25] "Dietary Goals for the United States / Prepared by the Staff of the Select Committee on Nutrition and Human Needs, United States Senate.," n.d., 131.

[26] null null et al., "Heart Disease and Stroke Statistics—2006 Update," *Circulation* 113, no. 6 (February 14, 2006): e85–151, https://doi.org/10.1161/CIRCULATIONAHA.105.171600.

Sigma Tactical Wellness Cardio-Metabolic Testing:

Over the last decade the incorporation of fitness trackers and calorie counters has become mainstream in order to help individuals maximize caloric "burn" with the common goal of weight reduction. The fatal flaw in this methodology lies with the misunderstanding that the idea of "burning" calories is a sufficient when working towards the goal of weight reduction. This is not true. Within muscle, both fats (intra-muscular triglyceride) and carbohydrates (glycogen) are stored as fuel sources underwriting calorie generation. The "decision" as to which macromolecule is the greatest contributor to basal calorie requirements is largely dependent on sleep patterns, stress, cardio-respiratory fitness, and nutritional status.

Within law-enforcement, increased intake of carbohydrates (upwards of 80% of total daily caloric intake) is common especially for those working overnight shifts. Chronic exposure to high-carbohydrate diets will increase dependency on glycogen as a fuel source which can trigger cravings of dietary sugar, create oscillations of energy status, generate adiposity (weight gain), and can increase the biosynthetic production of LDL and triglyceride.

It has been shown over multiple studies that increasing mono- and poly-unsaturated intake upwards of 55% of total daily caloric intake (Mediterranean cuisine) has been effective in improving rates of fat utilization at rest thus being an effective method of long-term weight reduction and healthy weight maintenance.

Similarly, chronic exercise at extremely high intensities has been thought of as a vehicle for weight reduction based solely on the bulk of calories burned during these types of activities (figure 6). However, when examining the *type* of calorie burned at these intensities (whether carbohydrate or fat derived), it is easy to see that exercise at higher intensities is exclusively carbohydrate dependent. Upon further examination, it is easy to see that exercise at lower intensities is much higher in fat contribution than carbohydrate contribution. Moreover, it has been documented that low-intensity exercise when combined with Mediterranean diets can

significantly increase fat utilization at rest which has been proven effective in reducing BMI in overweight individuals (BMI >= 30) by 5.8% and obese individuals (BMI >= 35) up to 7.1%.

Screening Process:

Each patient visit will be outlined as follows:

1. An on-site blood draw conducted by qualified phlebotomists provided by Cleveland Heart Lab. For officers that either miss scheduled on-site phlebotomy appointments or are unable to attend, Quest Diagnostics (parent company of Cleveland Heart Lab) will open their vast network of patient service centers (PSCs) to allow qualifying officers to have their blood drawn at a time and location entirely of their own choosing.

2. A carotid ultrasound or CIMT (used as a surrogate marker for coronary calcium scoring). This test can is vital in determining the presence of both soft and calcified plaque in young and veteran officers. Additionally, this test can be conducted on-site in conjunction with screening agencies that are positioned in rural/remote areas where access to imaging facilities or hospitals (for coronary calcium scoring) isn't feasible.

3. Cardio-metabolic Stress Test (includes active 12-lead EKG). Performed in conjunction to the 12-lead EKG, this test analyzes respiratory gases to determine individual metabolic contributions from both fat and carbohydrate stores within skeletal muscle.
   This information is crucial in determining both nutritional needs (supporting weight loss) and specific exercise zones designed to improve cardio-respiratory fitness and resiliency to physiological/occupational stressors.

4. a. The first 20min visit will involve a discussion with Sigma-trained exercise physiologists/dieticians in determination of nutritional needs to support both patient goals and individual medical presentation.
   b. The second 20min visit will focus on a breakdown of cardiac-inflammatory labs, analysis of CIMT findings, and dissection of 12-lead EKG/stress test. Patients will receive precise instructions pertaining to whether additional care at the primary or specialty level is warranted based on individual presentations.

Conclusion:

Sigma Tactical Wellness has developed a comprehensive cardiac screening evaluation along with an individualized nutritional and exercise prescription. This on-site screening consists of non-invasive imaging as well as advanced lipid panel testing to evaluate the early stages of the development of coronary disease and the inflammatory markers that can be used to predict the development of a heart attack. Sigma pairs this multi-disciplinary approach with cutting edge physiological testing designed to improve body composition, reduce incidence of metabolic disease, and improve on-duty performance. This screening includes all necessary components to address the disproportional health issues facing law enforcement officers face; which *can and will* have an effect on quality of life and longevity.

Figures

Figure 1

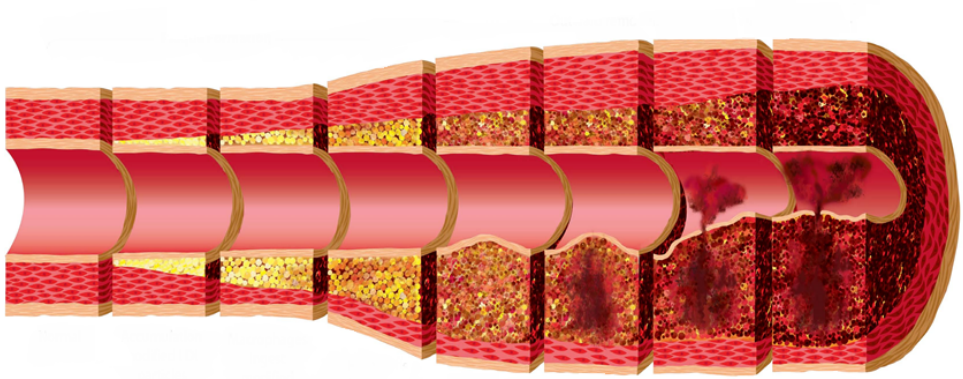


Figure 2

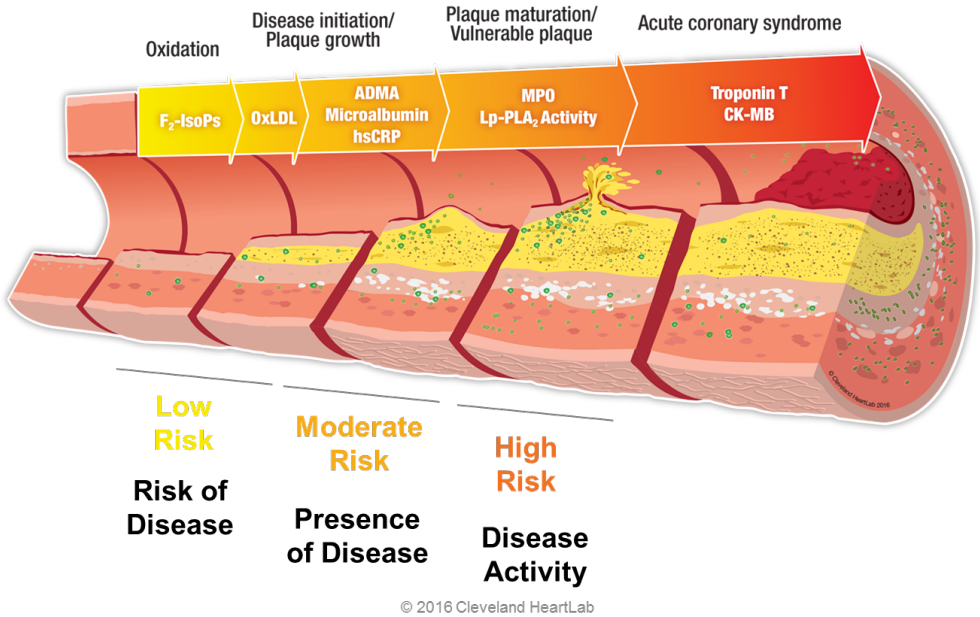


Figure 3

Figure 4

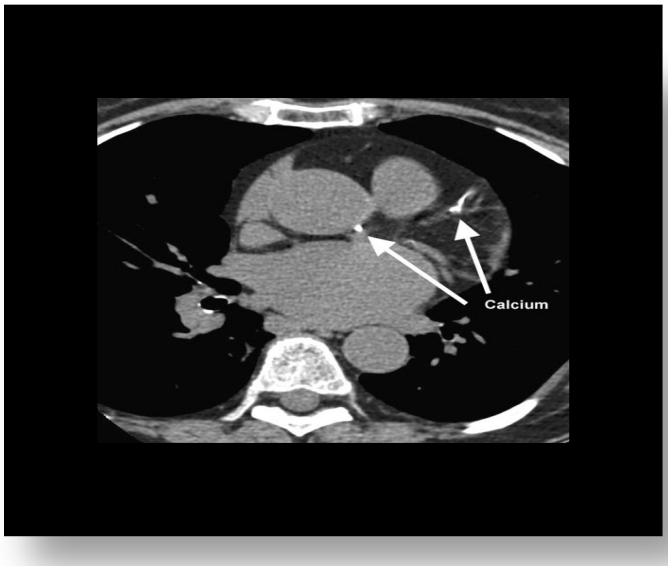


Figure 5

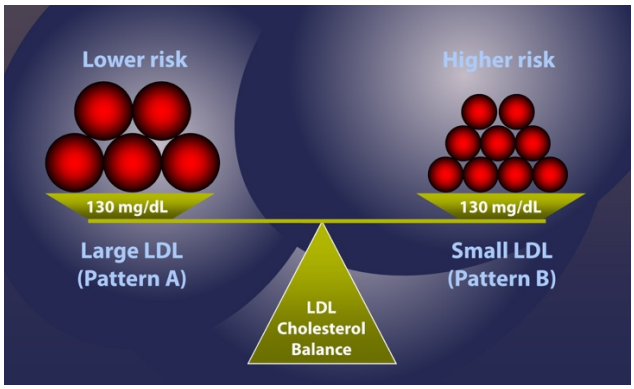
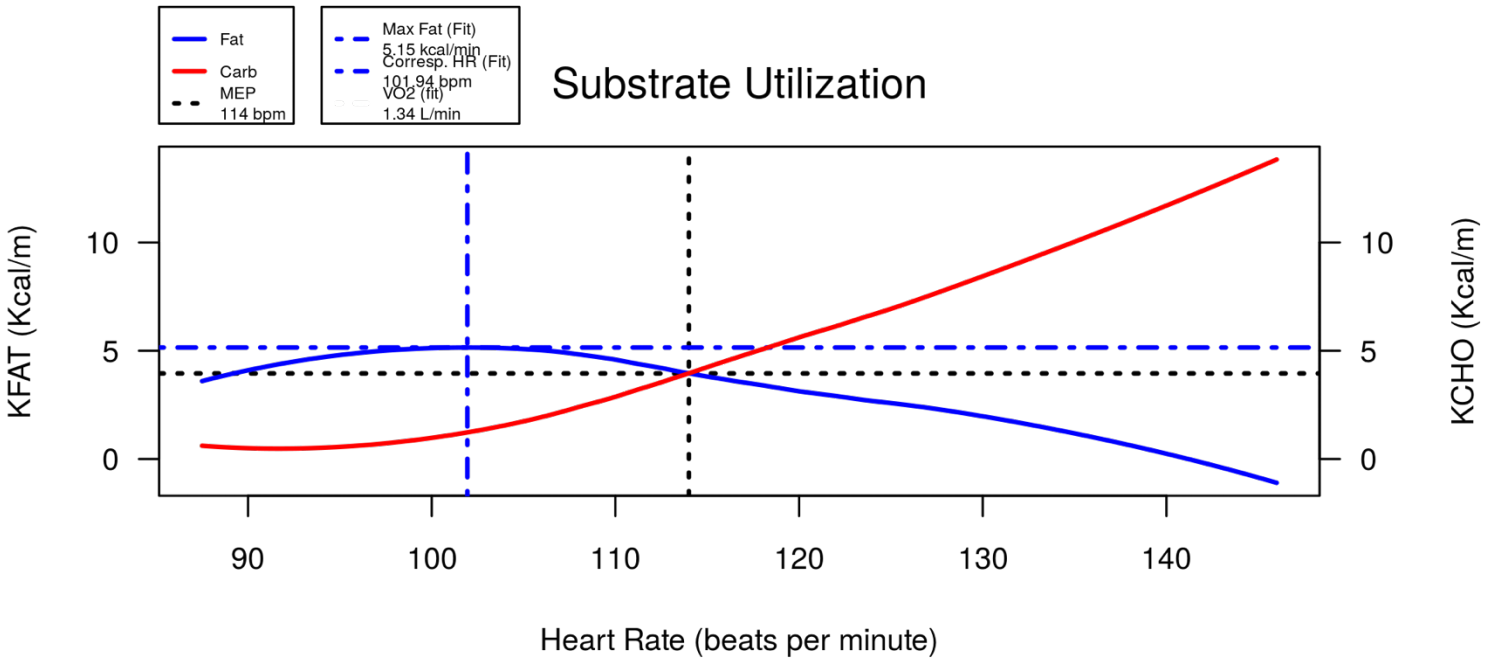


Figure 6



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