

# Student-Athlete Cardiac Assessment



## Professional Development Module



# Introduction

- Pediatric sudden cardiac arrest (SCA) can cause sudden cardiac death if not treated within minutes.
- The *Scholastic Student-Athlete Safety Act* was signed into law by Governor Chris Christie in June 2013. The purpose of the law is to prevent the occurrence of SCA by strengthening requirements for cardiac assessment during screening of student athletes prior to participation in school-sponsored interscholastic sports and intramurals.
- **The purpose of this professional development module is to refresh and enhance the knowledge of healthcare practitioners who conduct student-athlete pre-participation physical examinations.**
- According to the American College of Cardiology:  
[the] “ultimate objective of pre-participation screening of athletes is the detection of silent cardiovascular abnormalities that can lead to sudden cardiac death.”



# Directions for Completing the Module

The *Scholastic Student-Athlete Safety Act, N.J.S.A. 18A:40-41d*, mandates that:

- This module must be completed by all physicians, advanced practice nurses and physician assistants who perform student-athlete, pre-participation, physical examinations and screenings; and
- This module must also be completed by all school physicians;

In addition, upon completion of the PD module, the physician, APN or PA, will be able to download and print a Certificate of Completion. The physician, APN or PA, should retain the Certificate of Completion for his/her files, and is NOT required to submit a copy of his/her Certificate of Completion to any public school district or nonpublic school.

Following a short pause on the final slide, the viewer will be directed to add their name and NPI number as indicated.



# Educational Objectives

After completing the program, HCPs should be able to:

1. Describe the etiology and clinical presentation of sudden cardiac arrest in student-athletes;
2. Recognize normal structural changes of the athletic heart;
3. Describe the major etiologies of sudden unexplained cardiac death;
4. Recognize the critical nature of reviewing the student and family cardiovascular history;
5. Describe the steps of performing the cardiovascular physical examination; and
6. Recognize when to refer a student to a cardiologist for further assessment.



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# Definition of Sudden Cardiac Death

- Exercise-related sudden cardiac death is defined as an unexpected and witnessed sudden cardiac arrest occurring within one hour from an exercise bout in an apparently healthy person.
- It is due, in most cases, to the sudden onset of ventricular tachycardia or ventricular fibrillation, which is not compatible with the adequate pumping function of the heart, and leads to sudden collapse and loss of consciousness, ultimately resulting in death, unless normal heart rhythm is restored using an automated external defibrillator (AED).



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# Why is this Professional Development Module Important?

The following website offers a compelling demonstration for enhancing the knowledge of health care providers who conduct student-athlete pre-participation physical examinations:

<http://www.youtube.com/watch?v=tybz4rARO7g>



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# Incidence

- Sudden cardiac death in young athletes is very rare.
- About 100 such deaths are reported in the USA each year.
- The chance of sudden death occurring in any individual high school athlete is about one in 200,000 per year.
- Sudden cardiac death is more common: in males than in females; in football and basketball than in other sports; and in African Americans than in other racial and ethnic groups.



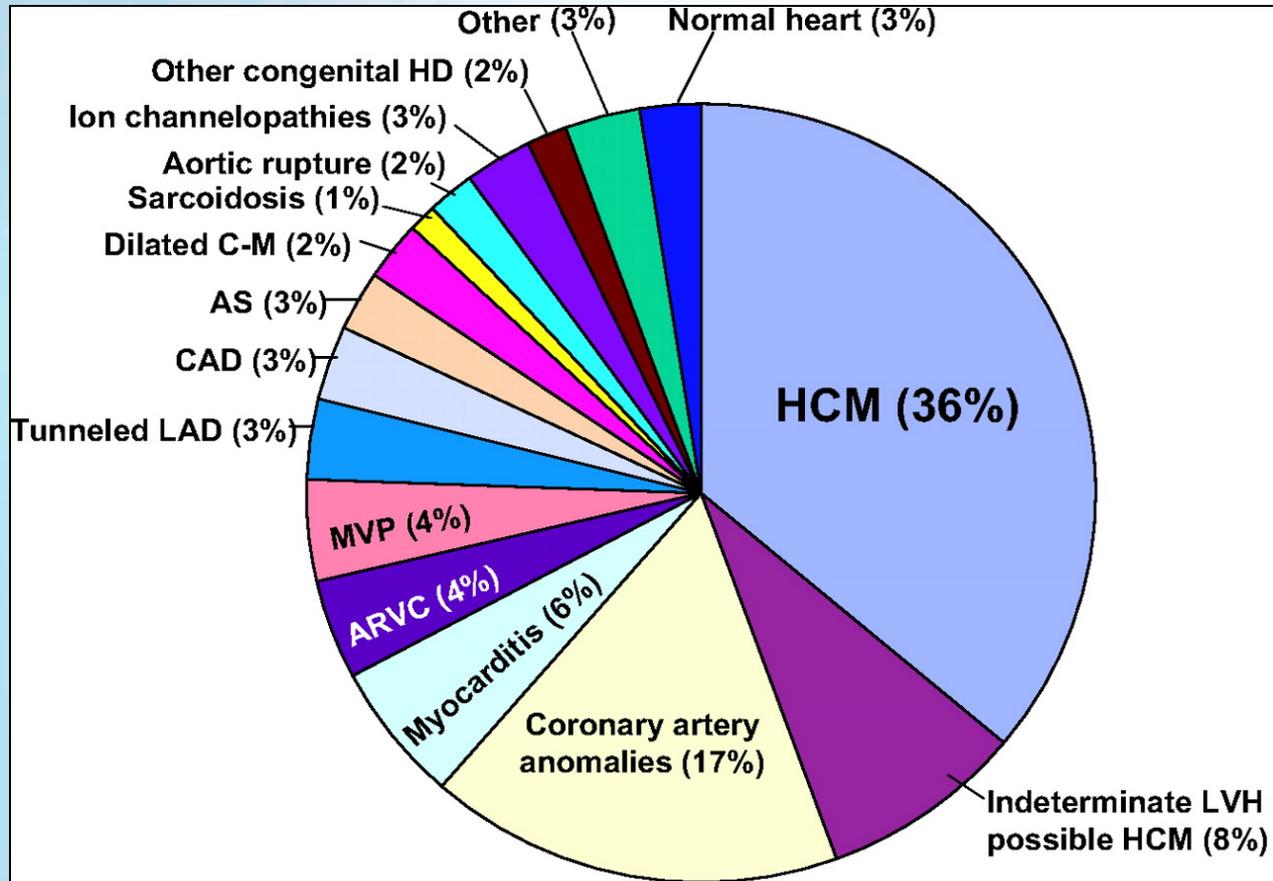
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# Etiology

- In susceptible individuals, due to some form of structural cardiovascular abnormality or electrical disease of the heart, the typical increased adrenaline response to intense physical activity *is itself* a trigger for arrhythmias.
- Arrhythmias may be characterized as life-threatening electrical disturbances of the heart, most commonly ventricular fibrillation.
- Thus, the presence of such lethal arrhythmias leading to ventricular fibrillation is extremely rare *in the absence of some form of underlying heart disease*.



# Causes of Sudden Death in Young Athletes



Maron, B. J. et al. Circulation 2007;115:1643-1455



# Athlete's Heart - Remodelling

- Enlarged heart due to intensive training
- Symmetric increased wall thickness of left ventricle (LV) to 13-15mm
- Increased LV cavity > 55mm
- Bradycardia
- $VO_2$  max > 45 ml/kg/min >110% predicted
- With deconditioning, heart wall thickness returns to prior size



# Review: Incidence

The chance of sudden cardiac death occurring to any individual high school athlete is:

- A. 1 in 100 per year
- B. 1 in 200 per year
- C. 1 in 20,000 per year
- D. 1 in 200,000 per year



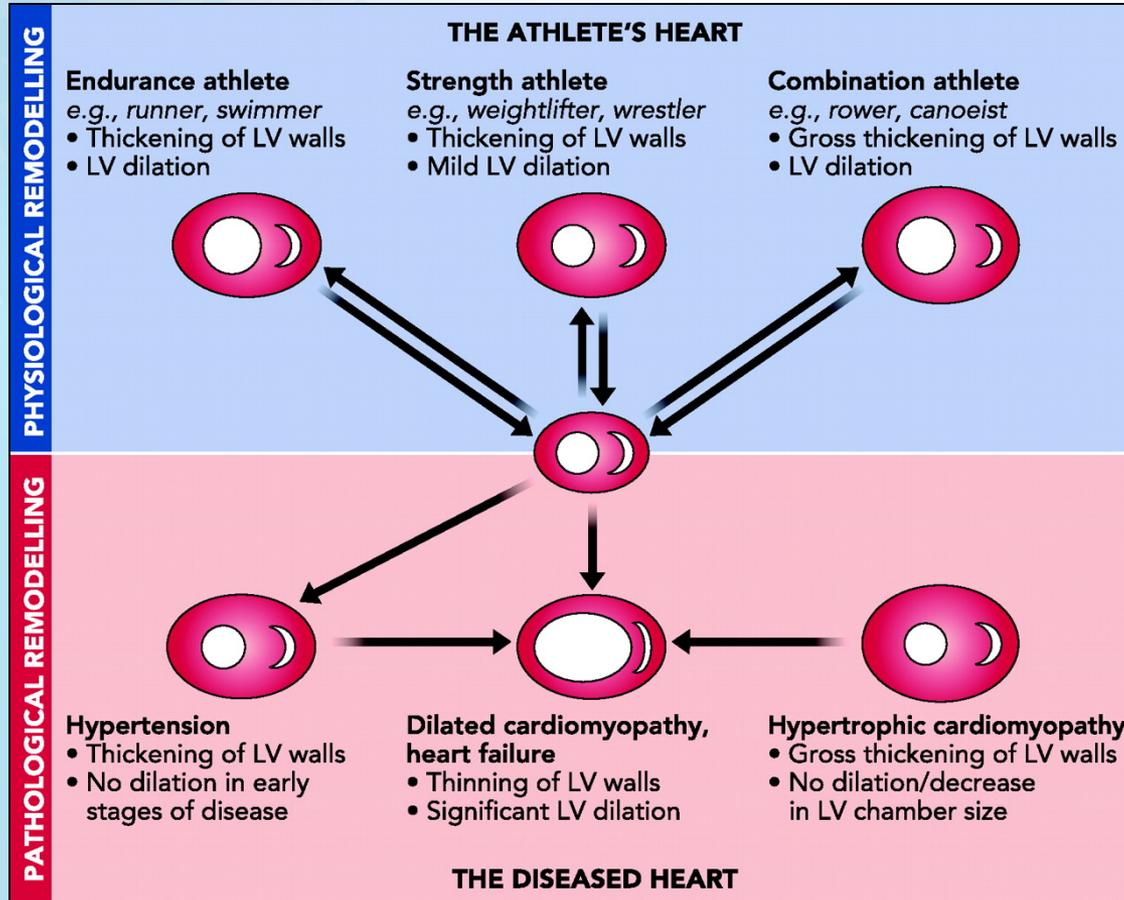
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**Correct answer:** D. 1 in 200,000 per year



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# Athlete's Heart vs Pathological Heart



Weeks K L , and McMullen J R Physiology 2011;26:97-105

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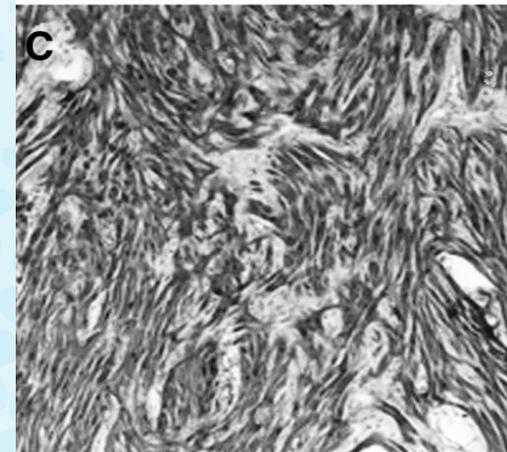
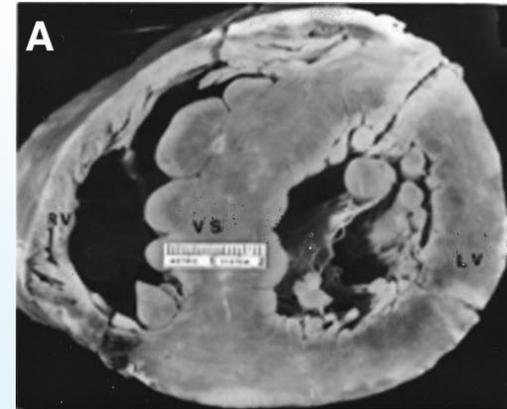


# Hypertrophic Cardiomyopathy

In the USA, HCM, formerly known as Idiopathic Hypertrophic Subaortic Stenosis (IHSS), is the most common cause of sudden death in student athletes (over 30% of patients).

In HCM, there is abnormal hypertrophy (thickening) of the walls of the heart.

Further, there is an associated disarray of myocardial fibers at the microscopic level.



# Hypertrophic Cardiomyopathy

- HCM is a genetic disorder.
- Its incidence is about 1 in 500 persons in the general population.
- Over 300 gene mutations involving the sarcomere proteins have been shown to lead to this condition.
- It is usually inherited as an autosomal dominant trait; however, the phenotypic expression may be delayed in many families.
- In addition, it may appear as a "de novo" mutation in individuals without a family history of the condition.



# Hypertrophic Cardiomyopathy

- About 20-30% of individuals who die with this disorder have prior symptoms which include exertional or non-exertional chest pain, dyspnea on exertion, palpitations, lightheadedness, and/or syncope (especially with exercise).
- In some cases, there is a family history suggestive of sudden death in relatives.



# Hypertrophic Cardiomyopathy

- The most common cause of sudden death is ventricular fibrillation due to abnormal anatomical substrate, and the presence of possible ischemia in the hypertrophied muscle, induced by increased heart rate and blood pressure during exercise, as well as the intense sympathetic discharge.



# Hypertrophic Cardiomyopathy

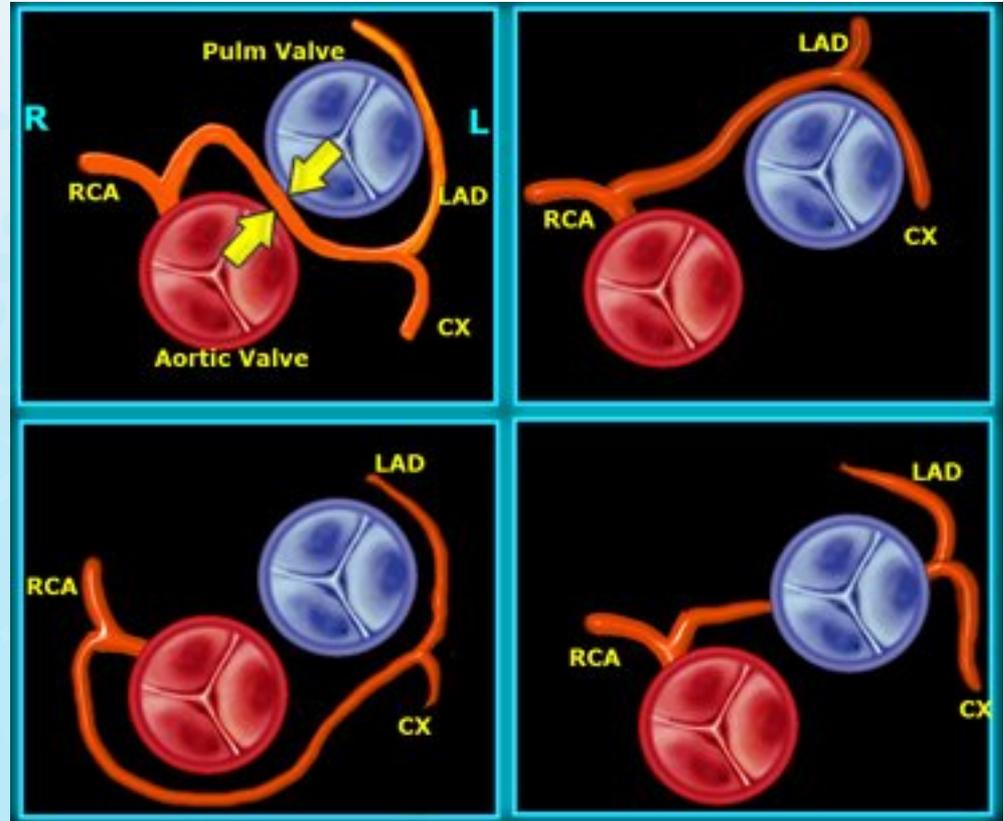
- Patients with obstructive hypertrophic cardiomyopathy have a narrow outflow tract due to the bulging of the interventricular septum and the anterior displacement of the mitral valve.
- This may be associated with a systolic murmur at rest but the obstruction (and the murmur) is increased when the heart becomes smaller as with decreased preload (such as standing, performing a Valsalva maneuver, and adrenergic stimulation).
- In some cases the cardiac output can fall enough to cause syncope and death.



# Congenital Abnormalities of Coronary Arteries

The second most likely cause of sudden cardiac deaths in athletes is congenital abnormalities of the coronary arteries. These can account for 10-15% of sudden deaths in athletes.

The most common abnormality is origin of the left main coronary coming off the right sinus of Valsalva of the aorta. The artery then courses between the aorta and the pulmonary artery making it prone to compression during exercise leading to myocardial ischemia, which can trigger severe cardiac arrhythmias and sudden death.



# Review: Etiology

In susceptible individuals, due to some form of structural cardiovascular abnormality or electrical disease of the heart, the typical increased adrenaline response to intense physical activity is itself a trigger for arrhythmias.

- A. True
- B. False



**Correct answer:** True



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# Other Diseases with Lower Frequency

- **Myocarditis:** caused by an acute inflammation of the heart, usually due to a virus in this age group. The most common virus is Coxsackie B.
- **Dilated Cardiomyopathy:** an enlargement of the heart, often for unknown reasons, characterized by myocardial scarring.
- **Electrophysiological abnormalities**
- **Marfan Syndrome**



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# Electrophysiological Abnormalities

- **Long QT syndrome:** an abnormal prolongation of the QT interval on the electrocardiogram (ECG):
  - Commonly will have a genetic basis.
  - Occurs in about 1 in 10,000 individuals.
- **WPW syndrome:** an accessory conduction pathway in the myocardium which usually leads to “benign” tachycardic arrhythmias although it can lead, in rare cases, to ventricular fibrillation.
- **Arrhythmogenic right ventricular cardiomyopathy (ARVC):** is another structural abnormality leading to sudden death in athletes; this condition is rare in the USA.



# Review: Etiology

Ventricular Fibrillation is the most common life threatening electrical disturbance of the heart in sudden cardiac death in student athletes.

- A. True
- B. False



**Correct answer:** True



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# Marfan Syndrome

- A genetic disorder found in about 1 in 10,000 individuals.
- Inherited as an autosomal dominant disorder.
- Aortic dilatation occurs due to an abnormal connective tissue protein (fibrillin) which results in cystic medial necrosis in the aorta.
- Suspicion can be based not only on family history, but tall stature, pectus excavatum, and hyperdistensible joints.
- Because of the dilatation of the aortic root, there is frequently the finding of a murmur of aortic insufficiency.
- The etiology of sudden cardiac death is due to the increased blood pressure and force of contraction of the left ventricle, causing excess stress on the abnormally weak wall of the aorta, leading to dissection or rupture. Thus, the cause of death is not a fatal arrhythmia, but rather an aortic dissection or rupture.



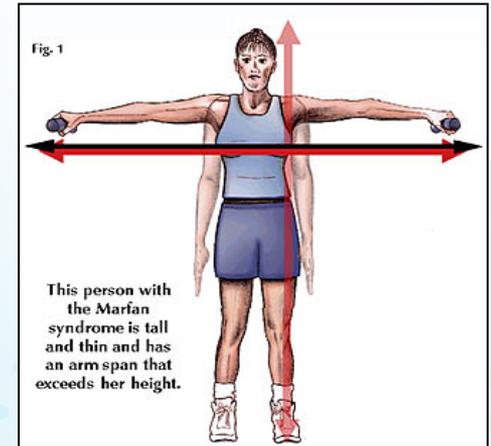
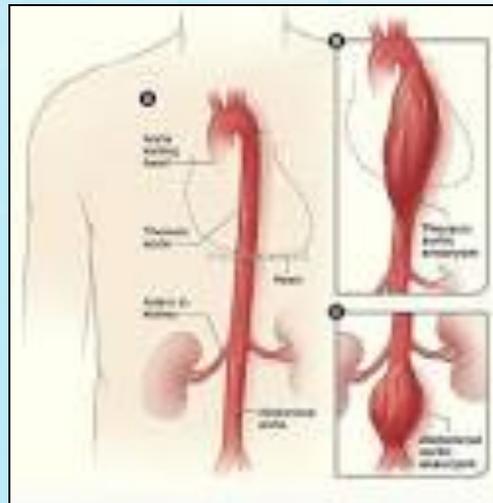
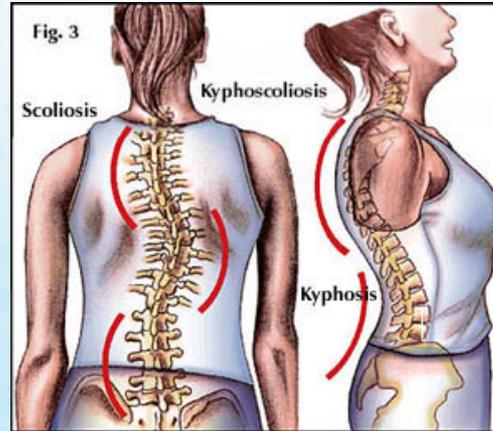
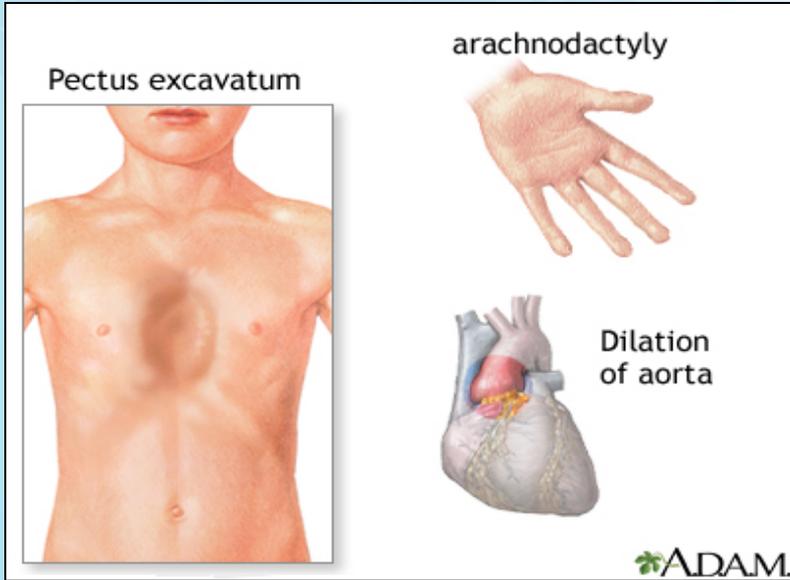
# Stigmata of Marfan Syndrome

- Mitral Valve Prolapse
- Aortic Insufficiency
- Pectus Excavatum
- Arachnodactyly
- Arm span > height 1.05:1 or greater
- Kyphosis
- High arched palate
- Myopia
- Lenticular dislocation



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# Stigmata of Marfan Syndrome



# Stigmata of Marfan Syndrome



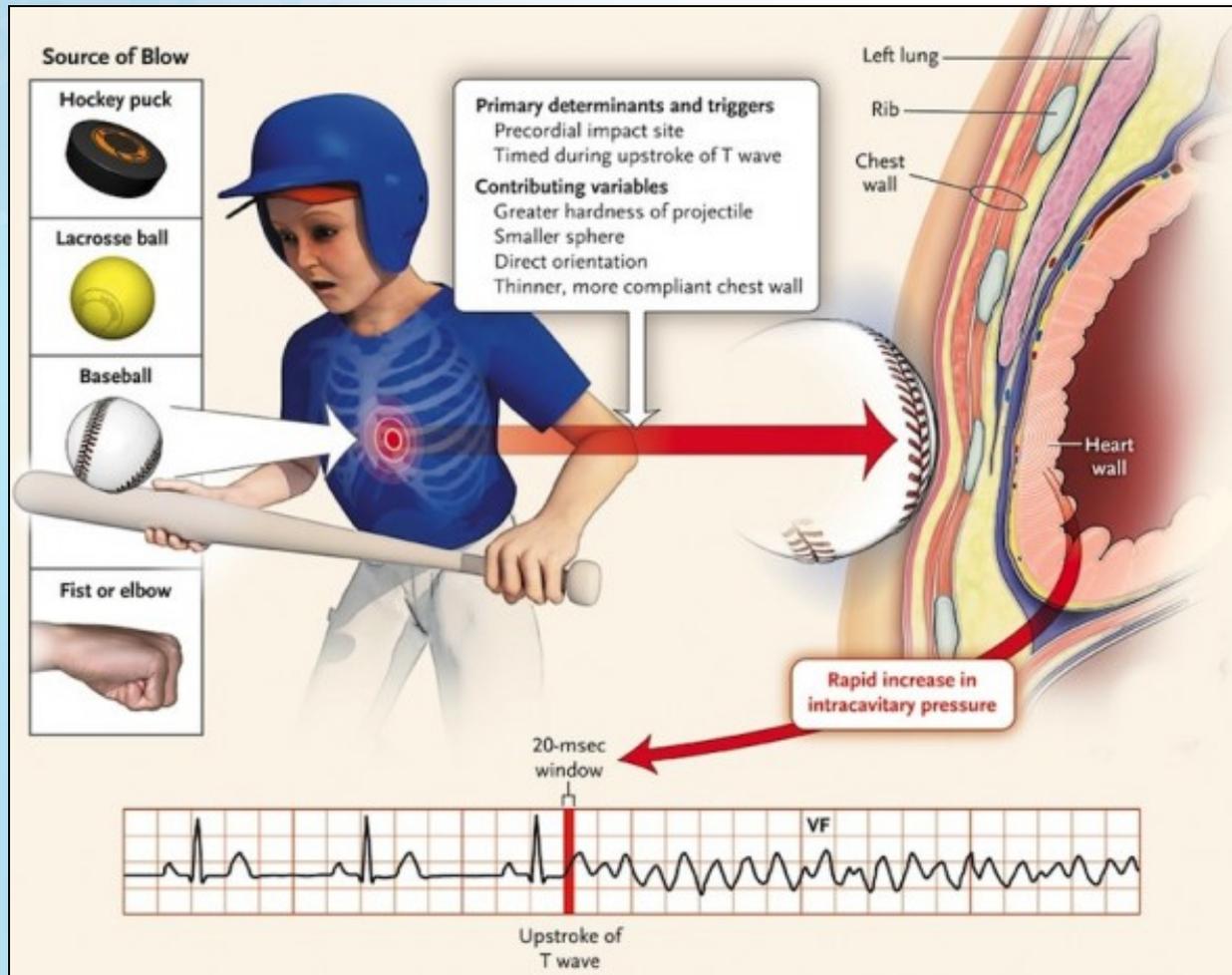
# Comotio Cordis

No discussion of sudden cardiac death in athletes would be complete without the mention of Comotio Cordis (“concussion of the heart”), in which death occurs from a fatal arrhythmia induced in a *normal heart* by the striking of the chest by a high velocity object such as a baseball, softball, or hockey stick or puck.

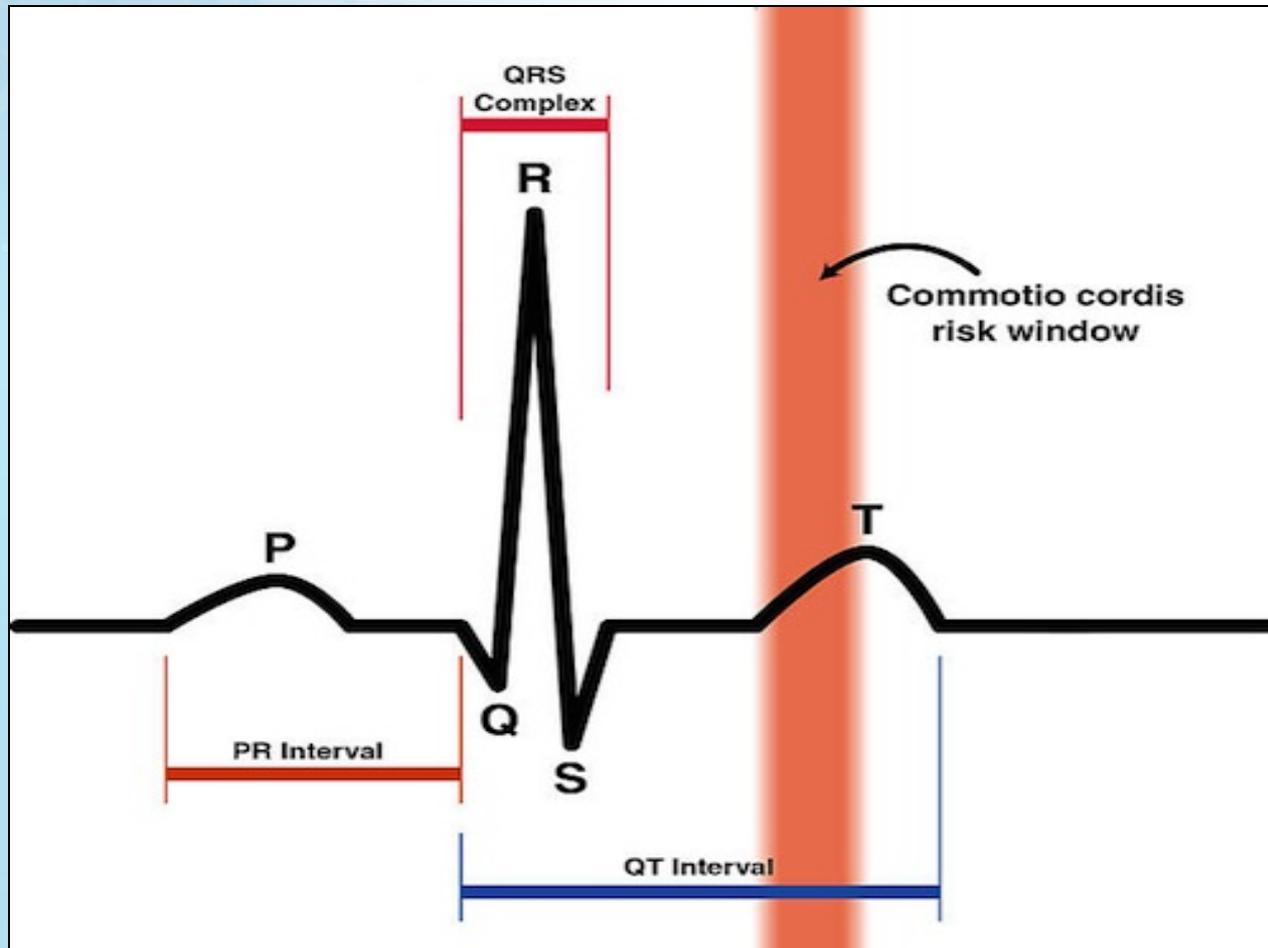


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# Commotio Cordis



# Commotio Cordis



# Can sudden cardiac death be prevented just through proper screening?

- A proper evaluation should find most, but not all, conditions that would cause sudden cardiac death in the athlete. This is because some diseases are difficult to uncover and may only develop later in life.
- Conditions may develop following a normal screening evaluation, such as an infection of the heart muscle from a virus.
- Screening evaluations and a review of the family health history need to be performed on a yearly basis by the athlete's primary health care provider.
- With proper screening and evaluation, most cases can be identified and prevented.



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# Review: Causes of sudden death in young athletes include:

- A. Coronary artery anomalies
- B. Hypertrophic Cardiomyopathy
- C. Aortic rupture
- D. A and B
- E. All of the above



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**Correct answer:** E. All of the above



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# Population Medical Screening: Purpose

The purpose of population medical screening is to separate “***normal***” individuals (those at low risk) from those individuals ***possibly abnormal and definitely abnormal within the overall*** population.



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# Rationale for Athletic Pre-Participation Screening

Pre-participation physical examinations were created to ensure that prospective athletes were ***healthy enough to safely participate in activity without significant risk*** of injury, illness or catastrophic outcomes ***due to existing detectable underlying medical conditions.***



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# Athletic Pre-Participation Screening: Provider Responsibility

Thus, it is the responsibility of those conducting these examinations to ***be clearly focused on identifying and restricting those at risk*** – especially for conditions that predispose to dying on the playing field.



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# Review: Hypertrophic Cardiomyopathy

20-30% of individuals with Hypertrophic Cardiomyopathy (HCM) who have sudden death have had prior symptoms of chest pain, dyspnea on exertion, palpitations, lightheadedness or syncope.

- A. True
- B. False



**Correct answer: True**



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# Student-Athlete Health History

- The purpose of obtaining a truthful and complete history is to identify significant family cardiac events and possible previous symptoms experienced by the student which warrant further investigation.
- The presence of a family member with knowledge of the family's medical history is critical, allowing for a more in-depth history with relevant information.



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# Review: Population Medical Screening

Population medical screening separates normal or low risk individuals from those with possibly abnormal and definitely abnormal risk.

- A. True
- B. False



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**Correct answer: True**



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# History

**Taking an appropriate, in-depth family history is extremely important in uncovering risk.**

1. Have you ever been denied or restricted participation in sports for any reason?

This will help to uncover previously diagnosed disorders such as arrhythmias, heart murmurs, cardiomyopathies or infections, such as Kawasaki disease, mononucleosis or Lyme disease, which could cause future risk.



# History

2. Have you ever passed out or nearly passed out during or after exercise?

Syncope during or after exercise is the most important and relevant symptom to obtain in the pre-participation exam.

Over 20% of patients ultimately diagnosed with HCM have had a previous syncopal or presyncopal event prior to a sudden cardiac event requiring defibrillation or resulting in death. This symptom is more concerning if it occurs immediately after cessation of activity.



# History

**A history of a syncopal event should trigger a full cardiac evaluation.**

If this event was recent, all significant physical exertion should be withheld until the workup is complete.



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# History

3. Have you ever had discomfort, pain, tightness or pressure in your chest with exercise?

Angina-type symptoms can be associated with HCM, infectious cardiomyopathy or anomalous coronary arteries and warrants a workup.

4. Does your heart ever race or skip beats (irregular beats) during exercise?
5. Has a healthcare provider ever told you that you have any heart problems such as high blood pressure, high cholesterol, Kawasaki disease, a heart murmur or heart infection?



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# History

6. Has a healthcare provider ever ordered a test for your heart, such as an electrocardiogram (ECG) or echocardiogram?

Prior results should be obtained if they were previously done for both 'screening' or for diagnosis of prior symptoms.

There are many ECG findings which are 'abnormal' in older individuals that are associated with 'athlete's heart syndrome' such as 1st degree AV blocks or Left Ventricular Hypertrophy.



# History

7. Do you get lightheaded or feel more short of breath than expected during exercise? Do you have problems now completing a workout that you have done readily in the past?

Worsening cardiovascular endurance is associated with decrease in systolic function. If an athlete is having worsening endurance not associated with a break from training, a full cardiovascular evaluation is warranted.

All of the inherited cardiomyopathies become expressed and symptomatic at different times in different patients, so even a negative past evaluation does not preclude the need for repeat studies.



# History

8. Do you get more tired or short of breath more quickly than your friends or teammates during exercise?
9. Have you ever had an unexplained seizure?

Seizures in childhood or febrile seizures do not warrant further cardiac evaluation, but a recent seizure during exercise is concerning.

All exercise should be restricted until full cardiac evaluation is complete.



# History

10. Does anyone in your family have HCM, Marfan Syndrome, Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC), Long QT Syndrome, Short QT Syndrome, Brugada Syndrome, or Catecholaminergic Polymorphic Ventricular Tachycardia?

The above conditions are genetic cardiovascular disorders that can be passed down through family members.

A positive family history of any of the above warrants referral to a pediatric cardiologist for a complete cardiac evaluation.



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# History

11. Has any family member or relative died of heart problems or had any unexpected or unexplained sudden death before age 50 (including asthma, drowning, unexplained car accident)?

People having a cardiac arrest often have seizure-like activity which may have been misinterpreted as the cause of death.

Drowning and car accidents can happen to people that have actually had a cardiac arrest as the true cause of the accident or drowning.



# History

12. Does anyone in your family have a heart problem, pacemaker, or implanted defibrillator?

In those patients with genetic cardiomyopathies, implantable defibrillators may serve as treatment for prevention of sudden cardiac death.

The presence of an implanted defibrillator, especially in a young relative, warrants further questioning and possible referral for workup.

13. Has anyone in your family had unexplained fainting, seizures, or near drowning?

Taking an appropriate, in-depth family history is extremely important in uncovering risk.



# Review: Syncope and Presyncope

A finding of prior restriction from sport participation, syncope or presyncope should trigger a full cardiac evaluation. If recent, all significant physical exertion should be withheld until work up is complete.

A. True

B. False



**Correct answer: True**



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# Review: Positive History Findings

A full cardiovascular evaluation is warranted if the history reveals:

- A. Recent syncopal or near syncopal event
- B. Lightheadedness during exercise
- C. Shortness of breath more than expected during exercise
- D. Seizure during exercise
- E. All of the above



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**Correct answer:** E. All of the above



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# Review: Positive History Findings

A family history of HCM, Marfan Syndrome, Arrhythmogenic Right Ventricular Cardiomyopathy, Long or Short QT Syndrome, Brugada Syndrome or Catecholamine Polymorphic Ventricular Tachycardia warrants a complete cardiac evaluation.

A. True

B. False



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**Correct answer: True**



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# Cardiovascular Physical Examination

## Focused Exam



# Student Preparation for the Cardiac Exam

- In an effort to keep the student at ease, explain the purpose of the cardiac exam and what you will be doing before doing it.
- Do not examine body parts through clothing as it reflects poor technique and may result in inaccurate assessment.
- Expose the minimum amount of skin necessary; this requires respectful use of a gown and/or drapes (males & females).



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# Student Preparation for the Cardiac Exam

- As with all other areas of the physical exam, establishing a quiet environment is important.
- Initially, the student should rest supine with the upper body elevated 30 to 45 degrees. Most exam tables have an adjustable top. If not, use 2 or 3 pillows.



# Key Components of a Pre-Participation Screening Focused Cardiovascular Physical Examination

- Listen carefully with a stethoscope for a heart murmur that changes in intensity with supine and standing positions or Valsalva maneuver.
- Palpate femoral arterial pulses simultaneously with radial pulses to exclude coarctation of the aorta.
- Observe for stigmata of Marfan Syndrome.
- Measure seated brachial blood pressure to exclude hypertension.



Maron, et al.



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# Review: Cardiovascular Exam

The cardiovascular physical exam includes auscultation of the heart to detect and evaluate heart murmurs. Auscultation is performed with the student:

- A. Supine
- B. Standing
- C. Valsalva
- D. All of the above



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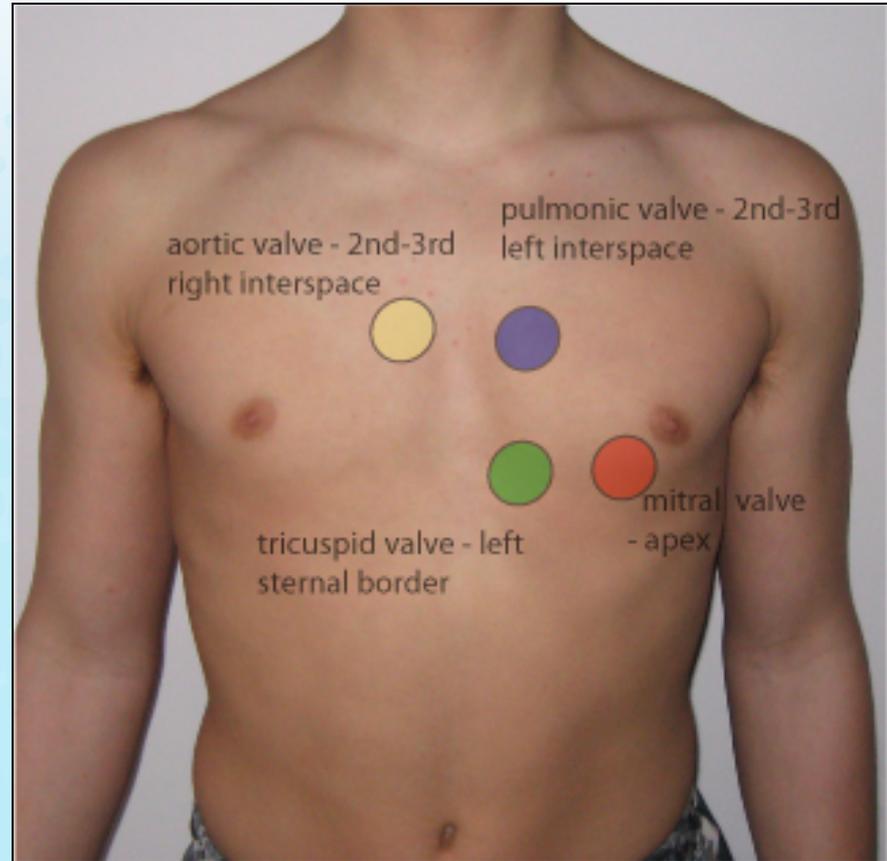
**Correct answer:** D. All of the above



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# Auscultation of the Heart

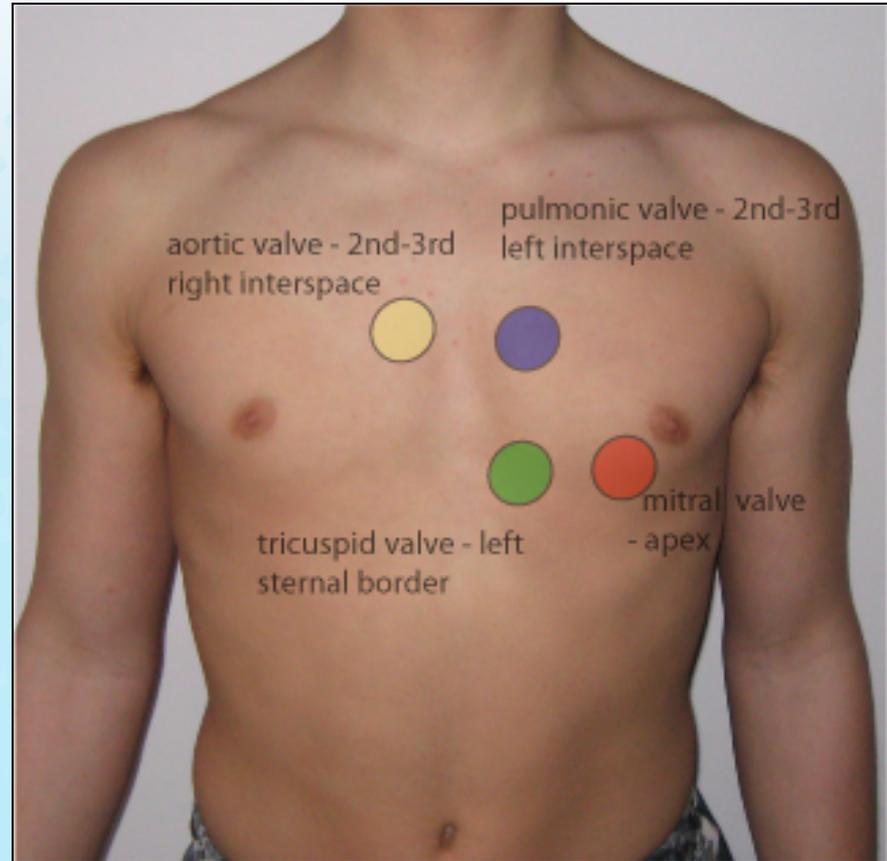
- (1) Engage the diaphragm of your stethoscope and place it firmly over the 2nd right intercostal space, the region of the aortic valve.
- (2) Then move it to the other side of the sternum and listen in the 2nd left intercostal space, the location of the pulmonic valve.

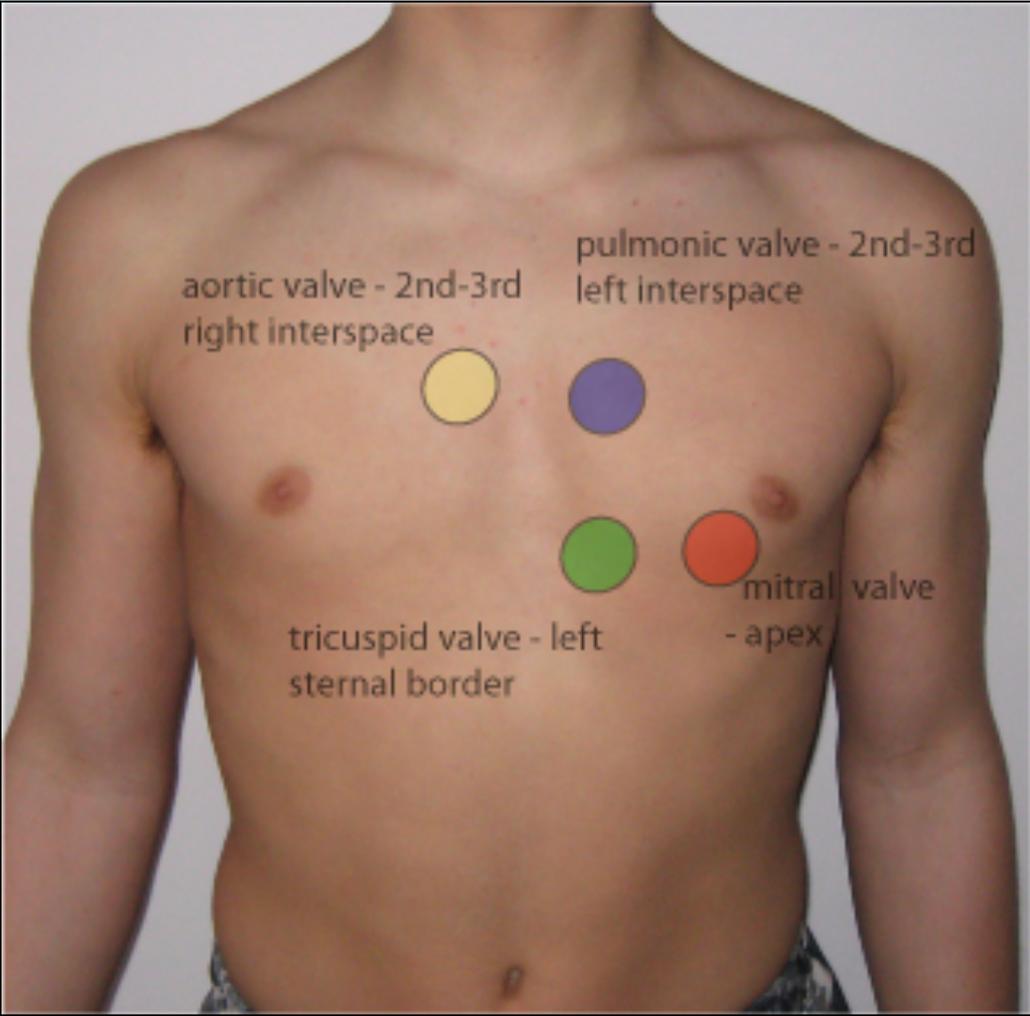


# Auscultation of the Heart

- (3) Move down along the sternum and listen over the left 4th intercostal space, the region of the tricuspid valve.
- (4) And finally, position the diaphragm over the 4th intercostal space, in the left midclavicular line to examine the mitral area.

These locations are rough approximations and are generally determined by visual estimation.





# Auscultation of the Heart

- In each area, listen specifically for the valve closure sounds known as S1 and S2.
- S1 will be loudest over the left 4th intercostal space and represents the closure of the mitral and tricuspid valves.
- S2 will be loudest along the 2nd R and L intercostal spaces and represents the closure of the aortic and pulmonic valves.



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# Auscultation of the Heart

- Note that the time between S1 and S2 is shorter than that between S2 and S1.
- This should help you to decide which sound is produced by the closure of the mitral/tricuspid and which by the aortic/pulmonic valves and therefore when systole and diastole occur.
- Compare the relative intensities of S1 and S2 in these different areas.



# Murmurs

- These are sounds that occur during systole (between S1 and S2) or diastole (after S2 and before S1) as a result of turbulent blood flow and fall into 2 broad groups:

Leaking backwards across a valve that is supposed to be closed. These are referred to as regurgitant or insufficiency murmurs (e.g. mitral regurgitation, aortic insufficiency); and

Flow disturbance across a valve that will not open fully or normally. These valves suffer from varying degrees of stenosis (e.g. aortic stenosis).

The following website includes audio examples of various murmurs.

<http://www.easyauscultation.com/cases?coursecaseorder=7&courseid=26>



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# Murmurs

- If you hear a murmur, ask yourself:  
Does it occur during systole or diastole?

What is the quality of the sound?

Does it get louder and then softer?

Does it maintain the same intensity throughout?

Does it start loud and become soft?



# Murmurs

What is the intensity of the sound?

The rating system for murmurs is as follows:

- 1/6... Can only be heard with careful listening
- 2/6... Readily audible as soon as the stethoscope is applied to the chest
- 3/6... Louder than 2/6
- 4/6... As loud as 3/6 but accompanied by a palpable thrill
- 5/6... Audible even when only the edge of the stethoscope touches the chest
- 6/6... Audible to the naked ear



# Hypertrophic Cardiomyopathy (HCM)

- HCM causes a crescendo-decrescendo murmur that may sound like aortic stenosis (AS).
- However, unlike AS, in which the sound is fixed, the obstruction produced by HCM is variable depending upon how full of blood the left ventricle is.
- Any maneuver that makes the ventricle less full by decreasing venous return (such as Valsalva maneuver) will make the obstruction (and murmur) worse.
- Conversely any maneuver that fills the ventricle more by increasing venous return (such as squatting) or decreasing emptying (hand grip) will make the obstruction (and murmur) less.



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# Hypertrophic Cardiomyopathy

## *Suspicious Exam Findings*

- Murmur is noted on routine examination.
- Medium pitched systolic ejection murmur (occurs between S1 and S2) at the lower left sternal border and apex.
- Murmur increases with Valsalva maneuver (straining against a closed glottis), upon standing, or immediately after exercise.



# Hypertrophic Cardiomyopathy

## *Characteristic Murmur*

- Murmur will get softer if the ventricle is filled with more blood as filling pushes the abnormal septum away from the opposite wall, decreasing the amount of obstruction.
- Murmur will get louder if ventricular filling is decreased. This phenomenon can actually be detected on physical exam and is a useful way of distinguishing between aortic stenosis (AS) and sub-aortic obstruction (HCM).



# HCM Murmur

- The murmur of HCM can generally be distinguished from that of valvular aortic stenosis in that the murmur of aortic stenosis usually does not change significantly with changes in ventricular filling induced by standing or squatting.



# Hypertrophic Cardiomyopathy

## *Essential Exam Maneuvers*

- Ask the student to perform a **Valsalva** maneuver while you listen. This decreases venous return and makes the HCM murmur louder (the opposite effect of the murmur of AS).
- With the student standing, and while listening, have the student **squat** down. This maneuver increases venous return, causing the HCM murmur to become softer (the opposite of AS).
- Now, while listening, have the student **stand** up and the murmur will get louder (the opposite of AS).



# Hypertrophic Cardiomyopathy

## *Essential Exam Maneuvers*

- Be sure to listen for at least 20 seconds after each change in position in order to fully appreciate any difference in the intensity of the murmur.



# Review: Coarctation of the Aorta

Coarctation of the aorta is suspected if simultaneous palpation of the femoral arterial pulse and radial pulse reveal:

- A. Both pulses are strong and there is no delay
- B. Distal pulses are diminished and delayed
- C. None of the above



**Correct answer:** B. Distal pulses are diminished and delayed



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# Athletic Pre-Participation Screening: Selection for Referral for Further Evaluation

Referring an athlete to a pediatric cardiologist depends on the history and physical examination findings and the clinical judgment of the health care provider.



# Athletic Pre-Participation Screening: Selection for Referral for Further Evaluation

Those who have been selected for further evaluation by a pediatric cardiologist, however, ***may or may not have*** a condition that requires a permanent restriction from athletic participation.



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# Review: Evaluation of Murmur in HCM

In Hypertrophic Cardiomyopathy, the murmur usually does not change significantly with standing or squatting.

- A. True
- B. False



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**Correct answer: False**



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# Athletic Pre-participation Screening: When to Refer to a Cardiologist

Although each case has its own nuances, there are certain “red flags” in the history and physical examination that usually prompt consultation with a pediatric cardiologist.



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# When To Refer: Red Flags Personal History

- Syncope or near-syncope on exertion
- Chest pain/discomfort on exertion
- Palpitations at rest or with exercise
- Excessive shortness of breath or fatigue with activities
- Chest pain in Turner syndrome



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# When To Refer: Red Flags Family History

- Cardiomyopathy
- Marfan Syndrome
- Long QT Syndrome
- Short QT Syndrome
- Clinically significant arrhythmias – e.g., WPW
- Premature sudden unexpected death (usually before age 50) – including drowning, single car accidents, dying while sleeping



# When To Refer: Red Flags Physical Examination

- Irregular heart rhythm
- Weak or delayed femoral pulses
- Fixed split second heart sound
- Any systolic murmur graded 3/6 or greater
- Any diastolic murmur
- Stigmata of Marfan Syndrome



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# Review: Red Flags Warranting Referral

Red flag(s) indicating the need for further cardiac evaluation/ referral include syncope or near syncope on exertion, chest pain or discomfort on exertion, palpitations at rest or with exertion, excessive shortness of breath.

A. True

B. False



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**Correct answer:** True



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# Pediatric Cardiology Work-up

- The pediatric cardiologist will review the history, perform a physical examination and will also obtain an electrocardiogram (ECG).
- An echocardiogram, which is an ultrasound test to allow for direct visualization of the heart structures, will likely also be done.



# Pediatric Cardiology Work-up

- The specialist may also order a treadmill exercise stress test and a monitor to enable a longer recording of the heart rhythm (Holter monitor).
- None of this testing is invasive or uncomfortable.
- Occasionally, a cardiac MRI and/or CT test will be necessary.



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# Summary

- This concludes the instructional component of the module.
- It is our sincere hope that as a result of this module you recognize the importance of
  - the careful history,
  - the detailed, focused examination, and
  - when to refer to a cardiologist.

The following slides include key references, resources, acknowledgments, and the **Certificate of Completion** for your records.



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# Key References

- PPE – Pre-participation Physical Evaluation 4<sup>th</sup> edition. Roberts WO, Bernhardt DT, eds. American Academy of Pediatrics 2010.
- Maron, BJ, Zipes DP. 36<sup>th</sup> Bethesda Conference Eligibility recommendations for competitive athletes with cardiovascular abnormalities. *J Am Coll Cardiol* 2005;45(8):1317-1375.
- Maron, BJ, Thompson PD, Puffer JC *et al.* Cardiovascular pre-participation screening of competitive athletes. *Circulation* 1996;94:850–856.



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# Resources

- Sudden Cardiac Death in Young Athletes pamphlet:

<http://www.state.nj.us/education/students/safety/health/services/cardiac.pdf>

- Pre-participation Physical Evaluation Form:

<http://www.state.nj.us/education/students/safety/health/records/athleticphysicalsform.pdf>



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This PowerPoint version of the *Student-Athlete Cardiac Assessment Professional Development Module* (PD module) is provided for healthcare providers who want to maintain a copy for their reference.

The Certificate of Completion is only accessible after viewing the PD module.

Thank You.

