BioEd℠

TEACHER'S GUIDE

SCIENTIFIC DECISION-MAKING

A CASE-BASED APPROACH FOR MIDDLE OR HIGH SCHOOL STUDENTS

 ISBN: 978-1-888997-84-2

Baylor College of Medicine

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CENTER FOR EDUCATIONAL OUTREACH

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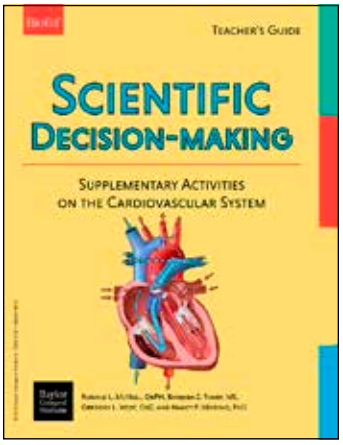
Related Unit Teacher's Guide



For in-depth activities on the heart, circulatory system and heart disease, see *Scientific Decision-making: Supplementary Activities on the Cardiovascular System.*

About the Project

The Scientific Decision-making curricular unit, produced as part of the project entitled AHRQ's Ischemic Heart Disease Products Translated for High School Populations, was funded by a grant (R18HS019248) from the Agency for Healthcare Research and Quality (AHRQ).
The project's goal is to develop—and evaluate the effectiveness of—high school-level teaching materials focusing on evidence-based decision-making using examples related to cardiovascular health.

Activities described in this book are intended for middle or high school students under direct supervision of adults. The authors, Baylor College of Medicine and AHRQ cannot be held responsible for any accidents or injures that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text. The opinions, findings and conclusions expressed in this publication are solely those of the authors and do not necessarily reflect the views of BCM or the sponsoring agency.

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Setup: 15 minutes | **Class:** One 45-minute class period

Decisions and Risk

Overview

- Students practice evidence-based decision-making by examining a simple choice: whether or not to consume a soft drink. They revisit their decisions after calculating the amount of sugar in a typical single-serving bottle.
- Students estimate and rank the risks of dying from a variety of causes, and then compare their estimates to actual data. Students discover that heart disease is a leading cause of death in the United States.

Nutrition Facts

Serving Size 20 fl oz
Servings Per Container 1

Amount Per Serving	% DV*
Calories 240	
Total Fat 0g	**0%**
Sodium 75 mg	**3%**
Total Carbohydrate 65g	**22%**
Sugars 65g	
Protein 0g	

Not a significant source of calories from fat, saturated fat, trans fat, cholesterol, dietary fiber vitamin A, vitamin C, calcium and iron.

* Percent Daily Values (DV) are based on a 2,000 calorie diet.

Typical nutrition facts label for a 20-fluid-ounce bottle of cola.

Personal choices are part of everyday life. Whether choosing what to wear in the morning, what to have for lunch, or which college to attend, our days are filled with decisions. Do we approach decision-making in a systematic and organized way? Perhaps not often enough, particularly when making decisions that affect our health, or that of our family members. A 2009 study concluded that more than one million people die needlessly each year due to decisions they have made. Why do we make poor choices, such as smoking, eating lots of high-sugar foods, or drinking too much alcohol? Peer pressure, resistance to change and misperceptions about risk all contribute to choices with potentially bad outcomes.

A choice that involves risk implies possible negative consequences. While we cannot avoid all risk (the Chinese symbol for risk even combines two characters, corresponding to "danger" and "opportunity"), solid decision-making requires the ability to assess risk and apply evidence appropriately. Consider the possible outcomes of a driver speeding to work or school in the morning. If all goes as planned, the motorist arrives on time to begin his or her day. But other more negative outcomes, such as being ticketed for speeding or having an accident, also are possible. Behavior that involves risk always can have a negative outcome. Fortunately, we can learn to make better choices, particularly those related to our health.

This lesson poses a simple choice: should students drink a sugar-sweetened beverage, or not? Studies show that people who regularly eat or drink products with added sugar tend to consume more calories than people who consume fewer of these items. Research also links sweetened beverages to weight gain. Cutting back on added sugars, especially from sweetened beverages such as regular soda and fruit-flavored drinks, can help to maintain a healthy weight and reduce the risks for several diseases.[1]

Materials

Teacher

- Pad of sticky notes (one note per student)
- 16- or 20-oz bottle of soft drink, any flavor (not sugar-free or diet)

Per Team of Students

- Plastic teaspoon
- 16-oz clear plastic cup
- 30 single-serving sugar packets
- Empty soft drink can or single-serving bottle (not sugar-free or diet, groups may have bottles from different sizes and kinds of drinks)
- Access to a calculator or computer
- Sheet of 8.5 in. x 11 in. paper
- Tape or glue stick
- Copy of "Sweetened Soft Drinks" page (one per group or student)
- Copy of "Selected Causes of Death" page (to save time in class, you may cut the sheet into strips for students ahead of time)

- Pair of scissors (only if students will be cutting statements into strips)
- Copy of "Lifetime Risk of Dying from Different Causes" page

Setup

Place all supplies in a central location for distribution and return. Students should work in teams of four.

Procedure

Part One: Informed Choices

1. Tell students they will explore human body systems and learn how to use evidence to make better decisions for themselves, or maybe other people. They will place themselves in the roles of scientists, healthcare providers and even persons with common health problems. Ask, *Would you choose to have diabetes? How about cancer or heart disease?* Follow by asking, *Do we deliberately choose or decide on bad things for our lives?* Allow a few minutes for students to think about and discuss these questions.
2. Follow by saying, *Let's focus on a simple decision.* Show students a standard 16- or 20-ounce soft drink bottle. Ask for a show of hands in response to the question, *Would you decide to drink this beverage?* Create a T-chart on the board with one side labeled "yes" and the other side labeled "no." Give every student a sticky note and have each write one reason either for ("yes") or against ("no") consuming the soft drink. Have a few students collect and post the notes on the chart. Tally the notes "for" and "against," and announce whether or not the majority of students would drink the bottle of soda.
3. As a class, identify and discuss the most common reasons for or against consuming the soft drink. Ask, *Do any of these reasons change your thinking?*
4. Tell students that they are going to gather more information about the soft drink. Divide the class into teams of four students, and have each team pick up the following supplies: one clear plastic cup, 30 sugar packets, one empty soft drink container, and at least one copy of the "Sweetened Soft Drinks" page.
5. Have each team follow the instructions on the "Sweetened Soft Drinks" page, and estimate the number of teaspoons of sugar in a 16- or 20-ounce soft drink (same size as shown to the class earlier). Tell them to be realistic, and explain that each sugar packet contains approximately one teaspoon of sugar. Direct teams to count out (but not open) the number of sugar packets they predict for the soft drink, and place the packets in their plastic cups.
6. Have teams compare the amounts of sugar estimated by the different groups.
7. On the board, write the grams of sugar in the drink you brought to class (a 16-ounce bottle typically has 54 grams of sugar; a 20-ounce bottle has 65 grams). Have each team use the formula below to calculate the number of teaspoons of sugar in the soft drink.

   Number of teaspoons of sugar = total grams / four grams of sugar per teaspoon
8. Have teams report and discuss their calculations. A 16-ounce drink with 54 grams of sugar would have 13.5 teaspoons of sugar; a 20-ounce drink with 65 grams of sugar would have 16.25 teaspoons.
9. Ask, *How many Calories do you think are in the soft drink?* Direct teams to complete the sheet and report their results to the rest of the class.
10. Have students put the sugar packets back into the cup and return all supplies to the central station.
11. Ask students if they were surprised by the amount of sugar or Calories in the soft drink.

Adolescents and Risk

Adolescents choose to engage in risky behaviors at a much higher rate than adults. Recent research shows that adolescents typically underestimate risks when the outcomes are ambiguous—in other words, the likelihood of a good or bad outcome is not known. This behavior probably is related to a need, typical of all young organisms, to explore and learn about the world. However, adolescents' attitudes toward risk change when the probabilities of alternative outcomes are known. In situations where risks are clearly stated, adolescents are more likely to avoid risky behaviors at about the same level as adults. These findings reinforce the importance of helping young people learn to use information to make better choices for their own health and well-being, and that of their families.

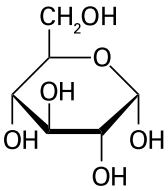
Tymula A, et al., 2012, PNAS 109:42, 17135–17140.

Discuss the role of carbohydrates in living organisms. Carbohydrates store energy in the form of chemical bonds. This energy becomes available when our bodies process the food we eat. When we eat too many Calories, the excess energy can be stored as fat.

12. Ask, *Given what you now know about the sugar content in this soft drink, would you choose to consume it?* Have students raise their hands or move their sticky notes to the appropriate side on the T-chart. Ask, *Have you ever had a "Big Gulp"? Did you know that a 32-ounce soft drink has about 27 teaspoons of sugar and 432 Calories?*
13. Ask, *Might you make different decisions about soft drinks in the future, based on what you just learned? Why or why not?* Lead a class discussion about the importance of using accurate information to make decisions. Mention that most decisions require us to choose between multiple options, which can lead to different outcomes (positive or negative).

Sugar Stores Energy

Carbohydrates store energy and serve as an organism's building materials. Carbohydrate molecules usually contain the elements carbon (C), hydrogen (H) and oxygen (O) in the molar ratio 1:2:1. Simple sugars, the smallest carbohydrate molecules, may contain as few as three carbon atoms. Sugars that are important for energy storage have six carbons. Glucose (a form of sugar), which exists as a ring structure in solution, is shown here to the right.



Fructose, another six-carbon sugar, combines with glucose to form sucrose (common table sugar). When linked in chains of hundreds of molecules, simple sugars form long molecules, known as polysaccharides (including starch in plants and glycogen in animals).

Part Two: Risk

1. Ask, *Do you think some decisions are riskier than others? What is "risk," anyway?* [Risk involves behaviors or actions that have possible adverse outcomes.] Explain that one way to quantify risk is to state it as likelihood that something will occur. In fact, scientists are able to estimate the risk of many kinds of events by studying how frequently they have happened in the past.
2. Provide a "Selected Causes of Death" sheet to each student team. Teams should read all of the statements, and use the scissors to cut the statements into strips (unless you have pre-cut the sheets).
3. Have teams discuss and predict how likely it is for each event to occur, and then arrange the statements from highest risk (top) to lowest risk (bottom). Provide tape and a separate sheet of paper on which students can secure their strips.
4. Discuss students' predictions briefly, asking which causes of death they ranked as being the highest and lowest risks. Allow groups to share some of their predictions and explain the reasoning behind their choices.
5. Distribute a copy of the "Lifetime Risk of Dying from Different Causes," sheet to each group, or project the sheet in front of the class. Tell students that the sheet shows estimates of the lifetime risk of dying from a variety of causes, based on the United States population. (In this activity, "lifetime risk" is the likelihood that an average person will die from the disease or type of accident indicated.)[2]
6. Lead a class discussion in which students compare their predictions to the actual statistics. Students will discover that two leading causes of death in the United States (heart disease and stroke) involve the cardiovascular system.

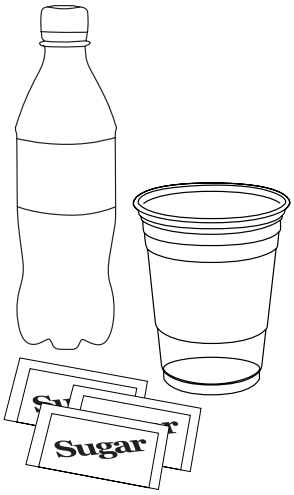
Extensions or Homework

- Have each student record (1) the kind and size of each sweetened drink (soft drinks, sweet tea, juice drinks, etc.) that he or she consumes in a 24-hour period, and (2) use label information or online calorie counters to estimate the total amount of sugar and calories in those drinks.
- The FDA recently began taking steps to reduce or eliminate the use of artificial trans fats in foods, because they increase the risk for heart disease. Lead a class discussion, or have students write essays about the pros and cons of taking similar action to limit the amount of sugar that manufacturers add to foods. ■

1 National Heart, Lung and Blood Institute (www.nhlbi.nih.gov).
2. National Safety Council. 2012. Lifetime odds of death for selected causes, in *Injury Facts 2012 Edition*, pages 41–43.

Sweetened Soft Drinks

Your group will need: one clear plastic cup, 30 sugar packets, one empty soft drink bottle and a calculator.



INSTRUCTIONS

1. Within your group, estimate how many teaspoons of sugar you believe are in the soft drink shown by your teacher.

   Estimate:_____ teaspoons

2. Each sugar packet contains approximately one teaspoon of sugar. Count out the number of packets that represents the number of teaspoons of sugar your team predicted. *Do not open the packets.* Place the unopened packets in the plastic cup.

3. Appoint one member to report your team's estimate to the rest of the class.

4. Your teacher will tell you the total number of grams of sugar in the drink. Write that number below.

   _____ grams

5. A packet or teaspoon contains approximately four grams of sugar. Use this information to calculate the number of teaspoons of sugar in the soft drink.

   Number of teaspoons of sugar = total grams / four grams of sugar per teaspoon

   Answer:_____ teaspoons of sugar in the soft drink

6. Since one gram of sugar has four Calories, how many Calories are in the soft drink?

   Answer:_____ Calories in the soft drink

7. Calculate the difference between your team's original estimate and the actual number of teaspoons of sugar in the soft drink.

   Difference =_____ teaspoons

8. Using the Nutrition Facts label on your group's soft drink container, repeat step 5 to calculate the number of teaspoons of sugar that would be that drink. Remember, one teaspoon of sugar weighs four grams.

   Answer:_____ teaspoons of sugar in the team's soft drink container

9. Repeat step 6 to calculate the number of Calories that would be in your team's drink. Keep in mind that one gram of sugar has four Calories [kcal].

   Answer:_____ Calories in the team's soft drink container

Selected Causes of Death

What are the lifetime risks of dying from the causes below? Cut out each statement (if your teacher has not already done so) and arrange the statements in order of likelihood from the most risk (top) to least risk (bottom). Secure the strips with tape to a piece of paper.

Accident while riding a bicycle

Victim of a cataclysmic storm (hurricane, tornado, etc.)

Accidental/unintended poisoning by alcohol, drugs, other chemicals

Accident involving fireworks or firecrackers

Being killed during an earthquake

Heart disease, heart failure or heart attack

Exposure to hornets, wasps or bees

Intentional self-harm

Being killed by a flood

Any kind of cancer

Bitten or attacked by dog

Struck by lightning

Accident while walking (pedestrian)

Accidental shooting

Stroke

Legal execution

Exposure to excessive natural heat

Accidental drowning

Accident while riding in a car (driver or passenger)

Falls

Intentional shooting (shot by someone with a firearm)

Any kind of motor vehicle accident

Lifetime Risk of Dying from Different Causes

Lifetime Risk	Cause of Death
1 in 6	Heart disease, heart failure or heart attack
1 in 7	Any kind of cancer
1 in 29	Stroke
1 in 98	Any kind of motor vehicle accident
1 in 109	Intentional self-harm
1 in 127	Accidental/unintended poisoning by alcohol, drugs or other chemicals
1 in 163	Falls
1 in 321	Intentional shooting (shot by someone with a firearm)
1 in 368	Accident while riding in a car (driver or passenger)
1 in 701	Accident while walking (pedestrian)
1 in 1,103	Accidental drowning
1 in 4,381	Accident while riding a bicycle
1 in 6,609	Accidental shooting
1 in 13,217	Exposure to excessive natural heat
1 in 29,196	Victim of a cataclysmic storm (hurricane, tornado, etc.)
1 in 79,842	Exposure to hornets, wasps or bees
1 in 97,807	Being killed during an earthquake
1 in 111,779	Legal execution
1 in 143,906	Struck by lightning
1 in 144,899	Bitten or attacked by dog
1 in 558,896	Being killed by a flood
1 in 652,046	Accident involving fireworks or firecrackers

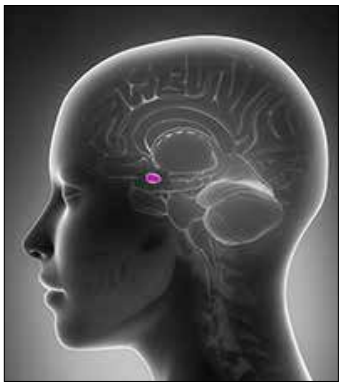
2

Setup: 15 minutes | **Class:** One 45-minute class period

Smarter Choices

Overview

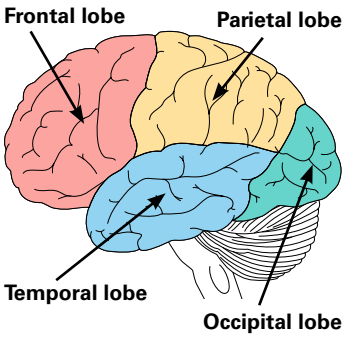
Students learn how to make informed decisions based on evidence. Working in groups, they answer a set of questions that enable them to identify and make a decision for a character in a complex, real-life situation. Students also construct decision T-charts.



The amygdala is located deep within the brain, near the hippocampus.

We make thousands of choices throughout our lives—many with important consequences. Which college should I attend? Should I stay in school? Which health insurance plan should I pick? Some decisions are easy, but most important choices are complex and have long-term impacts. Many decisions even affect a person's risk for disease or accidents.

Of course, decision-making happens inside the brain, which typically gathers and distills information from multiple sources before arriving at a decision. According to the Society for Neuroscience[3] the decision-making process is organized like a court trial. Sights, sounds and other data are entered into circuits in the brain, where other brain cells act as a jury, weighing each piece of evidence. When enough evidence has been evaluated, the brain makes a decision.



These decision "trials" involve several parts of the brain, particularly the frontal lobes area, or frontal cortex (front part of the brain). This area handles planning and reasoning, and has roles in abstract and concrete decision-making. The amygdala, a part of the brain responsible for emotions and instinctual reactions like fear and aggression, also is involved (see image, left sidebar).

Adolescent brains, which still are developing, solve problems and make decisions differently than adult brains do. Because adolescent frontal lobes are not yet fully mature, teens' actions and choices are guided more by the amygdala and less by the frontal lobes.[4] Due to their incomplete brain development, teens are more likely than adults to act on impulse, misread social cues or emotions, and engage in dangerous behaviors. In general, adolescents are less likely than adults to think before they act or consider the potential consequences of their actions.

In addition, the decision-making process can break down, especially when the brain is fatigued from being focused on a task for an extended time, or from lack of sleep. A tired brain is less effective at making important decisions, and more likely to make impulsive or confused choices.

Fortunately, adolescents can and do make good decisions, and they are able to improve their decision-making skills. In fact, we all can make better choices when we recognize what really is important, identify personal goals, and follow a systematic process to examine alternative solutions to a problem. In this activity, students will collaborate to make decisions for fictitious characters facing difficult decisions. In each case, students will answer the "Decision-making Questions" found on page 8.

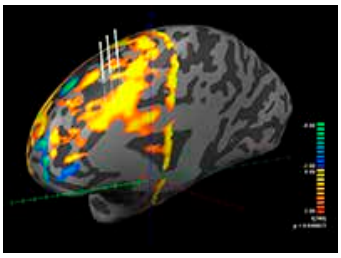
Once alternatives have been identified, a T-chart can be a simple, effective tool for evaluating options and making decisions. On one side of the chart, list the possible benefits or positive aspects ("pros") of a particular course of action. On the other side, list the negative aspects ("cons") of a decision. For example, Sandra was up late studying last night, and she is very tired this morning. Thus, the question to be decided is: "Should I sleep in this morning?"

As mentioned earlier, Sandra must identify the goal before making a decision. In this case, the goal might be to achieve a good grade on an algebra quiz during first period. A T-chart

depicting the advantages (pros) and disadvantages (cons) of sleeping late might look like the one to the left.

Sample T-chart for Sandra

PROS: SLEEPING LATE	CONS: SLEEPING LATE
Will be well rested	Might miss the bus and have to walk to school
Might perform better on test	If late for algebra class, might fail quiz
	No time to review material before quiz



In this functional MRI image, the brain is engaged in a decision-making task. The areas shaded yellow to red represent the highest brain activity and the areas shaded blue to green, the lowest brain activity. The three white lines slightly above the brain represent three electrode paths. Activity of individual neurons was recorded during the procedure from the posterior-most electrode.

Image courtesy of Sameer Sheth, MD, PhD. Used with permission (http://www.columbianeurosurgery.org/doctors/sameer-a-sheth/).

Materials

Teacher

Download (for projection) the following PowerPoint® slides from BioEd Online at **http://www.bioedonline.org/lessons-and-more/resource-collections/scientific-decision-making/**

- Brain Areas Used in Decision-making
- Decision-making Example (or copies of this example for each student)

Decision-making Questions

What is the real problem or decision to be made? The framing of a decision makes all the difference. Say Josh is tired of riding the bus 45 minutes each day to work. At first, his choices seem simple: "Should I buy a car or continue to ride the bus to work?" But there could be other factors to consider. Perhaps Josh dislikes his job, or maybe it is not really in his best interest to travel such a long distance to work. If so, his decision could include questions like, "Should I look for a job closer to his home?" or "Should I search for a job that pays more, so I could buy a car without straining my finances?" The way we define a problem and the options available to solve it determines the quality of the decision-making process and the final outcome.

What is the objective or goal? Answering the question, "What do I really want?" provides a basis for evaluating all possible choices. To clarify objectives, it may be useful to compose a "wish list," identify the worst and best possible outcomes, or think about how the decision will impact others. For example, Marissa may have several important objectives in mind as she tries to decide which college to attend: learn a subject area deeply, be intellectually challenged, have opportunities to participate in a variety of clubs, make lasting friendships, and be prepared for future pursuits. Her decision might become clearer if she lists her objectives in order of importance, and then thinks about the likelihood of achieving those objectives at the various colleges she is considering.

What are the alternative choices? The quality of a decision depends on the thoroughness with which options are evaluated during the decision-making process. Poor and/or limited alternatives inevitably lead to a poor final choice. To generate a useful list of alternatives, consider all possibilities, and eliminate any that will not help to meet the objectives. It is important to challenge limitations that could influence the decision. For example, Carlos may think that the high tuition at one college, which is an ideal match for him otherwise, means he should decide not to apply there. However, he may be able to overcome the cost issue by learning more about financial aid packages available at that school. Every feasible alternative should be evaluated in terms of how well it supports the objective(s).

Are there any tradeoffs? Many complex decisions involve compromise and require us to choose from several less-than-perfect alternatives. Monica's intent to finish college with high enough grades to apply to dental school might compete with her desire for an active social life. In that case, her decision will involve choosing from several less-than-perfect alternatives. If dentistry is a strong career goal, Monica may have to choose to limit her social activities to a couple evenings per week. Setting priorities ahead of time can help to objectively recognize and balance tradeoffs during the decision-making process.

How much risk is acceptable? Many choices involve risk or uncertainty. Because everyone has a different tolerance for risk, the "right" decision for one person may not be best for another. Each individual must reach a decision that balances his or her objectives with a level of risk that is acceptable to him or her. Josh would like to work closer to home. But the decision about quitting his current position to begin a job hunt in a different location depends on his ability to tolerate the risk of being unemployed for weeks or months.

- Decision-making Questions
- T-chart

Per Team of Students

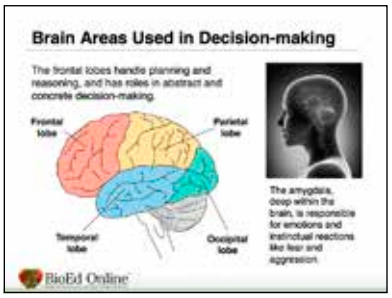
- Copies of Decision-making Scenario Example: Stephanie
- Copies of one of the six decision-making scenario pages (All members of each team should receive a copy of the same scenario; each team should receive a different scenario.)

Setup

Students should work in teams of two to four.

Procedure

1. Remind students that during the previous lesson, they examined a simple question: Should I consume a given soft drink? Ask, *Did you change your mind about consuming the soft drink after learning its sugar content? Did you think differently about your diet and exercise habits after learning about lifetime risks of heart disease?*
2. Ask, *What part of the body made these decisions for you?* [brain] Show students the slide, Brain Areas Used in Decision-making. If students are not familiar with regions of the brain, briefly describe the roles of the frontal lobes (the "thinking" part) and amygdala (the "emotional" part). Ask, by a show of hands, *Have you ever made a decision based on anger or short-term happiness, when you should have considered other information?* Follow by asking, *On the other hand, did you ever make a decision based on facts, when you should have factored in your feelings?*
3. Tell students that they can learn techniques for making better decisions. Remind them that most important decisions are complex, require rational and emotional considerations, and involve trade-offs between benefits and risks of less desirable outcomes. Ask students, by show of hands, *Have you ever have made a decision that did not produce the outcome you expected or wanted?*
4. Project the Decision-making Example (Stephanie) slide on the board, or provide a copy to each student. Have the students take turns reading portions of the text. Without further instructions, have the students work in groups of two to four to decide on a course of action for Stephanie. Have each group report its decision and provide a rationale for that choice.
5. Ask students, *Was it hard to figure out the best decision for Stephanie? Did you follow a process for selecting the best course of action?* Allow groups time to describe the procedures they followed to reach a decision.
6. Ask the class, *Would it help to have more guidance when making difficult decisions?* Project the following decision-making questions (available as a PowerPoint® slide accompanying this lesson) on the board, and briefly discuss each one.
   - **What is the real problem or decision to be made?** The way we define a problem and the options available to solve it determines the final outcome.
   - **What is the objective or goal?** Answering the question, "What do I really want?" provides a basis for evaluating all possible choices.
   - **What are the alternative choices?** The quality of a decision depends on the thoroughness with which options are evaluated during the decision-making process.
   - **Are there any tradeoffs?** Many complex decisions involve compromise and require us to choose from several less-than-perfect alternatives.
   - **How much risk is acceptable?** Many choices involve uncertainty, and everyone has a



Slide © Baylor College of Medicine.

different tolerance for risk. It is important to find a solution with an acceptable amount of risk.

7. Ask students for possible answers to each question above, using the Decision-making Scenario Example: Stephanie. Then have the class use their answers to make a decision for Stephanie. Ask, *Did everyone reach the same decision for Stephanie as your team did previously? Why or why not?*
8. Give each team copies of a different decision-making scenario page. Instruct teams to read their scenarios, discuss possible answers to the questions above, and choose the best answer for each. Instruct each group to use its answers to make a decision for its character.
9. Lead a class discussion in which groups explain the situations faced by their characters, their answers to each decision-making question, and their final decisions regarding the best course of action. Allow time for discussion after each presentation.
10. Have teams exchange scenarios, so that each is working with a new character. Describe the T-chart approach to decision-making. Project a slide that shows the template for using a T-chart for decision-making (see Sample T-chart, left sidebar).
11. Have each group create a T-chart and identify a goal and a question that defines the decision facing its character. Teams should show the pros and cons of one possible course of action. (If several alternatives are possible, students may want to create more than one T-chart to evaluate all of the advantages and disadvantages.) Finally, teams should decide on the best course of action for their characters.
12. Discuss the T-charts as a class, and lead a class discussion in which groups explain the situations faced by their characters, their answers to each decision-making question, their experience with T-charts, and their final decisions regarding the best course of action. Allow time for discussion after each presentation.

Sample T-chart

GOAL:

QUESTION:

Pros and cons of at least one possible alternative.

PRO	CON

Extensions or Homework

Some of our important decisions relate to health and medical treatments. Unfortunately, many people do not have enough information to make informed decisions about wellbeing and medications for themselves or family members. In class, show your students the video about how to ask questions of your doctor, **(http://www.ahrq.gov/patients-consumers/patient-involvement/ask-your-doctor/videos/waitroom/index.html)**, and discuss ways in which the decision-making techniques in this lesson could be applied to a healthcare situation.

For more neuroscience information and lessons, visit the Learning Brain section on BioEd Online **(http://www.bioedonline.org)**.

[3] Society for Neuroscience. Brain Facts: Decision-Making (http://www.brainfacts.org/sensing-thinking-behaving/awareness-and-attention/articles/2009/decision-making/).

[4] American Academy of Child & Adolescent Psychology. The Teen Brain: Behavior, Problem Solving, and Decision Making (http://www.aacap.org/AACAP/Families_and_Youth/Facts_for_Families/Facts_for_Families_Pages/The_Teen_Brain_Behavior_Problem_Solving_and_Decision_Making_95.aspx).

Decision-making Scenario Example: Stephanie

© Getty Images

Stephanie and her best friend, Caroline, decided to attend a party after their school's football game on Friday night. They didn't know Jonathan, who was having the party, but they accepted an invitation and drove to Jonathan's house in Caroline's truck. When they arrived, they were surprised to find the house packed with students, and to learn that Jonathan's parents were not present. Many of the students were drinking, and Caroline decided to try the punch that was being served.

About an hour later, Stephanie noticed that it was close to midnight. She needed to be home before 12:00, or her Mom would "ground" her for at least a week. Stephanie had play rehearsal every evening after school, and if she were grounded, she wouldn't be able to participate. She might even be eliminated from the cast. Unfortunately, Caroline didn't want to leave the party. Worse, she had become too drunk to drive.

What is the most important decision for Stephanie to make, and how would you guide her? ■

Decision-making Scenario: Brandon

© Getty Images

Brandon and Danielle have been dating ever since they were freshmen in high school. Now seniors, they spend a lot of time discussing their futures. They've even talked about living together after graduation. Both have applied to college. Danielle's options are limited, because she has to help care for her younger brother and sister while her Mom works the night shift as an emergency room nurse. Danielle has been accepted to a small local college and plans to major in accounting.

Brandon has his heart set on becoming a medical doctor. He currently is taking AP biology and precalculus, and has been a member of the HOSA Future Health Professionals Club for the last three years. To get into medical school, Brandon will have to earn excellent grades during all four years of college and achieve a high score on the national MCAT exam. He has applied to several colleges and universities, and has been accepted to all of them. He was fortunate to receive financial aid offers, so he won't have to factor cost into his decision.

Danielle was delighted when Brandon was accepted at the same college she plans to attend. The college is best known for its business programs, but it also offers courses in biology, chemistry and physics. A second college that accepted Brandon is located almost 600 miles away. It's very competitive and has one of the top biology programs in the country. Brandon also was accepted into the state university, just 250 miles away. It's a fine institution with a strong biology department, but class sizes are very large, and Brandon won't be able to live on campus.

What is the most important decision for Brandon to make, and how would you guide him? Answer the following questions from Brandon's perspective and make the best choice for him. Be prepared to present and explain your answers. ■

1. What is the real problem or decision to be made?	2. What is the objective or goal?	3. What are the alternative choices?	4. Are there tradeoffs?	5. How much risk is acceptable?	6. What should Brandon decide to do?
There are many possible decisions, all of which might determine the future course of Brandon's, and maybe Danielle's, life. Which one is most important?	Brandon has many goals—become a doctor, continue his relationship with Danielle, get good grades in college. Which objectives are important in this situation?	There are many ways in which Brandon could respond to this situation. Which alternative is best for the decision you identified in question 1?	Will Brandon have to compromise on one of the objectives in question 2 to satisfy another one? Which tradeoffs will he have to make?	This scenario presents a number of potential risks to Brandon and others. Which risks should play a role in his decision?	

Decision-making Scenario: Jason

© Getty Images

Jason is a junior in high school, but he doesn't like going to class very much. He has dyslexia, which makes it harder for him to read than it is for other students. He also doesn't feel like his courses are very useful or interesting. It's no surprise that his grades usually are C's and D's. After school, he spends a lot of time at the motorcycle shop by his house. He has gotten pretty good at repairing bikes and, for once in his life, he feels successful.

Chip, who owns the repair shop, has offered Jason a full-time position, starting in January. Jason is considering dropping out of school to take the job. He would make about $12 an hour, which seems like a lot of money to him.

The school counselor told Jason about a two-year program in small engine mechanics at a local community college. He explained to Jason that it typically takes at least three years of additional experience, after college graduation, to become a fully qualified service technician.

Jason doesn't want to spend another year and a half in high school, and then two more years in community college. He's eager to be out on his own. Further, his mom says that she could really use some help with expenses at home.

On the other hand, the thought of becoming a fully certified specialist appeals to Jason. He never thought that he could have a real career. But to apply to the community college program, he would have to graduate from high school, and maybe improve his GPA.

What is the most important decision for Jason to make, and how would you guide him? Answer the following questions from Jason's perspective and make the best choice for him. Be prepared to present and explain your answers. ■

1. What is the real problem or decision to be made?	2. What is the objective or goal?	3. What are the alternative choices?	4. Are there tradeoffs?	5. How much risk is acceptable?	6. What should Jason decide to do?
There are many possible decisions, all of which might determine the future course of Jason's life. Which one is most important?	Jason has many goals—be independent, feel successful, earn money. Which objectives are important in this situation?	There are many ways in which Jason could respond to this situation. Which alternative is best for the decision you identified in question 1?	Will Jason have to compromise on one of the objectives in question 2 to satisfy another one? Which tradeoffs will he have to make?	This scenario presents a number of potential risks to Jason. Which risks should play a role in his decision?	

Decision-making Scenario: Leslie

© Getty Images

Leslie, a high school senior, is a cheerleader, volleyball player and top student. Everyone knows who she is, and some of the younger girls in school try to emulate her. No surprise, she has many friends and a large following on social media.

Recently, a freshman named Allison sent a "friend" request to Leslie. Leslie doesn't really know Allison, but recognized her from school, so she accepted. Immediately, Allison began posting messages and photos on Leslie's page, asking about upcoming social events and commenting on all of Leslie's posts.

Within a couple hours, Leslie's other online friends—including many from school—began writing their own posts, making fun of Allison's comments, calling her "loser" and worse, telling her to stop pretending that she was part of their group. They posted nasty comments on Allison's page, along with altered versions of Allison's pictures, showing her as a pig.

When Leslie checks her account after volleyball practice, she's stunned by all of this activity. Allison took advantage of Leslie's willingness to "friend" her, and she ignored the unwritten rules of social media. Allison made a real mess of things by trying to push her way into Leslie's circle. Still, Leslie remembers her own freshman year, how difficult it was to fit in and make friends.

Speaking of friends, Leslie is shocked at the things her friends posted. She'd known some of these people since seventh grade, and never would have guessed they could be so cruel. She loves her friends and enjoys being part of the popular group. They share all their secrets, have a great time together and throw the best parties. Allison went way overboard, and Leslie knows that she and Allison will never be friends. She doesn't want risk her standing in the group, but she also feels upset and confused about what her friends posted about Allison.

What is the most important decision for Leslie to make, and how would you guide her? Answer the following questions from Leslie's perspective and make the best choice for her. Be prepared to present and explain your answers. ■

1. What is the real problem or decision to be made?	2. What is the objective or goal?	3. What are the alternative choices?	4. Are there tradeoffs?	5. How much risk is acceptable?	6. What should Leslie decide to do?
There are many possible decisions, all of which might determine the future course of Leslie's life, and maybe other lives too. Which one is most important?	Leslie has many goals—maintain her standing in the popular group, stand up for Allison, be a leader. Which objectives are important in this situation?	There are many ways in which Leslie could respond to this situation. Which alternative is best for the decision you identified in question 1?	Will Leslie have to compromise on one of the objectives in question 2 to satisfy another one? Which tradeoffs will she have to make?	This scenario presents a number of potential risks to Leslie and others. Which risks should play a role in her decision?	

Decision-making Scenario: Mike

© Getty Images

Last summer, Mike's best friend, Ben, moved because Ben's mom got a new job in another state. Mike and Ben had grown up together, and Mike missed goofing around with his friend, tossing the football, talking about the girls they liked… or didn't. And he was bummed that Ben hadn't been in touch recently.

Then, about two weeks into the semester, Ben wrote Mike a long, upsetting email. Ben said he was having a very hard time. He told Mike he'd made no friends, and that things were terrible at school. His classmates never invited him anywhere. They teased him about his accent, called him names. Ben felt like a total outcast and avoided everyone. Didn't know how to fit in, or if he even wanted to. His mom was working long hours, so Ben spent most of his time alone and depressed, angry at his mother, the school, everything.

Mike texted right back, trying to joke that Ben was just having "growing pains." But Ben said he couldn't see any way for things to get better. Over a few days, Ben wrote often about having no friends, no idea how things worked in this weird town, nothing to look forward to, and no hope.

Mike had never seen Ben like this. He asked if Ben's mother knew about his problems. Ben said no, and she wouldn't care anyway. Mike tried to persuade Ben to talk to his mom or a school counselor. But Ben refused. He said it wouldn't help. Nothing would help. Ben said this was just between best friends. He swore Mike to secrecy.

Mike agreed, but he hasn't heard from Ben since. Ben hasn't replied to Mike's texts or emails, and seems to have disappeared from the online social sites. Mike doesn't want to overreact, or betray Ben's trust. But he's very worried about his friend. He thinks about getting in touch with Ben's mom, but that would mean breaking his promise to Ben and losing Ben as his friend.

What is the most important decision for Mike to make, and how would you guide him? Answer the following questions from Mike's perspective and make the best choice for him. Be prepared to present and explain your answers.

1. What is the real problem or decision to be made?	2. What is the objective or goal?	3. What are the alternative choices?	4. Are there tradeoffs?	5. How much risk is acceptable?	6. What should Mike decide to do?
There are several possible decisions, all of which might determine the future course of Ben's and even Mike's life. Which one is most important?	Mike has multiple goals—support his friend, respect his "pact" with Ben, convince Ben to seek help. Which objectives are important in this situation?	There are many ways in which Mike could respond to this situation. Which alternative is best for the decision you identified in question 1?	Will Mike have to compromise on one of the objectives in question 2 to satisfy another one? Which tradeoffs will he have to make?	This scenario presents a number of potential risks to Mike and others. Which risks should play a role in his decision?	

Decision-making Scenario: Tomeka

© Getty Images

After a miserable freshman year in high school, Tomeka finally feels popular. Everything changed for the better when she started dating Justin in the middle of her sophomore year. Justin plays football and basketball, and knows all the cool kids. Now, Tomeka goes to the best parties and her phone beeps constantly with incoming texts. Her grades have suffered a little, but she still is making a B in most classes. She figures that she has plenty of time to bring her grades up before she has to apply to college in her senior year.

Justin's behavior has changed in the past several weeks. When they first started dating, he was a perfect gentleman. Lately, though, he has sent some very mean texts when Tomeka didn't text him back quickly enough. On Saturday, the football team lost a big game. Afterward, Justin yelled at Tomeka and slammed his fist into the car when she had to go back into a party for her purse. She was shocked by his violent response, but Justin apologized later, so she decided to ignore his behavior.

One girl who knows Justin well told Tomeka that he had given his former girlfriend a black eye. Tomeka finds it hard to believe Justin could act that way. Besides, she likes being one of the "in" couples at school. Maybe she should just leave things the way they are.

What is the most important decision for Tomeka to make, and how would you guide her? Answer the following questions from Tomeka's perspective and make the best choice for her. Be prepared to present and explain your answers. ■

1. What is the real problem or decision to be made?	2. What is the objective or goal?	3. What are the alternative choices?	4. Are there tradeoffs?	5. How much risk is acceptable?	6. What should Tomeka decide to do?
There are many possible decisions, all of which might determine the future course of Tomeka's life. Which one is most important?	Tomeka has many goals—be popular, go to college, feel safe. Which objectives are important in this situation?	There are many ways in which Tomeka could respond to this situation. Which alternative is best for the decision you identified in question 1?	Will Tomeka have to compromise on one of the objectives in question 2 to satisfy another one? Which tradeoffs will she have to make?	This scenario presents a number of potential risks to Tomeka. Which risks should play a role in her decision?	

Decision-making Scenario: Antonio

© Getty Images

Five years ago, Antonio immigrated to the US with his parents and little sister, Olga. It has been a challenge to adjust to the new culture, especially for Antonio's parents, who still struggle with English. Antonio and Olga have had an easier time. They have friends at school and make good grades. Antonio plays second base on his high school baseball team, and he plans to attend the state university after graduation next year.

Unfortunately, Antonio's father has been quite sick lately, with serious pain in his abdomen, an occasional temperature and digestive problems. Despite the family's efforts to convince him, he hasn't been willing to go to a doctor, insisting that he'll recover on his own. In fact, Antonio's father never has liked doctors. With his limited English, he's particularly uneasy when dealing with healthcare professionals in the US.

Antonio understands his father's point of view and wants to respect his wishes. They are very close, and it was his dad, after all, who made the biggest sacrifices to bring the family to the US. In many ways, his dad is his hero.

Antonio learned in class how important it is to seek medical attention as quickly as possible, and over the last few days, his father's symptoms have grown noticeably worse. But if anyone even hints at going to the doctor, his father gets upset.

Antonio has never questioned his dad before. He's worried this may be the first time, though, and it's very stressful for him. Antonio's mom is unsure what to do, and Olga is too young to understand. Antonio doesn't want to confront his father. He's worried that his father might even kick him out of the house for being disrespectful. But Antonio thinks his dad is very sick and might die if he doesn't get to a doctor.

What is the most important decision for Antonio to make, and how would you guide him? Answer the following questions from Antonio's perspective and make the best choice for him. Be prepared to present and explain your answers.

1. What is the real problem or decision to be made?	2. What is the objective or goal?	3. What are the alternative choices?	4. Are there tradeoffs?	5. How much risk is acceptable?	6. What should Antonio decide to do?
There are many possible decisions, all of which might determine the future course of Antonio's father's life, and may affect the entire family. Which one is most important?	Antonio has many goals—respect his father, help his father to get better, do what's best for the family. Which objectives are important in this situation?	There are multiple ways in which Antonio could respond. Which alternative is best for the decision you identified in question 1?	Will Antonio have to compromise on one of the objectives in question 2 to satisfy another one? Which tradeoffs will he have to make?	This scenario presents a number of potential risks to Antonio and others. Which risks should play a role in his decision?	

3

Setup: 15 minutes | **Class:** One or two 45-minute class periods

Introduction to Personal Stories

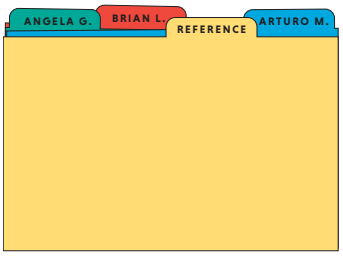
Overview

Students are introduced to three fictitious characters, Arturo, Brian and Angela, who will be followed through the rest of the unit. Each character experiences a health crisis that could be related to cardiovascular disease.

Regardless of age, everyone can make better choices to improve quality of life. In the activity, "Decisions and Risk," students learned that the most frequent cause of death in the United States is heart disease, heart failure or heart attack. According to the Centers for Disease Control and Prevention, certain health conditions, such as high cholesterol, high blood pressure and diabetes, combined with unhealthy eating habits, obesity, lack of exercise and/or alcohol and tobacco use, can place people at higher risk for developing heart disease. Heart disease also can run in families, and genetic disorders, including one that causes high levels of "bad" cholesterol (low density lipoprotein, or LDL cholesterol), contribute to elevated risks of heart disease and heart attack. So it can be very helpful to know family history and to seek treatment for conditions that are risk factors for heart disease or other serious illness.

In this activity, students will meet three characters who are experiencing health emergencies. One character, Arturo, has made a number of decisions that place him at risk for disease. Being overweight, not exercising and choosing a diet high in fat and refined carbohydrates all increase a person's likelihood of having high blood pressure, type 2 diabetes or clogged arteries. In turn, these conditions can precipitate a health crisis, such as a heart attack or a stroke. The second character, Brian, has chosen to smoke cigarettes. Smoking harms almost every organ in the body, and it is connected to about 1 of every 5 deaths in the US each year. It is the main preventable cause of death and illness. The third character, Angela, seems to be doing all the right things. She has just begun an exercise program and maintains an appropriate body weight. But something has happened to her, and it looks serious.

> Only about one percent of the US population follows the seven habits and behaviors known to promote a healthy cardiovascular system. These habits are (1) not smoking; (2) being physically active; (3) maintaining normal blood pressure measurements (systolic blood pressure reading of 120 or less, and a diastolic blood pressure reading of 80 or less); (4) having a healthy weight; (5) maintaining normal blood glucose levels; (6) maintaining normal total cholesterol levels (200 or fewer milligrams of cholesterol per deciliter of blood); and (7) eating a healthy diet (low in saturated fats and refined flour and sugar; high in whole grains, fruits and vegetables).



Materials

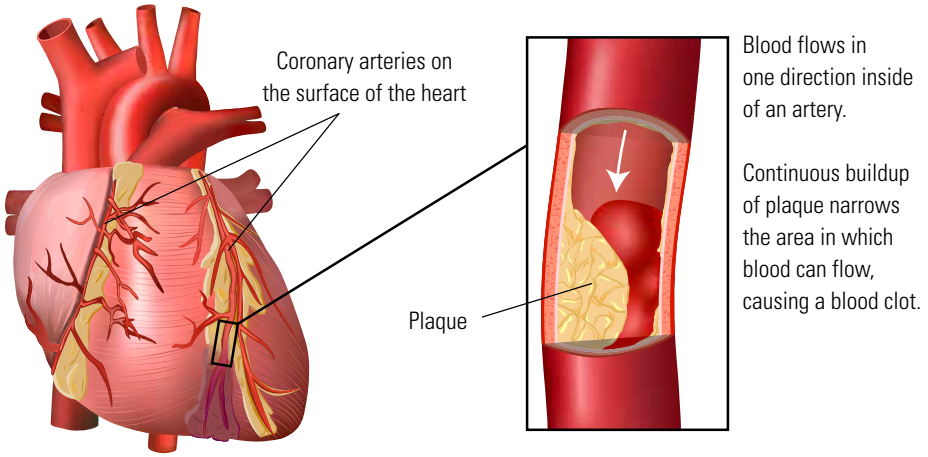
Teacher (see Setup)

- For each group of students, you will assemble a three-ring binder containing four tabs, or create a set of four folders. Each tab or folder will hold installments of the personal stories of one of the fictitious characters, Arturo, Brian or Angela. The fourth tab or folder will hold reference materials added throughout the unit. This system will enable students to refer back to earlier installments or reference materials, as needed.

What Is Coronary Artery Disease?

Coronary artery disease (CAD) develops when the arteries of the heart become damaged or diseased, usually due to a build-up of plaque. It often is precipitated by a condition, called atherosclerosis (Greek for hard paste), which begins with inflammation of, and damage to an artery's innermost layer (endothelium). The cause of the inflammation isn't known, but elevated cholesterol levels, high blood pressure and/or smoking may contribute to the initial damage. Inflammation in the artery attracts cholesterol and other substances, which build up just below the inner arterial wall. As we age, this buildup, called plaque, may become thick enough to cause significant blockage, resulting in a condition known as ischemia (reduction in blood flow through the vessel). Cardiac ischemia (or myocardial ischemia) is a reduced flow of blood and oxygen to the heart muscle. It can damage and weaken the heart muscle, or even cause total heart failure. Common symptoms include chest pressure or pain; arm, neck or jaw pain; cold sweat; nausea and vomiting. However, it also can be "silent," showing no symptoms at all.

Plaque Build-up in a Coronary Artery



- Interactive white board or video projector, and Internet access
- For each group of students, four copies of Part One of personal stories for Arturo, Brian and Angela
- Four copies of the "Table of Diagnostic Tests," pages for each group of students. (The table will be used again with the activity, "Team Diagnosis of Three Cases.")

Per Team of Students

- Binder with one prelabeled personal story tab (or set of three folders) for each character (Arturo, Brian and Angela), and a fourth tab or folder for reference materials (see description under Teacher Materials)

  Each binder or set of folders should include four copies of Part One of the personal story for each character and four copies of the table. This will enable every student to have his/her own copy to read or follow along. Copies should be returned to the binder or folders at the end of class.

Setup

For each group of students, put together a three-ring binder containing four tabs, or a set of four folders. Each tabbed binder section (or folder) will hold the personal story of one fictitious character—Arturo, Brian or Angela. The fourth tab or folder will hold reference materials added as you move through the unit.

Make copies of the Part One personal story pages for the three characters (Arturo, Brain and Angela). Place the pages in the appropriate binder section (or folder) for each group. These sheets will remain in the binder or folders, so students can refer to them as they obtain more information about the cases.

Make four copies of the "Table of Diagnostic Tests" pages for each group of students.

To access the video entitled, Scientific Decision-making, Part One, go to the "Lessons and More" tab on the BioEd Online website. Click on Resource Collections, then Scientific Decision-making. Or go directly to **http://www.bioedonline.org/lessons-and-more/resource-collections/scientific-decision-making/**. If your school limits access to YouTube or Vimeo, download the video from BioEd Online prior to class.

Have students work in teams of four to decide on a course of action for each character.

Related Activity

For further instruction on heart disease and heart attack, see the activity, "Coronary Artery Disease Model," in *Scientific Decision-making: Supplementary Activities on the Cardiovascular System*. It teaches students how inflammation and plaque build-up in arteries can lead to heart attack or stroke.

My Family Health Portrait

Image courtesy of the Office of the Surgeon General and the National Human Genome Research Institute, National Institutes of Health (https://familyhistory.hhs.gov/).

Procedure

1. Tell students that they will be following the personal stories of three fictitious characters, Arturo, Brian and Angela. In this first session, they will learn some background about the characters and follow them through a health crisis. Students should be prepared to take notes about each person from the information presented in videos or handouts.
2. Ask students, *Do you know any of the warning signs of a heart attack?* List their ideas on the board. Possible answers include: chest pressure or pain; arm, neck or jaw pain; cold sweat; nausea; feeling of indigestion and vomiting. Mention that heart attacks may not cause any pain or other symptoms.
3. Distribute the binders or folders to each student group. Have one or more students read or act out each personal story. Alternately, show the video, Part One, Scientific Decision-making, and distribute the Part One stories for students to refer to during the follow-up discussion. The video may be found at **http://www.bioedonline.org/lessons-and-more/resource-collections/scientific-decision-making/**.
4. After watching the video or reading Part One of the personal stories, lead a class discussion of each character's health crisis. Ask, *What happened to Arturo/Brian/Angela? How serious is his/her condition? Do you think any of his/her health problems result from decisions he/she has made?*
5. Ask, *Which vital signs for each person are within the normal range?* Call students' attention to the Table of Diagnostic Tests, explaining that it provides information about common vital signs and laboratory tests used with patients. Have students review the table and locate the vital signs mentioned in each personal story.
6. Have all student groups write short summaries of each patient's current condition, being sure to include any vital signs that are not within the normal range.

Extensions or Homework

Family history plays an important role in determining a person's risk for certain health conditions, including high blood pressure and early age heart attacks. According to the Centers for Disease Control and Prevention, a tendency for heart disease can cluster in families, so family medical history can provide important information for identifying risk in individuals. Family histories also can highlight shared inherited or environmental factors (such as eating habits) that can lead to incidence of a given disease among multiple family members. Have students use the My Family Health Portrait from the US Surgeon General website **(https://familyhistory.hhs.gov/)**, to create their own family health histories.

Personal Story: Arturo M.

Part 1

© Cathy Yeulet

Vital Signs and EKG Results

Vital Sign	EMTs: 7:15 PM	ER-RN: 7:45 PM
Temperature	101.0 °F	102.0 °F
Blood pressure (mm Hg)	145/100	142/95
Pulse rate (beats per minute)	120 bpm	92 bpm
Respiration rate (per minute)	28	20
Oxygen saturation (pulse ox)	92%	95%
Electrocardiogram (EKG)	Normal	Normal

Gender: Male
Age: 56
Race/ethnicity: Hispanic

Weight: 260 lbs
Height: 5 ft, 9 in.
Waist circumference: 47 in.

Tobacco use: No
Health insurance: Yes

It's Super Bowl Sunday and the whole family has gathered to watch the game on Arturo's big new TV. The house is overflowing with hot wings, pizza, chips, dips and desserts. Unfortunately, the game starts poorly for Arturo's team, and he yells at his new TV. It is unusual to see him get so angry. At halftime, he heads to the kitchen for more food. After overloading yet another plate with hot wings, he returns to his chair, patting his chest and frowning.

At **6:45 PM**, Arturo complains to his wife, Patricia, that he feels nauseous. He holds his plate of hot wings in his lap and watches the game quietly. He doesn't even cheer when his team scores a touch down. He lifts his plate to get a drink, but loses grip and drops the food. When he bends down to clean up the mess, Arturo slips out of his chair, hits his head on the table, and falls to the floor, unconscious.

Patricia calls 911 and uses a towel to put pressure on Arturo's bleeding head injury. Emergency medical technicians (EMTs) arrive within 20 minutes and begin first-responder intervention for Arturo, who regains consciousness. One EMT speaks with Patricia about what happened, while the other takes Arturo's vital signs (temperature, pulse rate, blood pressure and respiration rate). At **7:15 PM**, the EMTs treat Arturo's cut and attach electrocardiograph (EKG) wire leads to his chest to measure his heart's electrical activity. One EMT notices that Arturo's abdomen is tender. The ambulance leaves for the emergency room, and Patricia follows in her car.

When Arturo arrives at **7:35 PM**, the emergency room registered nurse (ER-RN) takes his vital signs and places an oxygen tube in each nostril. She notices that he is having a trouble taking breaths. She also clips a pulse oximeter to Arturo's finger and inserts an intravenous (IV) line in his right wrist vein. The nurse asks Arturo how he feels. He murmurs that his head hurts and his stomach aches. She records his SAMPLE information. (SAMPLE stands for: **S**igns/symptoms reported by the patient, **A**llergies, **M**edications, **P**ast medical history, **L**ast oral intake, **E**vents leading to this episode of injury or illness.) When reviewing Arturo's family history, the ER-RN discovers nothing remarkable related to heart disease.

Arturo's EKG is continually monitored on a computer screen. An EKG paper graph is recorded at **7:45 PM**, and placed in Arturo's chart. The ER physician reviews the EKG and the information in Arturo's chart, performs a physical exam, speaks briefly with Arturo and orders diagnostic tests. A phlebotomy technician draws blood for the tests at **7:50 PM.** ■

Personal Story: Brian L.

Part 1

© Andrey Shadrin

Vital Signs and EKG Results

Vital Sign	EMTs: 12:55 PM	ER-RN: 1:15 PM
Temperature	98.6 °F	98.6 °F
Blood pressure (mm Hg)	155/100	165/105
Pulse rate (beats per minute)	122 regular	120 regular
Respiration rate (per minute)	38 (shallow)	32 (shallow)
Oxygen saturation (pulse ox)	85%	87%
Electrocardiogram (EKG)	–	Irregular pattern

Gender: Male
Age: 40
Race/Ethnicity: White

Weight: 155 lbs
Height: 5 ft, 10 in.
Waist circumference: 32 in.

Tobacco use: Cigarettes, 1 pkg/day
Health insurance: Yes

Brian is walking across campus to check the final exam grade in his accounting course. He has a job but he decided to go back to college. He's nervous because he needs a good grade in the course so that he can apply to a master's degree program in hospital administration. Sadly, his dog died last week and he was distracted from his studies. To make things worse, his girlfriend told him she wants to date other people. Before Brian reaches class, his mother calls to remind him about driving her to the doctor for cancer treatments next week. Brian feels the pressure of his responsibilities. At **12:35 PM**, he sits down to have a cigarette.

Brian's heart starts to race. His forehead and palms feel clammy and cold. He is nauseous and his fingers are tingling. The world seems to be speeding around him, and he struggles for each breath. There is a growing tightness in his chest. He stands up, but he feels like he's going to pass out. Brian clenches his chest and falls back down to the bench. Kaitlin, a fellow student in his medical ethics class, asks if he is okay, but Brian doesn't respond. Kaitlin shouts out for help and calls 911 on her cell phone. Brian still is clutching his chest in pain and is breathing rapidly.

The EMTs arrive quickly. One EMT speaks with Kaitlin about the emergency. A second EMT speaks to Brian, trying to comfort him while taking his vital signs. The EMT attaches leads and records Brian's EKG. Slowly, Brian becomes more alert, but he remains pale. Noting Brian's rapid, shallow breathing, the second EMT places an oxygen mask over his nose and mouth to insure a good flow of oxygen to the lungs. Within minutes, Brian is on his way to the hospital.

At **1:15 PM**, the emergency room registered nurse (ER-RN) takes Brian's vital signs and places an oxygen tube in his nostrils. She clips a pulse oximeter to his finger while the admitting clerk attempts to obtain admission information from him. An intravenous (IV) line is started as the EKG technician hooks up the leads. A second RN begins taking Brian's SAMPLE information. (SAMPLE stands for: **S**igns/symptoms reported by the patient, **A**llergies, **M**edications, **P**ast medical history, **L**ast oral intake, **E**vents leading to this episode of injury or illness.) The EKG is recorded at **1:20 PM**, and a printout of the EKG graph is placed in Brian's chart.

The emergency room physician enters at **1:20 PM**, and asks Brian if he knows where he is. Brian nods in the affirmative. The physician reviews the notes taken by the EMTs and ER-RN. He checks Brian's EKG recording and the EKG monitor, performs a physical exam, and orders blood tests. A phlebotomy technician arrives at **1:45 PM**, and draws blood from Brian. She brings his samples to the laboratory, where the clinical laboratory technician runs the tests. ■

Personal Story: Angela G.

Part 1

© Fancy

Vital Signs and EKG Results

Vital Sign	EMTs: 9:30 AM	ER-RN: 9:45 AM
Temperature	98.6 °F	98.6 °F
Blood pressure (mm Hg)	166/110	160/105
Pulse rate (beats per minute)	118 bpm	100 bpm
Respiration rate (per minute)	28	18
Oxygen saturation (pulse ox)	96%	97%
Electrocardiogram (EKG)	–	Normal

Gender: Female
Age: 35
Race/Ethnicity: African-American

Weight: 122 lbs
Height: 5 ft, 5 in.
Waist circumference: 27 in.

Tobacco use: No
Health Insurance: No

Angela and her two girlfriends decided to begin the new year with a fitness program, and they're going to "break the ice" with a two-mile jog on this crisp January morning. Angela's running mates are more fit than she is. She hasn't had time to exercise because she spent the past few months looking for a job. But she recently was hired as a programmer, and starts next week.

Angela had indigestion last evening but is fine now. The group starts their jog at an easy pace, but about halfway into the run, the speed increases. Angela feels a sharp pain in her side, and indigestion. Figuring she's just out of shape, she finishes the run with her friends. But afterward, she's severely short of breath and lightheaded. Her heart is pounding and she has a headache.

Angela makes a quick exit and heads home. Her husband, William, notes that she looks pale and is breathing very heavily. When Angela does not respond, he becomes concerned that something serious is wrong. William immediately calls 911. He encourages Angela to lie down, but that makes her feel nauseated and dizzy, so she fights to sit upright again. Her skin is cold and clammy, and she says she might faint. She also complains of a lower jaw ache.

The EMTs arrive at **9:25 AM**, and begin first-responder intervention. One EMT speaks with Angela and William to learn what happened. The second EMT takes Angela's vital signs and begins monitoring her heart with an EKG. Angela throws up while her vitals are being taken. The EMTs wait momentarily to ensure that she is stable, and then prepare her for transport to the hospital emergency room. William rides with her in the ambulance.

At **9:45 AM**, the emergency room registered nurse (ER-RN) takes Angela's vital signs and attaches an oxygen tube. The nurse clips a pulse oximeter to Angela's finger and inserts an intravenous (IV) line. A technician hooks up the EKG leads to obtain a reading, which is complete at **10:00 AM**. A printout of the EKG is placed in Angela's chart. Meanwhile, her SAMPLE information is recorded. (SAMPLE stands for: **S**igns/symptoms reported by the patient, **A**llergies, **M**edications, **P**ast medical history, **L**ast oral intake, **E**vents leading to this episode of injury or illness.)

The emergency room physician enters at **9:50 AM**, and asks how Angela is doing. She still feels nauseous and has a headache. Then she vomits again. The physician reviews the notes taken by the EMTs and the ER-RN. The physician also checks Angela's EKG recording and the EKG monitor. She orders blood tests, including a pregnancy test, which is routine for women who may be exposed to x-rays. A phlebotomist arrives at **10:15 AM**, to collect blood samples. ■

Table of Diagnostic Tests

Reference: Page 1 of 2

Terms/Tests	Interpretation of Values	Description
CARDIAC ENZYMES	Creatine phosphokinase (total and the CK-MB fraction) and troponin (T). See individual tests below for interpretation of values.	Blood analysis to determine values for the enzymes creatine phosphokinase (CK) and troponin (T). Rapid elevation in the blood of these two proteins within the first 24 hours of an event usually indicates an acute myocardial infarction (MI) or heart attack.
Creatine Phosphokinase (CK or CPK) *blood total*	Normal: 30 – 155 IU/L (total of MB, MM, and BB fractions)	An enzyme indicating cell damage and consisting of three fractions, CK-MB (0 – 6%), CK-MM (96 – 99%), and CK-BB (0 – 1%), which together make up the total creatine phosphokinase value. These enzymes are released from the cells and increase blood values in response to damage in the heart (MB), muscle (MM), or brain (BB).
CK-MB *blood*	Normal: 0 – 6% of the total CK CK-MB is elevated within the first 4 hours of heart damage and peaks in 18 hours. Values may double during the first 24 hours of an MI, then return to normal.	Creatine Phosphokinase-MB is a type of CK enzyme important in heart muscle contraction, showing rapid elevation in the blood within the first 24 hours of an acute myocardial infarction (MI) or heart attack. An increase in CK-MB indicates heart muscle damage and leakage of CK-MB to the blood.
Troponin (T) *blood*	Normal: 0 – 0.2 ng/mL T is elevated within 6 hours of heart damage, and peaks at 18 hours, with values doubling, then returning slowly to normal.	A muscle protein that is released in large quantities to the bloodstream during muscle damage. Troponin (T) is released to the blood when the heart muscle has been damaged, such as during a heart attack (MI).
COMPLETE BLOOD COUNT (CBC)	—	This blood measurement determines the average size and number of red blood cells, the number of white blood cells, platelet number (clotting), and the amount of hemoglobin in the blood.
Red Blood Cells (CBC: RBC)	*Males* Normal: 4.2 – 5.6 million per mcL *Females* Normal: 3.8 – 5.1 million per mcL	The number and quality of RBCs determines how much oxygen your body tissues receive. The RBCs contain hemoglobin, which is the carrier for oxygen. RBC counts below the normal range may indicate bleeding or a type of anemia. Counts above normal may indicate lung, kidney, or bone marrow disorders, or dehydration.
White Blood Cells (CBC: WBC)	Normal: 3,800 – 11,000 per mcL	WBCs (leukocytes) help fight infections. There are several types of WBCs, but these are not distinguished on a CBC. Low WBC numbers may indicate bone marrow problems, liver or spleen disease, or radiation exposure. Above normal WBC counts may indicate leukemia, tissue damage (burns), inflammation, or body infections.
Hemoglobin (CBC: Hemoglobin)	*Males* Normal: 14 – 18 grams per dL *Females* Normal: 11 – 16 grams per dL	Hemoglobin is the protein in RBCs that carries oxygen. Low values may indicate anemia, bleeding, malnutrition, or overhydration. High values may indicate low blood oxygen levels, dehydration, or other disorders.
COMPUTED TOMOGRAPHY (CT Scan)	—	An imaging method that uses x-rays to create cross-sectional pictures of internal structures of the body, such as blood vessels. There is some exposure to doses of radiation during the CT (or CAT) scan process.
ELECTRO-CARDIOGRAM (ECG or EKG)	—	A graphical representation of the electrical activity of the heart to detect abnormalities. It is possible to identify if the heart muscle has been damaged in specific areas due to an acute myocardial infarction or heart attack.

Key: deciliter (dL), international unit (IU), liter (L), microliter (mcL), milliliter (mL), milliequivalent (mEq), nanogram (ng)

Table of Diagnostic Tests

Reference: Page 2 of 2

Terms/Tests	Interpretation of Values	Description
ELECTROLYTE: POTASSIUM [K] *blood*	Critically Low (hypokalemia): ≤3.7 mEq/L Normal: 3.7 – 5.2 mEq/L High (hyperkalemia): >5.2 mEq/L	An electrolyte with the crucial job of helping the heart beat by triggering the heart to squeeze blood through the body. Heart muscles need the right potassium balance to contract in a coordinated fashion. If the K value is low, the heart may beat ineffectively or in an uncoordinated manner (arrhythmias and incomplete contractions).
ELECTROLYTE: SODIUM [Na] *blood*	Low (hyponatremia): ≤134 mEq/L Normal: 135 – 145 mEq/L High (hypernatremia): ≥145 mEq/L	This electrolyte helps keep the body's water balance (amount of fluid inside and outside of cells). Na also is important for nerves and muscles. Hyponatremia is a result of dehydration, water retention, or sodium loss.
OXYGEN SATURATION *blood*	Critically Low: <90% Low: <95% Normal: 95 – 100% Measured with a pulse oximeter	A measure of oxygen level bound to hemoglobin in the red blood cells and circulating in the blood. When the level of circulating oxygen falls below normal, hypoxemia occurs and the person may experience shortness of breath, rapid breathing, dizziness, tachycardia, or even loss of consciousness. If the heart is not pumping effectively, or if there is poor loading of oxygen in the lungs, oxygen saturation falls.
PHYSICAL EXAM (PE)	—	Process in which the physician investigates the body for signs of disease. The main organs are visually inspected and palpated (use of hands to determine abnormalities), and listened to with a stethoscope. Poor reflexes indicate problems with the nervous system.
PREGNANCY TEST	Positive: Pregnant Negative: No pregnancy detected	A urine or blood sample is tested for the presence of human chorionic gonadotropin, This hormone is produced about six days after fertilization.
VITAL SIGNS	See individual vital sign measures below.	Assessment of basic body functions, including body temperature, pulse rate (heart rate), blood pressure, and respiratory rate (breaths per minute).
Blood Pressure *resting*	Normal: Systolic: <120 mm Hg Diastolic: <80 mm Hg Prehypertension: Systolic: 120 – 139 mm Hg Diastolic: 80 – 89 mm Hg High Blood Pressure: Systolic: 140 – >160 mm Hg Diastolic: 90 – >100 mm Hg	Vital sign measurement of the force exerted by the heart against the arterial walls when the heart contracts and relaxes. The upper number is the systolic pressure, which is a measurement of the blood pressure taken when the heart is contracting and forcing blood into the arteries. The lower number is the diastolic pressure, a measurement of pressure on the arteries when the heart is resting. A critically low blood pressure could indicate a failing heart or a response lo low oxygen in the blood.
Pulse Rate *per minute*	Low (bradycardia): < 60 bpm Normal: 60 – 90 bpm High (tachycardia): > 90 bpm	Vital sign measurement of the pressure of the blood felt against the wall of an artery as the heart contracts or beats. It is used to determine the number of times the heart beats each minute. There are several areas where the pulse can be measured, the most common being the radial pulse taken on the thumb side of the wrist.
Respiration Rate *per minute*	Low (hypoventilation): <12 Normal: 12 – 20 High (hyperventilation): > 20	Vital sign measuring the number of times per minute that the lungs lake in air (inspiration) and expel the air (expiration). Hyperventilation can result from ineffective heart pumping or poor loading of oxygen in the lungs.
Temperature *body*	Low: (hypothermia): <95 °F Normal: 97.6 – 99.6 °F High (fever): >100.6 °F	Vital sign measuring the balance between heat lost and heat produced by the body. In the United States, body temperature is measured in degrees Fahrenheit.

Key: deciliter (dL), international unit (IU), liter (L), microliter (mcL), milliliter (mL), milliequivalent (mEq), nanogram (ng)

4

Setup: 15 minutes | **Class:** One or two 45-minute class periods, depending on students' familiarity with the cardiovascular system.

Heart: Basic Measurements

Overview

Students are introduced to heart-related data, such as blood pressure and oxygen saturation, from the continuing stories of Arturo, Brian and Angela. They also learn basic information about the heart and circulatory system.

What Is in Blood?

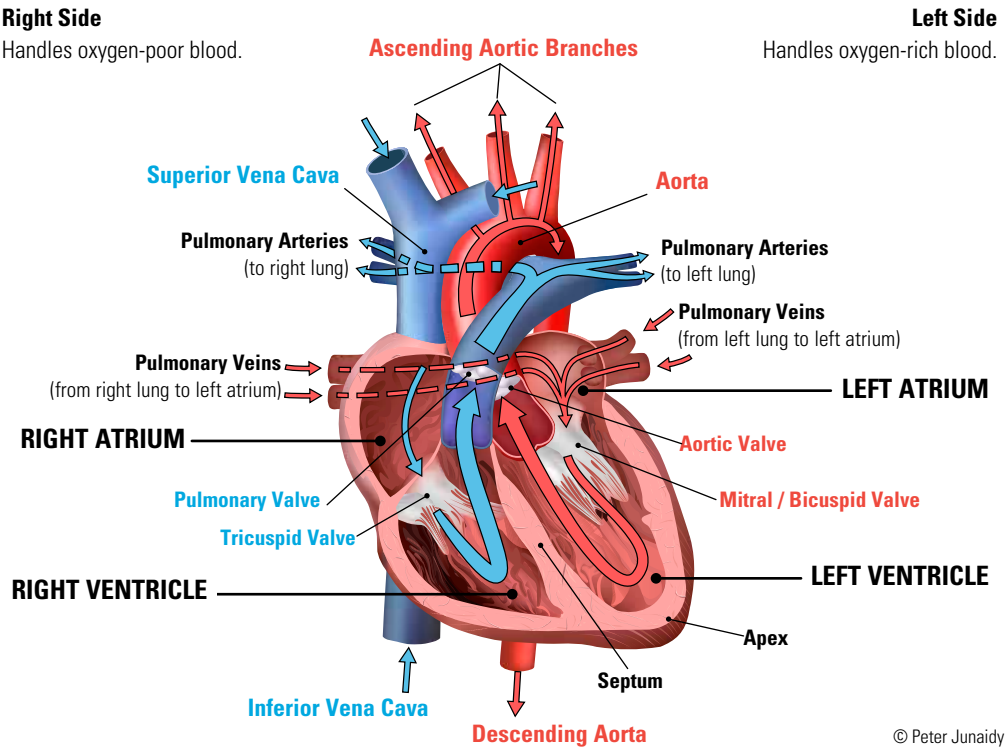
Blood, the liquid inside the heart and blood vessels, is comprised of fluid plasma and several different kinds of cells. Red blood cells (erythrocytes) contain hemoglobin, a molecule that binds to and transports oxygen. White blood cells (leukocytes) are found in blood and the fluid in tissues. There are several kinds of white blood cells, each with a specific role in protecting the body from invading microbes and foreign materials. Blood platelets are fragments of bone marrow cells that help blood to clot. Many other substances are carried in blood: glucose, amino acids, vitamins, hormones, proteins and ions (such as sodium, bicarbonate and potassium).

To survive, human body cells must exchange gases (oxygen and carbon dioxide), receive nutrients (like glucose), and eliminate wastes. These processes require an efficient system to transport substances around the body. The lungs play a key role, enabling the body to obtain oxygen from the atmosphere and eliminate carbon dioxide waste. Meanwhile, the digestive system provides nutrients for survival and works with the liver and kidneys to remove waste products from the body. The transportation network for these gases and nutrients is our closed circulatory system, which, amazingly, consists of 60,000 to 100,000 miles of blood vessels.

All of this circulation begins with the unique pump in the chest, the heart. Weighing less than a pound and a little larger than a fist, this tireless organ beats approximately 100,000 times every day—nearly three billion times in a lifetime. Even at rest, the heart works twice as hard as the leg muscles of a person running a sprint.

Birds and mammals, including humans, have four-chambered hearts. Two chambers (atria) receive blood and the other two (ventricles) pump it out. The right side of the heart receives oxygen-poor blood from the body and sends it to the lungs to be re-oxygenated. The left

The Heart Pumps Blood In and Out



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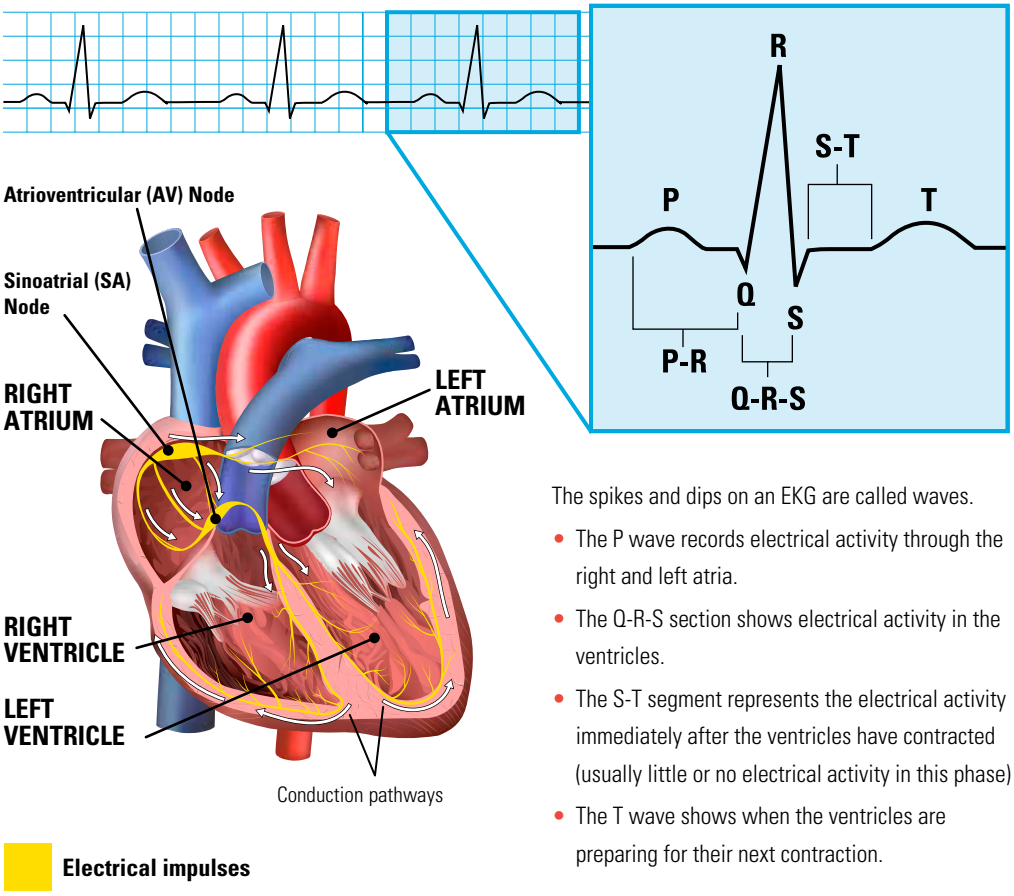
Fast Facts

According to the American Heart Association, possible risk factors for high blood pressure include: family history (high blood pressure runs in some families); advanced age; lack of physical activity; poor diet, especially one high in salt (sodium); being overweight or obese; and drinking too much alcohol.

Electrocardiogram Waves



The spikes and dips on an EKG are called waves.

- The P wave records electrical activity through the right and left atria.
- The Q-R-S section shows electrical activity in the ventricles.
- The S-T segment represents the electrical activity immediately after the ventricles have contracted (usually little or no electrical activity in this phase)
- The T wave shows when the ventricles are preparing for their next contraction.

side of the heart receives oxygen-rich blood from the lungs and pumps it out to the body. The "lub-dub" heartbeat you hear through a stethoscope corresponds to (1) the closing of one-way valves after blood has moved from the receiving chambers (atria) into the pumping chambers (ventricles); and (2) the closing of one-way valves at the base of the ventricles.

The heart pumps about once per second throughout our lifetimes. A resting adult circulates more than a gallon of blood throughout the body every minute; more than 2,000 gallons per day; nearly three-quarters of a million gallons each year. In a lifetime, our hearts will pump enough blood to fill three super tanker ships! The National Health Lung and Blood Institute offers an excellent animation of heart contraction and blood flow **(http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html)**.

Electrocardiogram. We cannot directly observe contractions and movement of blood through the heart, but we can study the process indirectly by recording the heart's electrical activity. With each heartbeat, an electrical signal spreads from the top of the heart to the bottom, causing the heart to contract and pump blood. This signaling process repeats with every heartbeat. An electrocardiogram (EKG or ECG) uses electrodes attached to the skin to collect information about these electrical signals, including their strength and timing when passing through each section of the heart. Information gathered from an EKG is presented

as a graph, which shows how fast the heart is beating and whether the rhythm is steady or irregular. The standard pattern of peaks and valleys in an EKG corresponds to alternating contractions and relaxation of the heart's chambers. Visit the URL below to view an online animation demonstrating how an EKG translates activity of the heart into a readable graph **(http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/electrical.html)**.

EKG/ECG is not the only way to observe or measure heart function and blood circulation. Additional methods are discussed below.

Pulse. Each time the heart beats, a surge of blood, known as a pulse, passes through the arteries. The pulse can be detected in specific locations, such as the wrist or neck, where arteries run near the surface of the skin. The number of pulses per minute provides a good estimate of heart rate. A normal resting heart rate in adults is 60–90 beats per minute.

Blood Pressure. When the heart pumps, moving blood generates pressure against artery walls. Blood pressure can be an indicator of one's health or risk for certain diseases. It is measured at two different time points: when the heart is contracting and causing a surge of blood (systolic pressure); and when the heart is at rest between beats (diastolic pressure). Blood pressure usually is written as a ratio, with the systolic number above the diastolic number, such as 120/80 mm Hg. (The unit "mm Hg" refers to millimeters of mercury, a way of measuring pressure.)

The table at left shows healthy and unhealthy blood pressure values.

Oxygen Saturation. Oxygen saturation is a common diagnostic test used to determine whether the heart and lungs are supplying the body with enough oxygen. Pulse oximetry ("pulse ox") uses a light sensor attached to a patient's finger to estimate oxygen levels in the blood (based on absorption of different wavelengths of red light). Healthy blood oxygen saturation levels vary from 94% and 99% (i.e., oxygen occupies between 94% and 99% of the hemoglobin binding sites in the bloodstream). These values are affected by the amount of oxygen in air, which decreases at higher altitudes, so a person who lives at sea level might have a normal reading of 98% at home, but 95% when he or she is in a mountain village 5,000 feet above sea level.

Stroke Volume and Cardiac Output. Circulation begins with the heart, a complex pump that provides the initial force for blood flow through the body. The heart provides enough force to send blood to the toes and back in 16 seconds, thereby providing oxygen and nutrition for the body's 75 trillion cells. Clearly, it is extremely important to maintain a healthy heart.

Two measurements that help to determine heart health are stroke volume and cardiac output. Stroke volume is the amount of blood pumped by the left ventricle with each beat. Cardiac output is the amount of blood pumped by the left ventricle every minute. These values can be estimated based on an individual's body size. Actual values are determined by a diagnostic procedure, called an echocardiogram. Comparisons of the estimated and actual values make it possible to determine the amount of heart muscle damage caused by disease or a heart attack.

Various disease states of the heart can reduce cardiac output so much that the heart becomes unable to supply enough blood flow (oxygen and nutrients) to meet the needs of the body cells. This condition, known as heart failure or cardiac insufficiency, is costly, disabling and potentially deadly.

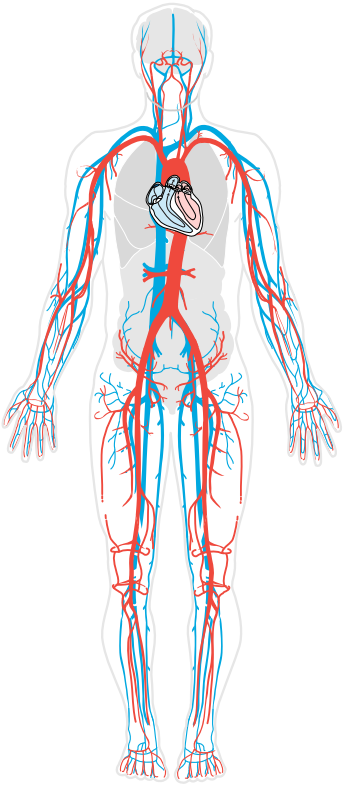
Blood Pressure Terms

Systole, the phase of heart contraction, is derived from the Greek word for "contract." Diastole, the relaxation phase, is from the Greek for "dilation" or "lengthening."

CATEGORIES FOR BLOOD PRESSURE LEVELS IN ADULTS[5]
(measured in millimeters of mercury, or mm HG)

Category	Systolic (top number)		Diastolic (bottom number)
Normal	<120	and	<80
Pre-hypertension	120–139	or	80–89
High Blood Pressure			
Stage 1	140–159	or	90–99
Stage 2	160+	or	100+

The Circulatory System



Materials

Teacher

- Set of Heart Facts Cards, printed on card stock and pre-cut to create a class set of cards
- Set of Heart Basics Station Cards, including Nomogram for Estimating Body Surface Area
- Computer and projector, interactive white board or overhead projector
- Automatic blood pressure cuff (arm or wrist)
- Finger pulse oximeter
- Digital thermometer and disposable tips
- Tape measure (feet and inches)
- Bathroom scale
- Wall clock with second hand, or small timers, or stop watches at stations C and D

Per Student

- Copy of "Heart Basics/Personal Data Sheet" (PDS)

Setup

Print or copy the Heart Facts Cards on card stock and pre-cut the cards to create a classroom set. Make copies of the Heart Basic Station cards on card stock and cut each sheet in half to separate the two cards. Make a copy of "Heart Basics/Personal Data Sheet" for each student. Set up one or more of each of the following stations around the classroom.

- **Station A:** Body Temperature card and a digital thermometer, plus disposable thermometer tips
- **Station B:** Blood Pressure card and a digital blood pressure cuff for arm or wrist (available at most drug stores for $15–$60)
- **Station C:** Heart (Pulse) Rate card and timer or clock with a second hand)
- **Station D:** Respiration (Breathing) Rate card and timer or clock with a second hand
- **Station E:** Oxygen Saturation card and finger pulse oximeter (available at most drug stores for $35–$50)
- **Station F:** Electrocardiogram (EKG) card and computer with Internet access set for students to view the following page: **http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/electrical.html**
- **Station G:** Heart Stroke Volume card, and copy of "Nomogram," page, tape measure attached to a wall, 12-inch ruler, bathroom scale
- **Station H:** Cardiac Output card

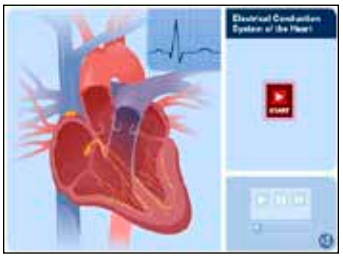
Conduct the first part of the activity as a class discussion. For the second part, have students work in teams of two or four, and rotate through each diagnostics station. Some teachers prefer to set up two stations for each measurement.

An answer key for the statements on the Heart Facts cards is provided on page 31.

Procedure

1. Remind students of the previous class session, during which they learned of three health emergencies. Students also learned about lifestyle choices and behaviors that can contribute to poor cardiovascular health. Tell students that now they will investigate the heart and circulatory system further, and learn more about the tests used by emergency medical personnel who treated Arturo, Brian and Angela.
2. Distribute one Heart Facts Card to each student. Tell students that not all of the "facts" on the cards are true. Have each student read his or her card aloud. The rest of the class should raise their hands if they believe the statement to be true.

Heart Contraction and Blood Flow



http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html

Image courtesy of the National Heart, Lung, and Blood Institute, National Institutes of Health.

Information Resources

- **American Heart Association**
  http://www.heart.org
- **National Heart, Lung and Blood Institute**
  http://www.nhlbi.nih.gov
- **Mayo Clinic**
  http://www.mayoclinic.com

3. Initiate a short discussion by asking, *Were you surprised by an any of the facts? Which ones and why?* Tell students that they will learn more about how to measure heart function.
4. Ask, *Why did most of the tests performed on Arturo, Brian and Angela relate to heart function?* Encourage students to discuss the tests, and lead them to understand that the heart is essential because it pumps blood throughout the body. Blood carries vital oxygen and nutrients to all cells and every body system (digestive, excretory, respiratory, muscular, etc.). It also transports and removes carbon dioxide and other waste products from every body system. We cannot live without blood circulation, and blood cannot circulate without the heart.

   If students are unfamiliar with the heart and circulatory system, show the following animation, Heart Contraction and Blood Flow, at the National Heart, Lung, and Blood Institute's website **(http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html)**.
5. Tell students that they will visit stations set up around the room to gather statistics similar to those obtained for Arturo, Brian and Angela. Point out the instruction card at each location, and demonstrate how to use the equipment and collect information at each station. Note that Station H requires data collected at Stations C and G, and that students must complete those Stations before going to Station H.
6. Distribute copies of the "Heart Basics/Personal Data Sheet," and have students work in teams of two to four as they circulate through each station. If a station they need to visit is occupied, instruct students to wait in their seats until it is available.

   Briefly discuss the importance of protecting patient confidentiality, emphasizing that information on the Personal Data Sheet is not to be shared. Explain that students are responsible for protecting their personal data.
7. If students are concerned about any of their personal readings (for example, high blood pressure), suggest that they visit the school nurse to receive new, possibly more accurate measures.
8. Conclude the activity by discussing students' observations about their vital signs. Their investigations of resting and active pulse rates, respiration and cardiac output should enable students to understand that our bodies' cells require more oxygen and nutrients at times of increased pulse or respiration rates (during exercise, for example).
9. Tell students to keep their personal data sheets for use with the activity, "Calculating Coronary Artery Disease Risk."

Extensions or Homework

One out of three Americans has high blood pressure. Often, the causes are unknown, but it possible to identify, and sometimes treat, risk factors for high blood pressure. Have students visit one or more of the websites listed in "High Blood Pressure Information Resources" (left sidebar), and find at least four different factors that increase a person's risk for high blood pressure. Students should list the factors, write one or two sentences describing the associated risks, and provide the name and URL of the website from which the information was obtained. ■

[5] National Heart, Lung and Blood Institute (http://www.nhlbi.nih.gov/hbp/detect/categ.htm).

Teacher Answer Key

For Heart Facts Cards

The following statements from the Heart Facts Cards (identified by number below) are FALSE. Correct answers are given in italics.

1. Each day, the adult human heart beats approximately 10,000 times.
   The heart beats 100,000 times each day.

10. A common test uses a light sensor attached to the finger to estimate the level of CO_2 in the blood.
    A common test uses a light sensor to estimate the level of oxygen (O_2) in the blood.

11. It takes only one minute for blood to travel from the heart, to the brain and back to the heart.
    It only takes eight seconds for blood to travel from the heart, to the brain and back to the heart.

15. Reptiles, birds and mammals all have 5-chambered hearts.
    Reptiles, birds and mammals all have 4-chambered hearts.

16. Blood accounts for about 15% of your total body weight.
    Blood accounts for about 7–8% of your total body weight.

17. An electrocardiogram, or EKG, creates a graph of the electrical activity within the brain.
    An EKG creates a graph of the electrical activity within the heart.

18. Too much sleep can cause irregular jumping heartbeats, called premature ventricular contractions (PVCs).
    Prolonged lack of sleep can cause irregular jumping heartbeats.

20. A man's heart typically beats faster than a woman's heart.
    A woman's heart typically beats faster than a man's.

26. Blood pressure is the force exerted by moving blood against the walls of the veins.
    Blood pressure is the force exerted by moving blood against the walls of the arteries.

29. Hardening of the arteries results from the buildup of cholesterol and iron inside blood vessels.
    Hardening of the arteries results from the buildup of cholesterol and fat.

31. Blood flows in both directions within arteries and veins.
    Blood flows in one direction. Arteries carry blood away from the heart; veins carry blood toward the heart.

Heart Facts Cards

1. Each day the adult human heart beats approximately 10,000 times.

2. A faucet would need to be open with the water running for at least 45 years to equal the amount of blood pumped by the heart in an average lifetime.

3. The adult heart is a little larger than your fist.

4. Every day, the heart uses enough energy to drive a truck twenty miles. In a lifetime, that's equivalent to driving to the moon and back.

5. Adults have almost 60,000 miles of blood vessels.

6. Because the heart has its own electrical impulses, it can continue to beat outside of the body.

7. Each day the adult human heart pumps more than 2,000 gallons of blood through the body.

8. The heart pumps enough oxygen and nutrients to maintain the 75 trillion cells of the human body.

9. During an average lifetime, the heart will pump enough blood to fill 200 train tank cars.

10. A common test uses a light sensor attached to the finger to estimate how much CO_2 is being carried in blood.

11. It takes only one minute for blood to go to the brain and back to the heart.

12. It takes only 16 seconds for blood to reach the toes and return to the heart.

13. Fish have a 2-chambered heart.

14. Frogs and salamanders (amphibians) have 3-chambered hearts.

15. Reptiles, birds, and mammals all have 5-chambered hearts.

16. About 15 percent of your total body weight is blood.

17. An electrocardiogram or EKG creates a graph of the electrical activity of the brain using information from electrodes attached to the skin.

18. Too much sleep can cause irregular jumping heartbeats called premature ventricular contractions (PVCs).

Heart Facts Cards

19 "Atrium," the upper chambers of the heart, is Latin for "entrance hall," and "ventricle," the lower chambers of the heart, is Latin for "little belly."

20 A man's heart typically beats faster than a woman's heart.

21 Blood is considered to be a connective tissue of the body.

22 Blood pressure is measured at two time points: when the heart contracts, causing a surge of blood, and when the heart rests between beats.

23 French physician Rene Laennec (1781-1826) invented the stethoscope when he felt it was inappropriate to place his ear on large-bosomed female patients' chests.

24 William Harvey, an English physician, concluded that there was a fixed amount of blood in the body and that it circulated in one direction.

25 Cocaine affects the heart's electrical activity and causes spasms of the arteries—which can lead to a heart attack or stroke, even in healthy people.

26 An adult woman's heart weighs about 16 ounces, a man's heart weighs about 32 ounces.

27 The aorta, which is the largest artery in the body, is about the same diameter as a garden hose.

28 The heart is located near the center of the chest, not on the left side.

29 Hardening of the arteries results from the buildup of cholesterol and iron inside blood vessels.

30 Beating of the heart is controlled by electrical signals.

31 Blood flows in both direction in the arteries and veins.

32 It takes 10 capillaries to equal the thickness of a human hair.

33 A heart attack happens when the flow of blood to the heart muscle itself becomes blocked.

34 Squid have three hearts: Two hearts to feed the gills for oxygen exchange, and one heart to pump blood around the body.

Personal Data Sheet (PDS)

PRIVACY NOTICE

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) requires that you maintain the confidentiality of personal health information. It is your responsibility to keep your personal data confidential. Do not write your name on this document. If you prefer, you may leave some of the spaces blank, but you must remember the numbers for calculation purposes.

Station A: Body Temperature

Your temperature. _____ °F

Station B: Blood Pressure (mm Hg)

Diastolic pressure: _____ **mm Hg**

Systolic pressure: _____ **mm Hg**

Pulse rate (if given by meter): _____ beats/minute

Station C: Heart (Pulse) Rate

Measurement 1: _____ beats/15 seconds

Measurement 2: _____ beats/15 seconds

Measurement 3: _____ beats/15 seconds

Average: _____ **x 4 =** _____ **beats/minute**

Exercise rate: _____ **x 4 =** _____ **beats/minute**

MAKE AN INSIDE FOLD HERE TO KEEP YOUR DATA PRIVATE.

Station D: Respiration Rate

Normal rate: _____ **breaths/minute**

Exercise rate: _____ **breaths/minute**

Station E: Oxygen Saturation (Pulse ox)

Percentage of oxygen in your blood. _____ **%**

Station F: Electrocardiogram (EKG)

Use the back of this sheet for notes.

Station G: Heart Stroke Volume (SV)

Height: _____ ft/in. Weight: _____ lbs

Body Surface Area (BSA): _____ m^2

Heart Stroke Volume: _____ **x 42.5 =** _____ **mL**

Station H: Cardiac Output (CO)

You need the results from Stations C and G for this Station.

Resting rate: _____ **x** _____ **=** _____ **mL**

Exercise rate: _____ **x** _____ **=** _____ **mL**

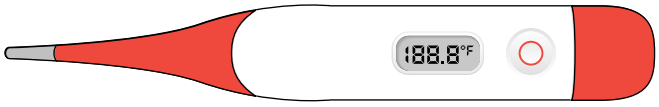
Why do you think cardiac output increases with exercise? Write a short paragraph explaining your answer on the back of this sheet of paper.

Station Cards

Station A: Body Temperature

Temperature in degrees Fahrenheit.

1. Prepare the digital thermometer by covering the tip (probe) with a plastic probe cover. The cover is a thin plastic sheath found within the bandage-size paper wrapper. Slide the probe tip between the two layers of the paper cover until it stops. Remove the paper from both sides. The thermometer is ready to use.
2. Press the small button next to the window to turn the thermometer on. The number 188.8 °F will appear, followed by the last temperature measured. After two seconds, the window will clear.
3. Insert the probe, with cover in place, into your mouth under your tongue. Wait 60 seconds and read the temperature. You may hear a beep when ready. Record your temperature on your PDS.
4. Discard the cover.
5. Proceed to the next station.



Station B: Blood Pressure (mm Hg)

Pressure exerted by blood flow on the walls of the arteries.

1. Sit down and relax for 30 seconds.
2. Review the operating instructions for the blood pressure monitor. It will be a device either placed on your wrist or wrapped around your upper arm, just above the elbow. The inflatable part of the monitor is the cuff.
3. If you are wearing a heavy shirt or sweater, roll up your sleeve to make better contact with the cuff.
4. Sit calmly and turn on the monitor. The monitor will inflate the cuff to provide pressure on your wrist or arm. Gradually, the cuff will deflate as it records your systolic (heart stroke) pressure and diastolic (heart rest) pressure. The monitor may also measure your pulse rate.
5. When the monitoring cycle is complete, write your numbers on your PDS.
6. Proceed to the next station.

Typical face on a digital blood pressure monitor

Station Cards

Station C: Heart (Pulse) Rate

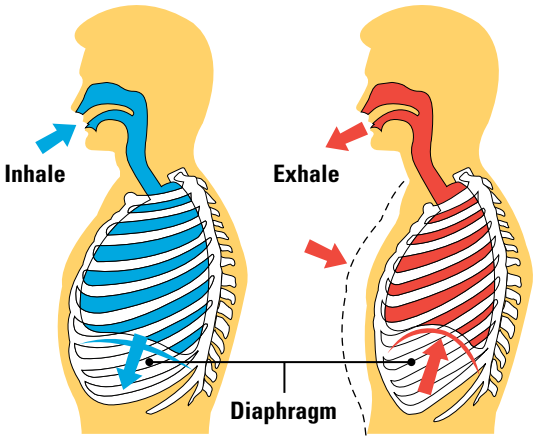
Number of heartbeats occurring in one minute.

1. Sit down and relax for 30 seconds.
2. Locate the radial pulse point on one of your wrists. This is a point just below the palm on the thumb side. Place two fingers on this point and feel for the rhythmic pulsing of your heart. You may have to adjust your finger position and pressure slightly to feel the pulse.
3. Watch a clock with a second hand and count the number of pulses you feel for 15 seconds. Record this number on your PDS.
4. Repeat the process and measure your pulse rate twice more. Record your results.
5. Total your three measurements and divide by three to obtain an average. Multiply the average by four to get your pulse rate per minute.
6. Run in place for 60 seconds, and repeat and record your pulse measurement.
7. Proceed to the next station.

Station D: Respiration (Breathing) Rate

Number of breaths taken in one minute.

1. Sit down and relax for 30 seconds. If you have just finished Station C, give yourself two minutes to return to a resting rate.
2. Using a clock with a second hand or a stopwatch as a reference, count the number of times you breathe for one minute. One complete breath consists of an inhale and an exhale. Record your results on your PDS.
3. Run in place for 60 seconds, and repeat and record your breathing rate measurement.
4. Proceed to the next station.

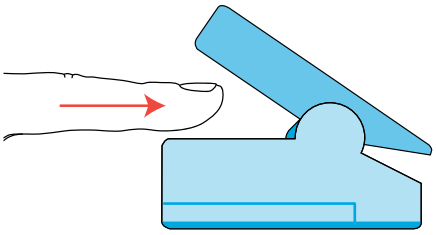


Station Cards

Station E: Oxygen Saturation (Pulse ox)

How much oxygen the blood is carrying, expressed as a percentage of the maximum it could carry.

1. Pick up the pulse oximeter and squeeze the upper ends together with the fingertips of one hand. This will open the lower end where the sensor is located.
2. While holding the oximeter open, insert one of your index fingers all the way into the opening.
3. Release your grip on the oximeter. It will close on your fingertip and automatically begin monitoring your oxygen saturation. Wait for the readings to appear.
4. Record the percentage of oxygen in your blood on your PDS.
5. The oximeter also will display your pulse rate. Record this rate and compare it to your pulse rate, as determined by Station C.
6. Proceed to the next station.



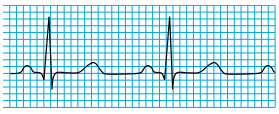
Typical face on a pulse oximeter

Station F: Electrocardiogram (EKG)

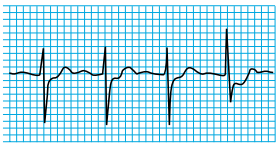
Graph of electrical signals produced by contraction in different sections of the heart.

1. Enter this address on the computer to bring up an animated diagram explaining Your Heart's Electrical System.

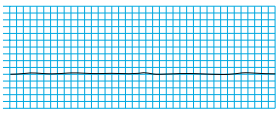
   http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/electrical.html
2. This presentation demonstrates the relationship between the heart's activity and the graph lines in an electrocardiogram.
3. Take notes as needed on your PDS. Use the back of this sheet if more space is needed.
4. Compare the three electrocardiograms to the right.
5. Proceed to the next station.



Normal EKG



Abnormal EKG



Flat Line

Station Cards

Station G: Heart Stroke Volume (SV)

Amount of blood pumped out to the body with each beat of the heart's left ventricle.

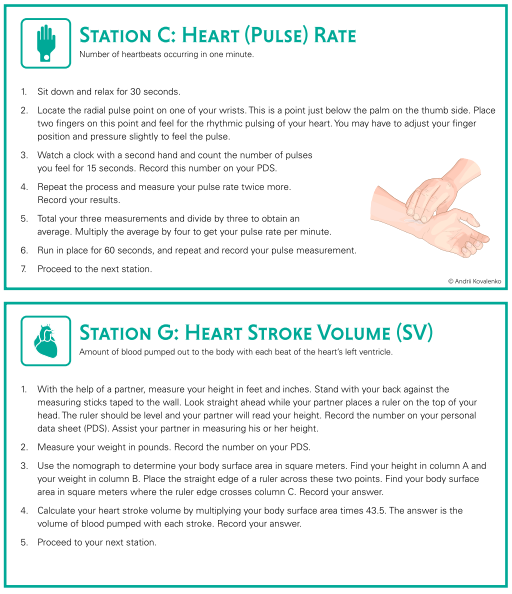
1. With the help of a partner, measure your height in feet and inches. Stand with your back against the measuring sticks taped to the wall. Look straight ahead while your partner places a ruler on the top of your head. The ruler should be level and your partner will read your height. Record the number on your personal data sheet (PDS). Assist your partner in measuring his or her height.
2. Measure your weight in pounds. Record the number on your PDS.
3. Use the nomogram to determine your body surface area in square meters. Find your height in column A and your weight in column B. Place the straight edge of a ruler across these two points. Find your body surface area in square meters where the ruler edge crosses column C. Record your answer.
4. Calculate your heart stroke volume by multiplying your body surface area times 43.5. The answer is the volume of blood pumped with each stroke. Record your answer.
5. Proceed to your next station.

Station H: Cardiac Output (CO)

Amount of blood pumped from the left ventricle of the heart per minute.

You will need the data from Stations C and G before beginning.

1. Cardiac output is the volume of blood pumped by the heart in one minute. Determine your resting cardiac output by multiplying your stroke volume (Station G) by your resting pulse rate (Station C). Record your answer on your PDS.
2. Determine your exercise cardiac output by multiplying your stroke volume (Station G) by your exercise pulse rate (Station C). Record your answer.
3. Proceed to your next station.



Station C: Heart (Pulse) Rate

Number of heartbeats occurring in one minute.

1. Sit down and relax for 30 seconds.
2. Locate the radial pulse point on one of your wrists. This is a point just below the palm on the thumb side. Place two fingers on this point and feel for the rhythmic pulsing of your heart. You may have to adjust your finger position and pressure slightly to feel the pulse.
3. Watch a clock with a second hand and count the number of pulses you feel for 15 seconds. Record this number on your PDS.
4. Repeat the process and measure your pulse rate twice more. Record your results.
5. Total your three measurements and divide by three to obtain an average. Multiply the average by four to get your pulse rate per minute.
6. Run in place for 60 seconds, and repeat and record your pulse measurement.
7. Proceed to the next station.

Station G: Heart Stroke Volume (SV)

Amount of blood pumped out to the body with each beat of the heart's left ventricle.

1. With the help of a partner, measure your height in feet and inches. Stand with your back against the measuring sticks taped to the wall. Look straight ahead while your partner places a ruler on the top of your head. The ruler should be level and your partner will read your height. Record the number on your personal data sheet (PDS). Assist your partner in measuring his or her height.
2. Measure your weight in pounds. Record the number on your PDS.
3. Use the nomograph to determine your body surface area in square meters. Find your height in column A and your weight in column B. Place the straight edge of a ruler across these two points. Find your body surface area in square meters where the ruler edge crosses column C. Record your answer.
4. Calculate your heart stroke volume by multiplying your body surface area times 43.5. The answer is the volume of blood pumped with each stroke. Record your answer.
5. Proceed to your next station.

Nomogram

For Estimating Body Surface Area (BSA)

EXAMPLE

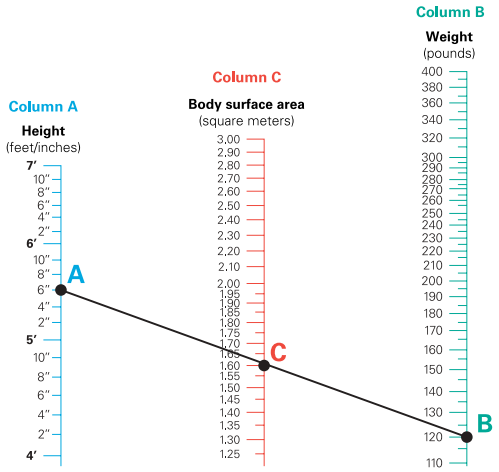
In the nomogram below, the subject is 5 ft, 6 in., in height (A) and weighs 120 lb (B).

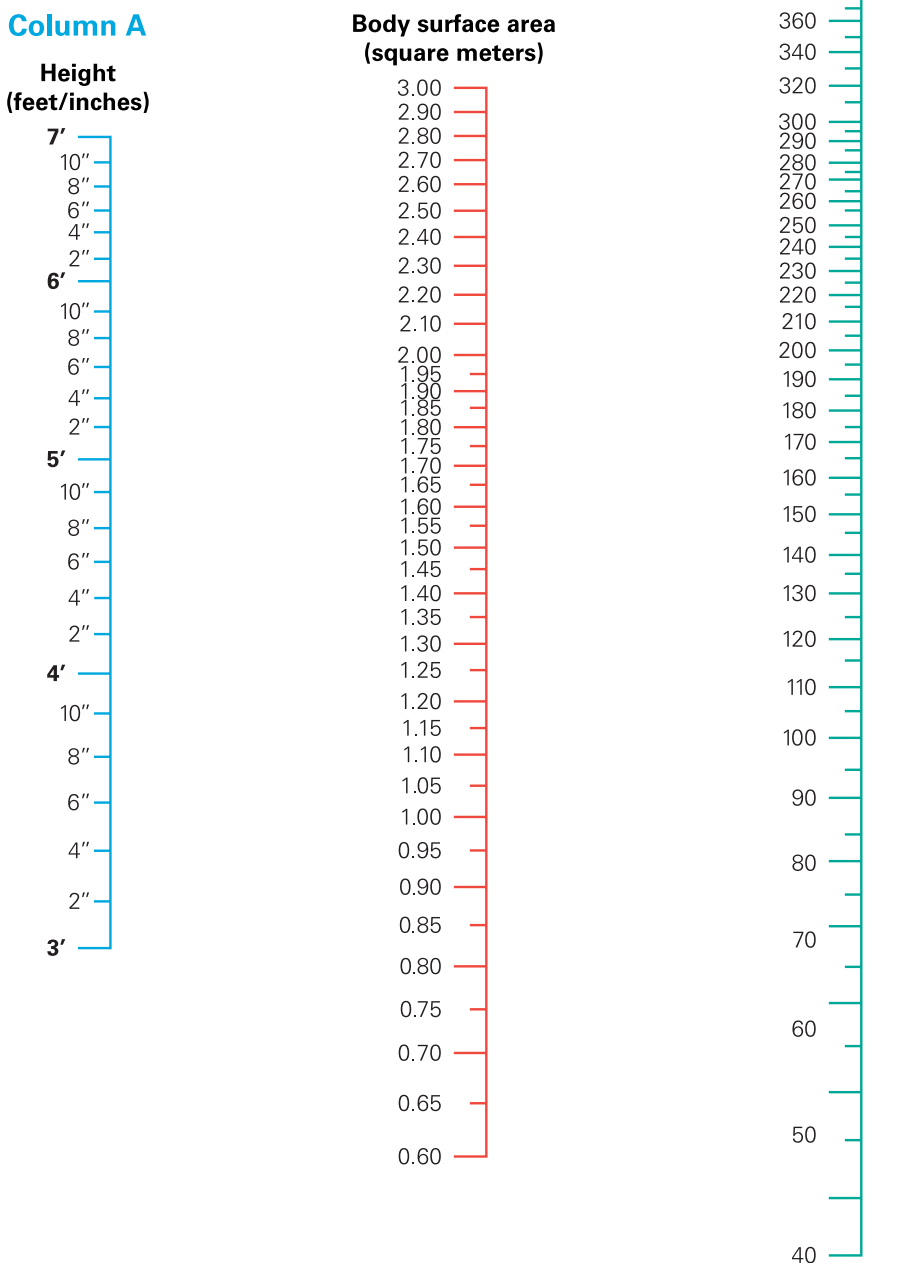
Body surface area (BSA) is revealed by connecting the dots with a line (see below).

Heart Stroke Volume in mL is determined by multiplying BSA x 43.5.

In this example, the equation and result are as follow.

1.6 m^2 x 43.5 mL/m^2 = 69.6 mL





5

Setup: 10 minutes | **Class:** One 45-minute class period

Calculating Coronary Artery Disease Risk

Overview

Students learn about risk factors for coronary artery disease (CAD) and heart attack, strategies for lowering those risks, and the importance of doing so. They use an interactive online tool from the American Heart Association to calculate the cardiovascular health score for Arturo, Brian and Angela, the three fictitious characters being followed through the unit.

Reduce Risk for Heart Disease

1. Be active.
2. Control cholesterol.
3. Eat better.
4. Manage blood pressure.
5. Maintain a normal weight.
6. Lose weight if needed.
7. Reduce blood sugar.
8. Stop smoking.

Heart Scores

A Heart Score of 10 means a person has the lowest possible risk of developing heart disease and stroke. The information below explains the scores for each character (see "Character Info," sidebar, page 41).

Arturo, Brian and Angela, are in the emergency room. By now, students will have surmised that all three may be experiencing some type of heart-related crisis. One condition that may have contributed the three patients' current health problems is coronary artery disease (CAD). As students discovered in Activity 2, risk is the possibility of damage, injury or other harm. It often is represented as the probability of a negative outcome. Students learned that in the United States, a person has a one-in-six lifetime risk of dying from heart-related illness.

Not everyone has the same risk for CAD or a heart attack, so it is important to understand (1) behaviors that increase the risk for developing heart disease, and (2) which behaviors or other factors can be modified to decrease the risk. Three important risk factors for developing heart disease cannot be modified: gender (sex), age, and heredity (family history and genetics). You cannot control the genes you inherit, and the chances for heart attack increase with age.

However, we can control, to more or less extent, many health factors that influence risk for heart disease. Personal choices about diet, exercise and smoking can affect cholesterol levels, blood pressure, body weight and blood sugar levels. In fact, smoking and diabetes (uncontrolled blood sugar) rank among the most important factors known to increase risk for heart attack. Teenage smoking causes immediate and long-term cardiovascular damage, and smoking into adulthood dramatically increases a person's chances of dying prematurely. Diabetes interacts with other risk factors, such as high blood pressure, to cause additional harm to the heart and circulatory system. By understanding our personal risks and making lifestyle decisions to lower risks that may be modified, we can take steps, even at an early age, to reduce the chances for CAD or a heart attack.

Materials

Teacher

- Interactive white board or video projector and computer
- Internet access
- Access to computer lab or individual computers (one per student)
- Copies of "Risky Business" activity sheet (one per student)
- Copies of "Heart Disease and Risk Factors" (enough for a classroom set, to be added to each team's reference folder when the activity is completed)
- Copies of "Patient Information Sheet" (enough for a classroom set, to be added to each team's reference folder when the activity is completed)

Per Student

- Access to a computer and the Internet
- "Personal Data Sheet" completed in the activity, "Heart: Basic Measurements"
- Copy of "Risky Business" activity sheet
- Copy of "Heart Disease and Risk Factors"
- Copy of the "Patient Information Sheet"

Character Info

ARTURO is a 56-year-old male with a rather unhealthy lifestyle that includes a high fat/high calorie diet and limited exercise. He is severely overweight, but has never had a cardiac event. If Arturo had diabetes, his Heart Score would decrease almost two-fold.

Diabetes is a MAJOR risk factor for heart disease. In combination with other risk factors, it can cause harmful changes to the heart, resulting in earlier and more severe cardiovascular problems. Treatments, such as heart bypass surgery or angioplasty to unblock arteries, are less successful in persons with diabetes.

BRIAN is a 40-year-old male under a great deal of stress. He also smokes cigarettes. When students change Brian's values from "smoker" to "nonsmoker," they will notice that his new Heart Score increases, and that his risk of coronary artery disease drops two-fold.

Smoking is a MAJOR risk factor for heart disease and heart attack, and in combination with other risk factors, it greatly increases the risk of cardiovascular problems. The 2012 Report of the United States Surgeon General describes tobacco use among youth ages 12–17 as epidemic. Ninety percent of all smokers begin before age 18. Tobacco use by youth causes immediate and long-term damage. Among youth who continue to smoke, one in three will die prematurely.

ANGELA is an active 35-year-old woman with a healthy lifestyle. However, she has high blood pressure (hypertension). This may be genetic, as her family has a history of cardiovascular disease. Controlling her blood pressure gives Angela an almost perfect Heart Score.

Setup

Be sure students have their "Personal Data Sheets" from the previous activity. Each student also will require access to his/her own computer, either in a computer lab or the classroom. Students will work individually unless there is a need to share computers.

Write the Internet address for My Life Check - Life's Simple 7 Success Plan on the board or overhead **(http://mylifecheck.heart.org/AssessmentTools2/main_en_US.html)**. It also is possible to access My Life Check - Life's Simple 7 Success Plan by clicking the "Get Your Assessment" tab at the top of home page for My Life Check **(http://mylifecheck.heart.org)**. This pathway will require each user to register.

In a computer lab setting, the first class to conduct the activity should bookmark the link for the classes that follow. If bookmarked, have the students title the bookmark "Heart Score." At the end of the activity, have students return the reference materials.

Procedure

1. Begin by asking students, *Do you think we can change our risks for certain diseases?* Allow time for student comments. Alternately, create a T-chart on the board and list risk factors that students believe CAN and CANNOT be changed. Ask, *Do you think lifestyle decisions may have made Arturo, Brian or Angela more or less likely to have medical problems?* Have students name some of the risk factors for Arturo, Brian, and Angela. Tell students that they are going to learn how these factors impact each character.
2. Make the article, "Heart Disease and Risk Factors," available for students in the reference folder or notebook. You may want to review this material with the class.
3. Use a interactive white board or computer and projector to access the Internet and demonstrate the American Heart Association's My Life Check - Life's Simple 7 Success Plan web site **(http://mylifecheck.heart.org/AssessmentTools2/main_en_US.html)**. As an example, you may want to work through Arturo's case with students.
4. Provide each student with a copy of the "Patient Information Sheet" and "Risky Business" activity sheet. Explain that the "Patient Information Sheet" includes some of the results from blood tests conducted on each patient while he or she was in the emergency room. As you work through the My Life Check process for Arturo, have students provide the answers for each question. Even if you conduct this as a demonstration, have each student record the scores for Arturo in Table 1.
5. Students should work independently to answer all questions on the "Risky Business" activity sheet.
6. As a final step, have students enter as much of information as possible to compute their own Heart Scores. They can find their blood pressure measurements on their "Personal Data Sheets." Students should not guess at other information, such as cholesterol. Unless they know the values, students should leave those spaces blank.
7. Discuss students' answers on the "Risky Business," sheet. A summary of the risk factors for each character is given in "Character Info" to the left.

Extensions or Homework

Have students visit the Healthy Eating Plate online to learn what constitutes a healthy diet **(http://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/pyramid/)**. Direct students to work in pairs to create menus for meals that would meet the Healthy Eating Plate guidelines.

Source material for "Heart Disease and Risk Factors Reference" (p. 44):
Agency for Healthcare Research and Quality
American Heart Association
National Heart Lung and Blood Institute (NHLBI). 2012 Report of the Surgeon General. (United States)

Risky Business

Student Name

1. We left Arturo, Brian and Angela on the way to their way to the emergency room. You will determine if each patient suffered a heart attack in a later activity. In this activity, we are going to use information gathered at the hospital to calculate the current life time risk of a heart attack for each patient.
2. Using a computer with Internet access, go to the American Heart Association's My Life Check® Life's Simple 7™ Success Plan at web link: **http://mylifecheck.heart.org/AssessmentTools2/main_en_US.html**
3. Once you are at the web site, select "Get started." On the "Terms and Conditions Agreement" screen, select "Yes" at the bottom of the box.
4. Screen 1 of 8 indicates the seven areas for health measurement in this plan. Once you have familiarized yourself with this screen, select "Next."

Find Arturo's Score

5. Using the data on the "Patient Information Sheet," answer the questions for "Arturo" as requested in the computer program. Complete Screens 2 through 4.
6. Use Screens 5 and 6 to calculate Arturo's current level of health for each of the seven health measurements.
7. Use Screen 7 to calculate the current Heart Score for Arturo. Record this score in the line labeled, "Current Health Information" in Table 1, below.

   Note. The best possible Heart Score is 10. This means that you have the greatest potential for a heart healthy life and the lowest possible risk of developing heart disease and stroke.

Table 1.

	Heart Score
Current Health Information	
With Younger Age	
With Diabetes	

8. How would being younger affect Arturo's Heart Score? Select the "Previous" button at the bottom of Screen 7 and continue doing this until you reach Screen 2. Change his age to 20 and step forward to obtain his "younger" Heart Score from Screen 7.
9. Record this new Heart Score next to "With Younger Age" in Table 1.
10. What is the effect of age in determining the Heart Score? Write a short answer on the back of this sheet.
11. How would having diabetes affect Arturo's Heart Score? Select the "Previous" button at the bottom of Screen 7, and continue doing this until you reach Screen 2. Change his age back to 56 and change his diabetes status to "Yes." Step forward to Screen 4 and change his fasting blood sugar to 140. Continue to see his new Heart Score and enter the number in the second row of Table 1.
12. How does having diabetes affect the Heart Score? Write a short answer on the back of this sheet.

Find Brian's Score

13. Select "Previous" until you are back at Screen 2. Enter Brian's risk factor data from the Patient Information Sheet. Enter his calculated Heart Score in Table 2.

Table 2.

	Heart Score
Current Health Information	
With Smoking Risk Removed	

14. Brian was identified as a smoker. Select "Previous" to access Screen 4 and remove the smoking risk. Record Brian's new Heart Score in Table 2.
15. How does smoking affect Brian's Heart Score? Write a short answer on the back of this sheet.

Find Angela's Score

16. Select "Previous" until you are back at Screen 2. Enter Angela's risk factor data from the "Patient Information Sheet". Enter her Heart Score into Table 3.

Table 3.

	Heart Score
Current Health Information	
With Controlled Blood Pressure	

17. Go back and change Angela's blood pressure readings to a normal value of 105/75 mm Hg. Enter her new Heart Score in Table 3.
18. How does having a normal blood pressure reading affect Angela's Heart Score?
19. Select "Previous" until you are back at Screen 2. Now, compute your own Heart Score. Enter as much information as possible to obtain your Heart Score. Summarize the information your entered on a separate sheet of paper, and write your Heart Score on the sheet. Bring your **personal** Heart Score information with you to your next class.

Patient Information

RISK FACTOR	ARTURO	BRIAN	ANGELA
1. Gender	Male	Male	Female
2. Age	56	40	35
3. Race/Ethnicity	Hispanic	White	Black
4. Height	5'9"	5'10"	5'5"
5. Zip code (outside of US)	NA	NA	NA
6. Previous heart or blood vessel disease events, conditions or procedures	No	No	No
7. Diabetes	No	No	No
8. Weight	260	195	120
9. Physical exercise			
Moderate activity	0	100	140
Vigorous Activity	0	0	0
10. Cups of fruit daily	1	2	2
11. Cups of vegetables daily	2.5	3	3
12. Servings of fish weekly: ≥ 2	No	No	Yes
13. Whole grains daily: ≥ 3 oz	No	No	Yes
14. Sugar beverages weekly: < 36 oz	No	No	No
15. Sodium (salt) daily: < 1,500 mg	No	No	Yes
16. Systolic blood pressure	135	165	160
17. Diastolic blood pressure	95	105	105
18. Total blood cholesterol	320	247	105
19. Fasting Glucose (sugar)	85	65	70
20. Smoking	No	Yes	No

NA = Not applicable

Heart Disease and Risk Factors

Reference

When discussing health, risk factors are conditions or behaviors that increase the likelihood of developing a disease. Some risk factors can be controlled, but others cannot. Not everyone has the same risk for coronary artery disease (CAD) or a heart attack. It is important to know behaviors that increase or decrease the risk for developing heart disease.

The three main risk factors for heart disease that cannot be modified are gender (sex), age, and heredity (family history and genetics). You cannot control the genes you inherit, or the reality that risk for heart attack increase with age. In fact, 82% of people who die from CAD are 65 or older. Men's risk of a heart attack increases during middle age; women's risk rises noticeably after 55 years of age. But even then, a woman's risk is lower than a man's. People of African American, Mexican American, American Indian, and native Hawaiian descent are at higher risk for heart disease than members of other groups. And individuals whose parent or parents had heart disease are more likely to than others to develop CAD.

The inability to change our age or heredity makes it even more important to manage risk factors over which we have some control. Personal choices about diet, exercise and smoking can affect cholesterol levels, blood pressure, body weight and blood sugar levels, all important factors related to the risk for heart attack. By understanding our risks and making decisions to lower risks that may be modified, we can take steps, even at an early age, to reduce the chances for CAD or heart attack.

Smoking is a major risk factor in men and women, and combined with other risk factors, it greatly increases the chance of cardiovascular problems. Smokers are 2–4 times more likely than non-smokers to develop CAD or have a heart attack. Further, constant exposure to other people's cigarette smoke (secondhand smoke) increases the risk of heart disease in the nonsmoker. The *2012 Report of the United States Surgeon General* describes tobacco use among youth ages 12–17 as epidemic, and 90% of all smokers begin before age 18. Tobacco use causes immediate and long-term damage, including CAD. Among young people who continue to smoke, one in three will die prematurely. Among youth who continue to smoke, one in three will die prematurely from smoking. Smoking harms nearly every organ in the body and is one of the main preventable causes of death and disease in the United States.

High total cholesterol and "bad" LDL cholesterol are associated with increased risk for heart disease. Total cholesterol values typically should not be higher than 200 mg/dL. LDL cholesterol is the main source of cholesterol that builds up in the walls of the arteries and causes CAD. Foods high in saturated fats are high in cholesterol; we can reduce the risk for CAD by limited these foods. "Good" HDL cholesterol lowers the risk for heart disease by helping to (1) remove LDL cholesterol from the bloodstream, (2) prevent formation of plaque in the arteries, and (3) remove plaque that already has collected on artery walls. Higher HDL values are associated with lower risk of heart disease. Regular, vigorous exercise is a great way to increase HDL cholesterol levels.

Blood pressure is the force of the blood against the walls of the arteries. When it stays elevated over time, it is called high blood pressure. This condition increases the heart's workload, and strains the heart, blood vessels and kidneys. High blood pressure has been associated with heart attack, stroke and kidney failure. Because it usually has no warning signs or symptoms, high blood pressure is especially dangerous and sometimes is referred to as the silent killer. When combined with other risk factors, such as obesity, diabetes, high cholesterol, or smoking, high blood pressure can increase the risk of a heart attack several fold.

In the last 30 years, obesity has tripled among people aged 12–19 years. Excess body fat, especially around the waist, increases the risk of a heart attack, even in the absence of other risk factors. Quite simply, the heart must work harder to supply nutrients and oxygen to the extra body mass. Losing just 10 pounds lowers the risk of a heart attack. Even in young people, overweight or obesity increases the risk of developing heart disease, high blood pressure, type 2 diabetes, gallstones, breathing problems and certain cancers.

Physical inactivity is a risk factor that almost anyone can change. Regular exercise, such as 30 minutes of walking per day, helps to prevent heart and blood vessel disease, and it actually strengthens the heart. The combination of regular exercise and a healthy diet is one of the best defenses against heart disease, because it helps control risk factors like high cholesterol, high blood pressure and diabetes.

Diabetes (uncontrolled high blood sugar) is a major risk factor for heart and blood vessel disease. In combination with other risk factors, it can harm the heart and cause more severe cardiovascular problems, and at a younger age. Surgical treatments for heart disease, such as bypass surgery or angioplasty, are less successful in persons with diabetes. In fact, people with diabetes have the same risk for future heart problems as do individuals who have had a heart attack. Sixty-five percent of diabetes patients die from some form of heart or blood vessel disease, so it is important for people with diabetes to work closely with healthcare providers to manage and control blood sugar levels through a program of diet and exercise.

There are three kinds of diabetes. Type 1 diabetes is inherited and usually is diagnosed in children or teenagers. Type 2 diabetes, the most common form, can develop at any age. Being overweight and inactive increases the risk for type 2 diabetes. A third form of diabetes, gestational diabetes, develops in some women during pregnancy. It usually goes away after the baby is born, but it does increase a woman's risk of developing type 2 diabetes later in life. ■

6

Setup: 30 minutes | **Class:** One or two 45-minute class periods

Team Diagnosis of Three Cases

Overview

Students work in teams and take on the role of medical personnel to analyze symptoms, order diagnostic tests, and determine the nature of the health crises being experienced by Arturo, Brian and Angela.

Health-related Careers

- Accountant
- Admitting Clerk
- Anesthesiologist
- Cardiologist
- Data and Systems Analyst
- Dietitian
- Electrocardiograph (EKG) Technician
- Emergency Medical Technician (EMT)
- Emergency Room Registered Nurse (ER-RN)
- Emergency Services Physician
- Licensed Practical Nurse
- Medical Laboratory Technician
- Nurse Anesthetist
- Pharmacist
- Pharmacy Technician
- Phlebotomist
- Scrub Nurse
- Surgeon
- Surgical Nurse
- Surgical Technologist

Physicians diagnose hearts attacks (acute myocardial infarctions, or MI) based on a patient's signs and symptoms, physical examination findings, electrocardiogram (EKG or ECG) results, and cardiac enzyme studies. Emergency personnel also assess the heart rate, blood pressure, breathing rate, and general appearance and alertness of the individual in crisis.

Typically, in cases where heart attack is suspected, emergency room personnel will attach wire electrodes or leads to the patient's chest and perform an EKG (a graphical record of the heart's electrical activity as it contracts and relaxes). Each heartbeat sends an electrical signal that travels from the top of the heart to the bottom, causing the heart to contract and pump blood. These electrical signals set the rhythm of the heartbeat, which produces the familiar jagged-line pattern on an EKG monitor. Emergency room professionals viewing the EKG printout can detect the rate of the heartbeat, abnormal heart rhythms, and the strength and timing of the electrical signals as they pass through each part of the heart. Students learned about this test in the activity, "Introduction to Personal Stories."

During a heart attack, damaged or destroyed heart muscle cells release chemicals, particularly proteins, called cardiac enzymes, into the bloodstream. Specific tests that measure the blood levels of these proteins can help determine whether a patient has had a heart attack. Normally, very low levels of cardiac enzymes are found in the blood, but the levels rise dramatically when heart muscle is injured or destroyed (as during a heart attack). Physicians usually order repeated blood tests of two cardiac proteins—creatine phosphokinase (CK) and troponin (T)—and compare their levels over time.

CK is an enzyme found in heart, brain, muscle and blood of healthy people. Blood levels of CK rise four to six hours after muscle damage, and peak about 18–24 hours after a heart attack. CK-MB is a form of the enzyme found mainly in heart muscle, so elevated blood levels suggest heart muscle damage. Troponin is released into the bloodstream more quickly (two to six hours after heart cell damage) than CK is, and blood levels of T peak in 12–26 hours. Because T is an "earlier" and somewhat more accurate indicator of cardiac muscle cell damage than CK is, it is the preferred marker for diagnosing heart attack. But both cardiac proteins typically are measured in patients suspected of having MI.

Materials

Teacher

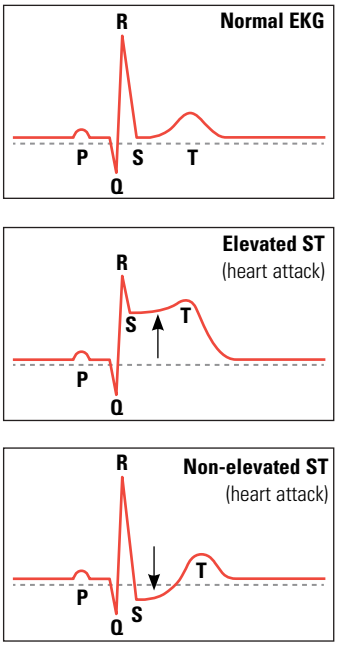
- Interactive white board or video projector and computer
- Internet access
- Copy of "Teacher Key to Diagnostic Tests and Exam Results"
- Copies of "Diagnosis of a Heart Attack" (add to Reference Folders)
- Copies of "Table of Diagnostic Tests" (add to Reference Folders)

Producing an EKG

With a typical EKG, a technician connects electrodes from a machine to a patient's chest, upper arms and legs. The machine records the heart's rhythm, producing the EKG printout.

Image courtesy of the NHLBI (http://www.nhlbi.nih.gov/health/health-topics/topics/hb/understanding.html).

EKG Readings



EKG readings provide information about the location and severity of arterial blockages in the heart. Usually, an EKG with an elevated ST segment indicates a more severe form of heart attack, with greater heart muscle damage.

- Diagnostic Test Cards (one set per student team), photocopied onto card stock, cut into sets and stored in zip-top bags
- Copies of the "Medical Team Instruction Sheet" (one per student team)
- Copies of "Patient Diagnosis" sheets for Arturo, Brain and Angela (one set per team)
- Copies of "Arturo: Part Two," "Brian: Part Two" and "Angela: Part Two" (one set per team)
- Copies of Expert Diagnostic team certificates (optional)

Per Student

- Set of Diagnostic Test Cards
- Copy of "Medical Team Instruction Sheet"
- Copy of "Patient Diagnosis" sheets for Arturo, Brain and Angela
- Personal story folders for each character
- Reference folder with a copy of the "Table of Diagnostic Tests" (added to folder previously, in the activity, "Introduction to Personal Stories") and "Diagnosis of a Heart Attack" (add to folder).
- Copy of "Arturo: Part Two," "Brian: Part Two" and "Angela: Part Two" (Do not add to the personal story files until after the activity is completed. Students will use this information at the end of the activity.)

Setup

Photocopy the Diagnostic Test Cards onto card stock and cut into sets. Make at least one copy per team of the "Table of Diagnostic Tests," "Diagnosis of a Heart Attack" and Part Two of the personal stories. Do not give students Part Two of the personal stories until they have completed their diagnostic teamwork on each patient. A "Diagnosis Answer Key" is provided to the left.

Have students work in teams of four.

Note. You may want to allow most of one class period to work through the first case, and follow with the other two cases during a second class period.

Procedure

1. Remind students that Arturo, Brian and Angela still are in the emergency room. Project the video, Scientific Decision-making, Part Two **(http://www.bioedonline.org/lessons-and-more/resource-collections/scientific-decision-making/)** to familiarize students with changes in the EKG and blood tests that are used to identify myocardial infarction (heart attack). Pause the video after the introduction. You will return to the video after student teams have finished diagnosing each patient. Depending on your students, you also may have them read the reference sheet, "Diagnosis of a Heart Attack," before beginning the activity or as homework the day before.
2. Tell students that they will work in teams, as medical personnel, to diagnose Arturo, Brian and Angela. Provide each team with the updated Reference folder, all three personal story folders (without Part Two for each character), a copy of the "Medical Team Instruction Sheet," and a set of Diagnostic Test Cards.
3. Read the "Medical Team Instruction Sheet" to the class, ensuring that students understand the diagnosis process. Answer any questions before proceeding.
4. Have students start with Arturo's case. Project or write the following questions on the board: *What do we know about the patient? What information do we need to diagnose his condition?* You may want to work through Arturo's case as a class, to be sure students understand the process.

Diagnosis Answer Key

CHARACTER: ARTURO

Diagnosis: Appendicitis; no heart attack; hypertension

Evidence: Abdominal tenderness, high white blood count, CT scan all indicated appendicitis. Normal EKGs and low levels of cardiac enzymes (in the normal range) suggested that a heart attack had not happened. Blood pressure was above 120/80, indicating hypertension.

CHARACTER: BRIAN

Diagnosis: Heart attack (myocardial infarction); hypertension

Evidence: Fast and irregular heart rhythm on EKGs, elevated levels of CK-MB and troponin, and a coronary angiogram provided evidence of heart attack. Blood pressure was above 120/80, indicating hypertension.

CHARACTER: ANGELA

Diagnosis: Pregnancy; slight anemia; hypertension

Evidence: Positive test confirmed pregnancy. Hemoglobin below 11 gm per dL is considered low (mild anemia) in females. Blood pressure was above 120/80, indicating hypertension.

Grand Rounds

Grand rounds are important teaching tools, used to help keep doctors and healthcare professionals up to date. Grand rounds presentations typically are lectures that focus on the medical problems and treatment of a particular patient, or on findings from new research on a variety of medical topics.

5. Students will select diagnostic tests or physical exam results to give them additional information about Arturo's condition—so that they can arrive at a diagnosis. The information on Arturo's "Patient Diagnosis" sheet will help them decide which diagnostic tests to order. Inform students that they also may request physical exam results (in the appropriate table on the "Diagnosis Sheet") to gain further insight into Arturo's medical condition. Each team may request three results at a time.
6. You will serve as monitor, using the Teacher Key to Diagnostic Test Results to fill in the "Results" column for each test requested by student teams. You may want to appoint one or more students to serve as additional monitors.

   Note: Students may calculate the CK-MB% of total CK on their own, or request the calculation result (at an additional cost).
7. After all teams have submitted a diagnosis, determine a winner based on the completeness of the diagnosis and time submitted (see "Diagnosis Answer Key," left sidebar). In case of a tie, also consider the amount of funds expended. (If you wish to print certificates for members of winning teams, a template is included at the end of this activity.)
8. Have members of the winning team present the evidence they used to reach a diagnosis. The class may question the team's presentation, with you as moderator. Ask the team, *Could you have saved the patient any money by ordering fewer or different tests?* Have the team defend its test choices. Allow further classroom discussion as necessary.

   OR hold team presentations after all three patients have been diagnosed. Conduct "Grand Rounds" in class (see "Grand Rounds," left sidebar), during which time each team presents one of its diagnoses and evidence. Following each team's report, others in the class may contribute to, or challenge the presentation. If lab coats are available, students should wear them for their Grand Rounds presentations.
9. Have teams repeat steps 4–8 to develop and reach diagnoses for Brian and Angela. Assist the teams as before. Depending on the time required to complete Arturo's diagnosis, Brian's case can serve as the start of day two for this activity.
10. After all the teams have made their diagnoses and presented their outcomes, read or have students read Part Two of each personal story. You also may show the next section of the video narrative.

    Explain that the additional information includes the emergency room physician's explanation of tests ordered and the reasoning for them, along with a definitive diagnosis and follow-up for each character.
11. Conclude by having students discuss the cases as a whole. Ask, *Were you surprised by any of the diagnoses? At first, did you think all of the patients were having a heart attack? Was cost a factor in any of the diagnoses?*
12. You may want to have each team write and submit a report of the tests ordered, and conclusions reached for each patient.

Extensions or Homework

Several kinds of careers are encountered in the personal stories of Arturo, Brian and Angela. Have students research and present different health-related careers to the class. Presentations should include a description of the career, educational requirements to obtain a position in this field, typical duties/responsibilities, and work settings for those who do this job. A partial list of professions involved in the cases is provided (see sidebar, p. 45). You can add to this list or allow students to choose a different health-related career, with your approval.

Teacher Key

To Diagnostic Tests and Exam Results

ARTURO: DIAGNOSTIC TESTS	ER: 7:50 PM	2:00 AM	8:00 AM	2:00 PM
Total CK series (IU/L)**	74	81	77	74
CK-MB (IU/L)**	2.2	2.3	2.2	2.2
CK-MB Fraction (% of total CK)	3.0%	2.8%	2.9%	3.0%
Troponin (ng/mL)**	0.06	0.07	0.06	0.06

PE-Abdomen Palpation* (physical exam)	Tenderness with guarding, lower right quadrant	CBC RBC*	4.7
PE-Ears, Eyes, Nose, Throat	Not remarkable	CBC WBC*	15,500
PE-Elbows and Knee Reflexes	Not remarkable	CBC Hemoglobin*	16
PE-Heart with Stethoscope	Not remarkable	CT Scan-Abdomen**	Inflamed appendix
PE-Lungs with Stethoscope	Not remarkable	CT Scan-Chest	Not remarkable
Potassium (mEq/L)*	155	CT Scan-Head	Not remarkable
Sodium (mEq/L)*	4.8	Pregnancy Test	NA

BRIAN: DIAGNOSTIC TESTS	ER: 1:45 PM	8:00 PM	2:00 AM	8:00 AM
Total CK series (IU/L)**	150	181	220	174
CK-MB (IU/L)**	6.4	19.9	47	15.7
CK-MB Fraction (% of total CK)	4.3%	11.0%	21.4%	9.0%
Troponin (ng/mL)**	0.15	1.88	0.97	0.75

PE-Abdomen Palpation* (physical exam)	Not remarkable	CBC RBC*	5.2
PE-Ears, Eyes, Nose, Throat	Not remarkable	CBC WBC*	7.1
PE-Elbows and Knee Reflexes	Not remarkable	CBC Hemoglobin*	16.3
PE-Heart with Stethoscope	Not remarkable	CT Scan-Abdomen**	Not remarkable
PE-Lungs with Stethoscope	Not remarkable	CT Scan-Chest	Not remarkable
Potassium (mEq/L)*	144	CT Scan-Head	Not remarkable
Sodium (mEq/L)*	4.2	Pregnancy Test	NA

ANGELA: DIAGNOSTIC TESTS	ER: 10:15 AM	4:00 PM	10:00 PM	4:00 AM
Total CK series (IU/L)**	74	80	75	55
CK-MB (IU/L)**	1.2	0.9	0.8	0.3
CK-MB Fraction (% of total CK)	1.6%	1.1%	1.1%	0.5%
Troponin (ng/mL)**	0.05	0.06	0.04	0.05

PE-Abdomen Palpation* (physical exam)	Tenderness in lower middle abdomen	CBC RBC*	3.0
PE-Ears, Eyes, Nose, Throat	Not remarkable	CBC WBC*	4.2
PE-Elbows and Knee Reflexes	Not remarkable	CBC Hemoglobin*	9.9
PE-Heart with Stethoscope	Not remarkable	CT Scan-Abdomen**	Should not be done
PE-Lungs with Stethoscope	Not remarkable	CT Scan-Chest	Not remarkable
Potassium (mEq/L)*	140	CT Scan-Head	Not remarkable
Sodium (mEq/L)*	4.5	Pregnancy Test	Positive

NA = Not applicable

* Valuable in preliminary or initial diagnosis.

** Important for definitive diagnosis of Angela's medical condition

Medical Team Instructions

Emergency Room Case Studies

You are third-year medical students completing a rotation in the emergency room of a county hospital. Your team will use clinical evidence to decide on a diagnosis for Arturo, Brian, and Angela. Your diagnosis must indicate (1) if each patient had a cardiac event and (2) what other medical issues, if any, are involved in each patient's health condition.

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INSTRUCTIONS

1. Complete your diagnosis of one patient before moving on to the next. Your teacher will tell you the order in which you should diagnose patients.

2. Use each patient's symptoms and vital signs, along with information in the Table of Diagnostic Tests. Read "Diagnosis of a Heart Attack" before you begin. This will give you some ideas about the types of information you need to make a diagnosis.

3. Your team must decide which additional tests (from the Diagnostic Test Cards) are needed for each patient. You also may request physical exam results. You may request three test or exam results at a time. But be aware, each diagnostic test or physical exam request card has a cost (dollar value). Medical personnel must try to provide the best care possible without wasting money on unnecessary tests.

4. The first team to make the correct, complete diagnosis for each patient will be recognized as Diagnostic Experts! But remember, while looking for evidence of a heart attack, you also may find evidence that leads to an alternative or combined diagnosis. A complete diagnosis must (1) state if the patient had a cardiac event and (2) identify other medical issues, if any, that are involved in the patient's current health condition. In the event of a tie, the team that has spent the fewest dollars wins. All teams must be prepared to defend their findings.

5. After you have decided on the first three diagnostic test results to order, record your selections, along with the corresponding point values, in Step 3 of the patient table. Bring the patient diagnosis sheet to your teacher for approval to receive requested test results.

6. Return to your work area and review your test results to decide if you have enough information to make a complete diagnosis. If so, record your diagnosis in Step 4 and submit the patient diagnosis sheet to the teacher.

7. If you need more information, you may select up to three more tests. Request them on the patient sheet as before, and submit your request to the teacher. You may continue to request test results until you have enough information. Once you have a diagnosis, record it in Step 4 and submit the patient diagnosis sheet to the teacher.

Patient Diagnosis: Arturo

1. Vital signs for Arturo, taken at his home by EMS, and in the ER, are provided in the table to the right. They will help you to diagnose Arturo's condition.

2. What do you already know about Arturo? Record any symptoms or information from the emergency room that may help you to choose additional diagnostic tests.

Vital Signs and EKG Results

Vital Sign	EMTs: 7:15 PM	ER-RN: 7:45 PM
Temperature	101.0 °F	102.0 °F
Blood pressure (mm Hg)	145/100	142/95
Pulse rate (beats per minute)	120 bpm	92 bpm
Respiration rate (per minute)	28	20
Oxygen saturation (pulse ox)	92%	95%
Electrocardiogram (EKG)	Normal	Normal

3. List the diagnostic tests your team selects for Arturo, and identify the points spent for each test. Have your teacher approve the tests and record the results. You may choose three test results at a time.

Diagnostic Tests/Physical Exam Requests	Points Spent	Results

4. Diagnosis for Arturo:

Teacher Time Stamp: _____ Dollars Spent: _____

5. Prepare your team's defense on the back of this page.

Patient Diagnosis: Brian

1. Vital signs for Brian, taken at the school by EMS,and in the ER, are provided in the table to the right. They will help you to diagnose Brian's condition.

2. What do you already know about Brian? Record any symptoms or information from the emergency room that may help you to choose additional diagnostic tests.

Vital Signs and EKG Results

Vital Sign	EMTs: 12:55 PM	ER-RN: 1:15 PM
Temperature	98.6 °F	98.6 °F
Blood pressure (mm Hg)	155/100	165/105
Pulse rate (beats per minute)	122 bpm (regular)	120 bpm (regular)
Respiration rate (per minute)	38 (shallow)	32 (shallow)
Oxygen saturation (pulse ox)	85%	87%
Electrocardiogram (EKG)	–	Irregular pattern

3. List the diagnostic tests your team selects for Brian, and identify the points spent for each test. Have your teacher approve the tests and record the results. You may choose three test results at a time.

Diagnostic Tests/Physical Exam Requests	Points Spent	Results

4. Diagnosis for Brian:

Teacher Time Stamp: _____ Dollars Spent: _____

5. Prepare your team's defense on the back of this page.

Patient Diagnosis: Angela

1. Vital signs for Angela, taken at home by EMS, and in the ER, are provided in the table to the right. They will help you to diagnose Angela's condition.

2. What do you already know about Angela? Record any symptoms or information from the emergency room that may help you to choose additional diagnostic tests.

Vital Signs and EKG Results

Vital Sign	EMTs: 9:45 AM	ER-RN: 10:00 AM
Temperature	98.6 °F	98.6 °F
Blood pressure (mm Hg)	166/110	160/105
Pulse rate (beats per minute)	118 bpm	100 bpm
Respiration rate (per minute)	28	18
Oxygen saturation (pulse ox)	96%	97%
Electrocardiogram (EKG)	–	Normal

3. List the diagnostic tests your team selects for Angela, and identify the points spent for each test. Have your teacher approve the tests and record the results. You may choose three test results at a time.

Diagnostic Tests/Physical Exam Requests	Points Spent	Results

4. Diagnosis for Angela:

Teacher Time Stamp: _____ Dollars Spent: _____

5. Prepare your team's defense on the back of this page.

Diagnostic Test Cards

Total Creatine Phosphokinase (CK or CPK) Series — **$450**
Cardiac enzyme

Creatine Phosphokinase-MB CK–MB Series — **$250**
Cardiac enzyme

CK-MB fraction (% of total CK) — **$30**
You must request Tests 1 and 2 to obtain this calculation.

Blood Count: Red Blood Cells (RBC) — **$65**

Blood Count: White Blood Cells (WBC) — **$65**

Blood Count: Hemoglobin — **$35**

CT Scan-Abdomen — **$850**
Computed tomography scan

CT Scan-Chest — **$850**
Computed tomography scan

CT Scan-Head — **$850**
Computed tomography scan

Electrolyte-Potassium [K] — **$35**

Electrolyte-Sodium [Na] — **$35**

PE-Abdomen Palpation — **$50**
Physician physical exam

PE-Ears, Eyes, Nose, Throat — **$80**
Physician physical exam

PE-Elbow and Knee Reflexes — **$30**
Physician physical exam

PE-Heart with Stethoscope — **$50**
Physician physical exam

PE-Lungs with Stethoscope — **$50**
Physician physical exam

Pregnancy Test — **$45**

Troponin (T) Series — **$450**

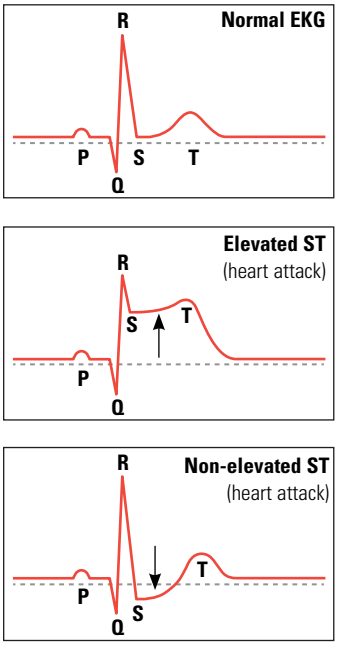
Diagnosis of a Heart Attack

Reference

With a typical EKG, a technician connects electrodes from a machine to a patient's chest, upper arms and legs. The machine records the heart's rhythm, producing the EKG printout.

Image courtesy of the NHLBI (http://www.nhlbi.nih.gov/health/health-topics/topics/hb/understanding.html).

EKG Readings



EKG readings provide information about the location and severity of arterial blockages in the heart. Usually, an EKG with an elevated ST segment indicates a more severe form of heart attack, with greater heart muscle damage.

Hearts attacks (acute myocardial infarctions or MI) are diagnosed based on an individual's signs and symptoms, physical examination findings, electrocardiogram results, and cardiac enzyme studies. In the case of a possible heart attack, emergency personnel will assess the heart rate, blood pressure, breathing rate, and general appearance and alertness of the individual in crisis.

Electrocardiogram (EKG/ECG)

Emergency personnel will place wire electrodes (leads) on the chest and perform an EKG (which is a graphical record of the heart's electrical activity as it contracts and relaxes). Each heartbeat sends an electrical signal that spreads from the top of the heart to the bottom. As it travels, the signal causes the heart to contract and pump blood. These electrical signals set the rhythm of the heartbeat. During an EKG, a jagged-line image appears on a monitor and shows the rate of the heartbeat, abnormal heart rhythms, and the strength and timing of the electrical signals as they pass through each part of the heart.

Blood Tests (Cardiac Enzyme Studies)

During a heart attack, heart muscle cells are damaged or destroyed resulting in release of their contents to the bloodstream. Specific blood tests can measure the amount of certain proteins called cardiac enzymes. These proteins are normally found in the blood at low levels. When heart muscle is injured or destroyed during a heart attack, the cardiac protein levels rise dramatically. Cardiac proteins include creatine phosphokinase (CK or CPK) and troponin (T). Normally, physicians order repeated cardiac enzyme studies for comparison. Blood samples are drawn at admission to the hospital, then repeated every 6 to 8 hours for 1 to 2 days following a suspected heart attack. A significant rise and fall in the cardiac enzyme levels indicates a heart attack.

Creatine Phosphokinase (CK/CPK)

Total CK levels generally rise within 6 hours after a heart attack. CK reaches its peak level in 18 hours then returns to normal within 4 days. Total CK is not specific for heart damage and can rise following vigorous exercise, injuries to muscles, or muscle inflammation. However, there are three measurable isoenzymes or fractions that together make up total CK. One fraction is specific for muscle (CK-MM), one specific for brain (CK-BB), and one specific for heart muscle (CK-MB). CK-MB, which is released in large amounts from damaged or destroyed heart muscle cells, is a more specific way to detect heart damage. Normally, CK-MB makes up 0% to 6% of the total CK in the bloodstream. During a heart attack, CK-MB levels typically rise within 4 hours and peak within 18 hours showing an increase of two or more times baseline values. The CK-MB levels fall within 3 days and return to normal.

Troponin (T)

The protein troponin (specifically the TnT fraction) is normally so low it cannot be detected in the blood. Troponin is released to the blood-stream in great amounts when heart muscle is damaged or destroyed. It is thought that the more troponin in the blood, the greater the damage to the heart. Blood levels of troponin typically rise within 6 hours after a heart attack and reach their highest level within 18 hours then fall slowly to normal levels within 10 days. ■

Personal Story: Arturo

Part 2

Arturo's Vitals and Diagnostic Test Results

DIAGNOSTIC TESTS/VITALS	ER: 7:45 PM	2:00 AM	8:00 AM	2:00 PM
Total CK series (IU/L)	74	81	77	74
CK-MB (IU/L)	2.2	2.3	2.2	2.2
CK-MB fraction (% of Total)	3.0%	2.8%	2.9%	3.0%
Troponin (ng/mL)	0.06	0.07	0.06	0.06
EKG	Normal	Normal	Normal	Normal
CBC (RBC, WBC, Hemoglobin)	RBC: 4.7 | WBC: 15,000 Hemoglobin: 16	NA	NA	NA
Potassium (mEq/L)	4.8	NA	NA	NA
Sodium (mEq/L)	155	NA	NA	NA
PE-Abdomen Palpation (physical exam)	Tenderness with guarding, lower right abdomen	NA	NA	NA
CT Scan-Abdomen	Inflamed appendix	NA	NA	NA
Blood Pressure (mm Hg)	142/95	135/85	135/90	140/85
Oxygen Saturation (pulse ox)	95%	95%	96%	95%
Pulse Rate	92 bpm	90 bpm	92 bpm	85 bpm
Respiration Rate (per minute)	20	12	15	14
Temperature	102.0 °F	102.0 °F	100.8 °F	100.5 °F
Total Cholesterol (mg/dL)	NA	NA	320	247
HDL Cholesterol (mg/dL)	NA	NA	36	38
LDL Cholesterol (mg/dL)	NA	NA	245	190
Triglycerides (mg/dL)	NA	NA	195	95
BMI (Kg/m^2)	NA	NA	38.4	NA

Key: deciliter (dL), international unit (IU), liter (L), microliter (mcL), milliliter (mL), milliequivalent (mEq), nanogram (ng). NA = Not applicable.

Physician Summary for Arturo

Arturo, a 56-year-old male, presented in the ER with a head laceration (cut) caused by a fall that resulted in unconsciousness.

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He complained of stomachache and nausea that were not relieved by antacids. His wife called 911. EMTs noted that the patient was short of breath, disoriented and pale in appearance, with tenderness in the abdomen. Vitals signs taken at the scene and in the ER indicated fever, rapid heartbeat, low oxygen saturation (92% initially) and high blood pressure. Serial EKGs were normal. The cut did not require stitches. Hemoglobin levels and red blood cell (RBC) count were normal, indicating minimal loss of blood.

Upon physical examination, tenderness with guarding (tension in the muscles of the abdomen) was detected, especially in the lower right abdomen. Nothing else in the exam was remarkable. A cardiac enzyme series, sodium and potassium, and CBC were ordered. Results indicated high sodium, possibly from dehydration, and an elevated white blood cell count, indicating inflammation or infection. Initial diagnosis was appendicitis. A cardiac event could not be ruled out at this time. An abdominal CT-scan was ordered, revealing a swollen appendix. The patient was prepped for surgery and an appendectomy was performed without complications. The cardiac enzyme series indicated no apparent heart attack. ■

Personal Story: Brian

Part 2

Brian's Vitals and Diagnostic Test Results

DIAGNOSTIC TEST/VITALS	ER: 1:15 PM	8:00 PM	2:00 AM	8:00 AM
Total CK series (IU/L)	150	181	220	174
CK-MB (IU/L)	6.4	19.9	47	15.7
CK-MB fraction (% of Total CK)	4.3%	11.0%	21.4%	9.0%
Troponin (ng/mL)	0.15	1.88	0.97	0.75
EKG (12-lead)	Irregular pattern	Irregular pattern	Normal	Irregular pattern
Blood Pressure (mm Hg)	165/105	155/100	165/105	145/95
Oxygen Saturation (pulse ox)	87%	85%	87%	90%
Pulse Rate	120 bpm	110 bpm	95 bpm	90 bpm
Respiration Rate (breaths per minute)	32 shallow	22	15	14
Temperature	98.6 °F	98.6 °F	97.4 °F	98.6 °F
Fasting Glucose (mg/dL)	NA	NA	NA	75
Total Cholesterol (mg/dL)	NA	NA	NA	247
HDL Cholesterol (mg/dL)	NA	NA	NA	38
LDL Cholesterol (mg/dL)	NA	NA	NA	190
Triglycerides (mg/dL)	NA	NA	NA	95
BMI (Kg/m^2)	NA	NA	28.0	NA

Key: deciliter (dL), international unit (IU), liter (L), microliter (mcL), milliliter (mL), milliequivalent (mEq), nanogram (ng). NA = Not applicable.

Physician Summary for Brian

Brian is a 40-year-old male who presented in the ER with symptoms of heart palpitations (pounding heart) and chest pain. He is a one-pack-a-day smoker, weighs 195 pounds, and is 5'10" in height. He was hypertensive upon arrival and has a history of hypertension (high blood pressure). He was at school when his heart started racing. He became cold, pale, clammy and nauseous. He also experienced tightness in his chest and tingling in his fingers. He became disoriented and unresponsive to immediate caregivers. A bystander called 911. Brian was stabilized and transported to the hospital ER.

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Vital signs taken at the scene and initially in the ER indicated rapid heartbeat, low oxygen saturation (85%), and high blood pressure. Breathing was fast and shallow. Initial and follow-up EKGs indicated a fast and irregular heart rhythm. Body temperature was normal. A complete blood count (CBC), and cardiac enzymes, sodium, and potassium tests were ordered. Results indicated normal electrolytes and CBC. Physical examination was unremarkable.

Initial diagnosis, which could not be ruled out at this point, was myocardial infarction (heart attack). Cardiac enzymes also indicated a myocardial infarction because levels of CK-MB and troponin were elevated in the first 24 hours following the event. A coronary angiogram (allows a doctor to visualize blockages in coronary arteries) revealed two significant blockages. The blockages were opened by balloon angioplasty with stenting. ■

Stents

During balloon angioplasty, a specially designed tube, equipped with a tiny balloon at the tip, is guided through a blood vessel in the arm or leg, and all the way into the affected coronary artery. When the balloon reaches the blockage, it is inflated several times to compact the plaque and widen the opening in the artery. Afterward, a wire mesh tube, called a stent, is left behind to keep the artery open.

Personal Story: Angela

Part 2

Angela's Vitals and Diagnostic Test Results

DIAGNOSTIC TESTS/VITALS	ER: 10:00 AM	4:00 PM	10:00 PM	4:00 AM
Total CK series (IU/L)	74	80	75	55
CK-MB (IU/L)	1.2	0.9	0.8	0.3
CK-MB fraction (% of Total)	1.6%	1.1%	1.1%	0.5%
Troponin (ng/mL)	0.05	0.06	0.04	0.05
EKG	Normal	Normal	Normal	Normal
Potassium (mEq/L)	140	NA	NA	NA
Sodium (mEq/L)	4.5	NA	NA	NA
Abdomen Palpation (physical exam)	Tenderness lower middle abdomen	Same	Same	Same
Pregnancy Test	Positive	NA	NA	NA
Blood Pressure (mm Hg)	160/105	155/105	160/105	145/100
Oxygen Saturation (pulse ox)	97%	98%	97%	97%
Pulse Rate	100 bpm	85 bpm	80 bpm	82 bpm
Respiration Rate (per minute)	18	16	14	14
Temperature	98.6 °F	98.9 °F	99.1 °F	99.0 °F
Fasting Glucose	NA	NA	90	NA
Total Cholesterol (mg/dL)	NA	NA	NA	NA
HDL Cholesterol (mg/dL)	NA	NA	NA	NA
LDL Cholesterol (mg/dL)	NA	NA	NA	NA
Triglycerides (mg/dL)	NA	NA	NA	NA
BMI (Kg/m^2)	NA	NA	20.0	NA

Key: deciliter (dL), international unit (IU), liter (L), microliter (mcL), milliliter (mL), milliequivalent (mEq), nanogram (ng). NA = Not applicable.

Physician Summary for Angela

Angela, a 35-year-old female, is 120 pounds, and 5'5" in height. Non-smoker. She presented in the ER with dizziness and vomiting. During a morning run, she experienced severe pain in her right side, indigestion and shortness of breath. Later, she was lightheaded and had a headache. Her husband said she was pale, short of breath, agitated, dizzy and nauseated. Angela told the EMTs she had an ache in her lower jaw, and she vomited while prepping for the trip to the ER.

At the hospital, Angela still had a headache, and was vomiting and dizzy. Breathing was normal. Vital signs indicated rapid heart beat, but normal pulse ox, respiration rate, and temperature. EKG was normal, but she was hypertensive. Physical exam revealed tenderness in the lower middle abdomen. Initial diagnostic tests: complete blood count (CBC), sodium, cardiac enzymes, potassium and a standard pregnancy test. Results indicated normal electrolytes. Lower central abdominal tenderness is suspicious. A cardiac event seems unlikely. CBC revealed low RBCs and low hemoglobin. Review of blood slide revealed hypochromic (paler in color), microcytic (smaller) red blood cells, indicative of iron deficiency anemia. Pregnancy test was positive. ■

Certificates

Diagnostic Expert Certification is Awarded to

_____

Scientific Decision-making Project
Baylor College of Medicine

_____
Date

Diagnostic Expert Certification is Awarded to

_____

Scientific Decision-making Project
Baylor College of Medicine

_____
Date

7

Setup: 30 minutes | **Class:** One or two 45-minute class periods

Comparative Effectiveness Decision-making Tools

Overview

Students will use information from real patient decision aids to determine if a supplemental drug treatment is advisable for each of the three characters followed throughout the unit.

Modern healthcare often provides more than one option for treating disease or reducing risk for developing health problems. Increasingly, government agencies and private organizations are producing tools to help patients and their doctors collaborate on healthcare decisions that are based on the latest scientific information available and patient preferences. Sometimes, the best decision is not clear-cut. Potential benefits and side effects, cost, interactions among medications, and patient behaviors and beliefs all influence the decision-making process.

Comparative effectiveness research helps physicians and patients make better decisions by presenting evidence on the effectiveness, benefits and harms of different treatment options. The evidence is generated by research studies that compare different drugs, medical devices, tests or surgeries.

In this activity, students will learn about two medications shown to help some patients with stable ischemic heart disease (coronary artery disease), high blood pressure or a weakened left ventricle. Then, students will decide if the drugs might be suitable for Arturo, Brian and/or Angela.

Materials

Teacher

- Interactive white board or video projector and computer
- Internet access
- Copies of Part Three of the personal stories of Arturo, Brian and Angela (One set per team. Do not add to binder sections or folders until the activity is concluded.)
- Copies of the consumer guides, *ACE Inhibitors and ARBS to Protect Your Heart?* and *Choosing Medicines for High Blood Pressure* (one copy of each per student team, or a classroom set if teaching multiple classes)

Per Team of Students

- Binder or folder set with the personal stories of Arturo, Brian and Angela
- Copies of Part Three of the personal stories of Arturo, Brian and Angela (distribute at end of activity)
- Copies (print or digital) of the two decision-making consumer guides, *ACE Inhibitors and ARBS to Protect Your Heart* and *Choosing Medicines for High Blood Pressure*
- Copy of "Decision-making Guiding Questions" student sheet
- Three pieces of notebook paper on which to record decisions and reasons called for on the "Decision-making Guiding Questions" sheet (one page each for Arturo, Brian and Angela)

Setup

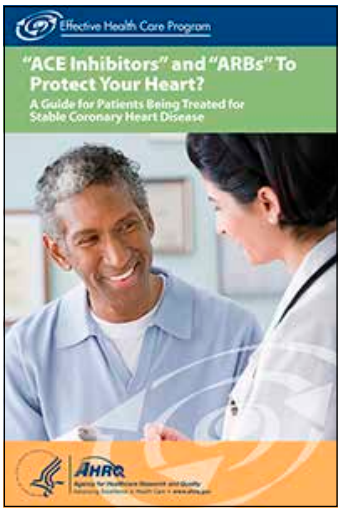
Make copies in advance. The two consumer guides, *ACE Inhibitors and ARBS to Protect Your Heart?* and *Choosing Medicines for High Blood Pressure*, may be printed, or students may use

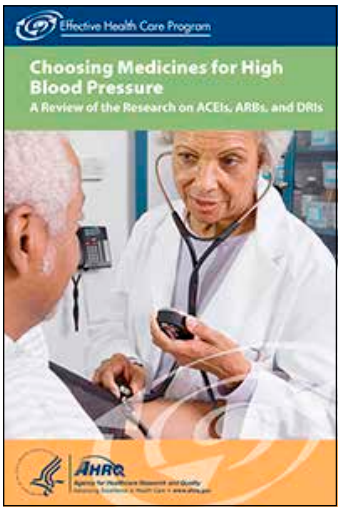
digital versions of the PDF documents on a computer or mobile device. The PDF versions can be found on the Effective Health Care Program website **(http://effectivehealthcare.ahrq.gov)**. Search by title once you have accessed the site.

Links to the PDF documents also can be found on the Scientific Decision-making resource page on BioEd Online **(http://www.bioedonline.org/lessons-and-more/resource-collections/scientific-decision-making/)**.

Have students work in teams of four. Place all reference materials in a central location prior to class.

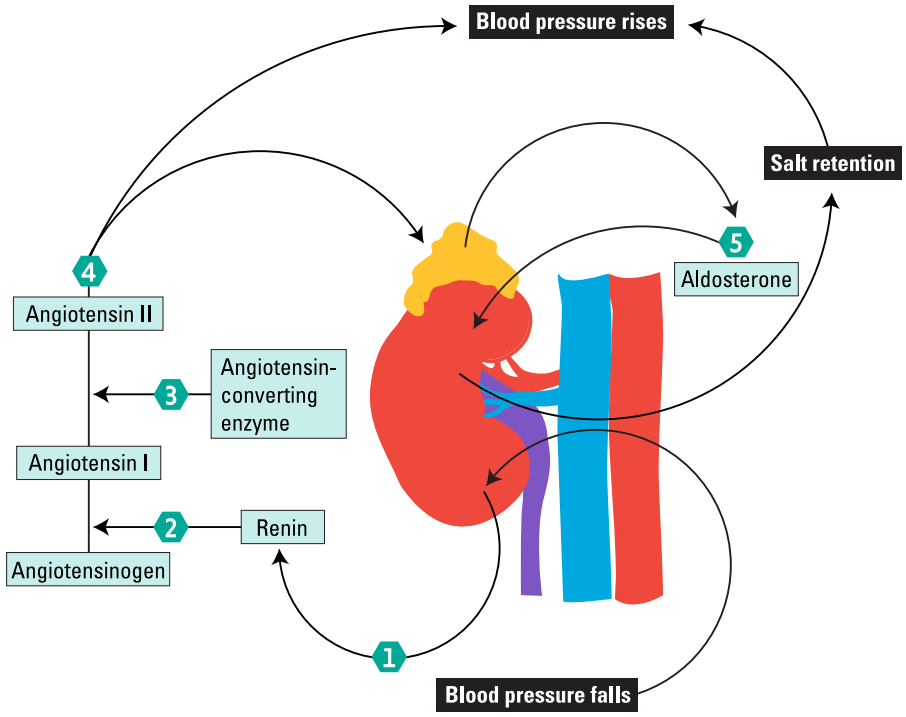
Effective Health Care Program





The Effective Health Care Program provides easy-to-read summaries and tools that can be used by consumers, doctors and policymakers **(http://www.effectivehealthcare.ahrq.gov/)**.

Medications for High Blood Pressure and Coronary Artery Disease (CAD)



Various hypertension and CAD medications work on different aspects of the cardiovascular system. Two common classes of medications work on the renin angiotensin system, which regulates blood volume and arterial pressure. The kidneys are the primary site of renin release.

One main product of the renin angiotensin system is angiotensin II, a hormone that causes blood vessels to constrict, and subsequently, an increase in blood pressure. Angiotensin II also stimulates secretion of the hormone, aldosterone, from the adrenal cortex. Aldosterone causes tubules of the kidneys to increase the levels at which sodium and water are reabsorbed into the blood. This leads to a higher volume of fluid in the body, which, in turn, elevates blood pressure.

Various medications lower blood pressure by blocking different parts of the renin angiotensin system. One class of medications prevents the enzyme, angiotensin converting enzyme (ACE), from converting the molecule, angiotensin I, into angiotensin II (see diagram,[6] step 3). Not surprisingly, these drugs are referred to as ACE inhibitors. Another class of medications, called angiotensin receptor blockers (ARBs), blocks the effects of the hormone, angiotensin, thereby preventing increases in blood pressure (occurs after step 4 in diagram).

Beta Blockers

Beta blockers are commonly prescribed for patients with high blood pressure. These drugs prevent stress hormones from bonding with receptors in the brain, heart, muscle tissues, eyes and vascular system, and reduce the intensity of the "fight or flight" reaction (which elevates blood pressure). Beta blockers lower arterial pressure by reducing the overall output of the heart from systolic compression, and also inhibit the release of renin from the kidneys.

Procedure

1. Prior to class, assign students the homework of reading the two consumer guides, *ACE Inhibitors and ARBS to Protect Your Heart?* and *Choosing Medicines for High Blood Pressure*. Alternately, have copies available in class for students to read as part of the lesson. See Setup for information on locating and downloading the guides.
2. Ask students if they have any questions about the information in the patient guides. Discuss the questions or post them on the board for follow-up later. Then ask, *Have any of you used materials like these guides, or helped a family member make a medical decision?*
3. Remind students about Arturo, Brian and Angela. Have volunteers present a brief overview and diagnosis of each case, from memory. [Arturo had appendicitis; Brian had a heart attack and two blocked arteries; Angela was pregnant and has high blood pressure.] Ask, *Do you think Arturo, Brian and Angela all have coronary heart disease, in addition to their immediate medical problems?*
4. Tell the class that all three characters will have medical follow-ups, during which they may receive prescriptions for one or more medication. Inform the class, *Now you will act as the personal physician for Arturo, Brian and Angela, and help them make a decision about one kind of medication.* Explain that physicians often take aggressive measures to reduce the risk for an initial or repeat heart attack in patients who have coronary artery disease or have had a heart attack. These measures may include drug treatments, lifestyle changes or even surgical procedures.
5. Tell students that they will be reviewing the medications described in the two patient guides. These medications, ACE Inhibitors and ARBs, are used to treat high blood pressure. They act on the hormone system that causes blood vessels to constrict and regulates fluid balance in the body. If you have advanced students, you may wish to explore regulation of blood pressure in greater depth [see "Medications for High Blood Pressure and Coronary Artery Disease (CAD), page 60].
6. Instruct teams to use the consumer guides, *ACE Inhibitors and ARBs to Protect Your Heart* and *Choosing Medicines for High Blood Pressure*, to answer the questions on the "Decision-making Guiding Questions" student sheet for each patient.
7. Have student teams present their ideas for treatment options, and help the class come to consensus on the most appropriate medications for Arturo, Brian and Angela. Students should consider the following important points in their answers.
   - **Arturo** has high blood pressure, but no evidence of coronary artery disease, and no family history of coronary artery disease. He does not have congestive heart failure, diabetes or kidney disease, and did not have a heart attack. Thus, students should reach the conclusion that an ACE Inhibitor or ARB is not appropriate for Arturo at this time. Other blood pressure medications would be more suitable (have students refer to page 2 of both guides for further information).
   - **Brian** does have coronary artery disease and has had a heart attack. Even though his heart function does not appear to be damaged, students should conclude that an ACE Inhibitor or ARB might be advisable for Brian (in addition to other medications). Most physicians will prescribe an ACEI first, because it is less expensive and works as well as ARBs to reduce the risk of future heart attacks. However, ACEI drugs do cause a persistent cough in some patients, which warrants changing to an ARB.
   - **Angela** is pregnant and has high blood pressure, which might be a result of her pregnancy. She does not have coronary artery disease, congestive heart failure,

diabetes or kidney disease, and did not have a heart attack. Thus, students should conclude that ACE Inhibitors and ARBs are not appropriate for her treatment. In addition, many drugs are not prescribed for women who are pregnant.

8. Provide Part Three of each character's personal story to student groups, or project the stories for the class. If you have Internet access, show the video, Scientific Decision-making, Part Three **(http://www.bioedonline.org/lessons-and-more/resource-collections/scientific-decision-making/)**. If your school limits access to YouTube or Vimeo, download the video directly from BioEd Online.
9. Have students discuss the final outcomes for Arturo, Brian and Angela. and ask students the following.
   - *Did anything about these cases impress or surprise you?*
   - *How will the information you learned affect your own lifestyle decisions?*
   - *Have you learned anything that could help your family and friends?*
   - *Do you think you will share this information with them?*

Extensions or Homework

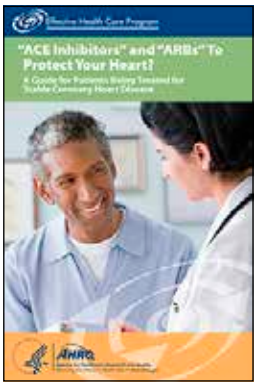
Show the online video, It's Time to Redesign Medical Data by Ted Goetz **(http://www.ted.com/talks/thomas_goetz_it_s_time_to_redesign_medical_data.html)**. Discuss the role of information in modern medicine, particularly the suggestions made in the video to reorganize medical data for consumers. Alternately, have students create their own colorful charts to make patient information, such as blood pressure readings, easier to understand and interpret. ■

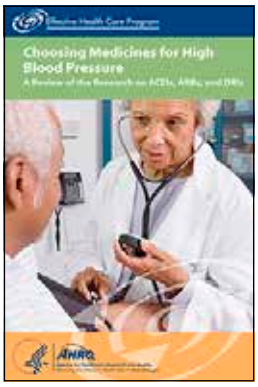
[6] Illustration from "Regulating Blood Pressure: The Renin-Antiostensin-Aldosterone System," The Merck Manual Home Health Handbook. (http://www.merckmanuals.com/home/heart_and_blood_vessel_disorders/high_blood_pressure/high_blood_pressure.html)

Decision-making Guiding Questions

Carefully read the two consumer guides, *ACE Inhibitors* (ACEI) *and ARBs to Protect Your Heart* and *Choosing Medicines for High Blood Pressure*. Both guides are designed to help patients make better decisions about medications.

Using information from the guides, your team must decide whether the medications described are appropriate for Arturo, Brian and Angela. On a separate sheet of paper, complete the steps below for each character.





1. Is either an ACE Inhibitor (ACEI) or ARB appropriate for this patient? Why? Answer the question Yes or No. To help you reach a decision, create a T-chart as shown below, listing reasons for or against using additional blood pressure drugs.

YES	NO
1.	1.
2.	2.
3.	3.

2. If you answered YES to question 1, decide whether an ACE Inhibitor or ARB is more appropriate. List the reasons that support your decision.

   Which is more appropriate, an ACE Inhibitor or ARB? _____
   List reasons to support your decision.

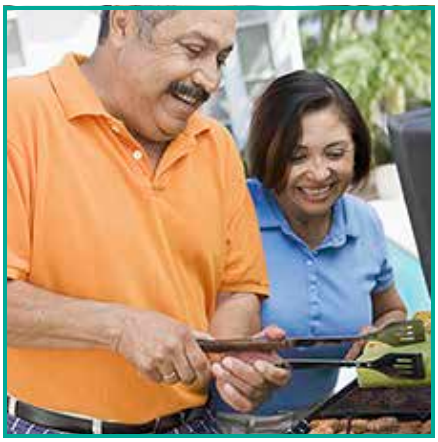
3. List the benefits and risks of the medication you have chosen (ACE Inhibitor or ARB) in a T-chart like the one below. Make the lists as long as necessary.

BENEFITS	RISKS
1.	1.
2.	2.
3.	3.

4. Do you have any other health-related or lifestyle recommendations for the patient? List your recommendations.

Personal Story: Arturo M.

Part 3



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The Next Two Days

Arturo was hospitalized for abdominal discomfort and underwent surgery to remove an infected appendix. His lab results indicated high total and LDL cholesterol. His blood pressure remained high during his stay in the hospital. He was discharged from the hospital 48 hours after his surgery. Healthcare professionals there recommended a variety of lifestyle changes, including a diet and exercise program. The physician prescribed medications and instructed Arturo to follow-up with his primary care physician in two weeks.

Visit to the Primary Care Doctor

Arturo's doctor recommended that he follow a diet low in fat, sodium and cholesterol. He also started Arturo on an exercise program to improve his fitness. The doctor prescribed a beta blocker (a kind of medicine to control blood pressure) and a cholesterol-lowering agent to help reduce Arturo's risk for a heart attack. His doctor did not prescribe an ACE Inhibitor or an ARB, because Arturo did not have congestive heart failure or kidney disease, and did not have a heart attack.

Six Months Later

When Arturo returned for a routine check-up six months later, he had lost 45 pounds and eight inches from his waist. He now watches his diet and exercises regularly with his wife, Patricia. His blood pressure is in the high-normal range. His cholesterol level is improving, but it's still higher than his physician would like. Arturo says these changes have increased his energy and desire to be involved in outdoor activities. ■

Personal Story: Brian L.

Part 3

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The Next Two Days

Brian was hospitalized for chest pain. It turns out he had blockages in two arteries in his heart. He had balloon angioplasty surgery to open the arteries where they had been blocked. Brian's recovery was uneventful. A follow-up blood test revealed elevated total and LDL cholesterol, and low HDL cholesterol. Brian was discharged from the hospital after three days. He was assigned to a cardiac rehabilitation program that would help him recover after the heart attack, reduce his risk for future heart problems, and start to implement healthy changes to his lifestyle. He received prescriptions for medicines to treat his hypertension and to prevent further plaque formation.

Visit to the Primary Care Doctor

Brian began his cardiac rehabilitation program, which includes a diet low in fat, salt and cholesterol; supervised exercise; enrollment in a smoking cessation program; and yoga (to help manage his stress). His primary care physician prescribed several medications, including aspirin, blood pressure medicine, and a cholesterol-lowering agent. The physician also prescribed an ACE Inhibitor (angiotensin converting enzyme inhibitor). However, Brian developed a persistent cough after taking the ACE Inhibitor for two weeks, so the doctor prescribed an ARB (angiotensin II receptor blocker) instead. ACE Inhibitors and ARBs work in different ways to lower blood pressure by preventing blood vessels from constricting.

Six Months Later

Six months after being admitted to the emergency room, Brian has lowered his blood pressure, total cholesterol and LDL cholesterol, and increased his level of "good" HDL cholesterol. He has managed to quit smoking, but still finds it hard to be around other people who are smoking. Brian was accepted to the hospital administration degree program he wanted, and he even has a new dog. In the end, he and his girlfriend broke up. But Brian is on his way to full recovery from his heart attack, and he has an optimistic outlook on life and his future. ■

Personal Story: Angela G.

Part 3

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The Next Two Days

Angela was surprised to learn of her pregnancy, and pleased that her tests revealed no cardiac event or illness. She was discharged the next day from the hospital, with orders to follow-up with her primary care physician to monitor her elevated blood pressure and begin prenatal care. Prenatal care is special healthcare for pregnant women. It includes regular checkups, so that any problems can be spotted early.

Visit to the Primary Care Doctor

Angela keeps her appointment with her primary care physician and schedules a visit with an obstetrician. She learns that she is slightly more than two months pregnant. Her blood pressure is in the prehypertensive range (138/89 mm Hg), so the obstetrician places Angela on a low-sodium diet and a moderate exercise program for pregnant women. She wants to monitor Angela's blood pressure closely. Angela is placed on iron supplements for anemia, but no blood pressure medications are prescribed. Neither an ACE Inhibitor nor an ARB is prescribed, because Angela does not have coronary artery disease, congestive heart failure, diabetes or kidney disease, and did not have a heart attack. In addition, these medications typically should not be used during pregnancy or in women who are likely to become pregnant.

Six Months Later

Six months later, Angela's blood pressure remains in the prehypertensive range, but her doctor believes it is to linked to the pregnancy. Blood tests indicate that her iron-deficiency anemia is improving. Then, seven months after her visit to the emergency room, Angela and William become the proud parents of a healthy baby girl, named Elizabeth. Angela's blood pressure improves after childbirth, and her primary care physician continues to monitor her progress to see if diet and an exercise program can control Angela's blood pressure without medication. ■