

Testing a Clot Buster

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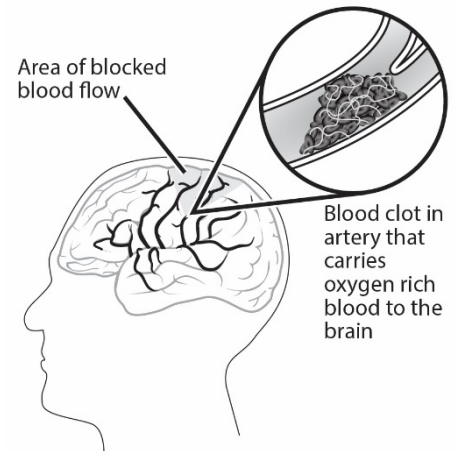
Part 1: Meet the Stroke Patients

Read each of the patients' stories below. Write two things that you learned about strokes from each of the stories.

Casey (age 78)



I was admitted to the hospital because I suddenly lost the ability to move my arm and leg on the right side of my body. The doctors said that I was paralyzed because I had a stroke. They explained that a blood clot formed in an artery somewhere in my body. A stroke occurred when the blood clot traveled to my brain and blocked an artery that supplies oxygen-rich blood to parts of my brain. The stroke had damaged the part of my brain that sent signals to the muscles in my arms and legs.



1. List two things you learned about strokes from Casey's story.

- _____
- _____

Maya (age 48)



My doctor warned me that I had a high risk of having a stroke because I am an African-American woman who smokes and is overweight. My blood pressure, blood sugar level, and cholesterol levels are high. My doctor prescribed medicine to reduce my blood pressure and cholesterol level. She also told me I need to quit smoking, lose weight, and keep my blood sugar level controlled. I tried to follow the doctor’s advice but after a while I slipped back into my old habits. This morning I started having trouble with my vision and my speech. I thought I might be having a stroke so I called an ambulance to take me to the emergency room.

2. List two things you learned about strokes from Maya’s story.

- _____
- _____

Neal (age 35)



My wife called 911 because she noticed that the right side of my face was drooping. I tried to explain that I was fine but my speech was slurred and my wife was having trouble understanding me. When the ambulance arrived, the EMT’s told me that I was having a stroke and it was critical that I go to the hospital immediately. They said that many strokes could be treated with clot buster drug injections. Clot buster drugs dissolve blood clots and restore blood flow to the brain. I was lucky that my wife immediately called for an ambulance. The clot buster drugs needed to be given within 3 hours of the first stroke symptoms.

3. List two things you learned about strokes from Neal’s story.

- _____
- _____

Denise (age 20)



I was teaching a yoga class when I suddenly developed a severe headache, dizziness, and nausea. I was too confused to drive so one of my students drove me home. Several hours later I called for an ambulance because my legs were becoming numb. When the doctors at the hospital did a brain scan, the scan revealed that I had a stroke. Because it was more than 3 hours after my stroke symptoms started, it was too late for them to use clot busting drugs to dissolve the blood clot in my brain. I needed emergency surgery to remove the blood clot.

4. List two things you learned about strokes from Denise's story.

- _____
- _____

5. Why would using clot busting drugs or clot removal surgery be beneficial for the patient?

6. If a patient with a stroke chooses to not have clot busting drugs or clot removal surgery, what negative impact might there be on the nervous system?

7. Strokes do not damage muscles, but parts of the body may become paralyzed for some stroke patients. How would you explain this?

8. Strokes do not damage the eyes but some stroke patients lose their vision. How would you explain this?

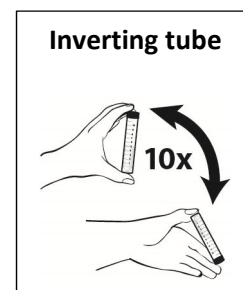
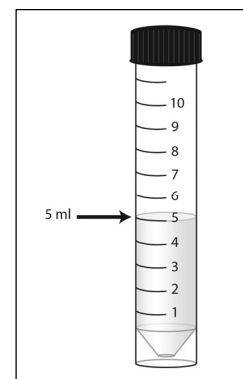
Part 2: Testing Clot Buster Drugs

A stroke occurs when blood flow to the brain is interrupted. Strokes may be caused by blood clots that block blood vessels in the brain or by ruptured blood vessels that cause bleeding in the brain.

When a stroke is caused by a blood clot, dissolving the clot to restore blood flow to the brain may prevent long-term brain damage or even death. “Clot buster” drugs are medications given in the hospital to break up or dissolve a blood clot that is blocking a blood vessel. Clot buster drugs should only be used to treat strokes that are caused by blood clots.

Chemists have created a new drug called Clot-X that they hope will dissolve blood clots. You have been asked to conduct laboratory tests to determine the concentrations of Clot-X that are effective in dissolving blood clots. Follow the instructions below to test three different concentrations of Clot-X.

1. You first need to make artificial blood.
 - a) Fill the tube labeled “Artificial Blood” to the 45 mL line with tap water.
 - b) Put the lid on the artificial blood tube and tighten the lid completely.
 - c) Shake the tube of artificial blood for 1 minute.
2. Next, you need to make blood clots. Use four tubes labeled “Tube A”, “Tube B”, “Tube C”, and “Tube D. Each tube contains 0.1 gram of blood clotting protein. The blood clotting protein in the tubes will interact with enzymes in the artificial blood to form blood clots.
 - a) Use the large dropper labeled “Artificial Blood” to add artificial blood to fill each of the tubes (A, B, C, and D) to the 5 ml line. *See the diagram on the right.*
 - b) Put a red lid on each of the four tubes and tighten the lids completely.
 - c) Gently invert (flip) each of the four tubes ten times to mix the clotting protein with the artificial blood. *See the diagram on the right.*
 - d) Let the four tubes sit for 2–3 minutes. What did you observe happening in the tubes?

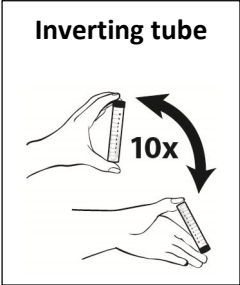


-
- e) Save these four tubes that contain blood clots. You will use them to test the new clot busting drug.

Concentration - Amount of substance per unit volume.
For example: 1 mg Clot-X/liter

3. You will now add different concentrations of **Clot-X** to each of the four tubes that contain blood clots:

- a) Use the large tube labeled “**Tube A.**” Pour the entire contents of the small tube labeled “Water (No Clot-X)” into tube A. Screw the red lid on tightly.
- b) Use the large tube labeled “**Tube B.**” Pour the entire contents of the small tube labeled “Clot-X 1 mg/liter” tube into tube B. Screw the red lid on tightly.
- c) Use the large tube labeled “**Tube C.**” Pour the entire contents of the small tube labeled “Clot-X 5 mg/liter” tube into tube C. Screw the red lid on tightly.
- d) Use the large tube labeled “**Tube D.**” Pour the entire contents of the small tube labeled “Clot-X 10 mg/liter” tube into tube D. Screw the red lid on tightly.
- e) Be sure the red lids are screwed tightly onto each of the four tubes that contain blood clots. Gently invert (flip) each tube ten times to mix the contents of the tubes. *See the diagram on the right.*
- f) Set the tubes aside for 5 minutes. While you wait, use the time to answer questions 4 through 6.



4. Which tube is the control tube—A, B, C, or D? _____

Explain why you selected this tube.

5. Explain why it is important to have a control tube.

6. Predict what you will observe in tubes that contain an effective concentration of clot busting drugs.

7. After 5 minutes, observe the contents of the 4 tubes for evidence of clot busting action. Record your observations in the chart below.

	Observations - Evidence for Clot Busting Action
Tube A Water	
Tube B Clot-X 1 mg/liter	
Tube C Clot-X 5 mg/liter	
Tube D Clot-X 10 mg/liter	

8. Which Clot-X concentrations (mg/liter) are effective in dissolving blood clots? Support your answer with evidence from the observation chart.

9. Clot-X is expensive, and high concentrations of Clot-X are more likely to cause harmful side effects including severe nausea and headaches. Based on this information, which Clot-X concentration (mg/liter) would you recommend be used to treat stroke patients? Explain why you selected this concentration.

Important! Follow the clean-up instructions provided by your teacher.

10. The Clot-X concentration that you selected in question 9 may not be the lowest concentration that works to dissolve clots while also minimizing costs and harmful side effects. You are asked to design a controlled experiment to determine more precisely the lowest concentration of Clot-X that is effective for dissolving blood clots.

Supplies available for your experiment:

- Artificial blood
- Blood clotting protein
- Five 10 mL tubes with lids
- Water
- Solutions with different concentrations of Clot-X (0-10 mg/liter)

Answer the following questions to explain how you would design your experiment.

a) What would you add to each of the five tubes? Be specific about the types, amounts and concentrations of substances you would put in each of the tubes that you would use.

b) How would you collect data or make observations for your experiment?

c) How would you identify the lowest concentration of Clot-X that is effective?

Part 3: Analyzing Data about Clot-X Effectiveness

Scientists know that Clot-X works to dissolve clots in a test tube. They now want to know how well Clot-X works in people. Scientists conducted a research study to determine how effective Clot-X is for treating strokes.

- 150 stroke patients were given a 1 mL injection of placebo (water) within 3 hours of the start of their stroke symptoms.
- 200 stroke patients were given a 1 ml injection of 3 mg/liter Clot-X within 3 hours of the start of their stroke symptoms.

Placebo - A fake medication that looks like the real medication but does not contain any substance likely to have an effect.

1. What treatment was given to the control group in this research study?

Six months later, scientists tested and recorded the level of disability for the living patients in both groups. They also recorded the number of patients in each group who had died. The data table below summarizes the results of this research study.

Effect of Treatment with Clot-X or Placebo on Level of Disability and Death

Treatment	Total Patients	Effect of Treatment after 6 Months Number of Patients with:			
		No disability	Mild disability	Severe disability	Death
Placebo	150	30	45	45	30
Clot-X	200	80	40	34	46

2. Notice that the Placebo (control) group included 150 patients and the Clot-X (experimental) group included 200 patients. Explain why this might make it difficult or misleading to use the data table above to compare the effects of the Placebo and Clot-X.

3. To more accurately compare the control group and the experimental group, scientists often use a data table with percentages of patients instead of a data table with numbers of subjects. Use the information from the data table on the previous page to complete the data table below.

$$\text{Percentage} = \frac{\text{Number of patients for category}}{\text{Total patients in treatment group}} \times 100$$

Effect of Treatment with Clot-X or Placebo on Level of Disability and Death

Treatment	Effect of Treatment after 6 Months PERCENTAGE of Patients with:			
	No disability	Mild disability	Severe disability	Death
Placebo				
Clot-X				

4. Do Clot-X treatments reduce the risks of death from a stroke? Support your answer with evidence from the percentages data table in question 3.

5. Do Clot-X treatments reduce the risk of mild and severe disability caused by a stroke? Support your answer with evidence from the percentages data table in question 3.

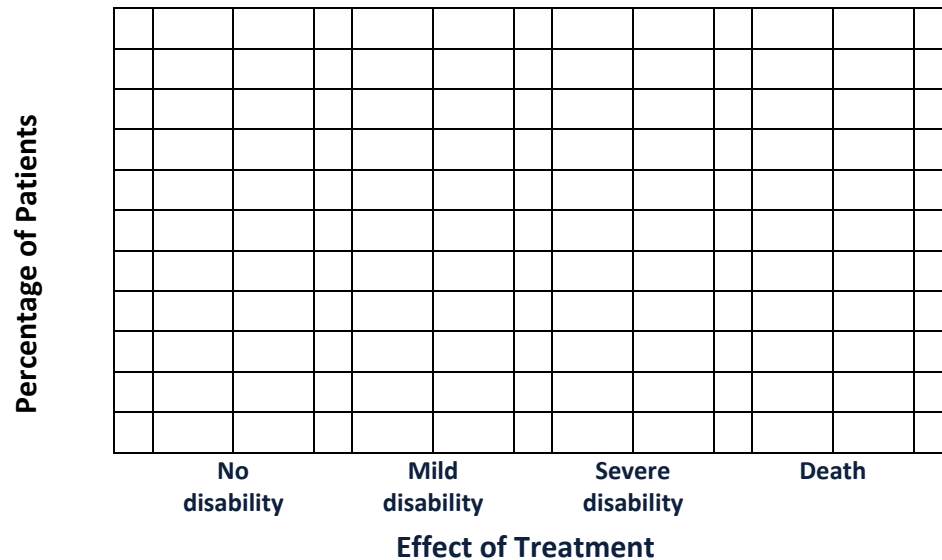
When patients and their family members need to make decisions about whether to have Clot-X treatments, it is important that they understand and be able to interpret information about the effectiveness of Clot-X. The information in a data table may be difficult for some patients and their families to understand. A **bar graph** can be used to make it easier to visualize the data.

6. Use the information in the percentages data table (question 3 on page 9) to complete the bar graph below.

- Write a title for the bar graph. *Hint: Look at the data table titles.*
- Write a scale on the y-axis (vertical axis).
- Complete the bar graph key.
- Plot the data for Clot-X and for the placebo.

Title: _____

Bar Graph Key: Clot-X Placebo



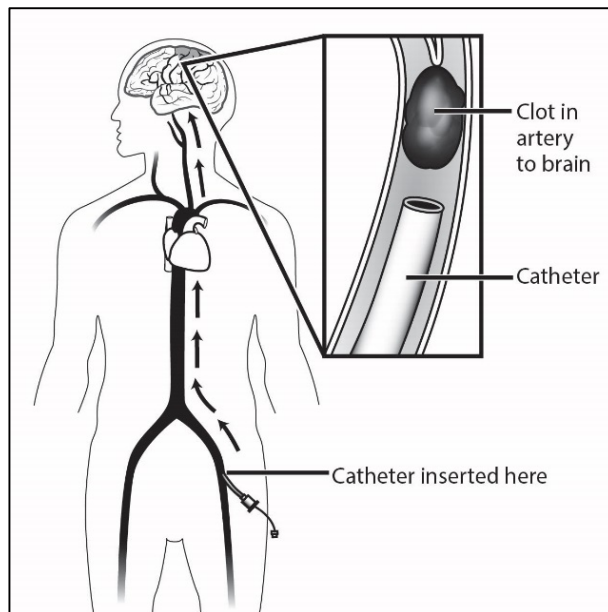
7. Explain why a bar graph may make it easier for patients and their families to understand the results of the experiment.

Part 4: Engineering a Tool for Removing Blood Clots

Clot busting drugs cannot be used to treat some patients. Clot busting drugs increase bleeding; therefore they cannot be used for patients who have bleeding problems or for patients who had recent surgery. Clot busting drugs travel through the blood to all parts of the body and may cause harmful side effects in many parts of the body.

Doctors would like to be able to do surgery to remove blood clots, instead of using clot busting drugs. You have been asked to engineer a surgical tool that can remove blood clots that block arteries that carry blood to the brain.

The technology to deliver a surgical tool to an artery in the brain already exists. Doctors can insert a catheter (a thin flexible tube) into a blood vessel in the leg. The catheter is then threaded through the heart and blood vessels to reach the clogged arteries near or in the brain. You may assume that a catheter could be used to deliver your surgical tool to the artery that contains the clot.

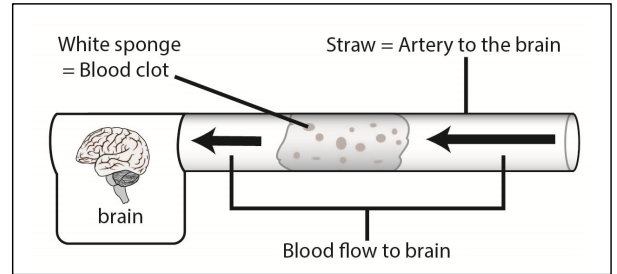


1. Look at the diagram of a blood clot above. Should your clot removing tool push the clot toward the brain or pull the clot out of the artery? Explain your reasoning.

Typically, engineers do not start by testing or trying out possible tools on people or on animals. Instead, they first try the tools out using **models**. You will need to make models of clogged blood vessels that you can use for testing to see how well your ideas for surgical tools work.

2. Use the materials in the bag labeled **For Model Arteries and Clots** to make 4 models that you can use for testing the surgical tools. *Refer to the diagram below.*

- a) The 4 straw pieces represent arteries that conduct blood to the brain. Attach a “brain” label to one end of each straw.
- b) The white sponge circles represent “clots.” Dip each of the sponge circles in water so that it expands to form a cylinder. Insert one white sponge cylinder into the middle of each of the four straw pieces. The red stir stick can be used to push the sponge “clot” into the straw “artery.”



Engineers begin their design work by considering all of the materials available for a task. They eliminate materials that are unlikely to work and select materials that are likely to work. They may also combine two or more materials to create something that works better than individual materials.

- 3. Observe the materials in the bag labeled **For Clot Removing Tools**. Do NOT open this bag. The things in the bag can be used to make surgical tools that could be used to remove the blood clots from the artery models.
- 4. **Without removing the materials from the bag**, select three materials that you think will NOT work to make a surgical tool or part of a surgical tool for removing blood clots. Record the names or make simple drawings of the materials you selected in the first column. Provide a reason for each of your choices in the second column

Materials that will NOT work	Reason for <u>eliminating</u> these materials

5. **Without removing the materials from the bag**, select three materials OR combinations of materials that you think are likely to be effective surgical tools for removing blood clots. Record the names or make simple drawings of the materials you selected in the first column. Provide a reason for each of your choices in the second column.

Note: You may plan to use tape to combine materials.

Materials or combinations that are likely to work	Reason the materials are likely to be effective tools

6. **Now you may remove the materials that you listed in question 5 from the bag.** Record the names or make simple drawings of the materials you selected in the first column. Test each of the materials or combination of materials that you selected. Provide an explanation of why each of the materials worked or did not work.

Note: You may use tape to combine materials. You may provide information on how the materials could be modified to improve their function.

Materials or combinations that you tested	Did the materials work? Provide evidence from your testing.

7. Based on your tests, which material or materials would make the best surgical tool for removing blood clots? Support your answer with information from your testing.

8. You may have a better idea for a surgical tool to remove blood clots. Think of something in everyday life that could be used to simulate your idea. What other material or materials would you use if you could use things that were not included in the bag of materials? Explain (or draw) how the material or materials would work to remove blood clots.

9. State one reason a doctor might use Clot-X instead of using clot removing surgery to treat a blood clot in the brain of a stroke patient.

10. State one reason a doctor might use clot removing surgery instead of using Clot-X to treat a blood clot in the brain of a stroke patient.
