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Using Blood-Typing to Determine Causes of Death in Surgery Patients

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INTRODUCTION

Description

In this activity, students will determine whether a higher-than-normal death rate among surgery patients in a hospital was caused by faulty blood-typing. They will be given a sheet that contains the blood types on record for the patients, the type of blood each patient received, and whether or not each survived the surgery. The students will be provided with simulated samples of each patient's blood and of the blood provided to each patient during surgery and a blood-typing kit. Students will use the information and materials to determine correct blood types for each patient and bag. They will also be able to determine whether patients were given the correct type of blood or not.

Student Audience

This activity is designed for high school students in biology or anatomy and physiology.

Goals for the Activity

The main goals for this experiment are for students to be able to

- use the scientific method to solve a problem,
- use correct lab technique to type blood,
- analyze data to determine where mistakes occurred in the typing procedure, and
- design an experiment.

Recommended Placement in the Curriculum

This activity would work well for anatomy and physiology students in grades 11 and 12.

STUDENT HANDOUT
Using Blood-Typing to Determine Causes of Death in Surgery Patients

Background Information for Blood Diversity

The surface of erythrocytes contains genetically determined glycolipids called antigens. Antigens are categorized into blood groups, two of which are the ABO and Rh groups.

All cells in the body contain antigens on their surfaces. One person's antigens may be recognized as foreign if transferred into another person's body. This will trigger an immune response. As part of the immune response, particular lymphocytes secrete proteins called antibodies, which bind to antigens. Blood transfusions can be fatal if the antigens and antibodies are incompatible.

There are at least 20 different blood groups in red blood cells; the major group is the ABO system. Type A has only the A-antigen. Type B has only the B-antigen. Type AB has both A- and B-antigens, and type O has neither. Blood type denotes the class of antigens (glycolipids) found on the surface of the red blood cells.

Each person inherits two genes that control the production of ABO antigens. A and B are codominant, and O is recessive. The immune system does not attack its own red blood cell antigens. A-antigens do make antibodies against B, etc. (This is believed to result from the presence in the plasma of preformed antibodies, made in response to some common bacteria in the digestive tract.) O produces both anti-A and anti-B antibodies. AB produces neither.

Before transfusions are performed, a cross match is made by mixing serum from the recipient with blood cells from the donor. If the types do not match, the recipient's antibodies attach to the donor's red blood cells and form bridges, causing the blood to clump or agglutinate. A- and B-antigens are called agglutinogens. Antibodies against them are called agglutinins. The clumping causes blockage of small blood vessels. The red blood cells begin to hemolyze (rupture), releasing their hemoglobin into the bloodstream and causing severe kidney damage.

Type O is called the universal donor (if the plasma is removed and only the cells are given). The plasma would cause agglutination. AB is called the universal recipient, but agglutination could cause problems if the volume of blood given is too large. Because of the dangers involved, the universal donor/recipient concept is strongly discouraged.

Another group of antigens is called the Rh factor. Rh comes from Rhesus monkeys, where the antigen was first discovered. Eighty-five percent of the population has this and is known as Rh+. The other 15 percent who do not make this antigen are Rh–. Rh factor becomes a problem when an Rh– mother gives birth to an Rh+ baby. During the first pregnancy, this does not pose a problem because the blood is kept separate. During birth, a variable degree of exposure may occur and the mother's immune system may become sensitized and produce antibodies against the Rh antigen. If the mother does produce the antibodies, they can cross the placenta in subsequent pregnancies and cause hemolysis of the Rh+ red blood cells of the fetus. This can cause the baby to be born anemic (erythroblastosis fetalis or hemolytic disease of the newborn).

This problem can be prevented by injecting the Rh– mother with antibodies against the Rh factor within 12 hours of the birth of each Rh+ baby. The injection will inactivate the Rh antigens, preventing the mother from becoming sensitized.

History

When Europeans first started transfusions in the seventeenth century, many people died, so the process was outlawed in France, England, and Italy. The following are some significant dates in the history of blood research:

1901 Karl Landsteiner (an immunologist) discovered human blood groups.
1920 Landsteiner discovered another factor (the M, N, and MN factor).
1930 Landsteiner received the Nobel Prize for physiology and medicine.
1940 Landsteiner discovered the Rh factor.
1949 Barr bodies in white blood cells of females were discovered.

STUDENT ACTIVITY SHEET
Using Blood-Typing to Determine Causes of Death in Surgery Patients

Purpose
To use blood-typing to solve a real-world problem.

Scenario
In a local hospital on Tuesday, September 10, four surgery patients died either during or immediately after surgery. All were routine surgeries that normally have low mortality rates. As a member of the hospital board, you are very concerned, so you decide to investigate this situation to determine whether negligence or criminal activity occurred.

You find that there were ten surgeries performed that day. Normally for these types of surgeries, the mortality rate is 0.1%. All patients were given 1–3 units of blood from the hospital blood bank. All patients were typed the day before surgery. All blood bags used in the surgeries were preserved and are available for testing.

You are a qualified lab technician and decide to do the investigating yourself.

The following is a record of the patients, their blood types, blood types received, and surgery.

Name	Blood Type	Surgery	Blood Received	Outcome	Units
Mr. S. Smith	A+	gallstones	O– bag 1	OK	1
Mr. Jones	A–	gallstones	AB– bag 2	death	2
Ms. Johns	AB+	tonsillectomy	O– bag 3	OK	1
Ms. Tims	A+	kidney stones	AB– bag 4	death	1
Mr. Williams	B+	hernia	AB+ bag 5	death	3
Ms. Ellis	B–	kidney stones	B– bag 6	OK	2
Ms. Post	AB+	hysterectomy	AB+ bag 7	death	1
Mr. Ackerman	AB+	gallstones	AB+ bag 8	OK	1
Mrs. Carter	O–	lump removed	O– bag 9	OK	1
Mrs. Patterson	AB–	face lift	AB– bag 10	OK	2

Materials
Per group
- blood-typing kit
  Artificial blood-typing kits are available from Sargent-Welch (800/727-4368, P.O. Box 5229, Buffalo Grove, IL, 60089, www.sargentwelch.com, *#WL54859) and from Flinn Scientific (800/452-1261, P.O. Box 219, Batavia, IL, 60510, #FB1225).*

- glass slides
- wax pencils
- gloves
- “blood” samples from each patient
- “blood” samples from each bag

Safety, Handling, and Disposal

It is your responsibility to specifically follow your institution’s standard operating procedures (SOPs) and all local, state, and national guidelines on safe handling and storage of all chemicals and equipment you may use in this activity. This includes determining and using the appropriate personal protective equipment (e.g., goggles, gloves, apron). If you are at any time unsure about an SOP or other regulation, check with your instructor.

Artificial blood does not pose the hazards real blood does, but you should wear gloves. Cleaning the slides in a 10% bleach solution is an option.

Procedure

Examine the data and answer the following questions.

1. Explain to the other hospital board members why this situation needs to be investigated.

2. Use the steps in the scientific method.
   a. Define the problem.
   b. Gather information.
   c. Make a hypothesis.
   d. Design and implement an experiment to test your hypothesis.
   e. Create a data table to record the results of the blood-typing.

Name	Blood Type	Blood Type Received
Mr. S. Smith		
Mr. Jones		
Ms. Johns		
Ms. Tims		
Mr. Williams		
Ms. Ellis		
Ms. Post		
Mr. Ackerman		
Mrs. Carter		
Mrs. Patterson		

f. Accept or reject your hypothesis and support your answer with data.
g. What happened to Mr. Jones?
h. Explain why Ms. Johns did not have any problems, even though they gave her the wrong type of blood.
i. Did any of the patients who received type O have any problems? Explain why someone who received type O– in surgery might have a problem with agglutination.
j. Explain on a cellular level why giving someone type B if he or she is type A would be a problem.
k. Why did this day have an abnormally high mortality rate?
l. Do you think this is a case of criminal activity or negligence?

INSTRUCTOR NOTES
Using Blood-Typing to Determine Causes of Death in Surgery Patients

Time Required
Four days are needed for this activity: one day for background lecture over blood-typing, one day for practice typing, one day for the lab, and one day for analyzing results.

Group Size
Groups of two are best.

Materials
Per group
- blood-typing kit
  Artificial blood-typing kits are available from Sargent-Welch (800/727-4368, P.O. Box 5229, Buffalo Grove, IL, 60089, www.sargentwelch.com, *#WL54859) and from Flinn Scientific (800/452-1261, P.O. Box 219, Batavia, IL, 60510, #FB1225).*
- glass slides
- wax pencils
- gloves
- "blood" samples from each patient
- "blood" samples from each bag

Safety, Handling, and Disposal
As the instructor, you are expected to provide students with access to SOPs, MSDSs, and other resources they need to safely work in the laboratory while meeting all regulatory requirements. Before doing this activity or activities from other sources, you should regularly review special handling issues with students, allow time for questions, and then assess student understanding of these issues.

Artificial blood does not pose the hazards real blood does, but students should wear gloves. Cleaning the slides in a 10% bleach solution is an option.

Points to Cover in the Pre-Lab Discussion
Lecture notes over blood types and history of blood-typing are included, and students should be given the background information prior to the lab. The instructor could demonstrate how blood-typing is done or allow students to practice the technique once before the actual activity.

Students should also be familiar with the scientific method from previous activities.

Procedural Tips and Suggestions
Prepare and label the blood samples before class begins. Prepare a master copy of the samples for your use. Remind your students to label the slides with wax pencils.

The actual blood problems are as follows:
- Mr. Jones was incorrectly typed. He actually had type A instead of AB.
- Ms. Tims' blood was typed correctly, but the bag was mislabeled O– instead of AB–.
- Mr. Williams was also typed incorrectly. He actually had B+ instead of AB+.
- Ms. Post was typed correctly; she died from complications.

Prepare a sample from each bag as follows:

Bag Number	Blood Type
Bag 1	O–
Bag 2	AB–
Bag 3	O–
Bag 4	AB–
Bag 5	AB+
Bag 6	B–
Bag 7	AB+
Bag 8	AB+
Bag 9	O–
Bag 10	AB–

Prepare the following samples for student use:

Name	Blood Type
Mr. S. Smith	A+
Mr. Jones	AB–
Ms. Johns	AB+
Ms. Tims	A+
Mr. Williams	B+
Ms. Ellis	B–
Ms. Post	AB+
Mr. Ackerman	AB+
Mrs. Carter	O–
Mrs. Patterson	AB–

Sample Results

Name	Blood Type (tested)	Blood Type Received During Surgery
Mr. S. Smith	A+	O–
Mr. Jones	A–	AB–
Ms. Johns	AB+	O–
Ms. Tims	A+	AB–
Mr. Williams	B+	AB+

Plausible Answers to Questions

g. What happened to Mr. Jones?
Mr. Jones died because he had type A– blood and received AB– in surgery. This was due to a mistake in blood-typing (his chart originally said he had AB–). This would cause his blood to clot, causing death.

h. Explain why Ms. Johns did not have any problems, even though they gave her the wrong type of blood.
Ms. Johns received O– in small quantities, and type O would not contain antigens. The blood will not clot in this instance.

i. Did any of the patients who received type O have any problems? Explain why someone who received type O– in surgery might have a problem with agglutination.
In this case no, due to it being used in small quantities. Type O is a universal donor only if the plasma is removed. If the plasma is given to an A, B, or AB patient, agglutination will occur.

j. Explain on a cellular level why giving someone type B if he or she is type A would be a problem.
The cells in an individual that has type B blood would contain B antigens on the membrane surfaces. If type A blood was introduced into the individual, the antigens would be recognized as foreign substances, and an immune response would be triggered, causing agglutination to occur.

k. Why did this day have an abnormally high mortality rate?
This day had an abnormally high mortality rate because a number of patients were not typed correctly originally.

l. Do you think this is a case of criminal activity or negligence?
Negligence.

Extensions and Variations

- Students could research the history of blood-typing.
- Students could create cellular models of agglutination.

References

Van De Graaff, K.M.; Fox, S.I.; Lafleur, K.M. *Synopsis of Human Anatomy and Physiology;* William C. Brown: Dubuque, IA, 1997; pp 362–365.

Otto, J.; Towle, A.; Bradley, J. *Modern Biology;* Holt, Rinehart, and Winston: New York, 1993; pp 663–664.