How new inventions help people with injuries and disabilities

Essential Question

How could new inventions change the way physical injuries and disabilities are treated?

Objectives

- To understand the steps of the invention process and how innovation can be used for social change.
- To improve upon the design of a common medical product or procedure using the design or invention process.

Overview

- Medical procedures or devices are used to prevent, relieve, treat or cure the symptoms of human suffering caused by a disease or an accident. Such medical inventions have existed for thousands of years and are undergoing constant
- improvement or innovation. In this lesson, students will research how medicine has changed over the course of history through improvements in design.

Procedure

1. What medical products can you think of that have been created to helped improved people's lives. A medical device or product is something someone invented, i.e. it's an invention!

Identifying a problem is the first step of the invention process, which students (and all inventors for that matter) will use to complete this project. What steps make up the invention process?

2. Watch this PBS NewsHour Student Reporting Labs video about Ryan Hudson-Peralta, a man with congenital limb deficiency.

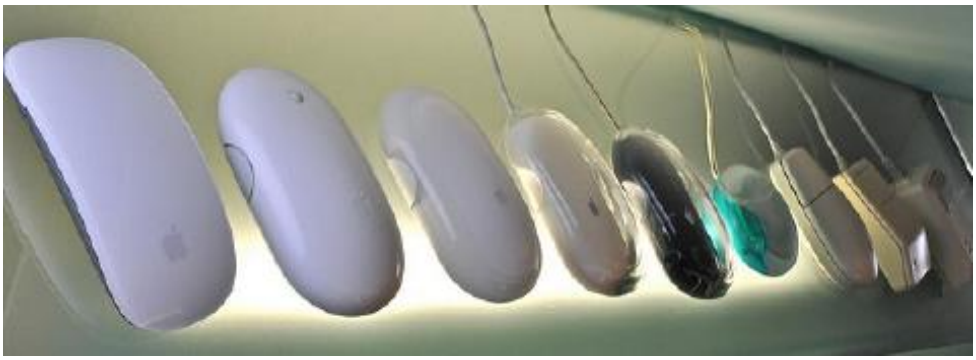
3. You will work in partners to answer the following questions based on the video:

- What inventions are featured in this video? How might they be useful to Hudson-Peralta? What were the options available to Hudson-Peralta 50 years ago with regards to work, having a family and recreational activities? If you are not sure, how could you find out?

- How have medical inventions and procedures changed from ancient civilizations to modern day? (e.g. antibiotics, leeches' treatment, soap)

- What is the difference between an invention and an innovation? Is there a difference? People tend to think of an invention as the first time someone has come up with an idea and innovation as an improvement upon an existing invention. It becomes a little tricky because an innovation could also be considered an invention in its own right.

Take a look at the image below. The invention of the computer mouse has taken on many forms. Think of all the innovations that have made to the mouse. What various innovations have been made to the mouse? What problem was each innovation trying to solve?



Main activity – Your turn to innovate

Part One: Video and reflective discussion

1. Watch the PBS NewsHour video, "Typing sentences by simply thinking is possible with new technology." What is the medical invention featured in the video? What other inventions is the new technology using?

- What branches of science are working together in order to help Dennis DeGray communicate using a computer? What pieces of the "puzzle" are each branch responsible for?

- What are some ethical considerations when enrolling paralyzed patients such as those with ALS into research experiments using untested neural prosthesis? How do scientists and doctors deal with those ethical considerations?

- How do you think this technology might be applied in the future?

Extension Activities

1. Medical timeline activity:
    - Go to PBS WGBH's website and complete the "Doctor Over Time," activity which lets students play the game to see how doctors over the years have handled the same illnesses http://www.pbs.org/wgbh/aso/tryit/doctor/
    - Next, think of a disease that dates back to 1900. Visit each year (1900, 1950, 1998) and complete the chart below. Use the table on the last page to down one or two notes for each section.
    - Explain how the treatments for the same diseases have changed over time. Why were these changes made? Describe the role medical inventions and innovations played in the diagnosis of disease.

If this does not work on school computer here it is in text format:

How do you feel today? You don't look so hot. We've taken the liberty of setting up appointments with three doctors from three different periods in this century. Let's see how each would treat your ailments.

1900

Welcome to Dr. Fieldstone's medical practice. I am Mrs. Fieldstone.
I'll take you to the doctor, but first, please tell me what ails you.

1950

Thank you for your address. We'll send you a bill for the Doctor's services.
Tell me what's wrong, then I'll take you to the doctor.

1998

Sorry to keep you waiting so long. I see that you've filled out all of the necessary forms and made your co-payment. Your HMO will take care of the rest.
Dr Gomez is ready to see you, but first, please tell me why you're here.

DISEASE (pick one of the diseases and research how handle in the past)

1. I have this pus-filled sore on my leg. The skin around the sore is hot and red.
2. I'm weak, nauseous, and very itchy all over. I'm also short of breath.
3. I'm always thirsty and hungry, and even though I eat a great deal, I lose weight. I also urinate a lot and feel weak.

1900: You have a pus-filled sore

Examination

It must be painful to walk on that leg. Next time something like this happens, contact me. I'll come out to your house. Now about the sore. You have a slight fever, and the lesion is very tender. The redness has not yet spread.

Diagnosis

I'm afraid this could be very serious. You have an infection -- probably Staphylococcus or Streptococcus.

Treatment

I'll remove the pus and clean the lesion. I'll then apply a poultice. No, a poultice has nothing to do with chickens -- remember, this is 20th century medicine! A poultice is a mass of linseed, mustard, or soap and oil between two pieces of muslin. The greatest danger is that your wound could become systemic, or spread to the blood. This is a life-threatening situation that must be avoided. If the infection shows signs of spreading, we may have to amputate the leg.

Prognosis

One year later...

You've become quite adept at using those crutches. What's left of your leg looks fine, and your body shows no signs of infection. You're lucky to be alive.

1900: You are weak and itchy

Examination

I understand you are weak, itchy, and nauseous. Go to the lavatory and leave a urine sample in the cup that's on the sink.

Diagnosis

Twenty minutes later...

I ran a test on your urine. When I heated it over a flame, it became nearly solid. This tells me that albumen, a constituent of the blood, is very abundant in the urine. Now a small amount of albumen is normal; a large amount is an indication of Bright's disease, a disorder of the kidneys.

Treatment

We need to lessen the burden on your kidneys. First, you'll need to take a daily alkaline-sponge bath with vigorous friction. I am also going to prescribe Virginia snake-root, which you should take in teaspoonful doses. We can further relieve the kidneys though leeching, mustard-poultices, and croton oil. All indigestible foods, such as coffee, pastries, new bread, and fats must be avoided.

Prognosis

one month later...

So you want the truth. Well, there's nothing else that can be done. It's just a matter of time before you pass away. I suggest you make all the necessary arrangements.

1900: You are always thirsty and hungry

Examination

I see. You are losing weight, and yet you feel as though you are always eating and drinking. You also told me that you always feel tired, and sometimes you don't even have the energy to get out of bed. Go to the lavatory and leave a urine sample in the cup that's on the sink.

Diagnosis

several minutes later...

I ran a test on your urine, which showed a high amount of grape-sugar. This, along with your other symptoms, leads me to conclude that you have diabetes, a disease related to a gland in your body called the pancreas.

Treatment

You need to take a daily alkaline-sponge bath applied with vigorous friction. I'm prescribing sugar of lead to restrict the flow of urine. If that doesn't work, we'll try creosote, in two-drop doses, or clear opium. You should not eat any foods that contain sugar. Instead, your diet should consist almost entirely of tender, fresh meats. Also, you will continue to be thirsty, but you must suppress this urge and drink very little. This is very important.

Prognosis

several days later...

I don't know if you can hear me, but you've lapsed into a coma. We did all we could, but I'm afraid that it's just a matter of time before you pass away.

1950: You have a pus-filled sore

Examination

Well, that's it for the complete history and exam. See, that only took a half an hour. Now you do have a slight temperature. And, as you know, the sore is very tender. Let me take a culture -- I'll just use a cotton swab to take a sample.

Diagnosis

Two days later...

Hello. How the sore? I have the results back from the bacteriologist, who has been nurturing the culture for the past two days. She reports that the lesion is infected with a type of bacteria called Staphylococcus.

Treatment

You are very fortunate. I had a similar wound when I was a child and nearly died from it. Antibiotic treatments have changed this. First came sulfa drugs in 1930s, with which we had limited success. Then only this year, penicillin became widely available for general use. It has had a remarkable impact on medicine. I'll give you a prescription for penicillin. You should also soak the lesion in very warm water to draw out the pus, and keep your leg elevated as much as possible.

Prognosis

Two weeks later...

Your lesion has completely healed. Another life saved by that miracle drug, penicillin!

1950: You are weak and itchy

Examination

OK, now that the complete history and full exam have been completed, I'll need to run a test. Go to the bathroom and give me a urine sample. You'll find a cup in there. Just leave the cup on the sink. And that'll be it for today -- I'll see you in two days.

Diagnosis

two days later...

How are you feeling today? Ah, during your exam two days ago I noticed that your tongue was coated, that your blood pressure was higher than normal, and that your breath had a certain odor. These, in addition to your other symptoms, led me to suspect a problem with your kidneys. That's why I asked for a urine test. The test found high amounts of red blood cells, as well as a protein called albumen. I'm afraid this is an indication of advanced kidney failure.

Treatment

A few years ago, a diagnosis of advanced kidney failure was a death sentence. But the development of an artificial kidney, a dialysis machine that removes wastes from the blood, is beginning to change that. I'm going to refer you to a kidney specialist. With regular, frequent visits to the hospital, we should be able to prolong your life.

Prognosis

Several years later...

You're looking well! Hey, the other day I asked a patient if he had broken any bones recently. He said, "You mean my own?" All right. So that's not my best joke. Anyway, the results from your latest blood-level-nitrogen test look fine. In other words, the dialysis is doing what it should -- removing waste products from your blood.

1950: You are always thirsty and hungry

Examination

I understand that you have to urinate frequently. That reminds me of one of my patients. I asked him if he had to get up in the middle of the night to urinate. He said, "Of course I do. Otherwise I would pee the bed!" Ha ha! Sorry. Just a little medical humor. Now let me give you a full exam.

Diagnosis

later that day...

There were a few things that caught my attention during the exam. When I checked your eyes, I noticed fluffy clouds around your retinal arteries. When I checked your carotid arteries and the arteries in your feet, I noticed a weaker than normal pulse. And then there's your urine sample, which showed a high level of glucose. These all indicate that you have diabetes mellitus. Because your pancreas isn't producing enough insulin, your body can't absorb the glucose in your blood. This is why you feel so tired.

Treatment

This is not the end of the world. I'm going to put you on a special diet. First, we'll need to stabilize your blood sugar with insulin. Then you'll need to go on a special diet. Each day, you need to consume 80 grams of protein, 80 grams of fat, and 160 grams of carbohydrates. Stay away from alcohol, which is almost all carbohydrates. I'll also show you how to give yourself a urine test and how to inject insulin.

Prognosis

three months later...

Good to see you! Although it's been great seeing you regularly this past year, I think we can cut back on your visits. Based on what I've seen in our routine tests, you seem to have the diabetes under control.

I'll see you in three months.

1998: You have a pus-filled sore

Examination

Hmm. Yes, you have one nasty-looking lesion. It's not fluctuant, which means, in layman's terms, that it's not squishy. If it were, I'd send you to a surgeon and have it drained. You also have a temperature of 100.2.

Diagnosis

The sore is infected, most likely with a bacterium called Staphylococcus.

Treatment

I want you to soak the lesion three to four times a day in warm water. The water should be as warm as you can stand it. This will help in draining the pus out of the wound. I'm also going to prescribe an antibiotic called cephalexin. Years ago, we used penicillin for Staph -- with great results. But because the bacteria have mutated over the years, penicillin is now ineffective.

Prognosis

Two days later...

The lesion is healing up nicely. The infection is under control.

1998: You are weak and itchy

Examination

You told the nurse that you're weak, nauseous, itchy, and short of breath. Your skin is sallow. I also see that your lower legs and feet are swollen. OK. I'm going run a couple of blood tests: a BUN, or blood urea nitrogen, a creatinine, and a complete blood count. I'll also need a 24-hour urine sample to check for creatinine clearance.

Diagnosis

Two days later...

I'm afraid the news is not good. Based on my information -- the symptoms you mentioned, plus your complexion, your swollen feet, and the results of your bloodwork -- you are suffering from renal failure. In other words, your kidneys are not working.

Treatment

I'm going to send you to a nephrologist -- a kidney specialist. She'll probably prescribe iron and vitamin pills, as well as erythropoietin, a hormone usually produced by the kidney, to treat your anemia, or low red blood cell count. She'll also put you on a special diet. You'll most likely go on a kidney dialysis machine, and, if all goes well, eventually receive a kidney transplant.

Prognosis

Five years later...

I glad you're feeling well. Your body seems to have accepted the new kidney with few complications. Of course, you need to continue taking your immunosuppressive drugs, or else your body will reject the new organ.

1998: You are always thirsty and hungry

Examination

So you're always hungry, you're weak, and you urinate frequently. How's your eyesight? Somewhat blurry? Please exhale. OK. I'm going to send you to the lab for a urinalysis and a blood test for glucose.

Diagnosis

several hours later...

All right, then. Your blood test and urinalysis indicate high levels of glucose, or sugar. The urinalysis also shows a high level of ketones. What all this means is that your pancreas is producing little or no insulin. You have Type I diabetes.

Treatment

We need to admit you to the intensive care unit at the hospital immediately. There, we'll administer insulin and fluids intravenously, and we'll be able to monitor your body's levels of glucose, potassium, and electrolytes. After you've stabilized, you'll need daily injections of insulin, careful monitoring, and a restrictive diet. I'm also going to refer you to an ophthalmologist to have your eyes checked out.

Prognosis

three months later...

Everything seems to be fine. Your glycohemoglobin is right where it should be, as is your blood sugar and urine microalbumin. I'll see you in three months.

Year	1900	1950	1998
Examination			
Diagnosis			
Treatment			
Prognosis			

If someone ever asked you would you rather live now or in the past what would you say? What if they offered you a million dollars (in 1900 dollars) to go back to 1900?