Historical Case 1—Allocating Insulin

About 1 of every 16 people in the United States has diabetes, a disease of excessive sugar in a person’s blood. There are two forms: type 1 and type 2. In the early 20th century, scientists knew that type 1 diabetes was caused by problems with the pancreas, yet it remained a fatal illness, and many people with the disease did not live very long. In 1921, though, Canadian biologist Fredrick Banting and University of Toronto medical student Charles Best isolated a chemical from the pancreases of healthy animals. When they injected it into animals with type 1 diabetes, the animals’ blood sugar decreased to normal levels. Banting and Best named this chemical insulin. The discovery of insulin made it possible for people with type 1 diabetes to live with their condition. In 1923, Banting was co-awarded the Nobel Prize in Physiology or Medicine.

When people heard the news about insulin—including physicians and patients from throughout the United States and Canada—they wrote, called, and stopped by to ask for some. Only a very small amount was available during the first year after the discovery, though, because mass production of insulin was not yet possible. At first, Banting, who was practicing medicine in Toronto, was not sure what to do.

Stop reading here and write your answer to the question below before turning to the next page.

In your opinion, what would have been the fairest way for Banting to distribute the insulin?
Banting decided that he would use a third of the insulin to treat patients in his own private practice. Another third he would use in a separate local clinic that he oversaw. The rest he gave to the Toronto General Hospital and Hospital for Sick Children.

Write your answer to the questions below.

Do you agree with how Banting distributed the insulin? Why or why not?

Historical Case 2—Allocating Penicillin

Penicillin’s ability to kill bacteria was discovered by chance in 1928. Scottish biologist and pharmacologist Alexander Fleming noticed that mold had crept into several of the culture dishes he was using in an experiment and stopped the growth of bacteria in these dishes. Fleming published his discovery but did not advance the research much further. In 1939, Australian scientist Howard Florey and a group of researchers at Oxford University, including Ernst Chain and Norman Heatley, conducted additional research and successfully developed penicillin as an antibiotic. Penicillin is a chemical found in the type of mold in Fleming’s dishes. Florey and Chain found that the drug could cure infections among soldiers wounded in World War II or people who contracted infections from blisters or cuts or from other bacterial diseases, including syphilis and gonorrhea. Fleming, Florey, and Chain shared the Nobel Prize in Physiology or Medicine in 1945 for their work with penicillin.

At first, penicillin was available only to military personnel. Medical criteria were used to determine who received it. As penicillin production increased, the drug was made available to civilians. The Committee on Chemotherapeutic and Other Agents (COC), an independent group of leading U.S. academic physicians, developed guidelines for the clinical use of penicillin. By 1943, public demand for the drug was far greater than the supply. The COC guidelines were used to determine who received the drug and who did not.

Stop reading here and write your answer to the question below before turning to the next page.

In your opinion, what would have been the fairest guidelines for distributing the penicillin?
The COC distributed the penicillin mostly on the basis of how serious the person’s infection was. The committee also wanted to find out more about whether penicillin would cure some rare diseases. So, they sometimes gave the penicillin to people with rare diseases even if they weren’t as sick as people with more common infections.

Write your answer to the questions below.

Do you agree with how the COC distributed the penicillin? Why or why not?

Historical Case 3—Allocating Dialysis Machines

Among their various functions, kidneys cleanse a person's blood of impurities. When they fail, the body suffers poisoning from the inside out. The hemodialysis machine (commonly called the dialysis machine) can function as an artificial kidney. Invented in the early 1940s by Willem J. Kolff, a Dutch physician-scientist, the machine was first used to save the lives of people with short-term, acute kidney failure. It works by taking blood from a patient's arteries, cleansing it of waste, and then returning it to the patient. Kolff and others struggled to find a way to use the machine over the long term, but most patients could receive dialysis only five to seven times. Each cycle of dialysis required surgery to connect arteries and veins to the machine. Patients whose kidney function did not improve soon used up all their possible arterial and venous connections and, so, had no way to connect to the machine.

In 1960, a simple invention called an implantable shunt made repeat use of hemodialysis over the long term possible. With the invention of the shunt, kidney failure was no longer life-threatening and, instead, became a chronic disease treatable by repeated dialysis. The implantable shunt was invented by University of Washington nephrologist Belding Scribner and his colleagues, especially biochemical engineer Wayne Quentin. The shunt created a connection between a patient's artery and vein that the dialysis machine could connect to repeatedly.

As a result of the success of Scribner's shunt, the Seattle Artificial Kidney Center at Swedish Hospital faced a serious problem: there weren't enough machines or trained personnel to serve all the people who needed dialysis. Physicians in the community did not want the responsibility of choosing which few patients would receive shunts and use the machines.

The hospital formed the Admissions and Policy Committee to decide which patients would get dialysis. The committee was composed of seven volunteers from the community—a lawyer, a minister, a housewife, a state government official, a labor leader, a banker, and a surgeon—and two physicians.

Stop reading here and write your answer to the question below before turning to the next page.

In your opinion, what would have been the fairest way for the committee to distribute access to dialysis?
The Admissions and Policy Committee used several criteria to determine who would receive dialysis:

1. Only people who would benefit medically from dialysis (as determined by a physician) were eligible.

2. Only adults—no children—were eligible. The committee’s argument was that more children would benefit if their parents or guardians who needed dialysis received it. Most adults supported multiple children.

3. Only residents of the State of Washington were eligible. Residents paid state taxes, and state taxes paid for treatment.

4. Only individuals who were “valuable to society when their lives were examined holistically” were eligible. That is, the committee used applicants’ “social worth” or “value to society” as a criterion. Committee members used several factors to determine social worth: income, sex, marital status, net worth, nature of occupation, extent of education, church attendance, number of dependents (more dependents gave applicants a better chance of being chosen), and potential for rehabilitation. The factors helped the committee determine the probable loss to society if an applicant died, including the loss of economic support to dependent children who would then need state financial assistance.

Write your answer to the questions below.

Do you agree with the criteria the committee used for distributing access to the dialysis machines? Why or why not?

### Cards for Day 1, Activity 2

<table>
<thead>
<tr>
<th>Received liver</th>
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<th>Received liver</th>
<th>Received liver</th>
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<tbody>
<tr>
<td>Received liver</td>
<td>Received liver</td>
<td>Received liver</td>
<td>Received liver</td>
<td>Received liver</td>
</tr>
<tr>
<td>Died while waiting</td>
<td>Died while waiting</td>
<td>Died while waiting</td>
<td>Died while waiting</td>
<td>Died while waiting</td>
</tr>
<tr>
<td>Still waiting</td>
<td>Still waiting</td>
<td>Still waiting</td>
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<td>Still waiting</td>
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</tbody>
</table>
## Liver and Liver-Transplant Fact Sheet*

<table>
<thead>
<tr>
<th>Scientific Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What organs and tissues can be transplanted?</td>
<td>Heart, heart valves, kidneys, lungs, pancreas, liver, tendons, bones, intestines, corneas, skin</td>
</tr>
<tr>
<td>How many people were listed for a liver transplant in 2008?</td>
<td>Roughly 16,000</td>
</tr>
<tr>
<td>How many people received a liver transplant in 2008?</td>
<td>Roughly 6,000</td>
</tr>
<tr>
<td>How many people died in 2008 while they were on the liver waiting list?</td>
<td>Roughly 2,000</td>
</tr>
<tr>
<td>What does the liver do?</td>
<td>It stores the vitamins, sugar, and iron that help give your body energy. It also controls the removal and production of cholesterol; clears the blood of waste products, drugs, and other toxins; makes clotting factors that stop bleeding after cuts or injuries; and releases bile that helps digest food and absorb important nutrients.</td>
</tr>
<tr>
<td>What is liver failure?</td>
<td>The liver fails when it is unable to filter wastes, toxins, and drugs from the blood or can no longer produce the clotting factors necessary to stop bleeding. Liver failure can lead to death.</td>
</tr>
<tr>
<td>Why do livers fail, causing people to need a liver transplant?</td>
<td>In adults, the most common reason for liver failure is cirrhosis. It’s caused by many types of liver injuries that destroy healthy liver cells and replace them with scar tissue. Cirrhosis can be caused by viruses such as hepatitis B and C, excessive alcohol consumption, autoimmune liver diseases, buildup of fat in the liver, and hereditary liver diseases. In children, the most common reason for liver failure is biliary atresia. Bile ducts, which are tubes that carry bile out of the liver, are missing or damaged in this disease. When bile cannot flow easily out of the liver, cirrhosis can arise. Other reasons for liver failure and transplantation are liver cancer, benign liver tumors, and hereditary diseases. Sometimes the cause of liver disease is not known.</td>
</tr>
<tr>
<td>How do liver transplants work?</td>
<td>There are two types of liver transplants: deceased donor and living donor. Usually, a liver transplant is done with a liver from a brain-dead person (a deceased donor). The liver is removed from the body and kept sterile until it is transplanted. The donor is matched to the recipient based on his or her medical condition, body size, and blood group. With living donors, doctors remove a piece of liver from someone while they are alive. The right half of a liver is usually removed from an adult donor and transplanted to another adult. For a child needing a transplant, a smaller part of the adult liver is removed and used. The donor’s liver regenerates.</td>
</tr>
</tbody>
</table>

*Continued*
<table>
<thead>
<tr>
<th>Scientific Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What must a patient do after a transplant to help the new liver work?</td>
<td>To keep the body from rejecting the new liver, the patient must take immunosuppressant medicines. One of the side effects of a weakened immune system, though, is getting more infections and illnesses. Doctors work to find the right dosage: enough medicine to help prevent rejection but not so much that the person’s immune system is overly compromised.</td>
</tr>
<tr>
<td>What is the survival rate for patients who receive a liver from a deceased donor?</td>
<td><strong>Sex</strong></td>
</tr>
<tr>
<td></td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td>Females</td>
</tr>
<tr>
<td>What is cold ischemic time?</td>
<td>The time between when an organ has been removed from a donor and when it is transplanted into a recipient.</td>
</tr>
<tr>
<td>Why is cold ischemic time important?</td>
<td>The shorter the amount of time an organ is not in a body, the better the chance of a successful transplant. For livers, the medically acceptable limit for cold ischemic time is 12 hours.</td>
</tr>
</tbody>
</table>

*All transplant statistics are from U.S. data only.*

The Liver and Liver Transplants—Checking for Understanding

Check Facts

1. List at least four functions of your liver.

2. Describe two causes of liver failure in adults.

3. Identify an action that you can take to help keep your liver healthy.

4. After a transplant, a patient must take medication.
   a) What are some of the side effects of the medications one must take after a liver transplant?
   b) Why are these medications necessary, despite the side effects?

Apply Your New Knowledge

5. Why is geography important to consider? In other words, why might a hospital give a liver to a patient closer to the hospital, even if this patient has been waiting for less time or is not as sick as another patient who lives farther away?

6. Out of all of the people waiting for a liver in 2008, what percentage died while waiting for a liver transplant?
7. Suppose that you are giving a presentation to compare percentage survival in males vs. females one year, three years, and five years after a liver transplant from a deceased donor. Using the area below, prepare a line graph in which you show the relevant data.
   a) Consider which variable (number of years or percentage survival) you will place on the X (independent) axis and which variable you will place on the Y (dependent) axis. Label each axis, and decide on an appropriate scale.
   b) Make two lines, one for females and one for males. Color-code your lines (or make one dashed and one solid).
   c) Provide a descriptive title.

8. On the basis of your graph above, do you think that the patient’s sex (male vs. female) makes a small, medium, or large difference in terms of percentage survival over five years?
Patient Profiles

Anita

Anita is a 19-year-old college student who has liver failure. When she was in high school, she visited another country where she was involved in a bad car accident. During surgery there, she contracted hepatitis C from contaminated blood. Anita has been attending her doctor’s appointments at her university’s health center regularly, and her liver has been monitored with frequent blood tests. Recently, however, her doctor told her that her liver is failing due to hepatitis C, and he listed her for a liver transplant one week ago. Anita has no other medical conditions, but recently, she started smoking cigarettes and drinking alcohol due to the stress of college and her serious health problem.

Anita has two living parents and one older sibling. Her parents are very concerned about her and frequently call and visit. She has a boyfriend in college. She is studying economics and is doing very well. Her advisor thinks she will get into law school without any difficulty.

Mario

Mario is a six-month-old infant who was born with biliary atresia. This means that Mario does not have bile ducts, so there is no way for the bile to get into his intestinal system to help digest food. This disease results in liver failure over time, and his doctor has told his parents that Mario’s liver is getting worse. Mario is otherwise healthy and well loved. His parents have never missed a doctor’s appointment, and they have extended family nearby to help take care of Mario’s three-year-old sister when Mario has appointments.

Mario’s doctor plans to list him for a liver transplant next week.

Emily

Emily is a 36-year-old single mother of two young children. Her husband died two years ago from cancer, and they spent all of their life savings on his medical bills. Emily has an autoimmune liver disease where her own body is attacking her liver. She has been taking her medications regularly, but her disease is still getting worse. She has been trying to keep up with her doctor’s appointments, but from time to time, she misses them because she has to take care of her children.

Emily works at home because she cannot afford childcare. Her parents live far away and are not able to help out with the children. Emily recently lost her health insurance, and she is not sure how she will pay for her expensive medications once her current supply runs out. She has no medical problems besides her liver disease. She does not smoke or drink alcohol.

Recently, Emily’s doctor told her that her liver disease has gotten much worse. She listed Emily for a transplant two months ago.
Luke

Luke is a 58-year-old military veteran who served in the Gulf War. When he returned from the war, he suffered post-traumatic stress disorder (PTSD) and started drinking alcohol. Luke abused alcohol for six years and developed liver cirrhosis, which has now progressed to liver failure. He completely stopped drinking alcohol two years ago. Luke also has high blood pressure. He has been good about taking his liver and blood pressure medications and keeps all his doctor’s appointments.

Luke has two grown children and a wife. He is employed as a security guard at a local business. Lately, he has become increasingly sick and has not been able to go to work. When he saw his doctor yesterday, she told him that his liver was nearing its end. She listed him for a transplant six months ago.
Additional Patient Information

Anita

• It is estimated that Anita will live 33 more years if she receives the transplant.
• Anita lives very close to a big transplant center, and it is likely that she will receive an organ that has a very short cold ischemic time.
• If Anita does not get an organ, her doctor thinks she will die within the next nine months.

Mario

• It is estimated that Mario will live 53 more years if he receives the transplant.
• Mario lives very far from a transplant center, and it is likely that he will receive an organ that has a very long cold ischemic time.
• If Mario does not get an organ, his doctor thinks he will die within one year.

Emily

• It is estimated that Emily will live 10 more years if she receives the transplant.
• Emily lives far from a transplant center, and it is likely that she will receive an organ that has a moderately long cold ischemic time.
• If Emily does not get an organ, her doctor thinks she will die within the next three months.

Luke

• It is estimated that Luke will live three more years if he receives the transplant.
• Luke lives close to a transplant center, and it is likely that he will receive an organ that has a moderately short cold ischemic time.
• If Luke does not get an organ, his doctor thinks he will die within the next two weeks.
Identifying Allocation Criteria and the Relevant Facts

Your teacher will ask you to fill in the top row of this chart with the criteria your class came up with—one criterion in each shaded box. In the column on the left are different facts that may or may not be relevant to the criteria. With your teacher, you will fill out the first column by placing check marks in the boxes next to the facts you would need to know to evaluate whether someone met the first criterion. Then, as homework, you will fill out the rest of the chart by looking at each criterion in the top row and checking off the facts that you think are relevant to that criterion. Be prepared to share your completed chart during class.

**Note:** To complete this task, you might need to consider data from Master 3.5: The Liver and Liver-Transplant Fact Sheet.

<table>
<thead>
<tr>
<th>Potentially Relevant Facts</th>
<th>Criteria relevant to allocating livers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient’s age</td>
<td></td>
</tr>
<tr>
<td>Patient’s sex</td>
<td></td>
</tr>
<tr>
<td>Cause of liver failure</td>
<td></td>
</tr>
<tr>
<td>Patient’s other medical conditions</td>
<td></td>
</tr>
<tr>
<td>Cold ischemic time</td>
<td></td>
</tr>
<tr>
<td>Compliance with medical requirements after the transplant</td>
<td></td>
</tr>
<tr>
<td>Access to health care</td>
<td></td>
</tr>
<tr>
<td>When the patient will die without a transplant</td>
<td></td>
</tr>
<tr>
<td>Patient’s career</td>
<td></td>
</tr>
<tr>
<td>Patient’s impact on dependents</td>
<td></td>
</tr>
<tr>
<td>Patient’s support system at home</td>
<td></td>
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<tr>
<td>Time on the waiting list</td>
<td></td>
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</tbody>
</table>

**Reflection Question:** Which of these criteria (listed in the top row in the shaded cells) do you think are the most important? Explain your answer on the back of this page.
The United Network for Organ Sharing (UNOS)—Two Policies

UNOS maintains lists of people who need organs and matches donated organs to them. It also develops policies on how to allocate organs according to the two goals of legislation passed in 1984: to be fair and to be useful (don’t waste organs and do use them well). Under the UNOS organizational system, the United States is divided into 62 local areas, grouped into 11 regions. A local organ procurement organization (OPO) operates within each of the 62 areas.

Pre-1998 UNOS Liver-Allocation Policy

FACT 1: Before 1998, if you needed a liver transplant, you were given a status based on your lab tests, the symptoms of your liver disease, and the amount of time you had spent on the waiting list.

**Status 1:** Sudden liver failure, transplanted liver failed to function, expected to die in seven days or fewer without transplant.

**Status 2A:** Chronic liver disease, expected to die in seven days or fewer without transplant based on objective and subjective medical criteria.

**Status 2B:** Chronic liver disease, need for a liver transplant was becoming more urgent, not as sick as Status 2A patients based on objective and subjective medical criteria.

**Status 3:** Chronic liver disease but not hospitalized.

FACT 2: If you were waiting for a liver, three other key features of the policy determined when and how you received one:

UNOS allocated livers locally, then regionally, then nationally. When a liver was available in an OPO local area, all Status 1, 2A, 2B, and 3 candidates in that area had a chance to receive the organ before anyone at the regional level. If you were dying and lived close to—but not in—an OPO local area with a liver, a Status 3 patient who lived in the area would receive the liver instead of you.

The severity of the patient’s illness was important. Medical judgment about symptoms figured into the status ranking, yet doctors differed in their interpretation of symptoms. For example, one doctor might decide you were Status 2A; another might say you were Status 2B.

The amount of time a candidate had been on the waiting list for a transplant was important. That amount of time didn’t indicate how sick you were, though. Doctors decided when to put patients on the waiting list, based on their own judgment. One doctor might add his patients to the waiting list early in their disease, and they might still be quite healthy when they reached the top of the list. Another doctor might add patients to the waiting list late in their disease, when they truly needed a liver. By the time a person reached the top of the list, he or she could be quite ill and might not survive.
Current UNOS Liver-Allocation Policy

**FACT 1:** Today, if you are so sick that you will die within one week without a liver transplant, you are **Status 1**.

If you are not expected to die within one week without a liver transplant, you are given a **Model for End-Stage Liver Disease (MELD)** score based on blood tests for

- bilirubin (reflects the liver’s ability to excrete bile);
- INR (reflects the liver’s ability to make blood-clotting factors); and
- creatinine (reflects kidney function—the more severe the liver disease, the more likely someone is to have poor kidney function).

The MELD score predicts your risk of death without a liver transplant over the next three months. The higher your score, the higher the chance you will die. Scores range from 6 to 40 (40 is most sick).

**FACT 2:** If you are waiting for a liver, one will be offered to you depending on your status.

Here’s how status is ranked:

1. Status 1 patient within the local area
2. Status 1 patient within the regional area
3. Patient within the local area with a MELD score greater than 15
4. Patient within the regional area with a MELD score greater than 15
5. Patient within the local area with a MELD score less than 15
6. Patient within the regional areas with a MELD score less than 15
7. Status 1 patient within the nation
8. Patient within the nation with the highest MELD score

Comparing the Past and Current UNOS Policies

Compare the past and current UNOS policies by completing each of the three areas in the Venn diagram below. Include information about what is included in the policies, as well as what is not included. For example, you could write a phrase such as “prioritizes whoever is sickest” as well as a phrase like “doesn’t mention worth to society.” Characteristics unique to the past policy belong in the far left region; characteristics unique to the current policy belong in the far right region; and characteristics shared by both policies belong in the middle region.
Final Assessment

As your final assessment for this module, your teacher will ask you to answer several, or all, of the following questions on a separate sheet of paper. You should write one well-organized paragraph per question.

1. Identify and explain one similarity and one difference between the current and past UNOS policies.

2. Suppose that two patients, Roma and Xavier, need liver transplants, and a liver is available from a deceased donor. The liver is an equally good match for both patients, so both are likely to accept it as long as they take a reasonably low dose of immunosuppressant medication. Both patients are willing to take this medication each day after a transplant, and both live the same distance from the hospital. Roma is 26 years old and has a MELD score of 13. Once she receives a liver, she is expected to live for 20 years, at least. Xavier is 54 years old and has a MELD score of 19. Once he receives a liver, he is expected to live for no more than 10 years. Under the current UNOS policy, who (Roma or Xavier) would get the liver? Explain why.

3. How do you think that the current and past UNOS policies compare in terms of fairness? In other words, do you think that one policy is fairer than the other? Fully explain your answer, being as specific as possible.

4. Suppose that UNOS writes a new policy that incorporates a new criterion: “reason for liver failure.” Prioritization will be given to patients who are sickest and live closest; “sickest” will be determined by Status 1 and MELD scores described in Master 3.10. However, if there are any ties in sickness and geography between patients, the hospital will then consider why the liver failure occurred. For example, a patient with an inherited liver disease would be given priority over a patient who has damaged his or her liver by drinking too much alcohol. Do you agree with this decision? Why or why not?

5. Would you change the current policy in any way to make it fairer? If not, why not? If so, identify and justify one specific change that you would make.