

Lung Transplants and Other Technologies

Not many years ago, lung diseases such as COPD and CF were automatically considered fatal, and life expectancy was relatively short. The progression of the disease would either gradually suffocate the patient or result in other complications that led to death. The emphasis in treatment was on making the patient as comfortable as possible while waiting for the inevitable.

New Technologies

Advances in medical knowledge and in drug and surgical treatments have changed our understanding of respiratory illnesses. These advances have saved the lives of thousands of patients and increased their quality of life and life expectancy.

FLAP Inhibitors

Diseases such as asthma and COPD are known as inflammatory diseases because their symptoms are caused by inflammation of the lining of the respiratory system. When special cells in the immune system detect foreign substances or infectious agents, they release chemicals that cause the characteristic signs of inflammation. These chemicals are produced as part of a complex series of chemical reactions that involve a protein called FLAP (5-lipoxygenase activating protein).

In January 2010, a pharmaceutical company announced that it had just completed a clinical trial of a new drug developed to treat asthma, COPD, and other inflammatory respiratory diseases. This new drug is in a category of drugs known as **FLAP inhibitors**. FLAP inhibitors bind to the FLAP protein, thereby preventing production of the chemicals that cause inflammation.

FLAP inhibitors a category of drugs that interfere with the production of chemicals that cause inflammation

Bronchial Thermoplasty

During an asthma attack, the muscles of the bronchioles contract and decrease the diameter of the airways. This restricts airflow into and out of the lungs. A new procedure, called **bronchial thermoplasty**, reduces the thickness of the muscles surrounding the bronchioles. This procedure results in less constriction of the airways when the muscles contract. Thermoplasty uses thermal energy to reduce the thickness of the muscle. A long, narrow tube, called a catheter, with a wire basket at the end is inserted through a bronchoscope into the lungs (**Figure 1**). (A bronchoscope is a long, thin, flexible—or rigid—tube that has a light and a video camera and is used to examine the bronchi.) The wire basket is expanded until it touches the walls of the bronchiole. Radio-frequency energy is transmitted through the catheter and heats the wire basket and the muscles to about 65 °C. The procedure is repeated along the length of the bronchiole a few millimetres at a time. Normally, three sessions are required to treat all the reachable airways of the lungs.

bronchial thermoplasty a procedure that decreases the amount of constriction of the airways during an asthma attack by using thermal energy to reduce the muscle thickness in the bronchioles

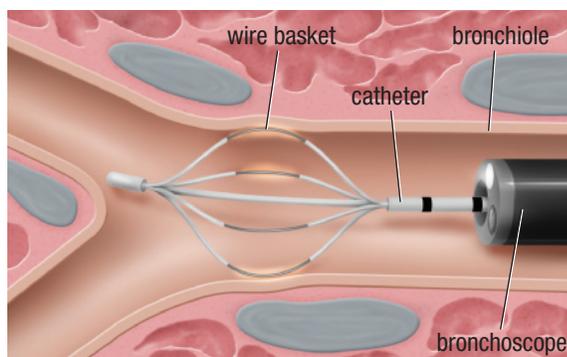


Figure 1 Bronchial thermoplasty reduces the thickness of the muscles in the bronchioles by heating the muscles.



Figure 2 An artificial lung system kept Katie Sutherland alive until donor lungs were available for transplant.

Artificial Lungs

In 2008, Katie Sutherland, a 16-year-old lung transplant patient at Toronto's Hospital for Sick Children, was kept alive by an artificial lung system (**Figure 2**). Katie was waiting for suitable donor lungs for transplant, but she became so sick that her medical team had no choice but to use a new technology that had never been used on a teen before. Doctors connected her to an iLA Membrane Ventilator, an external artificial lung system designed primarily to remove carbon dioxide from the blood. Doctors decided to use the iLA Membrane Ventilator for Katie because she had pulmonary hypertension, which is increased pressure in the blood vessels of the lung. This leads to enlargement of the right side of the heart and heart failure. Once Katie was connected to the device, it reduced the pressure in the pulmonary artery and the failure of the right side of the heart was resolved. The iLA Membrane Ventilator kept Katie alive for a month, until donor lungs became available. You will learn more about hypertension in the circulatory system in Chapter 11.

The iLA Membrane Ventilator is a small device connected to the body by two tubes, usually inserted into the femoral blood vessels, which are in the thigh (**Figure 3**). In Katie Sutherland's case, doctors used the iLA Membrane Ventilator in an innovative manner by connecting the device directly to her heart, between the right ventricle and the left atrium. As blood flows through the device, carbon dioxide diffuses from the blood into a hollow-fibre membrane that acts as artificial alveoli. Although the primary purpose of the device is to remove carbon dioxide, a small amount of oxygen also diffuses through the membrane into the blood, while the patient's lungs also provide some of the required oxygen. The surface of the membrane is treated with heparin. Heparin is a naturally occurring substance that prevents the blood from clotting on the membrane.

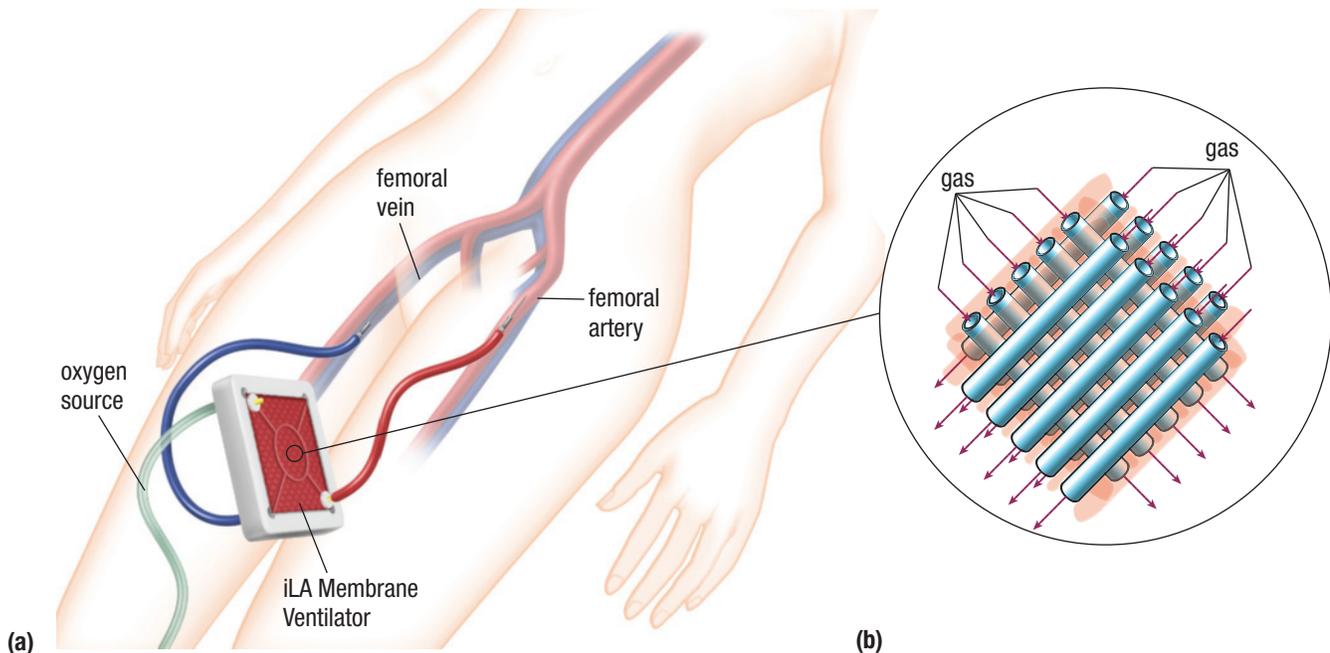


Figure 3 (a) The iLA Membrane Ventilator is a temporary artificial lung system that connects to the body, usually through the two femoral blood vessels. (b) Blood flows over the membrane and carbon dioxide diffuses into the hollow tubes, while a small amount of oxygen diffuses out.

The iLA Membrane Ventilator does not require a pump since it is connected to blood vessels. Blood is pumped through the device by the heart as part of normal circulation. If necessary, a mechanical pump can be used to increase the rate of blood flow and increase the oxygen supply.

Lung Transplants

In some cases, all treatments for diseases such as COPD and cystic fibrosis fail and the disease cannot be controlled. When this happens, the life-or-death option is a lung transplant.

A **lung transplant** involves replacing one or both diseased lungs with healthy lungs from a donor (**Figure 4**). Normally, donor lungs are obtained from a deceased person. The individual must have given prior consent for organ donation, or the family may donate the organs after the individual dies. Depending on the type of disease and the extent of damage to the lungs, it is possible to receive just a portion of a lung. In these cases, a section of lung can be transplanted from a living donor. Two or more living donors are necessary to create a fully functioning lung for the recipient. 🌐

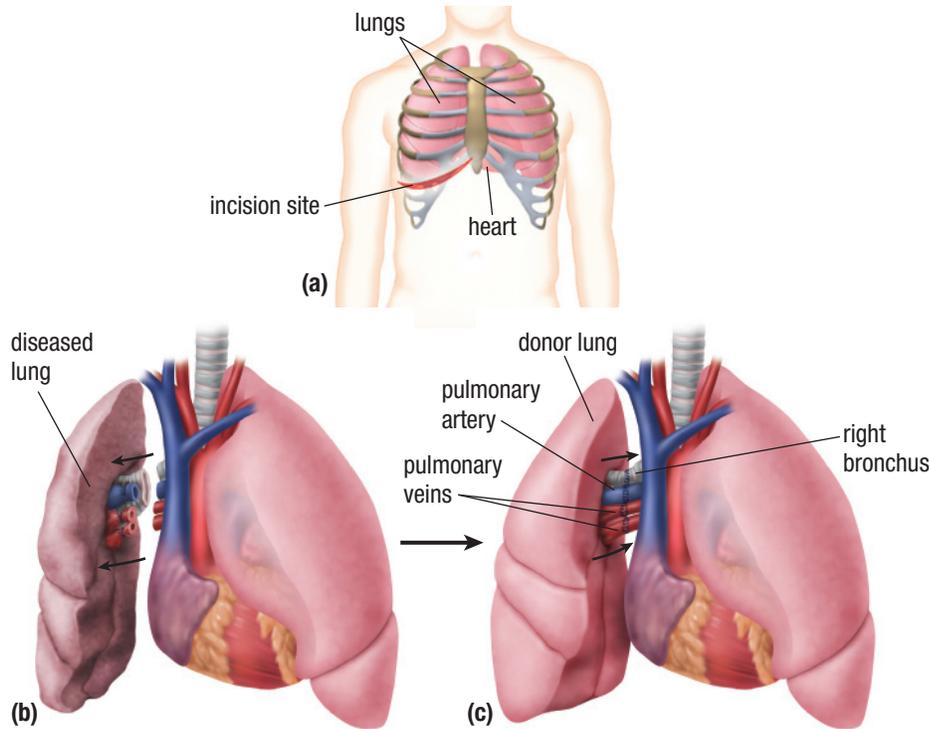


Figure 4 (a) The lung transplant operation takes place through an incision just below the ribs. (b) After the right pulmonary artery and veins are divided and tied off, and the right bronchus is cut, the diseased right lung is removed. (c) The healthy donor lung is put in place, and the blood vessels and bronchus from the lung are connected, restoring the blood and air supply.

Before a lung transplant can take place, the patient must be evaluated to determine if there are any underlying medical conditions that might affect the success of the operation. For example, patients may suffer from cancer, infections, or heart, liver, or kidney problems. Other factors that are also considered include cigarette smoking, substance abuse, and a history of ignoring medical advice.

A donor's blood and tissue type must be a close match to the recipient's for a successful transplant. If they do not match, the recipient's immune system will reject the transplanted organ. There is some degree of rejection in almost all transplants. To prevent or reduce the rejection response, transplant patients are required to take immunosuppressive drugs for the rest of their lives. These drugs suppress the immune system from acting to reject the transplanted organ. However, these drugs pose a significant risk because they suppress the entire immune system, making the patient much more susceptible to infections and other complications.

As with any major surgery, lung transplants involve risks of adverse reactions to medications, bleeding, infections, and blood clots. There are also risks of breathing problems and damage to other organs caused by immunosuppressive drugs. These risks can all affect the success of the transplant and the health of the patient.

lung transplant the surgical procedure of replacing a diseased lung with part or all of a whole healthy lung from a donor

CAREER LINK

Thoracic Surgeon

Some surgeons specialize in thoracic surgery. To find out more about a career as a thoracic surgeon,



GO TO NELSON SCIENCE

Transplant Success and Failure

The first lung transplants were not very successful. Cyclosporine, an immunosuppressive drug, was discovered in 1972 but was not commonly used until the 1980s. After the introduction of cyclosporine, lung transplants became a viable treatment option. Thousands of lung transplants have been performed worldwide since then.

The world's first successful lung transplant was carried out at the Toronto General Hospital, now part of the University Health Network, in Toronto in 1983, followed by the first double-lung transplant in 1986. Since the first transplants, the success rate has climbed significantly. The five-year survival rate for lung transplant patients is now around 60 %, and the number of transplants is increasing. The biggest problem faced by all organ transplant programs is a shortage of donor organs. In Canada, about 40 individuals die each year while waiting for a donor lung.

10.5 Summary

- Advances in scientific knowledge and technology have improved the quality of life and life expectancy of individuals suffering from respiratory diseases.
- FLAP inhibitors are a class of drugs under development that interfere with the production of chemicals that cause inflammation.
- Bronchial thermoplasty eases the symptoms of asthma by reducing the thickness of the muscles in the bronchioles, thereby reducing the constriction of the airways.
- Elimination of carbon dioxide from the bloodstream can be achieved by routing the blood through an artificial external lung. In the artificial lung, gas exchange takes place across a thin membrane of hollow tubes.
- If treatment of respiratory diseases is unsuccessful, a lung transplant may be the only remaining option. During lung transplants, the diseased lung is surgically replaced by a healthy lung from a donor.
- Organ rejection is the greatest risk associated with lung transplants. Immunosuppressive drugs reduce the risk of rejection, but increase the risk of infections.

10.5 Questions

1. Describe the potential of FLAP inhibitors as a treatment for inflammatory diseases. **K/U**
2. What is bronchial thermoplasty, and how does it help alleviate the symptoms of asthma? **K/U T/I A**
3. How is the iLA Membrane Ventilator different from actual lungs? What are some advantages and disadvantages of the artificial lung system? **K/U A**
4. All transplant patients have to take immunosuppressive drugs, yet these drugs can cause life-threatening problems. Explain this apparent contradiction. **K/U A**
5. What factors do you think are, or should be, taken into account when deciding on the most appropriate candidate to receive a lung transplant? Explain your reasoning. **K/U T/I A**
6. (a) There are protocols in place for individuals who wish to donate their organs after their death. Use the Internet and other sources to research the organ donation programs and policies in Ontario. Write a brief summary of your findings.
(b) Have you made a personal decision regarding organ donation? Discuss your feelings on this issue with a classmate. Record your arguments for and against organ donation. **T/I C A**



GO TO NELSON SCIENCE