



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Coimbatore – 35



DEPARTMENT OF BIOMEDICAL ENGINEERING

ARTIFICIAL LUNG

Artificial lung (AL) is a prosthetic device that provides oxygenation of blood and removal of carbon dioxide from the blood. The AL is intended to take over some of the functionality of biological lungs. It is different from a heart-lung machine in that it is external and designed to take over the functions of the lungs for long periods of time rather than on a temporary basis.

The heartlung machine inspired the design of AL devices, however, modern ALs are optimised to minimize patient trauma. Following the development of the heartlung machine, Extracorporeal Membrane Oxygenation (ECMO) was developed. This was intended to be used as a bridge to lung transplant (BTT), for patients too sick to wait until a donor lung was available. Mechanical Ventilation (MV) has also been used, however, it is damaging to the patient's lungs if used for extended periods of time. Both these therapies are expensive and are associated with poor quality of life, in part due to complex blood circuits required for these techniques to work.

Recent developments include simplifying the ECMO system, and devices that use 380 micron wide hollow fibers to simulate the function of alveoli have been developed. Several research groups, notably, the University of Pittsburgh, the University of Michigan, University of Maryland and Boston based groups are developing AL devices to bridge patients to lung transplant.

Cardiopulmonary bypass (CPB) is a technique that temporarily takes over the function of the heart and lungs during surgery, maintaining the circulation of blood and the oxygen content of the patient's body. The CPB pump itself is often referred to as a **heart–lung machine** or "the pump". Cardiopulmonary bypass pumps are operated by perfusionists. CPB is a form of extracorporeal circulation. Extracorporeal membrane oxygenation is generally used for longer-term treatment.

Cardiopulmonary bypass is commonly used in coronary bypass heart surgery because of the difficulty of operating on the beating heart. Operations requiring the opening of the chambers of the heart require the use of CPB to support the circulation during that period. The machine pumps the blood, and, using an oxygenator, allows red blood cells to pick up oxygen, as well as allowing carbon dioxide levels to decrease. This mimics the function of the heart and the lungs, respectively.

CPB can be used for the induction of total body hypothermia, a state in which the body can be maintained for up to 45 minutes without perfusion (blood flow). If blood flow is stopped at normal body temperature, permanent brain damage normally occurs in three to four minutes – death may follow shortly afterward. Similarly, CPB can be used to rewarm individuals suffering from hypothermia.

Extracorporeal membrane oxygenation (ECMO) is a form of CPB sometimes used as life-support for newborns with serious birth defects, or to oxygenate and maintain recipients for organ transplantation until new organs can be found.



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Coimbatore – 35



DEPARTMENT OF BIOMEDICAL ENGINEERING

CPB mechanically circulates and oxygenates blood for the body while bypassing the heart and lungs. It uses a heart–lung machine to maintain perfusion to other body organs and tissues while the surgeon works in a bloodless surgical field. The surgeon places a cannula in the right atrium, vena cava, or femoral vein to withdraw blood from the body. The cannula is connected to tubing filled with isotonic crystalloid solution. Venous blood which is removed from the body by the cannula is filtered, cooled or warmed, oxygenated, and then returned to the body. The cannula used to return oxygenated blood is usually inserted in the ascending aorta, but it may be inserted in the femoral artery. The patient is administered heparin to prevent clotting, and protamine sulfate is given after to reverse effects of heparin. During the procedure, hypothermia may be maintained; body temperature is usually kept at 28 °C to 32 °C (82.4–89.6 °F). The blood is cooled during CPB and returned to the body. The cooled blood slows the body's basal metabolic rate, decreasing its demand for oxygen. Cooled blood usually has a higher viscosity, but the crystalloid solution used to prime the bypass tubing dilutes the blood.

Lung transplantation or pulmonary transplantation is a surgical procedure in which a patient's diseased lungs are partially or totally replaced by lungs which come from a donor. Donor lungs can be retrieved from a living donor or a deceased donor. A living donor can only donate one lung lobe. With some lung diseases a recipient may only need to receive a single lung. With other lung diseases such as cystic fibrosis it is imperative that a recipient receive two lungs. While lung transplants carry certain associated risks, they can also extend life expectancy and enhance the quality of life for end-stage pulmonary patients.

Types of lung transplant

Lobe

A lobe transplant is a surgery in which part of a living or deceased donor's lung is removed and used to replace the recipient's diseased lung. In living donation, this procedure requires the donation of lobes from two different people, replacing a lung on each side of the recipient. Donors who have been properly screened should be able to maintain a normal quality of life despite the reduction in lung volume. In deceased lobar transplantation, one donor can provide both lobes.

Single-lung

Many patients can be helped by the transplantation of a single healthy lung. The donated lung typically comes from a donor who has been pronounced brain-dead.

Double-lung

Certain patients may require both lungs to be replaced. This is especially the case for people with cystic fibrosis, due to the bacterial colonization commonly found within such patients' lungs; if only one lung were transplanted, bacteria in the native lung could potentially infect the newly transplanted organ.

Heart–lung



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Coimbatore – 35



DEPARTMENT OF BIOMEDICAL ENGINEERING

Some respiratory patients may also have severe cardiac disease which would necessitate a heart transplant. These patients can be treated by a surgery in which both lungs and the heart are replaced by organs from a donor or donors.

A particularly involved example of this has been termed a "domino transplant" in the media. First performed in 1987, this type of transplant typically involves the transplantation of a heart and lungs into recipient A, whose own healthy heart is removed and transplanted into recipient B.