CONDITION

Pump lung

Pump lung is acute lung injury that can develop after cardiopulmonary bypass during heart surgery.

WHAT IT IS
Acute lung injury after heart-lung bypass

BODY SYSTEM
Lungs and breathing

MAIN SYMPTOMS
Low oxygen, breathlessness, rapid breathing, difficult ventilator weaning

WHAT CAUSES IT
Inflammation and fluid leakage after cardiopulmonary bypass

HOW IT IS DIAGNOSED
Oxygen testing, chest imaging, and exclusion of other causes

MAIN TREATMENT
Oxygen, breathing support, and careful fluid management

CAN IT BE CURED?
Sometimes - many cases resolve with support

IS IT AN EMERGENCY?
Sometimes - severe breathlessness or falling oxygen needs urgent care

LONG-TERM OUTLOOK
Mild cases often resolve; severe cases can be life-threatening

Overview

Pump lung is an older, informal name for lung injury that develops after cardiopulmonary bypass. It is also called postperfusion lung syndrome.

Cardiopulmonary bypass is the use of a heart-lung machine during some heart operations. The machine temporarily pumps blood and adds oxygen while surgeons work on the heart. This technology makes many complex operations possible, but it can trigger inflammation throughout the body.

In the lungs, inflammation may make tiny blood vessels unusually leaky. Fluid can then move into the lung tissue and air sacs, making it harder for oxygen to enter the blood. The lungs may also become stiffer than usual.

Small changes in lung function are common after major heart surgery and may instead be caused by shallow breathing, areas of collapsed lung, pain, fluid overload, or heart problems. The term pump lung is usually reserved for more significant lung injury linked to bypass. It is not a separate disease and does not occur after every bypass operation.

Pump lung ranges from a short-lived need for extra oxygen to severe acute respiratory distress syndrome, or ARDS. ARDS is a serious form of widespread inflammatory lung injury. Medical teams must distinguish pump lung from other problems that need different treatment.

Symptoms

Pump lung usually appears during the first hours or days after surgery. You may still be sedated or receiving mechanical ventilation when it begins, so the intensive care team may notice the first signs.

Possible features include:

Some people cough or feel chest tightness, but these symptoms are not specific to pump lung. Chest discomfort after surgery may also come from the incision, chest drains, or the operation itself.

Mild low oxygen after heart surgery does not automatically mean pump lung. Small areas of lung often close temporarily during anesthesia. This is called atelectasis and is a common cause of postoperative oxygen needs.

- A low blood oxygen level
- Rapid or difficult breathing
- Shortness of breath after waking
- Stiffer lungs during mechanical ventilation
- Difficulty reducing or removing breathing support
- New hazy areas on chest imaging

Causes and risk factors

During bypass, blood is circulated through artificial tubing and equipment. Contact with these surfaces can activate the immune system, including proteins and white blood cells involved in inflammation.

Blood flow through the lungs also changes during bypass. When normal flow returns, the lung

tissue may experience ischemia-reperfusion injury. This means that reduced blood flow followed by restored flow causes inflammation and cell stress.

These effects can damage the thin barrier between lung air sacs and blood vessels. Fluid and proteins may leak across that barrier, reducing the lungs' ability to exchange oxygen.

Several factors may contribute at the same time. These include the effects of anesthesia, the length and complexity of surgery, fluid shifts, blood transfusions, and changes in heart function.

Risk may be higher with:

These factors do not mean pump lung will occur. A person without known risk factors can still develop it, while many higher-risk people do not.

- Longer or more complex bypass procedures
- Emergency heart surgery
- Pre-existing lung disease
- Smoking or recent smoking
- Poor heart function
- Kidney problems or difficulty removing excess fluid
- Major bleeding or a need for multiple transfusions
- Another severe illness, such as infection

Diagnosis

There is no single test that confirms pump lung. Diagnosis is based on when the breathing problem began, oxygen measurements, imaging, and assessment for other causes.

A pulse oximeter measures oxygen through a sensor placed on the skin. An arterial blood gas uses a blood sample from an artery to measure oxygen, carbon dioxide, and acidity more precisely.

A chest X-ray may show widespread hazy areas caused by fluid or inflammation. Lung ultrasound or a CT scan may provide more detail when needed.

The team will also consider other explanations for low oxygen after heart surgery, including:

An echocardiogram, which is an ultrasound scan of the heart, can help assess heart function and pressure. Blood tests, cultures, airway samples, or scans may be used if infection, a clot, or another complication is suspected.

Severe cases may meet formal criteria for ARDS. These criteria consider timing, chest imaging, oxygen levels, and whether heart failure or excess fluid fully explains the problem.

- Atelectasis, where small lung areas have closed
- Fluid in the lungs because the heart is not pumping effectively
- Pneumonia
- A blood clot in the lungs
- Air or fluid around a lung
- Mucus blocking an airway
- A reaction linked to blood transfusion

Treatment and management

Treatment supports breathing while the lungs recover and addresses anything else contributing to the problem. There is no single medicine that immediately reverses pump lung.

Extra oxygen may be given through small nasal tubes or a face mask. If more support is needed, high-flow oxygen or non-invasive ventilation can assist breathing without placing a tube in the windpipe.

Severe lung injury may require mechanical ventilation. A ventilator moves air through a breathing tube while you are sedated. Teams generally use lung-protective ventilation, which limits excessive pressure and stretching of injured lungs. In severe ARDS, positioning a person face down may improve oxygen levels.

Fluid management is important. Too much fluid may worsen lung swelling, but too little may reduce blood flow to organs after major surgery. The team balances these needs using examinations, blood tests, urine output, heart measurements, and imaging. Medicines that increase urine production may be used when excess fluid is contributing.

Treatment may also include:

Steroids and other anti-inflammatory medicines are not a universal cure for pump lung. Their possible use depends on the full clinical situation and the cause of the lung injury.

- Support for reduced heart function
- Antibiotics like amoxicillin or doxycycline when a bacterial infection is suspected or confirmed
- Clearing mucus from the airways

- Pain control that allows deeper breathing and movement
- Breathing exercises and physiotherapy
- Early movement when medically safe
- Nutrition and prevention of blood clots or pressure injuries

Complications

Severe pump lung can progress to ARDS. This may lead to a longer intensive care stay and prolonged mechanical ventilation.

A breathing tube and critical illness can increase the chance of pneumonia, throat injury, delirium, and muscle weakness. Some people need a temporary tracheostomy, which is a breathing opening made through the front of the neck, if ventilation is required for an extended period.

Very low oxygen or severe inflammation can place strain on the heart, kidneys, brain, and other organs. However, organ problems after heart surgery often have several causes rather than lung injury alone.

Severe pump lung can be life-threatening. This does not describe every case: milder lung injury may improve with short-term oxygen and monitoring.

Prevention

Pump lung cannot always be prevented. Cardiopulmonary bypass itself can trigger inflammation even when surgery and postoperative care go as planned.

The surgical and intensive care teams may reduce avoidable lung stress by carefully managing bypass, ventilation, transfusions, blood pressure, and fluid balance. The safest approach depends on the operation and your overall health. No single measure guarantees prevention.

Before planned surgery, stopping smoking can reduce the broader risk of breathing complications. Treating an active respiratory infection and keeping conditions such as asthma or chronic obstructive pulmonary disease under control may also help. Use regular inhalers or other medicines as directed, and tell the surgical team about new cough, fever, wheezing, or breathlessness.

These steps may reduce general surgical risk, but they cannot ensure that pump lung will not occur.

Living with it and what to expect

The course depends mainly on the severity of the lung injury, the operation, heart function, and your health before surgery.

Mild cases may improve over several days as inflammation settles, fluid clears, and normal movement returns. Oxygen and breathing support can often be reduced gradually. This process may take longer when there is pneumonia, heart failure, kidney dysfunction, or significant atelectasis.

After severe lung injury, recovery may take weeks or months. Breathlessness, weakness, poor stamina, sleep problems, or a hoarse voice can continue after leaving intensive care. Some of these problems result from prolonged bed rest or ventilation rather than permanent lung damage.

Rehabilitation may include walking programs, breathing exercises, nutritional support, and cardiac rehabilitation. Progress is usually measured by what you can do safely, not by a fixed timetable.

Some people temporarily need oxygen after leaving hospital. The need should be reassessed because oxygen levels can improve during recovery. People with previous lung or heart disease may have more lasting limitations.

Follow-up may include oxygen measurements, chest imaging, breathing tests, and review by the cardiac surgery, cardiology, respiratory, or rehabilitation team. Many people recover useful lung function, but recovery cannot be promised, particularly after severe ARDS or multiple organ complications.

When to get medical help

In hospital, pump lung is treated as an urgent postoperative complication. Oxygen levels, breathing, heart function, and fluid balance are monitored closely. Tell a staff member promptly if you are awake and notice worsening breathlessness, chest tightness, or difficulty clearing mucus.

After leaving hospital, contact your surgical or medical team promptly if you have increasing breathlessness, a new or worsening cough, reduced exercise ability, or an increasing oxygen requirement. Fever, new leg swelling, rapid weight gain, or trouble lying flat also needs timely assessment because infection, a blood clot, or heart-related fluid buildup may cause similar symptoms.

Call emergency services for:

Routine follow-up is appropriate when symptoms are stable or slowly improving. Sudden deterioration is not something to wait for at a scheduled appointment.

- Severe or rapidly worsening difficulty breathing
- Blue or grey lips or skin
- New confusion, collapse, or extreme drowsiness
- Chest pain with sweating, faintness, or breathlessness
- Oxygen levels far below the range your care team gave you

Common questions

Is pump lung the same as ARDS?

Not always. Pump lung describes lung injury associated with cardiopulmonary bypass. Mild cases may not meet the criteria for ARDS. Severe pump lung can develop into ARDS when there is widespread inflammation, characteristic imaging, and major difficulty getting oxygen into the blood.

Is pump lung caused by fluid overload?

Not necessarily. Fluid may collect because inflamed lung blood vessels become leaky, even when the heart is working reasonably well. Heart failure and excess body fluid can produce similar chest X-ray changes, and both problems can occur together.

How long does pump lung last?

Mild injury may settle over several days. Severe cases can require breathing support for weeks, followed by recovery over months. The course is influenced by heart and kidney function, infection, previous lung disease, and the severity of the original illness.

Can pump lung happen without a heart-lung machine?

The term is normally used for lung injury linked to cardiopulmonary bypass. Similar inflammatory lung injury can happen after infection, trauma, aspiration, transfusion, or other major surgery, but it would not usually be called pump lung.

Will I need oxygen at home?

Some people need temporary oxygen after severe illness. Others leave hospital without it. If oxygen is prescribed, follow the equipment and safety instructions and attend reassessment, since the amount needed may change as the lungs recover.

Can pump lung happen again during another heart operation?

A previous episode does not mean it will definitely happen again. Risk is affected by the

planned procedure, bypass exposure, current heart and lung health, and other medical problems. Make sure a future surgical team knows about the earlier lung injury.

Sources

- Huffmyer JL, Groves DS. "Pulmonary complications of cardiopulmonary bypass." Best Practice & Research Clinical Anaesthesiology . 2015;29(2):163-175.
- Stephens RS, Shah AS, Whitman GJR. "Lung injury and acute respiratory distress syndrome after cardiac surgery." The Annals of Thoracic Surgery . 2013;95(3):1122-1129.
- Ng CSH, Wan S, Yim APC, Arifi AA. "Pulmonary dysfunction after cardiac surgery." Chest . 2002;121(4):1269-1277.
- Ranieri VM, Rubenfeld GD, Thompson BT, et al. "Acute respiratory distress syndrome: the Berlin Definition." JAMA . 2012;307(23):2526-2533.
- Fan E, Del Sorbo L, Goligher EC, et al. "An official American Thoracic Society, European Society of Intensive Care Medicine, and Society of Critical Care Medicine clinical practice guideline: mechanical ventilation in adult patients with acute respiratory distress syndrome." American Journal of Respiratory and Critical Care Medicine . 2017;195(9):1253-1263.
- National Heart, Lung, and Blood Institute. "Acute Respiratory Distress Syndrome." US National Institutes of Health. Reviewed 2022.