

# *Pulmonary embolism: a survivor's story*

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More than 650,000 people annually experience a pulmonary embolism (PE), leading to more than 60,000 deaths. PE is the third most common cause of death in the United States.<sup>1</sup> More people die each year from PE than motor vehicle accidents, breast cancer, or AIDS. Most deaths occur within 30 to 60 minutes after the onset of symptoms.

Pulmonary embolism is a serious condition that can cause:

- Permanent damage to part of the lung from a lack of blood flow to lung tissue
- Low oxygen levels in the blood
- Damage to other organs from lack of oxygen

Severity depends on the size and location of the embolism. If a large blood clot is blocking the artery in the lung, blood flow may be completely stopped, causing sudden death. If the clot is small, the reduced blood flow may damage the lung tissue. If the clot dissolves on its own, it may not cause any major damage.

Because the highest incidence of recognized pulmonary embolism occurs in hospitalized patients, surgical technologists should be aware of its symptoms, diagnosis, complications and treatment.

## **Definition**

PE is a sudden blockage of an artery in the lung. Nine out of 10 cases of PE are caused by a blood clot that forms in a deep vein in the leg (deep

vein thrombosis), breaks loose, travels to the lungs, and becomes trapped in one of the smaller lung arteries. Clots can also form in the veins of the arms, the right side of the heart, or even at the tip of a catheter placed in a vein. In rare cases, other types of clots (eg from fat, air bubbles, tissue from a tumor, or a clump of bacteria) can also lodge in the arteries of the lungs.

## **Risk factors**

Blood clot formation occurs when the patient loses mobility for a period of time:

- Recovery or inactivity after injury or surgery (open heart surgery, hip fractures, femur fractures, hip or knee replacements).
- During a long trip in a car or airplane

Other risk factors include:

- Cancer, especially pancreatic, ovarian and lung cancers, causes increased levels of substances that cause clotting.
- Medical conditions, such as varicose veins.
- Oral contraceptive use. Estrogen in birth control pills can increase clotting factors in the blood, especially in smokers.
- Current or recent pregnancy. Pulmonary embolism is the most frequent cause of death associated with childbirth.
- High blood pressure or cardiovascular disease.
- Being overweight or obese.
- Smoking.

Veins damaged from surgery or injured in other ways are more prone to blood clots. Surgical patients have long been recognized to be at special risk for PE and deep vein thrombosis (DVT), but the problem is not confined to surgical patients. Prospective studies show that acute DVT may be demonstrated in any of the following:

- General medical patients placed at bed rest for a week
- Patients in medical intensive care units
- Patients who are asymptomatic after coronary artery bypass graft

### Common signs and symptoms<sup>1,4,5</sup>

Many patients with PE have a vague sense that something is wrong but have difficulty defining or describing the problem. Consequently, they often delay seeking medical attention. At times, because symptoms are so vague and nonspecific, medical professionals will diagnose anxiety rather than pulmonary embolism. The most common signs and symptoms are:

- Unexplained shortness of breath, beginning suddenly at rest or with exertion.
- Chest pain that often mimics angina (chest pain caused by a temporary lack of sufficient blood flow to the heart). The pain may occur anywhere in the area of the lungs, and may radiate to the shoulder, arm, neck or jaw. It can be sharp and stabbing or aching and dull. It may be worse with deep breathing and cough.)
- Lightheadedness or fainting.
- General sense of anxiety.
- Increased heart rate (tachycardia).
- Excessive sweating.
- Swelling in the lower extremities.
- A cough that produces bloody or blood-streaked sputum.

### Diagnosis<sup>1,4,5</sup>

Many different types of tests, such as a chest X-ray, spiral CT scan, lung scan, or ultrasound, can be used to diagnose pulmonary embolism. However, diagnosis can be delayed because of the similarity of symptoms to other conditions, such as heart attack, panic attack, or pneumonia.

The following tests are often performed:<sup>4</sup>

- *Chest X-ray.* Results may appear normal or show an enlarged heart or injured lung, leading to further testing.
- *Electrocardiograph (EKG).* An EKG will help rule out a possible heart attack.
- *Arterial blood gas analysis (ABGs).* A sudden drop in the blood oxygen level may suggest a pulmonary embolism.
- *Spiral computed tomography.* This is a relatively new technique for visualizing the pulmonary arteries and involves continuously moving the patient through a rotating gantry and detector system.
- *Ventilation-perfusion scanning.* This test scans for abnormal blood flow through the



**FIGURE 1**  
Massive pulmonary artery emboli obstructing the right lung.

lungs after the injection of a radioactive tracer and the inhalation of a radioactive gas.

- (*Doppler ultrasound.* A noninvasive test, the Doppler ultrasound reflects sound waves to determine whether a blood clot is present in the large veins of the legs.
- (*Pulmonary angiography.* Pulmonary angiography is the most accurate way to diagnose PE. A catheter is inserted into a large vein, usually the groin, and threaded through the heart into the pulmonary arteries. A dye is injected and X-rays are taken as the dye travels along the arteries into the lungs. This test is not available at some smaller hospitals and is more invasive than other testing.

## A survivor's story

I am a survivor of a massive right pulmonary artery emboli obstructing almost the entire right lung (Figure 1). My pulmonary embolism (PE) occurred followed a left thoracotomy for a T8-9 discectomy with fusion. I was at home recovering from the surgical procedure when I experienced what I now realize were the symptoms of a PE. I had a sense that something was wrong and experienced increased shortness of breath, but it was pain and blood on urination that sent me to the emergency room.

I was the "poster child" for PE: I was overweight, recovering from major surgery (three days in intensive care, seven days in a rehabilitation hospital), and in a body brace from axilla to pubis. I live alone and I was unaware how ill I was. I waited for a friend to get off of work to take me to the ER, since the doctor's office was closed. Being in the health care field, I knew I couldn't go the ER without first taking a shower. To this day, I'm not sure how I managed to do it and get dressed. I could hardly breathe.

When I arrived at the ER, I was more concerned about my hematuria. This may have been a good thing, since it kept my mind occupied while the team performed the EKG, arterial blood gas, chest X-ray, and CT scan, started nasal oxygen and a heparin drip, and called in a pulmonologist, radiologist, and my surgeon.

By 11 pm, I was in vascular radiology undergoing a bilateral pulmonary arteriogram, inferior venacavagram, with initiation of thrombolytic therapy in the right pulmonary artery. Urokinase was dripped through a catheter placed in my right pulmonary artery proximal to the clot, and I was sent to ICU. An arteriogram was done at nine hours, at 14 hours, and at 33 hours, at which time the catheter was removed, a vena cava filter was inserted, and I was placed on a surgical floor to continue heparin therapy.

The PE was not the end of my story. I developed pulmonary hypertension, and then an allergy to heparin (leukocytopenia). I also had upper and lower endoscopies for blood in my stool. At the end of two weeks, I was finally able to go home with nasal oxygen, Coumadin®, and a very expensive trial drug for pulmonary hypertension.

This story does have a happy ending. Six months later, I was off the oxygen, my pulmonary pressures were almost normal, and I was back to light-duty work. Where do I go from here I am doing education. I no longer do what I love most, scrub cases, but my hospital is beginning a new perioperative class next month and it is time for me to turn over to the younger generation the knowledge of 30 years of experience.

- *Magnetic resonance imaging (MRI)*. A computer creates tissue "slices" from data generated by a powerful magnetic field and radio waves. This test may be used to view clots in the deep veins and lungs.
- *D-dimer*. This blood test detects the byproducts of abnormal blood clotting in the body.
- *Echocardiography*. This test detects abnormalities of the size or function of the right ventricle, which may be an indicator of pulmonary embolism.

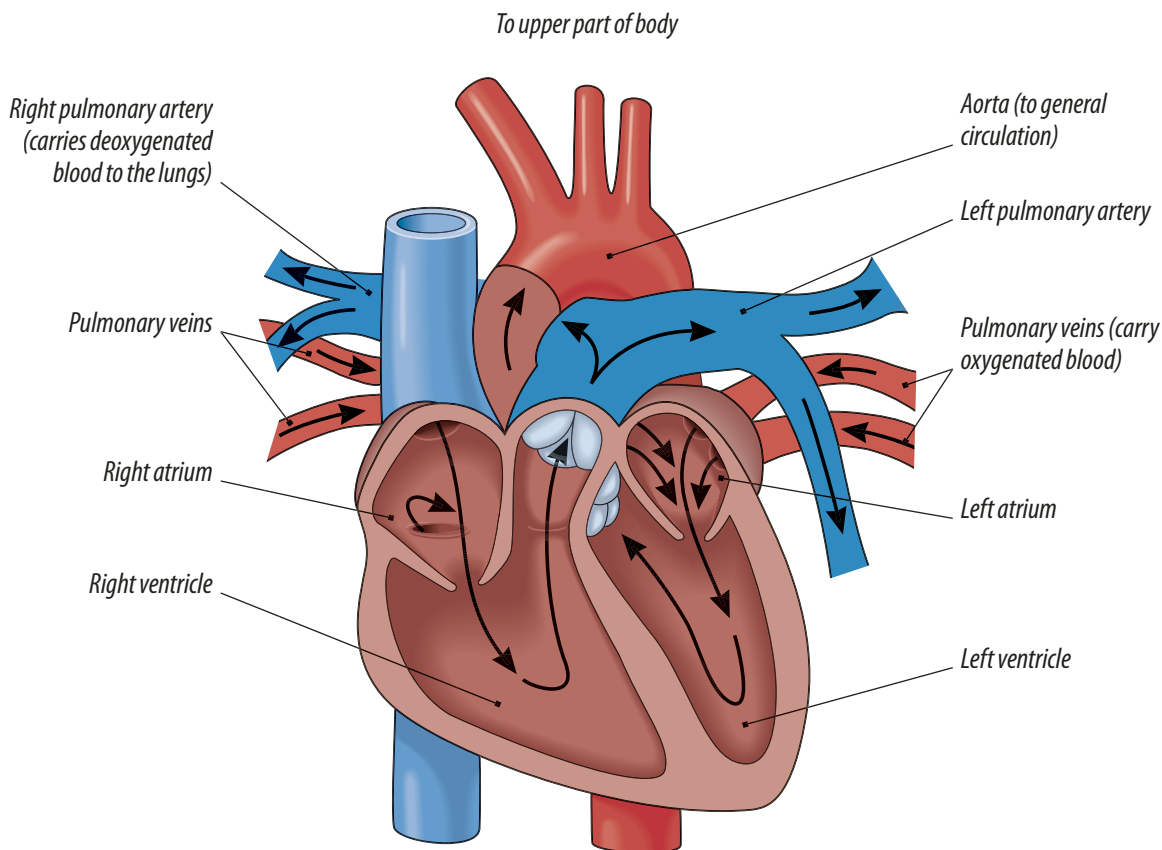
When a PE is suspected, a number of blood tests are also done to exclude important secondary causes. This includes a full blood count, clotting status (PT, APTT, TT), and some screening tests (erythrocyte sedimentation rate, renal function, liver enzymes, electrolytes). If one of these is abnormal, further investigations might be warranted.

## Treatment

Pulmonary embolism can range from mild to severe. Prompt treatment is essential to prevent serious complications or death. Acutely, supportive treatments, such as oxygen or analgesia, are often required. Massive pulmonary embolism, as confirmed by imaging or echocardiography, is treated with thrombolysis.

If symptoms are severe and life threatening, immediate and aggressive treatment is needed. Aggressive treatment may include thrombolytic medications, which can dissolve a blood clot quickly but can also increase the risk of severe bleeding. Another option for life-threatening PE from a large clot is surgical removal (embolectomy). This surgery is only available at a few large hospitals.

Early detection and treatment of DVT of at-risk patients can reduce the risk of pulmonary embolus. Subcutaneous heparin therapy may be used for patients on prolonged bed rest. Some patients may also benefit from having a vena cava filter inserted into the large central vein of the body. This filter can help prevent blood clots from reaching the lungs. It is used when anticoagulants are not an option, because clots form despite anticoagulant use, or there is



**FIGURE 2**

Understanding the connection between PE and heart failure.

A quick review of anatomy serves as a reminder of why the diseases of heart and lungs are so connected. Blood flows from the right side of the heart into the lungs where it releases carbon dioxide and picks up oxygen. Normally, it doesn't take much pressure to push blood into the lungs, so the walls of the right ventricle aren't as strong as those on the left, which pumps blood to the rest of the body. But when clots obstruct blood flow to the lungs, the heart has to pump harder. Although the heart can compensate for a time, eventually, the extra strain causes the right ventricle to fail. This failure can occur within minutes or hours of PE or take years, depending on the size of the blood clots.

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an increased risk of death or a severely restricted lifestyle if another PE occurs.

### Medications<sup>1,4,5</sup>

Anticoagulants are prescribed when pulmonary embolism is diagnosed or strongly suspected. Although anticoagulants can prevent new clots from forming and prevent existing clots from getting larger, they do not break up or dissolve existing blood clots. Heparin and warfarin are the two main types of anticoagulants used to treat pulmonary embolism.

Heparin is given by injection and immediately affects the clotting system of the body.

- Initial treatment with a low-molecular-weight heparin (LMWH) is usually preferred because it can be injected once or twice a day and may be given at home. Blood tests (eg Lovenox, Fragmin, Innohep) are not needed to monitor clotting effect.
- Unfractionated heparin is another form that can be used. It is given in the hospital intravenously. Frequent blood tests, usually every six hours, are required to monitor the clotting effects of this medication.

Warfarin (Coumadin®) is an oral medication that takes longer to start working.

- Warfarin is usually administered for three to six months or, if the patient has had previous DVTs or PEs, may be continued for life.
- Warfarin therapy often requires frequent dose adjustment and monitoring of the International Normalized Ratio (INR). The target INR range is usually between 2.0 and 3.0. Interactions with food, alcohol, and other drugs can dramatically alter INR.

Anticoagulants can increase the risk of bruising, cerebral hemorrhage, bleeding in the stomach and intestines (eg from ulcers). In addition, warfarin can occasionally cause a serious skin rash and reacts with many other medications and foods. Heparin can decrease platelet counts, leading to serious bleeding problems. (See a drug reference manual for a complete list of side effects.)

### **Fibrinolytics**

Fibrinolytic therapy has been the standard of care for all patients with massive or unstable PE since the 1970s. Over the past 20 years, a number of studies have demonstrated consistently that fibrinolytic therapy dramatically reduces the mortality rate, morbidity, and rate of recurrence of pulmonary embolism, regardless of the size or type of PE at the time of presentation.

Fibrinolytic regimens, popularly referred to as “clot-busters,” work by activating an enzyme that breaks down blood clots. Those in common use today include two forms of recombinant tissue plasminogen activator, t-PA (alteplase) and r-PA (reteplase), along with urokinase and streptokinase. However, thrombolytic medications increase the risk of bleeding, especially from recent wounds, at needle puncture sites, and in the digestive tract.

### **Complications**

Pulmonary embolism can be life threatening. About one-third of the people with undiagnosed and untreated PE don't survive. When the condition is diagnosed and treated promptly, however, that number drops dramatically. After one PE, patients have an increased risk of recurrence. Up to half of these recurrences may be fatal.

In addition to fatality, PE can lead to several serious complications, including:

- *Pulmonary hypertension.* A large number of conditions can contribute to pulmonary hypertension. One occurs when a large number of clots obstructs blood flow in the lung's blood vessels, making the right side of the heart work harder against great resistance. This condition is reversible if the embolism is treated appropriately.
- *Heart damage.* In a condition called cor pulmonale, the right ventricle becomes enlarged and eventually fails as a result of problems in the lungs. Understanding the relationship between the heart and lungs can help explain why this occurs (see Figure 2). Cor pulmonale may occur in minutes or over months or years depending on the size of the obstruction.

### **Prevention**

Although as many as two million Americans develop blood clots in their veins every year, many cases of PE and DVT can be prevented with a few simple measures.

#### **Preventive steps in hospitals<sup>8</sup>**

- *Heparin or warfarin therapy.* Anticoagulants, such as heparin and warfarin, are given to at-risk patients, both before and after an operation, as well as to patients admitted with a heart attack or stroke.
- *Graduated compression stockings.* Compression stockings steadily squeeze the legs, helping veins and leg muscles move blood more efficiently. They offer a safe and inexpensive way to keep blood from stagnating after general surgery. Studies have shown that compression stockings used in combination with heparin are much more effective than heparin alone.
- *Pneumatic compression.* This treatment uses thigh-high cuffs that automatically inflate every few minutes to massage and compress the veins in the legs. Studies show pneumatic compression can dramatically reduce the risk of blood clots, especially in patients who have had hip replacement surgery.



- ( *Physical Activity*. Getting the patient to ambulate as soon as the physician allows, as well as doing leg exercises in bed can help prevent PE.

#### **Personal preventive steps while traveling<sup>6</sup>**

Sitting during a long flight or automobile ride increases the risk of developing blood clots in the veins of the legs. The longer the ride, the greater the risk of DVT. To help prevent a blood clot from forming:

- ( *Take a walk*. If you're driving, stop every hour, walk around the car a couple of times, and do a few deep knee bends. Move around the airplane cabin once an hour or so.
- ( *Exercise in your seat*. Flex and rotate your ankles or press your feet against the seat in front of you. Or, try raising up and down on your toes. Don't sit with your legs crossed for long periods of time.
- ( *Wear support stockings*. These help promote circulation and fluid movement. Compression stockings no longer look like something your grandmother would wear. They're available in a range of stylish colors and textures.
- ( *Take aspirin*. If you're not allergic, consider taking a low dose of aspirin just before a long trip to help prevent clot formation.
- ( *Drink plenty of fluids before and during the trip*. Dehydration can contribute to the development of blood clots. Avoid drinking alcohol, as it can add to fluid loss.

#### **Conclusion**

Pulmonary embolism is a condition that occurs when an artery in the lungs becomes blocked. In most cases, the blockage is caused by one or more blood clots that travel to the lungs from another part of the body. The encouraging news is that a few simple measures, such as moving around during a long airplane trip, can go a long way toward preventing pulmonary embolism. In addition, treatment with medications that break up clots or prevent clots from forming can greatly reduce the number of deaths from this serious condition.

#### **About the author**

Margaret Sterling, CST, LPN, is the educational coordinator for surgery at Shore Memorial Hospital in Somers Point, New Jersey. She is responsible for the planning, implementation and evaluation of formal and informal learning and assisting surgical services personnel to perform competently. She also serves on hospital committees that deal with clinical ladders, clinical competency and cultural diversity.

Sterling has been working in the O.R. exclusively since 1982 and began her perioperative career in 1968. "I have been involved in the 'miracle of medicine' for the last 35 years."

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*Additional information is available from the Council for Leadership on Thrombosis Awareness and Management. A group of health-care professionals and educators committed to raising public and healthcare provider awareness of the risks of deep-vein thrombosis. Major initiatives: DVT-FREE National Screening Program and the ClotAlert™ Resource Center. 1-800-CLOT-FREE.*