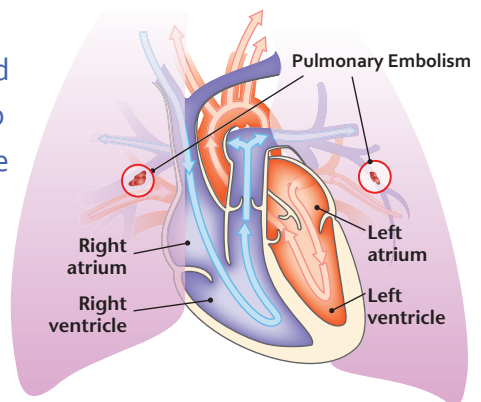


Pulmonary Embolism

Part 1

Blood flows through the lungs from the right side of the heart to pick up oxygen and get rid of carbon dioxide (called gas exchange). The blood then flows from the lungs back to the left side of the heart to be pumped out to the rest of the body. A pulmonary embolism (PE) is a blood clot that gets into blood vessels in the lungs and prevents normal flow of blood in that area. This blockage causes problems with gas exchange. Depending on how big a clot and number of vessels involved, it can be a life-threatening event.



Most blood clots that end up in the lungs first form in the legs as deep vein thrombosis (DVT). This fact sheet will discuss the diagnosis of pulmonary embolism. Part 2 will discuss treatment and prevention of pulmonary embolism.

What is an acute pulmonary embolism?

Embolism (Em-bo-liz-m) refers to a blood clot (embolus) that has broken off and is floating freely in the blood vessel. It can travel to another area of the body and cause a blockage of a blood vessel. Sometimes there are multiple clots (called emboli). Blood clots that do not travel and stay in the vein are called DVTs. Most blood clots that become pulmonary emboli form in veins in the leg. All veins in the body drain blood into larger veins that carry blood to the right side of the heart and on into the pulmonary arteries. This embolus travels from veins into right side of the heart. From the right side of the heart it enters the main pulmonary artery and can get stuck there or move further into one of the lungs. If there are several clots, they can go into different areas of one or both lungs.

When a blood clot is in a pulmonary artery, it blocks the flow of blood to the lung that needs to pick up oxygen. If not enough blood gets oxygen and moves to the left side of the heart, the oxygen level in the body drops dangerously low which can cause stress and damage to all the organs in body including the brain, kidneys, and heart. How severe this is depends on how much blood flow is cut off to the lungs.

In addition, because of blockage, pressure increases back on the right side of the heart. The right heart can get stretched and work harder. This can also affect the left side of the heart which get squeezed because of ballooned up (distended) right heart. If the left side of the heart is not able to pump enough blood, a person's blood pressure also drops.

All of these effects can lead to death, either suddenly, or if left untreated, in a short period after the pulmonary embolism occurs.

What is a deep vein thrombosis (DVT) and how it is related to PE?

A DVT is a clot that forms and builds up in the large veins of legs or sometimes the arms.

Signs and symptoms of a DVT in the affected leg (or arm) include,

- swelling
- pain
- redness
- warmth

Venous blood flow studies (doppler) can be done to look for a blood clot. Treating a DVT promptly can help relieve symptoms and prevent a pulmonary embolism.

What are risk factors for DVT or PE clots?

There are people who are at higher risk of a blood clot because of:

- An inherited condition such as a blood clotting disorder. In some cases, a family history of blood clots will be a clue to get checked for a genetic problem

such as Factor V Leiden

- Abnormal blood vessels such as varicose veins
- Certain diseases such as cancer or heart disease
- Pregnancy or in the 6 weeks following delivery
- Smoking
- Obesity
- Long car or airplane rides without stops to get up and move around (>4-6 hours at a time)
- Prolonged bed rest after major surgery or trauma
- Oral contraceptive pills/hormonal medications
- Older age (age 70 years and older)
- People with prior history of blood clot
- Failure to take blood thinners prescribed

The more risk factors a person has, the greater the chance of having a blood clot. It is important to recognize people who are at increased risk of a DVT as there can be ways to prevent them.

What are the symptoms of pulmonary embolism?

- Shortness of breath (usually sudden in onset)
- Light-headedness
- Chest pain
- Rapid heart beat
- Loss of consciousness
- Coughing up blood

How severe is Pulmonary Embolism?

Pulmonary embolism can be grouped based on the location of clot or how sick a person is.

Based on location of the clot into pulmonary artery following terms are used A) saddle PE (large clot into main pulmonary artery), B) lobar PE (into big branch of pulmonary artery), or C) distal PE (into small branches of pulmonary artery). Location of clot is progressively into smaller branches moving from category 'A' to 'C'.

Types based on how sick the person is can be divided into low, moderate or high risk pulmonary embolism. This is the risk of death or serious complications. Severity also is rated in part based on how symptomatic the person is, how well the lungs are working, and how low a person's blood pressure is.

To define risk and severity, the healthcare provider needs to order various blood tests and imaging (x-rays or scans or ultrasound of the heart). Treatment choices are also based in part on the risk or severity.

What are the tests to look for blood clots?

CT scan (an advanced version of x-ray) of pulmonary arteries is the most commonly used test to look for the pulmonary embolism. In this test, dye is injected into the veins of a hand or arm, and a CT computerized scan of the chest is done to look for clot in the lungs. Ultrasound

of the leg can also be done to look for the blood clots in the legs. An echocardiogram (type of ultrasound) of the heart is often done to evaluate the severity of pulmonary embolism on heart function and pressures. Blood tests can be done to look for blood clotting abnormalities, strain on the heart, or damage to other organs.

How is pulmonary embolism treated?

Typically, a person having an acute pulmonary embolism will be hospitalized and may have to go to the intensive care unit (ICU) for initial support and treatment. There are medications that can be used to help break up the blood clot (thrombolytics). Medicines that help prevent the clot from getting bigger or new ones from forming are also given (blood thinners called anti-coagulants such as warfarin or heparin). See the ATS Patient Information Series fact sheet on Treatment of Pulmonary Embolism for more detail at www.thoracic.org/patients.

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Reviewers: Patrick Belvitch MD, Eric Schmidt MD; Vinicio de Jesus Perez MD, FCCP FAHA.

R_x Action Steps

- ✓ If you have any symptoms of a possible blood clot in your leg or arm or lungs, seek medical help right away.
- ✓ If your healthcare provider tells you that you are at increased risk of a blood clot, follow advice to try to manage your risk and avoid blood clots.
- ✓ If you are prescribed anti-coagulant medication, take doses as prescribed and get follow-up blood tests as directed by your healthcare provider.

Healthcare Provider's Contact Number:

Resources

American Thoracic Society

- www.thoracic.org/patients

National Heart, Lung and Blood Institute

- <https://www.nhlbi.nih.gov/health/health-topics/topics/pe>

Centers for Disease Control and Prevention (CDC)

- <https://www.cdc.gov/ncbddd/dvt/index.html>

Clot Connect

- <http://www.clotconnect.org/healthcare-professionals/patient-handouts>

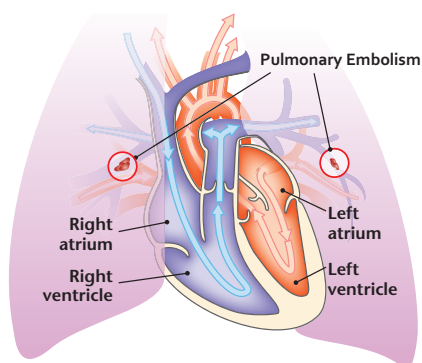
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Acute Treatment of Pulmonary Embolism

Part 2

A pulmonary embolism (PE) is a blood clot that forms in the blood vessels in the lungs and prevents normal blood flow in that area. Sometimes, pulmonary embolism is caused by a blood clot in the leg, called a deep vein thrombosis (DVT), breaking free and moving into the lung. If you have a PE, you will need some type of treatment. Having a PE also puts you at a higher risk for future blood clots.



This fact sheet will discuss acute (immediate) treatment of pulmonary embolism. The ATS Patient Information Series fact sheet 'Pulmonary Embolism' Part 1 explains what a pulmonary embolism is and who is at risk for them. ATS Patient Information Series fact sheet 'Long term treatment and prevention of PE' Part 3 gives information on how to prevent blood clots in the lungs and various blood thinners that are available for patients who need longer term treatment.

What are the usual treatments for Pulmonary Embolism?

Almost everyone who has a PE will need to be treated with a blood thinner (anticoagulation therapy). Sometimes, a person will need to be started on either an injection or an IV infusion and later be switched to a pill. These blood thinners do not dissolve or break up the clot; they prevent the clot from getting bigger while the body slowly dissolves the clot on its own. How long treatment is needed depends on why the clot formed and other risk factors.

If the PE is large and causing severe symptoms, special medications called thrombolytics can be used to break up and dissolve the clot. In rare and special circumstances, a person may need to undergo surgery to remove the clot (embolectomy).

What are common blood thinner medicines?

Once a blood clot is diagnosed, injectable blood thinners are usually started. The two most common are heparin and enoxaparin. Heparin is given as a continuous infusion, and enoxaparin is given as an injection under the skin once or twice a day. After the IV blood thinners have had enough time to work, your healthcare provider will start blood thinner pills

What medicines are used to break up big clots?

Sometimes, a person has a clot that is causing severe symptoms such as heart failure and a medicine is needed to try to break it up (called thrombolysis). Medicines to break up clots are given either through an IV into the body (systemic) or more directly in the area of the clot (local):

Systemic—Tissue Plasminogen Activator (tPA, alteplase)

When there is a severe or life threatening blood clot, a clot busting medication is given right away through an intravenous (IV) catheter. The medicine does have an increased risk of bleeding, including bleeding in the brain. Older people and people with multiple medical problems have a greater risk of bleeding. However, if a person is having serious compromise of heart function and blood pressure, this can be life-saving. Your healthcare provider can discuss the possible risks and benefits of this treatment.

Local—see Figure 1

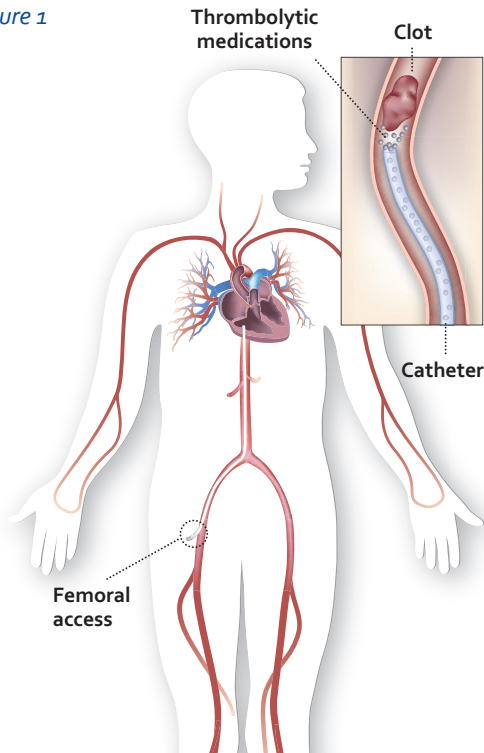
Clot busting medications like alteplase can at times be given directly into the area of the clot by placing a long catheter into a vein from either the neck or the groin (Figure 1). A specialist (expert radiologist or cardiologist) does this procedure. The risk of bleeding is lower than with systemic treatment but this approach is not always possible. The local placement of the clot buster medication is usually considered when a person is not too sick from the blood clot. Your healthcare provider can discuss the risks and benefits of this approach.

What if a person cannot take a blood thinner?

Some people are not able to take blood thinners because of a high risk of bleeding. In these cases, placement of an inferior vena cava (IVC) filter may be considered. See Figure 2.

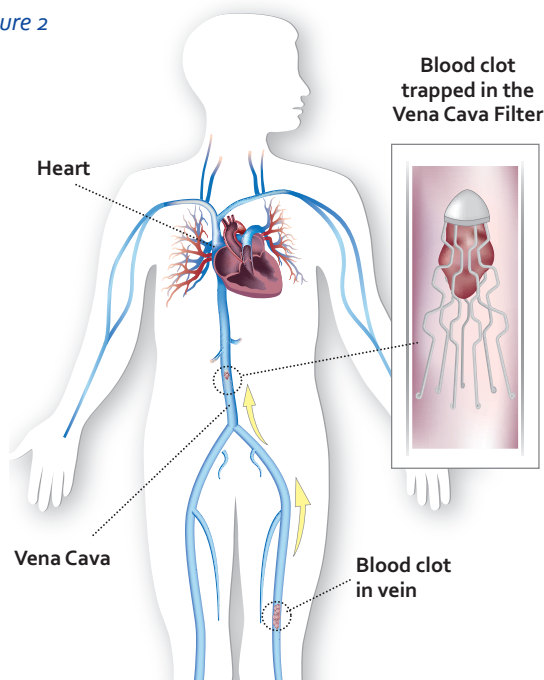
The filter is placed in the inferior vena cava (the major vein coming up from the lower body) to prevent blood clots from going from the legs up to the lungs.

Figure 1



It is estimated that 70% of the clots that go to the lungs come from leg (as DVT) and travel to the lung. A specialist (an interventional radiologist) places this filter. However, the filter can also be a source for new clot formation, so the filter should be removed in a timely manner when it is no longer needed. Your healthcare provider will help you decide if a filter is the best choice for you.

Figure 2



Embolectomy

Rarely, in the case of a life-threatening clot, surgery is done to remove the blood clot (embolectomy). This may require use of special critical life support measures such as extracorporeal membrane oxygenation (ECMO). You can learn more about ECMO at www.thoracic.org/patients.

Authors: Parth Rali, MD, Viral Gandhi, MD, Marianna Sockrider MD, DrPH

Reviewer: Catherine Chen MD, Patrick Belvitch MD

Rx Action Steps

If you are at risk of blood clots, talk to your healthcare provider about ways you can help prevent getting a DVT or PE.

- ✓ If you are on a blood thinner, always take it as prescribed. To keep a good level, take it at the same time of day and do not skip doses. Follow advice about avoiding foods that can affect the blood level.
- ✓ Get blood tests done as advised to monitor blood thinner levels.
- ✓ Stopping a blood thinner on your own can lead to another serious blood clot. If you are concerned about your treatment, talk to your healthcare provider.
- ✓ Watch for signs and symptoms of a blood clot or abnormal bleeding or bruising. Call your healthcare provider right away, if you are having any problems.

Healthcare Provider's Contact Number:

For More Information

American Thoracic Society

- www.thoracic.org/patients/
 - PE part 1 (Introduction)
 - PE part 3 (Long Term Treatment)

National Heart, Lung and Blood Institute

- <https://www.nhlbi.nih.gov/health-topics/pulmonary-embolism>

Center of Disease Control

- <https://www.cdc.gov/ncbddd/dvt/index.html>

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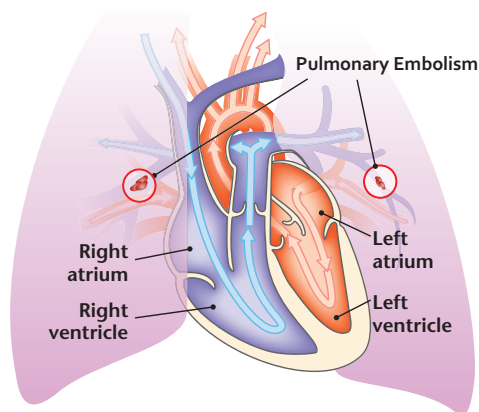
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Long-Term Treatment and Prevention of PE

Part 3

Once you have been diagnosed with pulmonary embolism (PE), it is very important that you take blood thinners every day as prescribed. The blood thinner is usually in the pill form or sometimes as injections that give yourself under the skin. There are various oral blood thinners (anticoagulants) available. This fact sheet describes the different type of blood thinners, monitoring that is needed while on blood thinners, and how to prevent future blood clots from developing. The ATS Patient Information Series fact sheet 'Pulmonary Embolism' Part 1 gives information about what is a pulmonary embolism and who is at risk of developing these blood clots and Part 2 'Acute treatment for Pulmonary Embolism' gives information how PE is managed right after it is found.



What are oral blood thinner medicines (oral anti-coagulants)?

Most people who have had a PE are sent home on oral blood thinners (anticoagulants). Warfarin, also known as Coumadin, is the most common oral blood thinner taken by mouth and has been used for decades. It takes several days for warfarin to reach adequate blood levels, so until the blood levels are in the goal range, a person will need to be on both injectable blood thinners and warfarin. When you are on warfarin, you will need regular blood tests to check drug levels. Your healthcare provider will advise you how often your blood level needs to be checked. Different foods you eat or drugs you take can affect warfarin levels in your body. It is very important that your drug levels are maintained in a strict range.

Because of some of these issues with warfarin, other oral blood thinners have been developed in recent years. These are directly active oral anticoagulants (DOACS) such as dabigatran (Pradaxa™), rivaroxaban (Xarelto™), edoxaban (Savaysa™) and apixaban (Eliquis™). These oral medications do not require monitoring of blood levels. There are criteria for who can take these medications and when they should be used. Your healthcare provider will help you decide

what the best choice of anticoagulant is for you.

What are injectable forms of blood thinner medications?

Enoxaparin (Lovenox™) or Dalteparin (Fragmin™) are given as a shot under the skin (subcutaneous). Most people do not need routine blood levels for this type of medication. If you had a blood clot because of cancer or while you are pregnant, this is the preferred form of therapy. Sometimes an injectable blood thinner is used until the oral blood thinner has taken effect.

What is done to monitor treatment of PE?

A person who is being treated with a blood thinner may need repeated blood testing over time depending on the medication being used. A person who is on a blood thinner should avoid activities that have a significant risk of injury that causes bleeding. If you are on a blood thinner, you should contact your healthcare provider right away if you have any signs of bleeding such as:

- black stool,
- heavy menstrual periods,
- an expanding bruise, or
- a very severe headache

How long does a person with PE need to be on a blood thinner?

Blood thinner treatment for PE is usually advised for at least 3-6 months. Your healthcare provider may advise a longer course depending on why you had the blood clot. Some people at high risk of blood clots may stay on blood thinner indefinitely.

Follow-up for Pulmonary Embolism

After receiving appropriate care in the hospital, a person who is on blood thinners will need regular follow-up with his or her primary care provider or a specialist (such as a pulmonologist—lung specialist). You may need other tests to try to find the cause of the PE. Taking your medicine exactly as prescribed is a key to preventing future blood clots. Recurrent PE can be life-threatening even if the first one was not severe. You should watch out for signs of a new PE or deep vein thrombosis (DVT—leg clots that can move up to the lungs) such as chest pain, shortness of breath, or swelling in the legs. If you notice any new symptoms, you should get in touch with your healthcare provider right away. Close follow-up is also important as a very small number of people who have had PE may go on to develop chronic thromboembolic pulmonary hypertension. An ATS Patient Information Series fact sheet is available on CTEPH at www.thoracic.org/patients.

How can I try to prevent a future blood clot from forming?

You can reduce the risk of developing a blood clot by stopping smoking, losing weight, and staying active. Drink plenty of liquids and take frequent breaks to walk around during car trips or airplane rides.

Certain types of medications can increase the risk of developing blood clots. Talk with your healthcare provider if any of the medications you are on increases the chances of developing a blood clot, and ways to manage that risk.

A blood clot can be the first sign of an undiagnosed cancer and your healthcare provider will advise if you need cancer screening tests.

Authors: Parth Rali MD, Viral Gandhi MD, Marianna Sockrider MD DrPH

Reviewers: Catherine Chen, MD, Patrick Belvitch, MD

Rx Action Steps

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Healthcare Provider's Contact Number:

For More Information

American Thoracic Society

- www.thoracic.org/patients/
 - PE part 1 (Introduction)
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