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### Patient information: Pulmonary embolism (Beyond the Basics)

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**PULMONARY EMBOLISM OVERVIEW** — Pulmonary embolism (PE) occurs when a blood clot dislodges from a vein, travels through the veins of the body, and lodges in the lung. Most blood clots (thrombi) originally form in one of the deep veins of the legs, thighs, or pelvis; this condition is known as deep vein thrombosis (DVT). (See "[Patient information: Deep vein thrombosis \(DVT\) \(Beyond the Basics\)](#)".)

The clot or clots block the blood flow to parts of the lung, preventing oxygen from reaching the brain and body. Pulmonary emboli are uncommon, but can be deadly if not identified and treated promptly. In the United States, it is estimated that over 50,000 people die every year as a result of a PE. Recognizing and treating a PE quickly can reduce the risk of serious complications and death.

**PULMONARY EMBOLISM RISK FACTORS** — There are a number of factors that increase a person's risk of developing PE.

**Inherited thrombophilia** — Inherited thrombophilia refers to a genetic problem that causes the blood to clot more easily than normal. Various factors in the blood clotting process may be involved, depending on the type of genetic problem present.

An inherited thrombophilia, such as deficiencies of [antithrombin](#), protein C, or protein S, is frequently present in people with a venous blood clot (ie, thrombus) who are less than 50 years of age. Other factors, such as factor V Leiden or the prothrombin gene mutation, increase the risk of venous thrombosis in all age groups. However, venous blood clots are infrequent before adolescence.

If a person is found to have a PE and there is no known medical condition or recent surgery that caused the PE, it is possible that an inherited condition is the cause. This is especially true in people who have more than one PE or if a family member has also experienced a PE. In these cases, testing for an inherited thrombophilia is often recommended (see '[Determining the cause](#)' below).

**Elevated clotting factors** — Having an increased level of one or more factors involved in blood clotting, such as factor VIII, increases the risk of a blood clot.

**Medical conditions or medications** — Some medical conditions and medications increase a person's risk of developing a blood clot:

- Pregnancy
- Obesity

- Smoking
- Cancer
- Heart failure
- Previous DVT or PE
- Increased age
- Kidney problems, such as nephrotic syndrome (see "[Patient information: The nephrotic syndrome \(Beyond the Basics\)](#)")
- Certain medications (eg, birth control pills, hormone replacement therapy, [tamoxifen](#), [thalidomide](#), erythropoietin). The risk of a blood clot is further increased in people who use one of these medications and smoke or are overweight.

**Surgery and related conditions** — Surgical procedures, especially those involving the hip, pelvis, or knee, increase a person's risk of developing a blood clot. During the recovery period, this risk often continues because the person is less active. Inactivity during long trips can also increase a person's risk of developing a blood clot. Precautions to reduce the risk of blood clots are discussed below (see '[Special precautions with pulmonary embolism](#)' below).

**Acquired thrombophilia** — Some types of thrombophilia are not inherited, but can increase a person's risk of developing a blood clot:

- Certain disorders of the blood, such as polycythemia vera or essential thrombocythemia
- Antiphospholipid antibodies (antibodies in the blood that can affect the clotting process) (see "[Patient information: The antiphospholipid syndrome \(Beyond the Basics\)](#)").

**PULMONARY EMBOLISM SYMPTOMS** — The signs and symptoms of PE can vary from one person to another. Common signs and symptoms of pulmonary embolism include the following:

- Shortness of breath or needing to breathe rapidly
- Sharp, knife-like chest pain while taking a deep breath
- Coughing or coughing up blood
- A rapid heart rate

**PULMONARY EMBOLISM DIAGNOSIS** — If a person's history, symptoms, and physical exam suggest a PE, tests are needed to confirm the diagnosis. Tests to diagnose PE include ventilation/perfusion lung scanning, spiral computed tomography (CT), and pulmonary angiography. Some patients with a suspected PE will also undergo testing to determine if DVT exists, which is described in detail in a separate topic review. (See "[Patient information: Deep vein thrombosis \(DVT\) \(Beyond the Basics\)](#)".) If a DVT is diagnosed, further testing to determine if a PE is present may not be necessary because both conditions are treated in the same way.

**D-dimer** — D-dimer is a substance in the blood that is often increased in people with PE. D-dimer levels are abnormal in 95 percent of patients with PE; a person with a normal D-dimer level is unlikely to have a PE. If the D-dimer test is negative and the patient is thought to have a low risk of PE based upon their signs and symptoms, PE is unlikely and further testing may not be needed.

**Spiral computed tomography** — Spiral CT scanning uses a combination of x-rays and computers to take detailed pictures of the inside of the body. The patient lies inside a tube-like structure; x-rays are taken after the injection of an intravenous dye, which highlights the vessels in the lung (CT angiography) or the leg veins (CT venography). Spiral CT is the study of choice in medical centers that have experience performing and interpreting the test.

However, spiral CT may not be suitable for patients with poor kidney function and patients who are unable to have a CT for other reasons (eg, an allergy to contrast dye). These patients usually need an alternate test (eg, ventilation/perfusion lung scan) or special treatment to reduce the risk of an allergic reaction before CT angiography.

**Ventilation/perfusion lung scanning** — A ventilation/perfusion lung scan, sometimes called a V/Q scan, is commonly used to diagnose patients with a suspected PE. During this test, the patient inhales a small amount of a radioactive substance. A radioactive substance is also injected into the bloodstream. A machine is used to examine how these

radioactive substances are distributed within the lungs. If a person has a PE, the scanner can detect the area of lung in which the blood flow has been blocked by the blood clot.

**Pulmonary angiography** — There have been significant improvements in non-invasive tests for PE. However, some patients still require a more invasive test, called pulmonary angiography, to confirm or exclude PE with certainty. Angiography is the "gold standard" test to diagnose PE.

Pulmonary angiography is performed by inserting a catheter through a vein in the groin area (the femoral vein). The catheter is guided into a branch of the pulmonary artery. Dye is injected through the catheter, highlighting the blood vessels in the lung on x-ray.

**Determining the cause** — After determining that a PE is present, the clinician will want to know what caused it. In many cases, there are obvious risk factors such as recent surgery or immobility (see '[Acquired thrombophilia](#)' above). In other cases, the person will be tested for inherited thrombophilia (see '[Inherited thrombophilia](#)' above).

Persons with an acquired or inherited abnormality may require additional treatment or preventative measures to reduce the risk of future blood clots. Some experts recommend that the family members of a person with an inherited thrombophilia be screened for the inherited condition if this information would impact their care, although this issue is controversial.

**PULMONARY EMBOLISM TREATMENT** — Treatments for PE help to prevent a new or enlarging blood clot and reduce the risk of complications related to the clot while the body's own enzymes dissolve the clot. The primary treatment for venous thrombosis is anticoagulation. Other treatments include thrombolytic therapy and placing a "clot filter" in one of the major blood vessels (the inferior vena cava).

**Anticoagulation** — Anticoagulants are medications that are commonly called blood thinners. The medication does not actually thin the blood, but rather prevents new blood clots from forming. Patients with venous thrombosis are usually treated first with an injectable anticoagulant. There are several anticoagulants available, including:

- Unfractionated [heparin](#)
- Low molecular weight [heparin](#) ([enoxaparin/Lovenox®](#), [dalteparin/Fragmin®](#), or [tinzaparin/Inohep®](#))
- [Fondaparinux](#) (Arixtra®)

When two treatment choices are similarly effective, the choice of anticoagulant usually depends upon the healthcare provider's preference, the patient's medical condition and preference, and cost considerations.

All of the anticoagulants can be injected into the skin by the patient, a family member, or a home health nurse. This allows a person to be treated at home. [Heparin](#), low molecular weight heparin, or [fondaparinux](#) is usually continued for at least five days, along with another medication called [warfarin](#) (Coumadin®). Warfarin is a pill that is taken by mouth. After approximately five days, the heparin, low molecular weight heparin, or fondaparinux are discontinued while the warfarin is continued for at least three months.

Less commonly, the patient does not take [warfarin](#) but takes a daily injection of low molecular weight [heparin](#) or [fondaparinux](#) for the entire treatment period. Low molecular weight heparin is much more expensive than warfarin, but does not need to be monitored with blood tests.

**Duration of treatment** — Treatment with an anticoagulant is recommended for a **minimum** of three months.

- In patients with a reversible risk factor, such as bed rest, the clinician often treats the patient for at least three months or until the risk factor is resolved.
- Patients with a first episode of a spontaneous or unprovoked venous thrombosis are treated for a **minimum** of three months. After three months and on a regular basis thereafter, the patient should meet with their healthcare provider to discuss the risks (bleeding) versus the benefits (decreased risk of another clot) of continued treatment. For patients who do NOT have an increased risk of bleeding and can continue anticoagulant monitoring, many experts recommend continuing [warfarin](#) indefinitely.

- Some patients with a first DVT or PE will need anticoagulation indefinitely, especially those with certain risk factors (hereditary thrombophilia or antiphospholipid antibody syndrome).
- Most experts recommend continuing anticoagulation indefinitely for people with two or more episodes of venous thrombosis or if a risk factor is permanent (eg, a mechanical heart valve).

**Thrombolytic therapy** — In some cases, a clinician will recommend giving a medicine into a vein to dissolve the blood clot(s). This is called thrombolytic therapy. This therapy is more commonly used in patients who have serious complications related to PE or DVT and in patients with large blood clots in the leg or lung who are at low risk of serious bleeding as a side effect of the thrombolytic therapy. The best chance of responding to thrombolytic therapy is when there is a short time between the diagnosis of DVT/PE and the start of treatment.

**Inferior vena cava filter** — An inferior vena cava (IVC) filter is a device that blocks the circulation of clots in the bloodstream. It is placed in the inferior vena cava (the large vein leading from the lower body to the heart) with a catheter that is inserted into a vein in the groin and threaded through the blood vessels. An IVC filter is often recommended in patients with PE who cannot use anticoagulants because of recent surgery, a stroke caused by bleeding, or significant bleeding in another area of the body. IVC filters can be used along with surgical procedures to remove blood clots.

An IVC filter is also recommended in some patients who develop recurrent PE despite anticoagulation. It may also be recommended for patients whose lung problems makes them susceptible to life-threatening complications if another PE were to occur.

**Embolectomy** — Embolectomy is the medical term for removal of PE from the lung. It may be performed using catheters (similar to those used for pulmonary angiography) or with a surgical procedure that is similar to open heart surgery. This procedure may be considered if a person is in serious condition as a result of the PE (eg, persistent low blood pressure due to PE). In this situation, thrombolytic therapy is usually attempted first. If thrombolysis fails or is not an option, embolectomy may be attempted.

## PULMONARY EMBOLISM PREVENTION

**Surgical patients** — Certain high-risk patients undergoing surgery (especially bone or joint surgery and cancer surgery) may be given anticoagulants to decrease the risk of developing a blood clot. Anticoagulants may also be given to women at high risk for venous thrombosis during and after pregnancy.

In surgical patients with a moderate to low risk of blood clots, other preventive measures may be used. For example, some surgical patients are fitted with inflatable compression devices that are worn around the legs during and immediately after surgery. The devices periodically fill with air and apply gentle pressure to improve circulation and help prevent clots.

Graduated compression stockings may also be recommended; these stockings should be custom fitted to apply pressure to the lower legs, with the greatest pressure at the ankle. The pressure should gradually decrease up to the knee. For all patients, walking as soon as possible after surgery can decrease the risk of a blood clot.

**Extended travel** — Prolonged travel appears to confer a 2- to 4-fold increase in risk of developing a deep vein thrombosis or pulmonary embolism [1]. There are a few tips that may be of benefit during extended travel ([table 1](#)).

## SPECIAL PRECAUTIONS WITH PULMONARY EMBOLISM

**Recurrent PE** — Patients being treated for a pulmonary embolism are at an increased risk for developing another PE, although this risk is significantly smaller when [heparin](#) or [warfarin](#) (Coumadin®) is used. However, all patients should watch for signs of a new PE, including new chest pain with difficulty breathing, a rapid heart rate, or lightheadedness. This complication can be life-threatening and requires **immediate attention**. Emergency medical services are available in most areas of the United States by calling 911.

**Bleeding** — Anticoagulants such as [heparin](#) and Coumadin® can have serious side effects and should be taken

**exactly** as directed. If a dose is forgotten, the patient should call their provider or clinic for advice. The dose should not be changed to make up for missed doses. Patients should immediately report to the pharmacist or physician if the pill or tablet looks different than the previous bottle.

Other precautions are necessary when taking Coumadin, which are outlined in a separate topic review. (See "[Patient information: Warfarin \(Coumadin\) \(Beyond the Basics\)](#)".)

Patients may bleed easily while taking anticoagulants. Bleeding may develop in many areas, such as the nose or gums, excessive menstrual bleeding, bleeding in the urine or feces, bleeding or excessive bruising in the skin, as well as vomiting material that is bright red or like coffee grounds. In some cases, bleeding can develop inside the body and not be noticed immediately. Bleeding inside the body can cause a person to feel faint, or have pain in the back or abdomen. A healthcare provider should be notified immediately if there are any signs of this problem.

**Wear an alert tag** — People who take anticoagulants should wear a bracelet, necklace, or similar alert tag at all times. If medical treatment is required and the person is too ill to explain their condition, the tag will alert responders about the patient's use of anticoagulants and the risk of excessive bleeding.

The alert tag should list the person's medical conditions, as well as the name and phone number of an emergency contact.

**Reduce the risk of bleeding** — Some simple modifications can limit the risk of bleeding:

- Use a soft bristle toothbrush
- Floss with waxed floss rather than unwaxed floss
- Shave with an electric razor rather than a blade
- Take care when using scissors or knives
- Avoid potentially harmful activities (eg, contact sports)
- Do not take [aspirin](#) or other NSAIDs (eg, [ibuprofen](#), Advil, Aleve, Motrin, Nuprin) while taking [warfarin](#). Other nonprescription pain medications, such as [acetaminophen](#), may be a safe alternative.

**WHERE TO GET MORE INFORMATION** — Your healthcare provider is the best source of information for questions and concerns related to your medical problem.

This article will be updated as needed on our web site ([www.uptodate.com/patients](http://www.uptodate.com/patients)). Related topics for patients, as well as selected articles written for healthcare professionals, are also available. Some of the most relevant are listed below.

**Patient level information** — UpToDate offers two types of patient education materials.

**The Basics** — The Basics patient education pieces answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials.

[Patient information: Deep vein thrombosis \(blood clots in the legs\) \(The Basics\)](#)

[Patient information: Pulmonary embolism \(blood clot in the lungs\) \(The Basics\)](#)

[Patient information: Pleuritic chest pain \(The Basics\)](#)

[Patient information: Medicines to prevent blood clots: Warfarin \(Coumadin\) \(The Basics\)](#)

[Patient information: Medicines to prevent blood clots: Dabigatran, rivaroxaban, apixaban \(The Basics\)](#)

**Beyond the Basics** — Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are best for patients who want in-depth information and are comfortable with some medical jargon.

[Patient information: Deep vein thrombosis \(DVT\) \(Beyond the Basics\)](#)

[Patient information: The nephrotic syndrome \(Beyond the Basics\)](#)

[Patient information: The antiphospholipid syndrome \(Beyond the Basics\)](#)

[Patient information: Warfarin \(Coumadin\) \(Beyond the Basics\)](#)

**Professional level information** — Professional level articles are designed to keep doctors and other health professionals up-to-date on the latest medical findings. These articles are thorough, long, and complex, and they contain multiple references to the research on which they are based. Professional level articles are best for people who are comfortable with a lot of medical terminology and who want to read the same materials their doctors are reading.

[Activated protein C resistance and factor V Leiden](#)

[Anticoagulation during pregnancy](#)

[Anticoagulation in acute pulmonary embolism](#)

[Deep vein thrombosis in pregnancy: Epidemiology, pathogenesis, and diagnosis](#)

[Deep vein thrombosis and pulmonary embolism in pregnancy: Prevention](#)

[Deep vein thrombosis and pulmonary embolism in pregnancy: Treatment](#)

[Diagnosis of acute pulmonary embolism](#)

[Diagnosis of suspected deep vein thrombosis of the lower extremity](#)

[Fibrinolytic \(thrombolytic\) therapy in acute pulmonary embolism and lower extremity deep vein thrombosis](#)

[Placement of inferior vena cava filters and their complications](#)

[Low molecular weight heparin for venous thromboembolic disease](#)

[Overview of acute pulmonary embolism](#)

[Overview of the causes of venous thrombosis](#)

[Therapeutic use of heparin and low molecular weight heparin](#)

[Treatment of acute pulmonary embolism](#)

[Chronic thromboembolic pulmonary hypertension: Surgical treatment](#)

[Treatment of lower extremity deep vein thrombosis](#)

The following organizations also provide reliable health information.

- National Library of Medicine

([www.nlm.nih.gov/medlineplus/healthtopics.html](http://www.nlm.nih.gov/medlineplus/healthtopics.html))

- National Heart, Lung, and Blood Institute

([www.nhlbi.nih.gov/](http://www.nhlbi.nih.gov/))

- American Heart Association

([www.americanheart.org](http://www.americanheart.org))

[1-7]

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## REFERENCES

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## GRAPHICS

### Tips to avoid lower leg swelling and deep vein thrombosis during prolonged travel

**All travelers should consider the following recommendations for flights longer than six to eight hours:**

- Stand up and walk around every hour or two
- Wear loose-fitting, comfortable clothing
- Flex and extend the ankles and knees periodically, avoid crossing the legs, and change positions frequently while seated
- Consider wearing knee-high compression stockings
- Avoid medications (eg, sedatives, sleeping pills) or alcohol, which could impair your ability to get up and move around