

Recent Trends in Application of Blood Thinners in Medicine

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Abstract

Blood clotting is a normal function of the body, which maintains homeostasis in one's body. Clotting is used in order to prevent any major bleeding within the body after an injury. However, certain blood clotting can create blocks in the veins or arteries that prevent blood from reaching different parts of the body. Blood thinners, such as anticoagulants and antiplatelets, were developed in order to combat dangerous blood clots before they resulted in serious harm to a patient. They prevent specific factors that are directly involved in the formation of blood clots. Despite their usefulness, blood thinners should be used under supervision of a physician as they can lead to many complications if incorrectly taken. This article discusses the recent trends in application of blood thinners and review different blood thinners, how they work, and why they are beneficial in the medical field. Specifically, the processes the body undergoes when forming blood clots will be explained. Also, different anticoagulants or antiplatelets and their various effects will be explored. Finally, this paper will define specific uses of blood thinners and how they are being improved. These types of drugs are very useful in medicine and will become more reliable as research continues to improve.

Keywords: Anticoagulants; Antiplatelets; Blood Clots; Embolism; Clotting Factor

Introduction

In the medical field, a very common form of drug used on all types of patients are blood thinners. Blood thinners are used in patients in order to combat blood clots, also known as thrombosis. These can be detrimental to one's health and can lead to complications such as heart attacks and strokes. There are many different uses for blood thinners that will be discussed in this article.

Generally, blood clotting in the body is a normal process that keeps the human body healthy. In fact, it is used to stop bleeding whenever an injury or harm occurs in the body, which allows the wound to heal properly [1]. However, there can be complications that occur when the body forms these blood clots. These complications include the blood clots not breaking down, the blood clots forming where they should not, and many others. These can be detrimental to a patient's health if not identified and treated promptly.

There are different types of blood clots that can occur throughout the body. One main form of a blood clot is known as an embolism. Embolisms occur whenever a blood clot or other substance flows through the blood pathways such as veins or arteries, creating a blockage that prevents blood flow to critical areas of the body [2]. These can occur in many parts of the body such as the lungs or brain. There are also many methods of identifying patients that suffer from these blood clots.

In order to treat abnormal blood clots, blood-thinning medications are prescribed to patients to help break down or prevent the formation of the clots. Two main categories of blood thinners exist. The first category of blood thinning medication is known as anticoagulant. This medication inhibits the formation of blood clots by reducing the activity of clotting factors that are responsible

for the synthesis of fibrin [3]. The other type of blood thinner is an antiplatelet, which directly targets and prevents platelets from being synthesized [3]. This prevents blood clots from forming or growing more than they already have.

The main purpose of this article is to introduce and discuss the many ways thrombosis can impact patients and the way the blood thinners can be useful for these patients. Also, different studies that support the use of these blood thinners will be discussed.

Thrombosis overview

One of the main ways thrombosis can be prevented and treated is by identifying the blood clots before any severe injuries occur to someone. The first important factor to account for is the type of blood clot. There are many different ways blood clots can occur in the blood circulation.

Blood clotting occurs whenever a buildup of platelets occurs in the blood. The body uses these small blood cells to form the blood cells. However, there are also proteins known as clotting factors or coagulation factors that assist in the formation of blood clots in the blood. A majority of these clotting proteins are synthesized in the liver [4]. One of these coagulation factors is known as fibrinogen, which is essential for clotting. The reason fibrinogen is important in the clotting process is that it leads to the production of fibrin [4]. Fibrin mixed with the platelet blood cells form strong and porous blood clots. However, despite the strength of the clot increasing with fibrin, the fibrin blood clots are still able to deform and break down [5]. The process of clotting factors being used to form the fibrin that makes up blood clots is shown in figure 1. Coagulation is a vital process in homeostasis, yet it can still cause issues whenever they cause blockages in arteries and blood vessels.

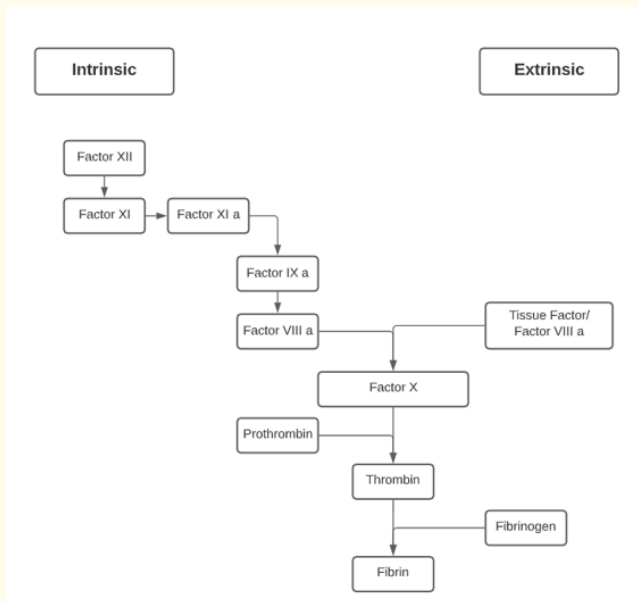


Figure 1: Coagulation Cascade.

One may undergo various tests if they are suspected of having a blood clot. One of the first steps is a basic physical examination. Blood clots in certain areas of the body carry their own specific symptoms. For instance, brain embolisms can be identified when a patient has speech or vision impediments, seizures, and overall loss of function [6]. Also, embolisms in the lungs can cause chest pains and trouble breathing. There are also certain tests such as an ultrasound or a CT scan that can be used to see if there is any clot in the certain area of the body, such as the head [6].

Types of blood clots

The first type of blood clot that will be discussed is an embolism. These types of blood clots are formed and break off from where they originated. They flow throughout the blood stream and can reach different areas of the body, causing many complications. There are many types of embolisms. For example, there are pulmonary, brain, retinal, and many other embolisms that each result in different issues within the body. Pulmonary embolisms are blood clots that form elsewhere in the body and end up in one of the arteries within the lungs. Pulmonary embolisms can lead to ventricular failure, chest pains, and difficulty with breathing. Smaller clots within the lungs may become lodged in the smaller arteries of the lungs while the larger clots may become lodged in the main pulmonary artery, which can lead to more severe symptoms [7]. Some of these symptoms include chest pains, increased blood pressure, and the embolisms can also be fatal if they are left untreated [8].

Another type of embolism is a brain embolism. Similar to a pulmonary embolism, this is a blood clot that originates in a different part of the body and becomes stuck in an artery in the brain or in an artery that supplies blood to the brain [9]. These blood clots can originate in places throughout the body such as the heart, chest, legs, and the arm. Whenever a blood clot creates a blockage of an artery in or around the brain, the lack of blood flow leads to the brain not receiving the necessary amount of oxygen. This leads to an ischemic stroke. These types of strokes account for around 87 percent of all strokes [10]. The brain embolisms can occur throughout the brain, as shown by the circles in figure 2.



Figure 2: Brain Embolisms.

Many of these embolisms and thrombi can lead to serious injuries and even lead to death. That is why identifying and treating them early is extremely important to the patients' health. The use of anticoagulants can be used with patients that have increased risk of blood clots in order to prevent any thrombosis or embolism that can lead to serious injuries.

Types of blood thinners

There are a few options available when blood thinners are being used to treat a patient who has blood clots or prevent them. The different types may be used in different scenarios, depending on the patient and what risks they may be more susceptible to. However, the two main categories of blood thinner medications are anticoagulants and antiplatelets.

Anticoagulants are used to inhibit the body's process that produces blood clotting in arteries and veins. This means these medications are able to slow down the buildup of blood clots and prevent blood clots that have already formed from continuing their growth [11]. However, these medications are not prescribed in order to break down existing blood clots as they are a preventative measure in high-risk patients. These medications are typically taken orally as a pill. Also, the main characteristic of these drugs is that they target clotting factors, which prevents fibrin from forming [3]. An example of this medication is warfarin, which is one of the more common anticoagulants. This drug is taken orally in patients who are at risk of strokes due to embolism, such as the ones discussed previously [11].

The next type of blood thinner is an antiplatelet drug. This type of drug targets the formation of blood clots by preventing platelets in the blood from grouping together, thus preventing the formation of an embolism [3]. They are similar to anticoagulants in that they are also delivered to the body orally. The most common and most used antiplatelet in the medical field is aspirin. Aspirin works by interacting with the cyclooxygenase enzyme. This enzyme works by activating thromboxane A₂ which begins the process of platelet production. [12]. Aspirin is able to inhibit the cyclooxygenase enzyme, therefore slowing the production of the platelets in the bloodstream.

There is one other type of blood thinner that may also be used to treat patients dealing with thrombosis. This treatment is called thrombolysis. This treatment directly combats the blood clots that have already been formed. These methods and drugs are used in emergency cases where a blood clot needs to be dissolved. This includes any pulmonary, brain, heart, or acute embolism in the body [13]. There are two ways of performing this treatment. The first form of thrombolysis is the use of medications. These are delivered through a catheter which dissolves the clot. The other way is a mechanical method. This is the use of a machine to break down and extract the blood clot [14].

Risks of blood thinners

Despite the benefits of all of these drugs or methods to prevent or get rid of blood clots, there are risks involved with the use of them. Some of the risks involve excessive bleeding because the clotting process has been hindered, specifically internal bleeding. This usually occurs when there is too much of the blood thinner taken by the patient. Although excessive bleeding is the main concern when discussing the risks of blood thinners, other side effects such as fevers, headaches, and bruises.

There are certain tests that can be performed in order to determine why the body is reacting a certain way to the medication. These tests are known as pharmacogenetic testing which examines the specific genes that impact the body's reaction to a medication, in this case, blood thinners such as warfarin [15]. In the case of Warfarin, a type of anticoagulant, there are two genes that can be tested. These genes are CYP2C9 and VKORC1 [15]. Also, another form of testing that can be performed is therapeutic drug monitoring. This is a test that determines how much of a certain medication is in a patient's blood and can help determine how much of the drug the patient should be taking to be effective [16].

An example of a side effect impacting the health of a patient negatively can be seen with heparin, which is an anticoagulant rather than antiplatelet. This means heparin does not normally impact the platelets that create blood clots. However, in certain cases, the immune system can react negatively to the use of heparin. This leads to heparin-induced thrombocytopenia, which means there is a lower

platelet count [17]. The process that causes this is whenever heparin is bound to platelet factor 4, which creates a complex. This is viewed by the immune system as a harmful substance and antibodies are produced against it. These antibodies end up destroying the platelets [17]. Heparin-induced thrombocytopenia is dangerous because these patients are also at higher risk of forming blood clots.

Overall, these risks for blood thinners can be very dangerous as they can lead to excessive bleeding. They can also lead to less concerning side effects such as headaches or fevers. Also, certain However, these risks are not outweighed by the benefit of anticoagulants since blood clots can be very dangerous or even fatal. This means close monitoring of the patient should be able to prevent serious side effects from becoming harmful to their health.

Uses of blood thinners in the medical field

As stated previously, the main reason blood thinners such as anticoagulants or antiplatelets are used in the medical field is to prevent and assist in getting rid of blood clots. The medicine works by preventing clotting of the blood, which decreases the chance of embolism or thrombosis from occurring. There can be many situations where a patient may need to use a blood thinner.

Whenever a patient needs blood thinners there are certain factors that indicate the use of the medication. For instance, certain patients are at a much higher risk of blood clots. For example, a patient may have a higher risk of blood clots because of surgery, pregnancy, obesity, or cancer [18]. Also, family history can be a factor in one's tendency to form blood clots. This is caused by mutations in certain genes that code for proteins and clotting factors [10].

As stated previously, a common use for blood thinners is after medical procedures and surgeries. The reason that blood thinners may be used after a procedure is due to the recovery time of the patient. During the recovery period after surgery, a patient may need to remain still for long periods of time, which can lead to the formation of blood clots [19]. This ensures the patient will heal properly without running into the risk of developing thrombosis. An example of this occurrence is whenever one has a joint replacement surgery due to arthritis or other reasons. This would cause the patient to not be able to move around as much which can lead to clots forming and, in some cases, cause an embolism. Therefore, the prescription of anticoagulants or antiplatelets is important for around ten to fifteen days after surgery [20].

There are also cases in medicine where anticoagulants or antiplatelets may interfere with a procedure. An example of this is during dental or oral surgeries. In some cases, patients may bleed more because they are taking blood thinner medications which may cause more bleeding during the dental procedure than normal. Some dental procedures like this are gum surgery or tooth extractions [21]. If this case occurs, usually a dentist views the medical history and determine if there are any indications of blood clots such as a stroke. Then, the procedure will either take place normally, the dose of the blood thinner may be lowered, or the use of the medication will be stopped until after the procedure [21].

These are just a few examples of when a blood thinner may be prescribed whenever one may go through medical procedures. Blood thinners can play an integral part in ensuring that a patient recovers fully and maintains good health during recovery. They also play a role in keeping at risk patients, such as cancer patients, from developing these blood clots that can break off in the blood pathways and travel to other organs in the body.

Research trials

Blood thinners are very well researched and effective at treating blood clots in the veins and arteries. There have been many research trials and tests that highlight their effectiveness in certain situations. These research trials allow the medicine to be tested to see if they are useful, reliable, and safe for use.

The first trial that will be highlighted tested warfarin's benefits as an anticoagulant and if it outweighed its potential risks. In order to determine this, patients with atrial fibrillation were examined as they took the warfarin medication. Atrial fibrillation patients are ones with irregular heartbeats. Roughly 182,680 patients were tested over the course of one and a half years. The results were based on a net benefit system, where the number of ischemic strokes that were prevented was subtracted from the excessive internal bleeding [22]. The study was able to determine that anticoagulants were useful due to the risk of ischemic strokes being greater than the risk of internal bleeding with the medication [22].

There have also been studies regarding the use of blood thinners and the treatment of ill covid-19 patients. For instance, one study examined the use of heparin in both critically ill and non-critically ill covid-19 patients. The study was performed because patients who died to the corona virus infection were observed with blood clots throughout their circulatory system [23]. The two types of patients were differentiated by the treatment they required. If a patient was hospitalized but did not require any external organ support such as ventilator, they were non-critically ill. If the patient did require intensive care treatments, they were critically ill [23]. The study was able to determine that a full dose of heparin had a 99 percent chance of reducing intensive care in non-critically ill patients. However, critically ill patients still experienced blood clots, although at a lower rate, and still required hospitalization and organ support [23].

The final research study that is useful involves investigating the use of genetic testing, known as pharmacogenetic testing, and if it improves the accuracy of dosing blood thinners. For these trials, patients who underwent joint replacement surgery were prescribed warfarin either based of genetic testing or based on clinical information such as height or weight [24]. Specifically, the CYP2C9, VKORC1, and CYP4F2 genes were tracked for the testing. It was found that adverse events were around four percent less likely when using genetic testing, meaning that the dosing was more accurate for warfarin [24].

How blood thinners will improve

Previously, the only real option when viewing blood thinner medications has been coumadin. Versions of this medication are more commonly known as warfarin. However, certain aspects of coumadin make it challenging to use correctly. For instance, whenever a patient is taking coumadin medications, they will require blood tests regularly in order ensure the drug is working correctly and safely for the individual [25]. Also, coumadin can cause side effects due to outside factors very easily, such as changes in diet or the consumption of alcohol [25]. Therefore, there are new methods of blood thinning that have been developed in the past few years to replace coumadin.

One of the first examples of a medication that is being developed to replace coumadin are novel oral anticoagulants, also known as NOACs. Coumadin normally works by limiting the function of vitamin K which is a factor in making clotting factors [25]. NOACs work by targeting clotting factors as well. However, the advantage of NOACs over coumadin is that their effects are not as impacted by other drugs or foods [26]. This means patients taking these medications are less likely to run into complications. Despite this medication claiming to be more convenient to the patient, there is one serious drawback to NOACs that can be harmful. Coumadin is able to be easily reversed by giving the patient vitamin K to reverse the blood thinners effects [27]. NOACs do not yet have a way to be reversed. This means excessive bleeding that can normally be treated under coumadin can be fatal to patients using NOACs [27]. Further research of these medications is required in order to become safe and effective for regular use.

Another developing technology that can be used instead of standard blood thinners is the watchman device. Unlike all of the previous treatments, the watchman device is not a drug that is used to combat blood clots. Rather, this is a device that is placed in the left atrial appendage of the heart, which prevents blood clots that form in this location to break off and travel to the rest of the blood-stream [28]. This device is able to reduce the chances of a stroke occurring due to a blood clot. However, similar to NOACs, this treatment also has risks that should be evaluated. For instance, in certain cases, the left atrial appendage could become ruptured, which would require an immediate procedure [28]. Overall, this method can be a viable option, but has serious risks involved.

These forms of new blood thinners show promising signs to improve the way the medications are taken and how effective they are. They do however still come with risks that need to be accounted for and further researched. This will ensure that any patient that opts for these treatments will receive safe and reliable care to combat harmful blood clots.

Conclusion

Overall, blood thinners are a viable and safe method of preventing blood clots as well as stopping them from growing further and causing blood flow stoppages in other parts of the body. The purpose of this article was to explore how blood thinners are used as well as how the medical field utilizes these medications to benefit the health of their patients.

For this research article, anticoagulants and antiplatelets were discussed. Anticoagulants target specific clotting factors that result in the synthesis of fibrin, which plays a role in the production of blood clots in the body. For example, warfarin is a type of anticoagulant that targets the vitamin K which helps produce clotting factors [25]. Antiplatelets are similar because of their purpose of slowing blood clots from forming. However, rather than targeting clotting factors, antiplatelets work by preventing the production of platelets, which normally clump together to form blood clots [3]. There was also a third form of blood thinning that was identified. This option is known as thrombolysis and is used in emergency situations where a patient needs to have a blood clot removed immediately. This treatment either involves the use of drugs through a catheter or using a machine to physically break down a blood clot then remove it from the affected area [14].

However, there are also concerns when using blood thinners such as anticoagulants. Excessive bleeding can occur along with other side effects such as fevers. There are certain tests that are usually involved with the use of blood thinners to control these negative effects. For instance, genetic testing of specific genes such as the CYP2C9 and VKORC1 genes can allow a patient to get a more accurate dosage of a medication, therefore reducing the chances of adverse events [15]. This translates over to how doctors will use these medications to better treat their patients.

There are many situations in the medical field where a patient will require the use of anticoagulants. One common occurrence is whenever a patient undergoes a joint replacement surgery. Since they will be sitting still for a long period of time during recovery, the use of an anticoagulant is a precaution to ensure a patient will not develop an embolism [19]. There are also cases where the use of a blood thinner may cause an issue with an operation. Since bleeding will typically increase with the use of these medications, some procedures, such as dental care, require further examinations. Usually, a dentist will decide if the use of the blood thinner needs to be adjusted prior to a procedure [21]. These provide insight to how blood thinners are used or dealt with during surgeries.

Finally, there were three research trials involving blood thinners that were examined. The first highlighted the net risk of the use of warfarin [22]. The second research trial examined the impact blood thinners had on recovering covid-19 patients [23]. Finally, the last study determined that genetic testing improved the accuracy of prescribing blood thinners over normal clinical indicators [24].

Overall, this article determined that blood thinners are a useful medication in preventing serious injuries in patients. They prevent blood clots from growing and moving elsewhere in the body, which can lead to heart attacks and strokes. They also have their risks when taking medications. They can react poorly to outside factors such as other medications and can also lead to abnormal bleeding. With proper testing and care, however, they are a safe and effective option for many at-risk people.

Future trends

As discussed in the article, there are many ways blood thinning treatments are adapting and evolving in an attempt to make them a more viable option than the traditional anticoagulants seen today. For instance, new types of drugs known as NOACs have been developed

that target clotting factors similar to anticoagulants. However, they claim to be less susceptible to outside factors such as diets [26]. Despite this, the medications have flaws in that there are no methods of reversing their results [27]. Another new method to combat blood clots is the watchman device. This device is placed in the left atrial appendage and stops blood clots that have already formed from flowing to the rest of the body because it blocks their pathway [28]. These can also be dangerous because there is a risk of physical damage to the heart [28]. Overall, new methods of anticoagulation are being developed, but require much further research before they are completely safe for use.

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