

Analysis of deaths related to
“Acute Pulmonary Thromboembolism”

August 2017

Medical Accident Investigation and Support Center
Japan Medical Safety Research Organization

In publishing the recommendations
for prevention of recurrence of medical accidents
(Number 2)

Fumimaro Takaku
Chair of the Board of Directors
Japan Medical Safety Research Organization

Based on the Medical Accident Investigation System enforced in October 2015, the Medical Accident Investigation and Support Center [ISC] of the Japan Medical Safety Research Organization [Medsafe Japan] has been working with every effort to promote medical safety and to prevent recurrences of medical accidents. Along with the advancement and diversification of the current medical surroundings, medical institutions are supposed to have taken preventive measures against medical accidents, accumulating reports of near-miss incident cases so as not to allow serious accidents to occur. However, serious events do occur in fact, at times resulting in the death of the patient. Such cases have been reported to ISC. I believe that the mission of the Medical Accident Investigation System is to accumulate these reports, to investigate and analyze each case and to provide information for preventing recurrence of serious events.

Nearly two years have elapsed since the enforcement of the Medical Accident Investigation System, and we, ISC, have published our second report for the recurrence prevention of medical accidents which was compiled in our Expert Analysis Subcommittee. The number of “In-Hospital Investigations” reported to ISC was 330 cases in total during one and a half years from the enforcement of the system until March 2017. ISC decided to take up the deaths caused by “Acute Pulmonary Thromboembolism” as the second object of analysis. The targets were eight cases reported to ISC this time under the Medical Accident Investigation System. Considering that similar deaths related to acute pulmonary thromboembolism had occurred repeatedly in the past, and in view of the seriousness of being resulted in death, these recommendations were compiled.

ISC’s measures to prevent recurrences of accidents are based on the analyses of the eight “Death” cases and are focusing on “how to avoid accidents that may lead to death”. “Guidelines” released by the government and academic societies were examined from broad knowledge. We believe that our measures should be distinguished from such guidelines. With this in mind, we sincerely hope that the recommendations in this report will be widely utilized in each medical institution to avoid deaths resulted from “acute pulmonary thromboembolism”.

Finally, we would like to express our sincere gratitude to the medical institutions and bereaved families who cooperated in providing in-hospital investigation reports and offering additional information, as well as to the experts of the analysis subcommittee who analyzed the eight cases in detail and explored the measures to prevent recurrence, for their understanding and cooperation.

Analysis of deaths related to
“Acute Pulmonary Thromboembolism”

August 2017

Expert Analysis Subcommittee for
Acute Pulmonary Thromboembolism

Committee for Prevention of Recurrence
Medical Accident Investigation and Support Center

Recommendations for the prevention of recurrence of medical accidents (Number 2)
Analysis of deaths related to “Acute Pulmonary Thromboembolism”

[Comprehension of risks and recognition of the disease]

Recommendation 1

It is important to grasp the possible risks of developing acute pulmonary thromboembolism (acute PTE) in hospitalized patients and it should always be aware that acute PTE occurs suddenly and affects the patient’s life, whereas it shows very poor specific initial symptoms, which makes early diagnosis difficult.

[Prevention]

Recommendation 2

«Prevention with patient participation»

Healthcare professionals and patients should share the risk. Patients should be instructed to proactively practice prophylactic actions, and to inform the staff as soon as such symptoms appear as are suspected of acute PTE or deep vein thrombosis.

Recommendation 3

«Comprehension of deep vein thrombosis»

Many of the embolic sources of acute PTE are thrombi in the lower extremity veins and the pelvic veins. When clinical symptoms are suspected of deep vein thrombosis, an echographic examination of the lower extremity veins should be performed to confirm the presence or absence of thrombus.

[Early detection and early diagnosis]

Recommendation 4

If symptoms of dyspnea, chest pain, tachycardia, tachypnea and/or blood pressure decrease with unknown obvious etiology are complained or observed, the staff should be reminded of a possibility of acute PTE and consider to carry out a contrast-enhanced CT scan or other exams for early diagnosis.

[Initial treatment]

Recommendation 5

In situations where acute PTE is strongly suspected, or when the diagnosis is confirmed as acute PTE, an immediate anticoagulation therapy, that is, a single intravenous administration of heparin, should be discussed.

[Establishment of in-hospital system]

Recommendation 6

Regarding risk assessment, prevention, diagnosis and treatment of acute PTE, an in-hospital organization (like response team or nominated staff) where related problems can be consulted should be structured as part of a medical safety program. A cooperative system with other institutions should be established where out-hospital consultations and transfers are available as required.

August 2017

Expert Analysis Subcommittee for Acute Pulmonary Thromboembolism
Committee for Prevention of Recurrence, Medical Investigation and Support Center
Japan Medical Safety Research Organization

Table of Contents

1. Introduction	7
1) About acute pulmonary thromboembolism.....	7
2) The background and definition/situation of setting up the Expert Analysis Subcommittee.....	8
3) State of related medical accident reports	8
2. Methods of analysis	9
1) Extraction of target cases.....	9
2) Information gathering on target cases and arrangement	9
3) Meetings of the Expert Analysis Subcommittee	9
3. Overview of target cases.....	10
4. Recommendations and explanations for the prevention of recurrence	12
5. What we expect of (or what we want to propose to) academic societies and companies.....	20
6. Conclusion.....	21
« References ».....	22
7. Materials	24
Acute pulmonary thromboembolism (acute PTE) [Investigation items checklist]	24

[Glossary]

Pulmonary thromboembolism: PTE	The pathology where venous thrombosis generated in the deep part of the lower extremities and pelvis occludes the pulmonary artery to cause pulmonary circulation disturbance. Acute pulmonary thromboembolism is the condition where pulmonary circulation disturbance has occurred suddenly.
Deep vein thrombosis: DVT	The vein traveling deeper than deep fascia is called the deep vein, and deep vein thrombosis is the pathology where thrombus develops in the deep vein.
Venous thromboembolism: VTE	Acute pulmonary thromboembolism and its embolic source, deep vein thrombosis, are one disease that occurred in different forms, and the treatment methods for both diseases are basically the same. Recently they are collectively referred to as venous thromboembolism.

1. Introduction

1) About acute pulmonary thromboembolism

Acute PTE refers to the pathology in which thrombus generated in the deep vein of the lower extremities or pelvis occludes the pulmonary artery to cause disturbance of pulmonary circulation. Recognition that this disease is the secondary complication of deep vein thrombosis is essential, and the guidelines for the diagnosis, treatment and prevention of PTE and deep vein thromboembolism (hereinafter referred to as "guidelines") have been issued.

Acute PTE occurs suddenly without specific initial symptoms, and it is one of the diseases with a high probability of following a process to death. Acute PTE became broadly known as economy-class syndrome by the event where a young woman developed a PTE after a long flight on her way back from the 2000 Sydney Olympic Games. In Japan also, it became well known by the occurrence in a famous soccer player who attended an overseas expedition. In addition, it was reported that this disease occurred in the victims of the Niigata Chuetsu Earthquake in 2004, the Great East Japan Earthquake in 2011 and the Kumamoto Earthquake in 2016 who had led evacuation lives in such narrow places as in the car; since then, the name economy-class syndrome has been established firmly.

Acute PTE was regarded as a disease with a low frequency of occurrence in Japan. Now, it is recognized that, compared with the situation in the past, the number of occurrences has increased because of the Westernization of lifestyle habits, increase in elderly people, advancement in treatment, growing awareness of this disease, etc. However, there have been few epidemiological surveys on the accurate incidence of PTE; therefore, it is difficult to grasp the overall number under the present circumstances. According to Nakamura et al., as a result of the five questionnaire surveys conducted in Japan, it is reported that the number of patients diagnosed with PTE increased 4.6 times between 1996 and 2011 and that in the report of 2011 the number of patients was 126 per million.

In 2004, Japan's first guidelines (*Guidelines for the Diagnosis, Treatment and Prevention of Pulmonary Thromboembolism and Deep Vein Thrombosis*) were formulated, and at the same time, "PTE preventive management fee" was established as the medical fee. After the survey of PTE during the perioperative period, Kuroiwa et al. of the Japanese Society of Anesthesiologists reported that PTE occurred in at least 3.1 patients per 10,000 surgeries, fatal PTE in 0.6 patients, and the mortality rate was as high as 17.9%. Although the incidence of PTE tended to increase in 2002-2003, it started to decline after formulation of the guidelines and establishment of "PTE preventive management fee" in 2004. Likewise, the perioperative mortality rate continued to increase until 2005, but it has been on a downward trend since 2008.

According to the vital statistics by the Ministry of Health, Labour and Welfare, the total number of deaths due to PTE increased from 591 in 1988 to 1,655 in 1998, 2.8 times in 10 years. After that, it still continued to increase to 1,900 in 2005, but no increase was shown thereafter even though there was fluctuation from year to year. Since diagnosis is difficult owing to the nature of the disease, it is speculated that there were occurrences of PTE that were not reflected in the vital statistics.

Thanks to the formulation of guidelines and the policies to cover the insurance premium for "PTE preventive management fee", the efforts for recognition and prevention of PTE in hospitals have spread nationwide, and certain preventive effects seem to have been obtained. However, reports of death cases to the Medical Accident Investigation and Support Center [ISC] has still been continuing, and we believe additional measures are required to be taken thoroughly.

2) The background and definition/situation of setting up the Expert Analysis Subcommittee

With regard to acute PTE, many reports have already been provided, the guidelines have been formulated concerning its features, preventive measures, treatments, etc., and risk analysis and enlightenment/education of the onset prevention have been performed. However, the death cases due to acute PTE have still been reported to ISC as an unexpected death caused by medical intervention. Among them there are many cases where acute PTE was determined as a cause because other causes were denied or because of a PTE suspect diagnosis as one of the causes while naming multiple disease conditions. In some case acute PTE was revealed as a cause by autopsy because an immediate definitive diagnosis at the onset was difficult and acute PTE was not in practitioners' mind until death.

Many inpatients fall under the high-risk group, initial symptoms are chest pain and tachypnea, etc. which are so general that it is difficult to diagnose acute PTE at the occurrence, and the disease progression from occurrence to death is so rapid. In view of these facts, prevention and early diagnosis are extremely difficult, which may have resulted in unexpected death.

Under these circumstances, we decided to take up this theme and establish the Expert Analysis Subcommittee for Acute Pulmonary Thromboembolism to consider preventive measures against recurrence of medical accidents. Of the cases where the diagnosis of acute PTE was confirmed as the cause of death, verification and analysis were performed from the viewpoint of how to avoid the situation leading to death. It is also necessary to accumulate report cases in the future and analyze them in detail. We would like to make this attempt the first step.

3) State of related medical accident reports

[Publically available data of the Project to Collect Medical Near-miss/Adverse Event Information, Japan Council for Quality Health Care] (January 1, 2010 to as of August 3, 2016)

The results of searching with the keywords such as “acute pulmonary thromboembolism”, “pulmonary thromboembolism”, “PTE”, “pulmonary embolism”, “PE”, “pulmonary infarction” and “pulmonary artery thrombosis”, showed that 53 cases of death related to acute PTE had been reported.

[Model Project for Survey and Analysis of Deaths Associated with Clinical Practice, Japan Medical Safety Research Organization] (from September 2005 to the closing of the project in 2015)

In 10 years from 2005 to 2015, 224 death cases were investigated and reported. Three cases (1.3%) of deaths related to acute PTE were reported.

2. Methods of analysis

1) Extraction of target cases

Of the 330 cases in the in-hospital investigation reports reported during the one year and six months from October 1, 2015 to March 31, 2017, the cause of death of the 11 cases was determined as acute PTE by the medical institutions.

Considering that, for the purpose of drawing measures to avoid death, it was useful to examine only the cases where the definitive diagnosis of acute PTE had been made, the Expert Analysis Subcommittee set the following conditions on the target of analysis.

[Conditions on analysis target]

Of the 11 cases where medical institutions assumed the cause of death to be acute PTE through the in-hospital investigations, the cases that meet any one of the following three conditions were chosen for analysis from the viewpoint of autopsy, CT or other laboratory findings.

1. Definitive diagnosis has been made based on the autopsy result.
2. Clinical diagnosis has been done with the contrast-enhanced CT performed during the clinical course.
3. From the findings on electrocardiogram and echocardiography, etc. during the clinical course, it is comprehensively interpretable that the probability of acute PTE is extremely high.

[Determination of target cases]

Of the 11 cases, three cases satisfied condition 1 on the analysis target (definitive diagnosis has been made based on the autopsy result), two cases satisfied the condition 2 (clinical diagnosis has been done with the contrast-enhanced CT performed during the clinical course), and three cases satisfied the condition 3 (From the findings on electrocardiogram and echocardiography, etc. during the clinical course, it is comprehensively interpretable that the probability of acute PTE is extremely high).

The above eight cases satisfied the conditions on targets of analysis set by the Expert Analysis Subcommittee and were decided to be the targets for analysis.

2) Information gathering on target cases and arrangement

Based on the information listed in the in-hospital investigation reports submitted to ISC, each case was analyzed by the Expert Analysis Subcommittee. With regard to the descriptions that required confirmation, additional information was collected with cooperation of the reporting facilities as far as possible. Additional data were sorted and arranged according to the items of investigation. (See 7. "Materials")

3) Meetings of the Expert Analysis Subcommittee

- First meeting November 28, 2016
- Second meeting March 30, 2017
- Third meeting May 11, 2017
- Fourth meeting June 19, 2017
- In addition, online discussions through electronic media, etc.

3. Overview of target cases

Case 1 Orthopedics

- The patient in the 60s hospitalized for femoral neck fracture. Body mass index (hereinafter referred to as "BMI"): 26
- The patient had mild paresis due to brain tumor surgery and was taking antiepileptic drugs. Active exercise of the ankle and toe had been performed as a preventive measure against acute PTE.
- Hip joint replacement surgery was performed on day 6 of hospitalization. Cardiopulmonary arrest occurred during surgery. Acute PTE was diagnosed by an echocardiography. Thrombus aspiration, thrombolytic therapy and inferior vena cava filter placement were performed, but the patient died the next day.

Case 2 Orthopedics

- The patient in the 40s hospitalized for femoral neck fracture. BMI: 35
- While waiting for the scheduled operation, rehabilitation on the bed and active exercises of the ankles and toes were performed.
- Artificial femoral head replacement was performed on day 4 of hospitalization. After spinal anesthesia, the patient complained of dyspnea when being put in lateral decubitus position and oxygen was administered. Chest dysphoria was observed 1 hour later, and then became disturbing. Just after that, blood pressure and percutaneous arterial blood oxygen saturation (hereinafter referred to as "SpO₂") decreased; therefore, life support was implemented. Outstanding dilatation of the right ventricle was confirmed with echocardiography, and acute PTE was diagnosed. Thrombolytic drug was administered. Filling defects were confirmed in both pulmonary arteries by the chest contrast-enhanced CT. Life support was continued, but the patient died without return of spontaneous circulation.

Case 3 Orthopedics

- The patient in the 80s hospitalized for femoral neck fracture and pneumonia treatment. BMI: 22
- Thrombus was found in the soleus muscle vein in the calf by the echography of the lower extremity. Therefore, active exercise of the ankle and toe and continuous administration of heparin were performed as a preventive measure against acute PTE.
- Artificial femoral head replacement was performed in approximately two weeks of hospitalization. Spasm-like symptom and decreased blood pressure appeared after induction of spinal anesthesia. Life support was implemented, but the patient died. Disease was assumed as acute PTE by electrocardiogram and echocardiography findings.

Case 4 Neurosurgery

- The patient in the 50s hospitalized for the conservative treatment after putamen hemorrhage and ventricle perforation. BMI: 26
- Under treatment for diabetes and hypertension, psychotropic drugs had been taken. Activities of daily living (hereinafter referred to as "ADL") were independent before hospitalization.
- Intermittent pneumatic compression was implemented at bed rest. The timing of attachment and detachment was unknown. One week after hospitalization, gait training was started. Three days later, queasy symptoms and fatigue were observed; therefore, the rehabilitation was shifted to on the bed method. Transfer from the bed to a wheelchair and excretion in a toilet were possible. When gait training was resumed approximately three weeks later, dyspnea and tachypnea were observed, and the consciousness level decreased. Disease was diagnosed as femoral deep vein thrombosis and acute PTE of both pulmonary arteries by the contrast-enhanced CT. Life support was continued but the patient died after a few days.

Case 5 Neurosurgery

- The patient in the 60s hospitalized for brain tumor excision and postoperative chemotherapy. BMI: 33
- With hypertension and diabetes, the patient was taking an anticoagulant drug for atrial fibrillation. ADL was generally independent.
- During hospitalization from the day 2nd to 8th (the day of surgery), anticoagulant drug was changed to heparin. Intermittent pneumatic compression was implemented during surgery. After surgery, hematoma was found in the tumor resected cavity, and the patient was managed with tracheal intubation. Then, the decreased blood pressure was observed, and the respiratory conditions were worsened. Although life support was implemented, the patient died on the day of surgery. Acute PTE was diagnosed by autopsy.

Case 6 Neurosurgery

- The patient in the 70s hospitalized for emergency due to putamen hemorrhage. BMI: 29
- The patient had a hypertension. Approximately 2 weeks after the craniotomy for the resection of hematoma, the intermittent pneumatic compression was altered to the elastic stockings.
- Approximately 3 weeks after surgery, the patient fainted during the training of sitting on the edge of the bed and complained of chest dysphoria with decreased SpO₂, but soon recovered. Then, while continuing rehabilitation, the patient complained of knee pain and malaise, and at the same time, decreased blood pressure, tachycardia and decreased SpO₂ appeared, resulting in cardiopulmonary arrest. Thrombus was found in the pulmonary artery by chest CT, and acute PTE was diagnosed. Life support was implemented, but the patient died on the same day.

Case 7 Psychiatry

- The patient in the 40s hospitalized for the medical care and protection due to schizophrenia and suicidality. BMI: 27
- Restraint of the trunk and extremities was implemented to prevent self-injurious behavior. The patient was taking psychotropic drugs.
- The patient wore elastic stockings during trunk restraint. On day 5 of hospitalization, the patient complained of chest pain with abnormal findings in the electrocardiogram examination, but he was set under follow-up observation because the symptoms disappeared. Approximately 3 weeks after hospitalization, at 30 minutes after the start of open observation, the patient was found collapsed in the toilet. Life support was implemented, but the patient died without the return of spontaneous circulation. Acute PTE was diagnosed by autopsy.

Case 8 Cardiology

- The patient in the 40s hospitalized for pneumonia and bacterial pleuritis. BMI: 28
- The patient had a history of myocardial infarction, but treatment was interrupted. For 10 days before hospitalization, the patient had had strange feelings and pain in the lower extremities and swelling had been observed, but they were reduced at the time of hospitalization.
- Several hours after hospitalization, dyspnea, left chest pain, and decreased blood pressure were observed. Although oxygen administration was started, dyspnea was augmented and resulted in cardiopulmonary arrest. Life support was implemented, but the patient died. Acute PTE was diagnosed by autopsy.

4. Recommendations and explanations for the prevention of recurrence

[Comprehension of risks and recognition of the disease]

Recommendation 1

It is important to grasp the possible risks of developing acute pulmonary thromboembolism (acute PTE) in hospitalized patients and it should always be aware that acute PTE occurs suddenly and affects the patient's life, whereas it shows very poor specific initial symptoms, which makes early diagnosis difficult.

Acute PTE occurs in every clinical department, but early detection and early diagnosis are difficult because its symptoms are not so specific. At the same time, however, it is well known that early diagnosis and appropriate treatment improves its mortality rate remarkably. Every healthcare professional should grasp the possible risks and share them within the medical team, and always be aware the possibility of occurrence of acute PTE.

● Comprehension of risks

Acute PTE occurs by overlapping of some risk factors for thrombus formation such as blood stagnation, vascular endothelial disorder, and blood hypercoagulability. The factors of blood stagnation include prolonged bed rest, obesity, general anesthesia, leg paralysis and plaster cast immobilization of the lower extremities. The factors of vascular endothelial damage include a state in which veins have been damaged by various surgeries, trauma, bone fracture, central venous catheterization, etc. The factors of blood hypercoagulability include drugs and infectious diseases such as malignant tumor, pregnancy, various surgeries, trauma, oral contraceptives, and estrogen preparations.

In eight target cases, as risk factors for acute PTE, the prolonged bed rest for 2 days or longer was found in seven cases, obesity of BMI 25 or more was in seven cases, various surgeries were in five cases, and drug use such as the psychotropic drugs was in three cases. Other risk factors such as general anesthesia, malignant tumor, and infectious diseases were also observed.

When looking at them by each field, there were three cases of hip surgery in the orthopedic field, and in the neurosurgery field there were two cases of craniotomy and one case of conservative treatment after cerebral hemorrhage.

Many risks are often encountered in daily medical practice; however, understanding the risks provides a clue to suspect and diagnose acute PTE at the time when symptoms occur. It is necessary to recognize the risks and go into the medical care every day.

Each clinical department should refer to the guideline of each academic society in order to evaluate the risks. Classification by the risk of venous thromboembolism of each surgery and disease is shown in Table 1 "Stratification of the risks of venous thromboembolism in each field."

Table 1 Stratification of venous thromboembolism (VTE) risks in each field

Risk levels	General surgery/Urology/ Gynecological surgery	Orthopedic surgery	Obstetric field
Low risk	<ul style="list-style-type: none"> • Non-major surgery in the patients under 60 years of age • Major surgery in the patients under 40 years of age 	<ul style="list-style-type: none"> • Surgery on the upper extremity 	<ul style="list-style-type: none"> • Normal delivery
Intermediate risk	<ul style="list-style-type: none"> • Non-major surgery in the patients aged 60 years or above, or with risk factors • Major surgery in the patients aged 40 years or above, or with risk factors 	<ul style="list-style-type: none"> • Upper extremity surgery associated with bone harvest from the ilium and harvesting nerves and skin from the lower extremity • Spinal surgery • Spinal injury and spinal cord injury • Surgery on the lower extremity • Single trauma below the distal femur 	<ul style="list-style-type: none"> • Caesarean section delivery (other than high risk)
High risk	<ul style="list-style-type: none"> • Major surgery of cancer in the patients aged 40 years or above 	<ul style="list-style-type: none"> • Hip joint replacement surgery, artificial knee joint replacement, hip fracture surgery (including the shaft of femur) • Pelvic osteotomy (such as Chiari osteotomy of pelvis or rotational acetabular osteotomy) • When additional risk factors of VTE are complicated with lower extremity surgery • Surgery on lower extremity malignant tumor • Severe trauma (multiple trauma) and pelvic fracture 	<ul style="list-style-type: none"> • Caesarean section delivery of old obese woman • Vaginal delivery with a history of VTE or thrombophilia
Highest risk	<ul style="list-style-type: none"> • Major surgery in the patients with a history of VTE, or with thrombophilia (thrombotic diathesis) 	<ul style="list-style-type: none"> • When the patients undergoing high-risk surgery have a history of VTE or presence of thrombophilia 	<ul style="list-style-type: none"> • Caesarean section delivery with a history of VTE or thrombophilia

A comprehensive risk level is determined by considering additional risk factors to the risk of treatment or disease to be prevented from VTE. For example, in the case of strong additional risk factors, the risk level should be raised by one step, and even in the case of weak additional risk factors, you should consider raising the risk level if multiple factors are overlapped.

Additional risk factors that increase risks are: Thrombophilia, history of venous thromboembolism, malignancy, cancer chemotherapy, severe infection, central venous catheterization, prolonged bed rest, leg paralysis, cast immobilization of the lower extremity, hormone therapy, obesity, varicose vein, etc. (Thrombophilia refers mainly to anti-thrombin, protein C deficiency, protein S deficiency, antiphospholipid antibody syndrome)

Although the major surgery has no strict definition, all abdominal operations or other surgeries that take more than 45 minutes are the basis of major surgery and will be comprehensively evaluated with reference to anesthesia method, amount of bleeding, amount of transfused blood and operation time, etc.

Japanese Circulation Society, *Guidelines for the Diagnosis, Treatment and Prevention of Pulmonary Thromboembolism and Deep Vein Thromboembolism* (Revised edition, 2009)

http://www.j-circ.or.jp/guideline/pdf/JCS2009_andoh_h.pdf (Browsed on August, 2016) (Reprinted with permission)

● Recognition of the disease

Symptoms of acute PTE are said to be poor in specific symptoms, and in all the target cases, the disease started from general symptoms and findings like chest pain, dyspnea and tachycardia. In some cases, the condition suddenly changed in approximately 30 minutes after the occurrence of symptoms, and in five cases, the condition deteriorated drastically. In addition, after the occurrence of the initial symptoms, in one case acute PTE was diagnosed before the sudden change, in four cases it was diagnosed after the sudden change, and in three cases the diagnosis was not done until the autopsy.

Looking back on the cases later, multiple risk factors of acute PTE were seen in all cases and symptoms suspected of acute PTE were occurring, but they did not lead to an early diagnosis. Orthopedic femoral neck fracture and cranial nerve disease were regarded as the diseases that have high risk of acute PTE.

Therefore, in addition to understanding the risk in multiple professions including patients, you should recognize that there is a possible occurrence of acute PTE in all inpatients, and when symptoms associated with acute PTE occur, it is necessary to cite acute PTE as a differential disease.

[Prevention] @

Recommendation 2

«Prevention with patient participation»

Healthcare professionals and patients should share the risk. Patients should be instructed to proactively practice prophylactic actions, and to inform the staff as soon as such symptoms appear as are suspected of acute PTE or deep vein thrombosis.

Hospitalized living tends to restrict patients' behavior and often reduces the activity level, which leads to the risk of developing acute PTE. In carrying out its prevention, you should fully explain the risks to the patient and obtain understanding and cooperation.

- Importance of physical prevention and pharmacological prevention

Physical prevention and pharmacological prevention are available for the prevention of VTE, but the basic is physical prevention. Physical prevention includes early ambulation and active exercise, wearing elastic stockings and intermittent pneumatic compression.

Especially early ambulation and active exercise are useful and are safe for patients who are at risk of bleeding and are unable to apply anticoagulant therapy. If a patient requires prolonged bed rest, simply moving the ankle joint on the bed is considered highly effective in prevention because it accelerates venous blood flow of the lower extremities. In addition, performing plantar dorsal flexion of the ankle joint has few complications, many patients can perform the movement, and it is an inexpensive preventive measure. Therefore, it is necessary to obtain patients' understanding and cooperation so that they can practice positively. If possible, early ambulation and active exercise should be recommended to all patients, regardless of risk level. However, depending on the condition of the patient, there are cases in which early ambulation and active exercises are not possible, so an attending physician's determination and permission for implementation are required.

In the case of hip joint surgery in the orthopedic field, plantar dorsal flexion of the ankle was performed, but intermittent pneumatic compression was not implemented. In some cases, the patients were unable to wear elastic stockings because of pain in the fracture site. In the cases of hip joint surgery, physical prevention may sometimes become difficult to implement because of pain in the affected area. So, if possible, doing the operation at an early stage will also shorten the period of bed rest, which is of assistance in preventing venous thromboembolisms.

In the cases in the neurosurgical field, plantar dorsal flexion of the ankle could not be performed in two cases due to the patients' disorientation, distraction and paralysis, but it was implemented in one case. Elastic stockings were worn in one case. Intermittent pneumatic compression was performed in all cases, but it was done only during the perioperative period rather than during all rest periods. When early ambulation and implementation of pharmacological prevention are difficult, thorough implementation of physical prevention such as active exercises, wearing elastic stockings and intermittent pneumatic compression not only during the perioperative period but during all rest periods is a feasible preventive measure.

Regarding pharmacological prevention in the target cases, anticoagulation therapy was performed in one case after consultation with the specialized clinical department. Anticoagulant drugs used in the pharmacological prevention include heparin, fondaparinux, enoxaparin, edoxaban and warfarin. When using anticoagulants, you should evaluate the risk of bleeding, and if the risk is high, consult the specialized clinical department such as the cardiovascular internal medicine. If the risk of bleeding exceeds the benefits of anticoagulant drugs, there is also a choice to refrain from using them.

- Prevention by the patient participation

When implementing preventive measures, it is necessary to fully explain to the patient the risk of occurrence of acute PTE and preventive measures and to obtain understanding and cooperation. Among the target cases, the risk of developing acute PTE was explained in five cases and the preventive measures were implemented. Based on the importance of the physical prevention, if there is no medical problem, you should positively recommend plantar dorsal flexion of the ankle to the patients and encourage them so that they can do it alone. The wearing of elastic stockings and the intermittent pneumatic compression also serve as an opportunity for patients themselves to be conscious of the risk of acute PTE. However, depending on the condition of the patient, in some cases it is not possible to implement early ambulation and active exercises, so an attending physician's determination and permission for implementation are required.

Posting an illustration like the one below on the bedside leads to awareness of prevention for the patients and medical staff.



Preventive measures against pulmonary thromboembolism performed by yourself

An example of explanation sheet for the patients at bed rest is available on the following website.

URL:

<https://www.medsafe.or.jp/uploads/uploads/files/teigen-02setumei.pdf>

You can download to use it.



- Patient cooperation for early detection

For the detection of initial symptoms and early diagnosis, instructions to the patients about the symptoms are useful because there are the cases where acute PTE progresses rapidly, resulting in death.

Explanations of the symptoms of acute PTE were made in five cases, three of which were explained to notify healthcare professionals. However, in two cases, other than surgical cases, although the patients were complaining of symptoms, it did not lead to an early diagnosis of acute PTE.

Performing preventive measures against deep vein thrombosis has certain effects on the prevention of acute PTE. However, preventive measures have a limit and cannot prevent all acute PTEs. If you can identify the symptoms at an early stage, you may be able to save some patients by early diagnosis and treatment appropriate to their condition. In order to obtain patients' cooperation, you should explain acute PTE and its symptoms to the patients according to their understanding level. Further, the patients should be instructed to tell the medical staff positively when they have realized any events or abnormalities usually seen in acute PTE, or in deep vein thrombosis which will be detailed in the next section.

[Prevention]

Recommendation 3

«Comprehension of deep vein thrombosis»

Many of the embolic sources of acute PTE are thrombi in the lower extremity veins and the pelvic veins. When clinical symptoms are suspected of deep vein thrombosis, an echographic examination of the lower extremity veins should be performed to confirm the presence or absence of thrombus.

● **Deep vein thrombosis**

In two of the target cases, the echographic examination of the lower extremity vein was performed.

Many of the embolic sources of acute PTE are thrombi in the lower extremity veins and the pelvic veins. Deep vein thrombosis occurs because of bed rest from physical limitations, tends to occur in the calf, and is seen in several dozen percent of inpatients, but it mostly disappears in a few days. What is called central type of deep vein thrombosis above the knee has a higher possibility of causing an acute PTE than the one in the calf.

Clinical symptoms of deep vein thrombosis are swelling of the whole lower extremities, laterality of circumference of the lower extremities, pain and redness in the femur, popliteal fossa and calf along the deep veins of the lower extremities, and differentiation from other diseases and inflammation are also required.

When symptoms of deep vein thrombosis are observed, or vein compression and obstruction are suspected due to pelvic giant mass, perform the examinations, such as the echography of the lower extremity vein and lower extremity contrast-enhanced CT, and start the treatment when necessary. This will suppress the onset of acute PTE.

Table 2

Simplified method for evaluating potential disease of pulmonary thromboembolism.

⟨The text is provided on page 17⟩

Simplified Wells Score	
Clinical features of DVT	1
Heart rate > 100/min	1
Surgery or prolonged bed rest during the last 4 weeks	1
History of PE or DVT	1
Bloody sputum	1
Cancer	1
Possibilities other than PE are low	1
Total score	
<hr/>	
<u>Clinical possibility</u>	
Low	1 or less
High	2 or more

DVT: Deep vein thrombosis,
PE: Pulmonary embolism

Gibson NS, Sohne M, Kruip MJ, et al: “Further validation and simplification of the Wells clinical decision rule in pulmonary embolism.” *Thrombosis and Haemostasis* 2008; 99(1): 229–234. (Modified)

[Early detection and early diagnosis]

Recommendation 4

If symptoms of dyspnea, chest pain, tachycardia, tachypnea and/or blood pressure decrease with unknown obvious etiology are complained or observed, the staff should be reminded of a possibility of acute PTE and consider to carry out a contrast-enhanced CT scan or other exams for early diagnosis.

- Initial symptoms, clinical findings

Major symptoms and clinical findings of acute PTE are dyspnea, chest pain, tachycardia and tachypnea. It may also occur due to decreased blood pressure or shock.

When you look back on the target cases, two cases of dyspnea, two cases of chest pain, chest discomfort, palpitations, cough, bloody sputum and syncope were observed as subjective symptoms. As clinical findings, three cases of tachypnea, three cases of decreased SpO₂, two cases of tachycardia, two cases of decreased blood pressure, and one case of shock were found.

The cases where temporarily decreased blood pressure, decreased SpO₂, dyspnea, chest pain, chest discomfort was observed several days before the onset of acute PTE, and the case where tachycardia continued for several days before the onset were observed.

As characteristic onset situations of acute PTE, it has been reported that in many cases it occurred at standing up, ambulation, bowel movement and urination after resting. And in the target cases, it occurred after the postural change following spinal anesthesia and after the release of physical restraint. The symptomatic state sometimes changes so suddenly that the time to the life support may become short. Taking into account the patient's underlying disease, risk factors, contributors and onset situation, you should suspect acute PTE and lead to early diagnosis.

- Examinations for an early diagnosis

When acute PTE is suspected, if a thrombus is found by contrast-enhanced CT, it will be a definitive diagnosis. If contrast-enhanced CT cannot be performed, it may be diagnosed using echocardiography. In five cases suspected of or diagnosed as acute PTE, a contrast-enhanced CT and echocardiography were performed, but in all cases, it was after the sudden change that the examinations were conducted.

Generally tested D-dimer is of help to exclusion diagnosis because acute PTE can be denied if the value is normal.

Although they may not reveal a specific change, a negative T wave, sinus tachycardia and other symptoms may appear in the electrocardiogram.

If apparent symptoms of dyspnea, chest pain, tachycardia, tachypnea and decreased blood pressure of unknown etiology are observed, you should suspect the possibility of acute PTE with the clinical findings in mind and consider performing a contrast-enhanced CT for an early diagnosis. As an indicator of whether to suspect the acute PTE cases strongly, Table 2 "Simplified method for evaluating potential disease of pulmonary thromboembolism" (see page 16) can be referred to.

In addition, if you are uncertain about the diagnosis of acute PTE, you should consult the specialized clinical departments such as cardiovascular medicine, etc.

**That symptom,
isn't it associated with
acute PTE?**

[Initial treatment]

Recommendation 5

In situations where acute PTE is strongly suspected, or when the diagnosis is confirmed as acute PTE, an immediate anticoagulation therapy, that is, a single intravenous administration of heparin, should be discussed.

- First choice of the anticoagulant therapy — Single intravenous administration of heparin

In five of the target cases, death occurred within 1 hour to 2 and a half hours after the start of lifesaving following a sudden change, and the time from sudden symptomatic change to death was short. Even though the details of treatment of acute PTE differ depending on the severity, it is recognized that the patient who has survived the acute phase will have a good prognosis. Therefore, it is important to start treatment immediately after the emergence of early symptoms and findings.

When unknown etiologies like hypoxemia, right heart overload, decreased blood pressure and fluctuated heart rate are observed, acute PTE is strongly suspected. In such situations or when a diagnosis of acute PTE is confirmed, you should evaluate the risk of bleeding, and single intravenous dose of 3,000 to 5,000 units of heparin (or 80 units per 1 kg of body weight) should be immediately administered as an initial treatment.

Among the target cases, there were no such cases where single intravenous dose of heparin was administered as an initial treatment, after all.

When acute PTE is strongly suspected, or when its diagnosis is confirmed, emergency treatment with heparin should be performed and consultation with a specialist physician should be conducted at the same time. Because knowledge and experience are required to control heparin, as for continuing treatment after emergency heparin administration, you should consult a specialized clinical department of acute PTE such as cardiology.

Heparin does not have the ability to directly dissolve the thrombus or embolus generated. However, it is said that by accelerating the inhibition of thrombin and activated factor X by antithrombin and by lowering the coagulation ability, the completed thrombus is secondarily dissolved. In situations where acute PTE is strongly suspected, or when acute PTE is diagnosed, an administration of heparin should be decided first of all because the effect occurs rapidly. It is possible to deal with hemorrhage after the administration of heparin because the half-life of heparin is as short as around one hour, the loss of effect occurs earlier by dose reduction and discontinuation, and because a neutralizing drug, protamine, is available.

[Establishment of in-hospital system]

Recommendation 6

Regarding risk assessment, prevention, diagnosis and treatment of acute PTE, an in-hospital organization (like response team or nominated staff) where related problems can be consulted should be structured as part of a medical safety program. A cooperative system with other institutions should be established where out-hospital consultations and transfers are available as required.

Not only the response after the onset of acute PTE but also an in-hospital organization (like response teams or nominated staff) in a medical safety committee should be structured during normal operations to assume a role in the preventive activity of acute PTE, diagnosis and treatment after onset. For these matters, create in-hospital manuals so that everyone can understand and respond to them.

- In-hospital cooperation system

Always keeping in mind acute PTE, the risk should be re-evaluated periodically for long-term inpatients, including the pathological change in patient's condition between pre- and post-operation, and preventive treatment should be undertaken in accordance with the change in condition of the patient by multiple professions.

In all of the target cases, the manuals and countermeasures of acute PTE were demonstrated in the hospital. Regarding the in-hospital consultation and medical intervention of acute PTE, in three cases consultation was made with the cardiovascular medicine and the emergency departments after the sudden change and medical intervention was performed, and in one case consultation was made with cardiovascular surgery department before the onset of acute PTE.

As for the prevention, diagnosis, and treatment of acute PTE, the specialized clinical departments such as the cardiovascular internal medicine and the person in charge should be clarified beforehand and an in-hospital system that allows consultations and requests for medical intervention should be established.

- Cooperation system when there are no specialized clinical departments in the hospital

In many cases there are no specialized clinical departments for the prevention, diagnosis and treatment of acute PTE in individual hospitals. Because acute PTE may occur in any clinical department, even in the medical institutions having no specialized clinical departments, the system should be set up in a medical safety committee in which the response teams and nominated staff in charge will play roles in prevention, diagnosis and treatment.

The teams and staff in charge should acquire the basic knowledge of prevention, diagnosis and treatment via the guidelines for acute PTE. Furthermore, in cooperation with the outside medical institutions and the local key hospitals that have specialized clinical departments, a cooperation system should be established which enables the hotline that allows for consultation about medical intervention and emergency contact at any time, hospital transfer and so on.

Additionally, in the specialized clinical departments and local key hospitals that respond to the consultations on acute PTE and to the requests for medical intervention, it is also necessary for the team and the staff to acquire specialized knowledge and prepare for an emergency response, assuming that an urgent consultation or medical intervention will be requested.

5. What we expect of (or what we want to propose to) academic societies and companies

Since acute PTE occurs in any medical practice settings, with regard to its prevention, diagnosis and treatment, we expect that academic societies and companies will support and lead the efforts by individual medical institutions.

(1) Ascertaining current status by case registration

In order to improve prevention, diagnosis and treatment of acute PTE and to reduce the recurrence of medical accidents, it is necessary to know the current status of the occurrence of acute PTE in Japan, clinical features and treatment methods.

It is expected that registration of the cases diagnosed as acute PTE by CT or pathological autopsy (*Registry*) will be implemented nationwide.

(2) Improvement of medical devices to prevent venous thromboembolism

We expect the development of elastic stockings that are easy to put on and take off and that discomfort and skin disorders are few, and of the convenient and lightweight instruments for intermittent pneumatic compression.

(3) Education of acute PTE for physicians and nurses

In the prevention, diagnosis and treatment of acute PTE, medical personnel of all departments have played important roles; therefore, it is hoped that the opportunity for training to acquire basic knowledge will be created for these healthcare professionals. We expect each academic society to provide the educational opportunities for prevention, diagnosis and treatment method of acute PTE.

Furthermore, we expect a specialized academic society of pulmonary thromboembolism to provide opportunities of checking basic knowledge and acquiring the latest knowledge with regard to prevention as well as the diagnosis and treatment of acute PTE in an emergency, so that the specialized persons in charge at each medical institution will be able to respond to consultations from other departments appropriately

6. Conclusion

The Expert Analysis Subcommittee for Acute Pulmonary Thromboembolism extracted cases of acute PTE that have frequently been reported as the causative disease of death among the cases reported from the whole country as medical accidents. We reviewed the factors that would avoid death and compiled the recommendations for preventing a recurrence so that the onset could be prevented as much as possible.

Acute PTE is a disease that will lead to an unhappy outcome unless you are constantly aware of the onset of disease and advance prevention and diagnosis. It is also hoped that these recommendations will be widely used because there is a possibility that the medical personnel in all clinical departments may face to respond.

We stated in Recommendation 1 that healthcare professionals should recognize the characteristics of this disease, and in Recommendation 2 that this recognition should be guided to patients to get their cooperation and that they should concentrate on prevention first of all. Yet, because the possibility of onset of the disease remains, we mentioned in Recommendation 3 that the staff should understand deep vein thrombosis causing acute PTE, and in Recommendation 4 that if the possibility of developing acute PTE is high, contrast-enhanced CT and such should be performed promptly. In Recommendation 5 we wrote that if acute PTE is suspected or diagnosed, anticoagulant therapy should be considered immediately, and in Recommendation 6 that an in-hospital organization that responds to acute PTE and an out-hospital system of cooperation with the outside institutions as required should be established.

Owing to the characteristics of an acute PTE, there is a limit to the prevention of onset and the lifesaving after onset. However, we are yet to continue to make efforts to reduce the incidence of this disease by collecting and analyzing the cases for a follow-up report in the future.

Finally, we would like to express our deepest condolences to the patients who died due to the accident and to the bereaved families, as well as to express our sincere gratitude to the medical institutions that contributed to the investigation of the causes, the prevention of recurrences, and cooperated in providing in-hospital investigation reports and additional information. We hope that the recommendations of this report will serve to contribute to the lifesaving of patients, as well as be useful for healthcare professionals as a step in the process of improving medical safety.

« References »

- 1) 2008 年度合同研究班報告：肺血栓塞栓症および深部静脈血栓症の診断、治療、予防に関するガイドライン（2009年改訂版）
Joint Working Group Report in FY 2008: *Guidelines for the diagnosis, treatment, and prevention of pulmonary thromboembolism and deep vein thrombosis* (2009 revised edition)
- 2) Nakamura M, Yamada N, Ito M, et al. “Current management of venous thromboembolism in Japan: Current epidemiology and advances in anticoagulant therapy.” *Journal of Cardiology* 2015; 66(6): 451-459.
- 3) Kuroiwa M, Morimatsu H, Tsuzaki K, et al. “Changes in the incidence, case fatality rate, and characteristics of symptomatic perioperative pulmonary thromboembolism in Japan: Results of the 2002–2011 Japanese Society of Anesthesiologists. Perioperative Pulmonary Thromboembolism (JSA-PTE) Study.” *Journal of Anesthesia* 2015; 29(3): 433-441.
- 4) Gibson NS, Sohne M, Kruip MJ, et al. “Further validation and simplification of the Wells clinical decision rule in pulmonary embolism.” *Thrombosis and Haemostasis* 2008; 99(1): 229–234.
- 5) Yhim HY, Jang MJ, Bang SM, et al. “Incidence of venous thromboembolism following major surgery in Korea: from the Health Insurance Review and Assessment Service database.” *Journal of Thrombosis and Haemostasis* 2014; 12(7): 1035-1043.
<https://www.psp-jq.jcqh.or.jp/post/proposal/713> (Browsed on March 10, 2017)
- 6) 日本整形外科学会診療ガイドライン委員会 / 日本整形外科学会症候性静脈血栓塞栓症予防ガイドライン策定委員会（編）：『症候性静脈血栓塞栓症予防ガイドライン』2017. 南江堂
Japanese Orthopaedic Association Medical Practice Guideline Committee/Japanese Orthopaedic Association Symptomatic Venous Thromboembolism Prophylaxis Guideline Formulation Committee (ed.): *Symptomatic Venous Thromboembolism Prophylaxis Guidelines 2017*. Nankodo
- 7) CLOTS Trials Collaboration; Dennis M, Sandercock PAG, Reid J, et al. “Effectiveness of thigh-length graduated compression stockings to reduce the risk of deep vein thrombosis after stroke (CLOTS trial 1): a multicentre, randomised controlled trial.” *Lancet* 2009; 373(9679): 1958-1965.
- 8) Bang SM, Jang MJ, Kim KH, et al. “Korean Society of Thrombosis and Hemostasis: Prevention of venous thromboembolism, 2nd edition: Korean Society of Thrombosis and Hemostasis Evidence-based Clinical Practice Guidelines.” *Journal of Korean Medical Science* 2014; 29(2): 164- 171.
- 9) Guyatt GH, Akl EA, Crowther M, et al. “Executive summary: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines.” *Chest* 2012; 141(2 Suppl): 7S-47S.
- 10) Sakuma M, Nakamura M, Yamada N, et al. “Venous thromboembolism: deep vein thrombosis with pulmonary embolism, deep vein thrombosis alone, and pulmonary embolism alone.” *Circulation Journal* 2009; 73(2): 305-309.
- 11) 呂彩子、山則正、谷藤隆信、他：急性広範囲性肺血栓塞栓症の臨床経過と病理所見の対比『脈管学』2004；44(6)：241- 246。
Saiko Lyu, Norimasa Kageyama, Takanobu Tanifuji, et al. “Comparison of clinical course and pathological findings of acute massive pulmonary thromboembolism.” *Journal of Japanese College of Angiology* 2004; 44(6): 241-246.
- 12) Konstantinides SV, Torbicki A, Agnelli G, et al. “Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). 3.10.1 Suspected pulmonary embolism with shock or hypotension. 2014 ESC guidelines on the diagnosis and management of acute pulmonary embolism.” *European Heart Journal* 2014 Nov 14;35(43):

3044-45.

- 13) Corrigan D, Prucnal C, Kabrhel C, et al. "Pulmonary embolism: the diagnosis, risk-stratification, treatment and disposition of emergency department patients." *Clinical and Experimental Emergency Medicine* 2016; 3(3): 117-125.

7. Materials

Acute pulmonary thromboembolism (acute PTE) [Investigation items checklist]

Items		Viewpoints	Concrete items	
Basic information	Patient information	Clinical department		
		Name of illness or injuries		
		Previous disease		
		Oral medicine	<input type="checkbox"/> Present (Details: _____) <input type="checkbox"/> Absent	
		ADL before hospitalization	<input type="checkbox"/> Living on his/her own life <input type="checkbox"/> Gait to the bathroom and such <input type="checkbox"/> Bed rest	
		Degree of rest after the hospitalization		
		Purpose of hospitalization		
	Data information	Data at hospitalization	Age: _____ year-old, Gender: <input type="checkbox"/> Male <input type="checkbox"/> Female	
			<input type="checkbox"/> Height: _____ cm <input type="checkbox"/> Body weight: _____ kg	
			<input type="checkbox"/> BMI: _____	
<input type="checkbox"/> Blood pressure: _____ mmHg <input type="checkbox"/> Pulse: _____ /minute <input type="checkbox"/> Respiratory frequency: _____ /minute <input type="checkbox"/> SpO ₂ : _____ %				
		<input type="checkbox"/> Hemoglobin: _____ g/dL <input type="checkbox"/> Hematocrit: _____ % <input type="checkbox"/> Platelets: _____ × 10 ⁴ μL <input type="checkbox"/> PT-INR: _____ <input type="checkbox"/> APTT: _____ second <input type="checkbox"/> D dimer: _____ ng/mL <input type="checkbox"/> Other (_____)		
Cause of death	Autopsy, Ai	Ai	<input type="checkbox"/> Photographed <input type="checkbox"/> Not photographed	
		Autopsy	<input type="checkbox"/> Performed <input type="checkbox"/> Not performed	
	Other	Reason for definitive diagnosis	<input type="checkbox"/> Diagnosis by autopsy results <input type="checkbox"/> Diagnosis by a contrast-enhanced CT <input type="checkbox"/> From electrocardiogram and echocardiogram findings, etc. the possibility of PTE was determined to be extremely high <input type="checkbox"/> Other (_____)	
Explanation of PTE to the patients	Timings	Timings	<input type="checkbox"/> At hospitalization <input type="checkbox"/> Before surgery <input type="checkbox"/> After sudden change <input type="checkbox"/> Other (_____)	
	Explanation	Methods	<input type="checkbox"/> Explanation sheet <input type="checkbox"/> Verbal <input type="checkbox"/> Other (_____)	
		Details	<input type="checkbox"/> Symptom and risk <input type="checkbox"/> Preventive measures <input type="checkbox"/> Response when a symptom occurs <input type="checkbox"/> About prognosis <input type="checkbox"/> Other (_____)	
Risk assessment of PTE	Risk factors of PTE	Risk factors	<input type="checkbox"/> Prolonged bed rest <input type="checkbox"/> Obesity <input type="checkbox"/> General anesthesia <input type="checkbox"/> Leg paralysis <input type="checkbox"/> Cast immobilization <input type="checkbox"/> Fracture <input type="checkbox"/> Malignant tumor <input type="checkbox"/> Infectious disease <input type="checkbox"/> Prior venous thrombosis <input type="checkbox"/> Dehydration <input type="checkbox"/> Other (_____)	
			<input type="checkbox"/> Surgery	<input type="checkbox"/> Operative methods <input type="checkbox"/> Time required _____ hours _____ minutes <input type="checkbox"/> Body position
			<input type="checkbox"/> Drugs	<input type="checkbox"/> Birth control pills (Oral contraceptives) <input type="checkbox"/> Estrogen preparations <input type="checkbox"/> Psychotropic drugs <input type="checkbox"/> Other (_____)
			<input type="checkbox"/> Symptom of DVT	<input type="checkbox"/> Swelling of the entire lower extremities <input type="checkbox"/> Laterality of circumference of the lower extremities <input type="checkbox"/> Pain and redness of the femur, popliteal fossa, and calf along the deep veins of the lower extremities

Items		Viewpoints	Concrete items
	Risk assessment	Evaluation table	<input type="checkbox"/> Present <input type="checkbox"/> Absent
		Timings	<input type="checkbox"/> At hospitalization <input type="checkbox"/> Before surgery <input type="checkbox"/> Other ()
		Evaluator	<input type="checkbox"/> Physician <input type="checkbox"/> Nurse <input type="checkbox"/> Other ()
		Results	<input type="checkbox"/> Highest risk <input type="checkbox"/> High risk <input type="checkbox"/> Intermediate risk <input type="checkbox"/> Low risk <input type="checkbox"/> None
		Additional examinations after evaluation	<input type="checkbox"/> The echographical examination of the lower extremity veins <input type="checkbox"/> D-Dimer (blood test) <input type="checkbox"/> Contrast-enhanced CT <input type="checkbox"/> Other ()
Risk prevention and diagnosis and treatment of PTE	Preventive measures against PTE	Conducted/ Not conducted	<input type="checkbox"/> Conducted <input type="checkbox"/> Not conducted Reason for "Not conducted" ()
		Start timing	<input type="checkbox"/> At hospitalization <input type="checkbox"/> Before surgery <input type="checkbox"/> During surgery <input type="checkbox"/> After surgery <input type="checkbox"/> When the resting level changed to "Bed rest" <input type="checkbox"/> Other ()
		Details and treatment period	<input type="checkbox"/> Early ambulation (from ___ / ___, to ___ / ___) <input type="checkbox"/> Active exercise (plantar dorsal flexion exercise) (from ___ / ___, to ___ / ___) <input type="checkbox"/> Elastic stockings (from ___ / ___, to ___ / ___) <input type="checkbox"/> Intermittent pneumatic compression (from ___ / ___, to ___ / ___) <input type="checkbox"/> Pharmacological therapy (from ___ / ___, to ___ / ___) <input type="checkbox"/> Other ()
		Evaluation of implementation	<input type="checkbox"/> Present: Timing () <input type="checkbox"/> Absent
	Symptoms and findings by which PTE was suspected	The time when symptoms emerged	() days after hospitalization () days after injury)
		Situation when the symptoms emerged	Explain the specific situation Ex: Chest pain after the first ambulation on the third day after operation Decreased SpO ₂ during surgery on the second day of femoral neck fracture
		Symptoms	<input type="checkbox"/> Dyspnea <input type="checkbox"/> Chest pain <input type="checkbox"/> Chest discomfort <input type="checkbox"/> Palpitation <input type="checkbox"/> Cough <input type="checkbox"/> Bloody sputum <input type="checkbox"/> Loss of consciousness <input type="checkbox"/> Other ()
		Findings	<input type="checkbox"/> Decreased blood pressure <input type="checkbox"/> Decreased SpO ₂ <input type="checkbox"/> Shock <input type="checkbox"/> Tachycardia <input type="checkbox"/> Tachypnea
	Diagnosis of PTE	Blood data	<input type="checkbox"/> Arterial blood gas analysis <input type="checkbox"/> PT-INR: <input type="checkbox"/> APTT: <input type="checkbox"/> D dimer: ng/mL <input type="checkbox"/> BNP <input type="checkbox"/> Other ()
		Diagnostic imaging	<input type="checkbox"/> Contrast-enhanced CT <input type="checkbox"/> Echocardiography <input type="checkbox"/> Electrocardiogram <input type="checkbox"/> Pulmonary arteriography (DSA) <input type="checkbox"/> Other ()
Examination timing		<input type="checkbox"/> hours after occurrence of symptoms	
PTE treatment	Department that decided PTE treatment	<input type="checkbox"/> Relevant department <input type="checkbox"/> Cardiovascular medicine <input type="checkbox"/> Respiratory medicine <input type="checkbox"/> Emergency <input type="checkbox"/> Anesthesiology <input type="checkbox"/> Internal medicine <input type="checkbox"/> Other ()	
	Initial treatments	<input type="checkbox"/> Anticoagulant therapy <input type="checkbox"/> Fibrinolytic therapy <input type="checkbox"/> Other	
	The time from the emergence of the above symptom to the start of initial treatment	<input type="checkbox"/> () minutes/hours	

Items		Viewpoints	Concrete items	
		Treatment performed after the initial treatment	<input type="checkbox"/> Anticoagulant therapy <input type="checkbox"/> Thrombus crushing <input type="checkbox"/> Surgical thrombectomy <input type="checkbox"/> Inferior vena cava filter placement <input type="checkbox"/> Other ()	<input type="checkbox"/> Thrombolytic therapy <input type="checkbox"/> Thrombus aspiration
	Cooperation	Consulting timing	<input type="checkbox"/> When the risk was assessed <input type="checkbox"/> At the start of symptoms <input type="checkbox"/> After diagnosis	<input type="checkbox"/> None
Information on medical institution	In-hospital system	Response system in the event of a sudden change	<input type="checkbox"/> Present	<input type="checkbox"/> Absent
		Organization for PTE prevention (Response team and nominated persons)	<input type="checkbox"/> Present	<input type="checkbox"/> Absent
		Manual for PTE preventive therapy	<input type="checkbox"/> Present	<input type="checkbox"/> Absent
		In-hospital consultation system	<input type="checkbox"/> Present	<input type="checkbox"/> Absent
	Cooperation system	Out-hospital cooperation	<input type="checkbox"/> Present	<input type="checkbox"/> Absent

Members of the Expert Analysis Subcommittee for Acute Pulmonary Thromboembolism

Subcommittee chairman	Toru Sato	Japanese Circulation Society
Subcommittee member	Michiaki Itabashi	Japanese Society of Gastroenterological Surgery
	Ken Eguchi	Japan Psychiatric Hospitals Association
	Keiko Kinoshita	Japan Academy of Critical Care Nursing
	Masayuki Kuroiwa	Japanese Society of Anesthesiologists
	Nobuhiro Tanabe	Japanese Respiratory Society
	Shigeru Nakamura	Japanese Orthopaedic Association
	Makoto Mo	Japanese Society for Cardiovascular Surgery

Conflicts of interest

With regard to the contents of this report, Medical Accident Investigation and Support Center confirmed the status of conflicts of interest that was self-declared from the members of the Expert Analysis Subcommittee for Acute Pulmonary Thromboembolism.

Members of the Committee for Prevention of Recurrence

Chairman	Hisahiro Matsubara	Professor, Department of frontier surgery, Graduate school of medicine, Chiba University
Vice chairman	Shin Ushiro	Director/Professor, Medical Safety Management Division, Kyushu University Hospital
Committee member	Yumi Arai	Medical safety manager/Assistant chief nurse, Medical Quality/Safety Promotion Office, Kitasato University Hospital
	Sadaomi Imamura	Executive director, Japan Medical Association
	Michio Ueno	Vice president, Fukuoka Prefecture Medical Association
	Keiko Kasai	Managing director, Japanese Midwives Association
	Hamako Katsumata	Executive director, Japanese Nursing Association
	Yoshio Kato	Lawyer, Sakae Legal Affairs Office
	Ryutaro Kawano	Center director, Medical Simulation Center, Jichi Medical University
	Yasushi Kodama	Lawyer, Niiboshi Legal Affairs Office
	Emiko Kondo	Director, Office of Safety I, Pharmaceuticals and Medical Devices Agency
	Kazunori Sugai	Director, Medical Information Management Office, National Center for Global Health and Medicine
	Minoru Tada	Instructor, Department of Gastroenterology, The University of Tokyo Hospital
	Fumito Tsuchiya	Vice president, Japanese Society of Hospital Pharmacists
	Haruhiko Tsutsumi	Hospital director, Saitama Medical Center
	Hiroshi Matsuda	Hospital director, Kashiwazaki Welfare Hospital, Tachikawa Medical Center
	Hiroaki Mitsui	Managing director, Japan Dental Association
	Hiroaki Miyata	Professor, Department of Health Policy and Management, School of Medicine, Keio University
Makoto Yano	Deputy general manager, Healthcare Service Headquarters, Japanese Red Cross Society	
Ikuko Yamaguchi	President, NPO Sasaeai Center for Health Care and Human Rights COML	

Executives of the Japan Medical Safety Organization

Chair of the board	Fumimaro Takaku	Japan Medical Safety Research Organization
Senior Executive Director	Keiji Tanaka	Japan Medical Safety Research Organization
Executive Director	Sosuke Kimura	Japan Medical Safety Research Organization

Recommendations for the prevention of recurrence of medical accidents (Number 2)
Analysis of deaths related to acute pulmonary thromboembolism

Issued in August 2017

Edited and published by Japan Medical Safety Research Organization
World Trade Center Building (5th Floor),
2-4-1 Hamamatsucho, Minato-ku, Tokyo 105-6105 Japan
TEL: 03-5401-3021 (Main number)

Contact: Sosuke Kimura, MD.PhD.
Kimura.s@medsafe.or.jp

According to Article 6, paragraph 15 of the Medical Care Act, the Japan Medical Safety Research Organization was designated as the Medical Accident Investigation and Support Center, and is to perform the duties prescribed in each item of Article 6, paragraph 16 of the same Act (hereinafter referred to as “duties including investigations”).

The content to be published in this report were summarized based on the information reported in accordance with Article 6-paragraph 11 of the same Act. This information is based on the data obtained at the time of writing, and we do not guarantee the contents over the future. In addition, this report should be applied by those who use it with their free will, judgment and choice based on their individual responsibility. It does not restrict the discretion of healthcare professionals or impose duties or responsibilities on them.

It is forbidden to duplicate (or make photocopies of) all or part of this report without permission with the exceptions allowed under copyright law.

Preventive measures against pulmonary thromboembolism

What is pulmonary thromboembolism ?

(Economy class syndrome)

It is a disease in which pulmonary blood vessels are clogged with a thrombus (blood clot) and you suddenly feel difficulty in breathing, fast breathing, chest pain, and/or palpitations.

* This disease is also referred to as "Economy class syndrome" because it developed due to the deterioration of blood flow in the legs after a long flight.

How does
it happen?

If you do not move your legs on the bed after hospitalization, the blood flow in your legs will become worse, and a thrombus will be likely to occur. Then, the thrombus flows up to the lungs by some kind of triggers and the disease occurs.

What you can do to prevent pulmonary thromboembolism

Move your toes back and forth to the extent as far as possible.

Doing so allows your leg muscles to move, and blood circulation will be improved.

POINT!

*As for moving your toes, you should do it with the permission of your physician.



What should I do if it occurs?

If you notice any of the unusual symptoms below, tell them to your physician or nurses.

- Difficulty in breathing [Dyspnea, Tachypnea]
- Chest pain
- Palpitation (fast beating) [Tachycardia]
- Leg pain

Name of the medical institution: