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ORIGINAL ARTICLE

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

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Abstract
Purpose This study aimed to examine the incidence, case fatality rate, and characteristics of perioperative symptomatic pulmonary thromboembolism (PS-PTE) throughout Japan.
Methods From 2002 to 2011, confidential questionnaires were mailed annually to all Japanese Society of Anesthesiologists-certified training hospitals for data collection to determine the incidence and case fatality rate of PS-PTE patients. Data from 10,537 institutions in which a total of 11,786,489 surgeries had been performed were analyzed using the Mann–Whitney and Chi-square tests.
Results In total, 3,667 PS-PTE cases were identified. The average incidence of PS-PTE was 3.1 (2.2–4.8) per 10,000 surgeries, and the average case fatality rate was 17.9 % (12.9–28.8 %). The incidence of PS-PTE began to significantly decrease in 2004 compared with that of 2002 (0.0036 vs. 0.0044 %: $p < 0.01$). The case fatality rate temporarily increased toward 2005 (17.9 to 28.8 %); however, it gradually decreased since 2008 (15.7 %) and was the lowest (12.9 %) in 2011. Regarding the trends in prophylaxis, the rate of mechanical prophylaxis increased significantly in 2003 compared with that of 2002 (59.5 vs. 35.0 %: $p < 0.01$), and almost plateaued (73.1–83.1 %) after 2004. Furthermore, the rate of pharmacological prophylaxis started increasing in 2008 (17.6 %) and reached around 30 % after 2009 (28.8–30.2 %).
Conclusions The results of our 10-year survey study show that the incidence of PS-PTE decreased significantly since 2004, and the case fatality rate seemed to show a downward trend since 2008. Major changes in the distribution of prophylaxis in PS-PTE patients were observed.

Keywords Perioperative · Pulmonary thromboembolism · Incidence · Case fatality rate · Prevention

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Introduction

Venous thromboembolism (VTE), which includes pulmonary thromboembolism (PTE) and deep vein thrombosis, is recognized as a serious perioperative complication and is one of the main causes of in-hospital death. In fact, approximately 10 % of all in-hospital deaths are attributed to PTE, and autopsy studies have suggested that deaths occurring within 30 days of surgery may be related to acute PTE [1, 2].

The Japanese Society of Anesthesiologists (JSA) has seriously considered the issue of VTE, especially PS-PTE as well as anesthesia-related complications. Consequently, since 2002, annual surveys on PS-PTE were conducted in Japan (a) to determine the incidence, case fatality rate, and case characteristics (age, sex, body mass index, surgical site, having risk factors, etc.); (b) to disclose the annual situation of PS-PTE; and (c) to detect any changes in the results of the survey [3–7].

Several studies have investigated the incidence of VTE or PTE in patients who have undergone surgery at specific sites such as the knee, hip, abdomen, or spine [8]. However, to our knowledge, no study has compared the incidence of VTE or PTE at all these surgery sites collectively during this study period. Here, we report the results of JSA-PTE Research from 2002 through 2011 and changes in PS-PTE incidence, case fatality rate, and trends in prevention methods. We also compare differences in the PS-PTE incidence of subgroups according to age, sex, and surgical site.

Methods

Data collection

After obtaining approval from the Safety Committee and Board of Directors of the JSA, the JSA-PTE Study was carried out between January 1, 2002, and December 31, 2011. Confidential questionnaires were annually mailed to all JSA-certified training hospitals. The questionnaire included the following: total number of surgeries managed by an anesthesiologist (including monitored anesthetic care); details of PS-PTE cases such as age, gender, body mass index, surgical site, major risk factors (with or without long rest, malignancy, trauma, past or current history of VTE, etc.), and type of prophylaxis carried out; and within 30-day outcome after PS-PTE onset. Any data revealing personal identification were not included to maintain confidentiality.

Definition of PS-PTE

In this study, cases of PS-PTE were registered according to the following diagnostic criteria: (1) evidence of PTE determined by enhanced computed tomography, pulmonary angiography, pulmonary perfusion scintigraphy and/or pulmonary ventilation scintigraphy, magnetic resonance imaging, echocardiogram, or autopsy; (2) suspicion due to symptoms such as cold sweat, agitation, chest pain, dyspnea, shock, and cardiopulmonary arrest; and (3) strong suspicion of PTE by the clinician during the perioperative period. However, according to the study design, the collection of data depended on the anesthesiologists, since they were responsible for administering the questionnaire. Moreover, we did not strictly define the perioperative period. Customarily, in Japan, “perioperative” is the period spanning from when the patient is admitted to the hospital for surgery to when the patient is discharged, and the follow-up period after discharge is probably not included.

Definition of thromboprophylaxis

In this study, mechanical prophylaxis was defined as the use of intermittent pneumatic compression devices and/or elastic stockings. Pharmacological prophylaxis was defined as the use of anticoagulant drugs that have already been shown to have an effect in VTE, such as non-fractionated heparin, low molecular weight heparin, anti-Xa agents, vitamin K inhibitors, and anti-thrombin agents, except aspirin. The use of inferior vena cava filters included either permanent or temporary filters.

The period of prevention was not specifically defined. We asked the respondents which prevention method was implemented at any time in the perioperative period.

Calculation of incidence per subgroup

The incidence of PS-PTE according to individual characteristics was determined by dividing the patients into subgroups based on age, sex, and surgical site. At first, the estimated number of surgeries of each condition were calculated as total number of surgeries in each year (the uppermost column in Appendix B) $\times$ the percentage of surgeries in each condition (data partially obtained from another study: Appendix A [9]). Next, the total estimated number of surgeries in each subgroup was calculated as the sum of the estimated number of surgeries from 2002 to 2011. Finally, the incidence of PS-PTE in each condition was calculated as follows: Total number of PS-PTE/total number of estimated surgeries $\times$ 100. For example, the incidence of PS-PTE in the abdomen was calculated as follows: total number of PS-PTE cases in the abdomen/(estimated number of surgeries in 2002 + estimated number of surgeries in 2003 …estimated number of surgeries in 2011) = 1,319/[(837,540 $\times$ 29.4 %) + (925,260 $\times$ 29.1 %) + (1,449,517 $\times$ 29.9 %)] = 1,319/3,526,578 = 0.00038.

Statistical analysis

Analyses were performed using SPSS 17.0 (SPSS Inc., Chicago, IL, USA). All continuous variables were analyzed by the Mann–Whitney test and Chi-square test. A p value of less than 0.05 was considered statistically

Table 1 Incidence and mortality of perioperative symptomatic pulmonary thromboembolism

Year	Sent		Response (%)	No. of PS-PTE patients	No. of surgery	Incidence of PS-PTE*	No. of deaths	Case fatality rate (%)	Incidence of fatal PS-PTE*
2002	844	467	(55)	369	837,540	4.4	66	17.9	0.8
2003	844	504	(60)	440	925,260	4.8	83	18.9	0.9
2004	960	642	(67)	409	1,131,154	3.6	89	21.8	0.8
2005	1,060	556	(52)	257	922,453	2.8	74	28.8	0.8
2006	1,065	573	(54)	272	1,209,135	2.2	53	19.5	0.4
2007	1,092	643	(59)	296	1,150,783	2.6	58	19.6	0.5
2008	1,116	634	(57)	324	1,177,626	2.8	51	15.7	0.4
2009	1,155	815	(71)	427	1,422,034	3.0	64	15.0	0.5
2010	1,184	864	(73)	432	1,560,987	2.8	62	14.4	0.4
2011	1,217	832	(68)	441	1,449,517	3.0	57	12.9	0.4
Total	10,537	6,530	(62)	3,667	11,786,489	3.1	657	17.9	0.6

* Per 10,000 cases

PS-PTE perioperative symptomatic pulmonary thromboembolism

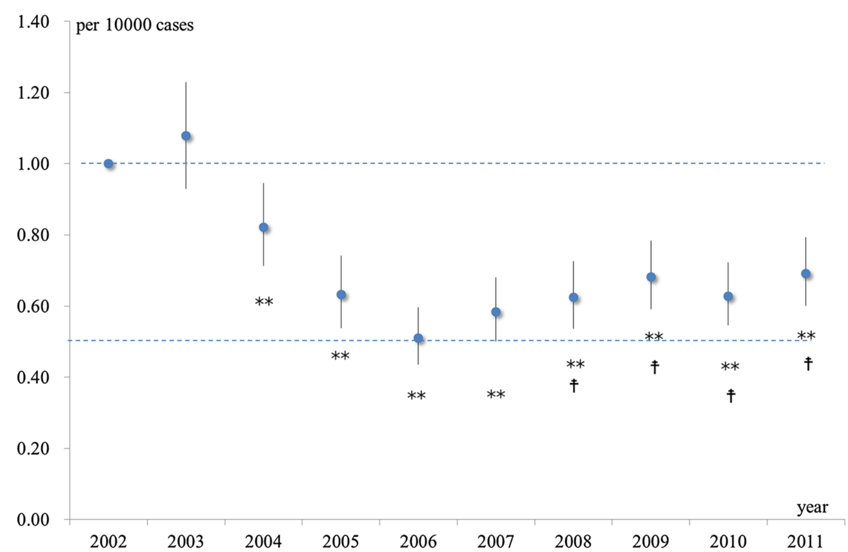

Fig. 1 Relative risk of incidence of perioperative symptomatic pulmonary thromboembolism based on the 2002 incidence. The *error bars* show the 95 % confidential interval. $^{**}p < 0.01$ vs. 2002, $^{\dagger}p < 0.01$ vs. 2006

significant. Changes in incidence and case fatality rate per year are presented as estimated relative risk with the corresponding 95 % confidence intervals (CI), and the results of the comparison of incidences according to different demographic and clinical parameters are presented as estimated relative risk with the corresponding 95 % CI.

Results

Questionnaires were mailed to a total of 10,537 institutions, and responses were obtained from 6,530 institutions (62 % response rate). A total of 11,786,489 surgery cases were managed by an anesthesiologist, and PS-PTE was observed in 3,667 cases (incidence rate, 3.1 per 10,000 surgeries). Among these cases, the total number of deaths was 657 (17.9 %), and the incidence of fatal PS-PTE was 0.6 per 10,000 cases (Table 1).

A significant reduction (vs. 2002) in the incidence of PS-PTE was observed in 2004 (0.036 %, $p < 0.01$), and further reduction was observed in 2005 (0.022–0.31 %) compared with that of 2004 ($p < 0.01$). The lowest incidence was observed in 2006 (0.022 %). Nevertheless, the incidence slightly increased after 2008 compared with that of 2006 ($p < 0.01$) (Fig. 1).

The case fatality rate increased significantly in 2005 compared with that in 2002 ($p < 0.01$). Then, it began to decrease slightly in 2008 and dropped in 2011; however, there was no statistically significant difference between the case fatality rate in 2002 and 2011 ($p = 0.050$) (Fig. 2).

Fig. 2 Relative risk of case fatality rate of perioperative symptomatic pulmonary thromboembolism based on the 2002 incidence. The *error bars* show the 95 % confidential interval. $^{**}p < 0.01$ vs. 2002, $^{\#}p = 0.050$ vs. 2002

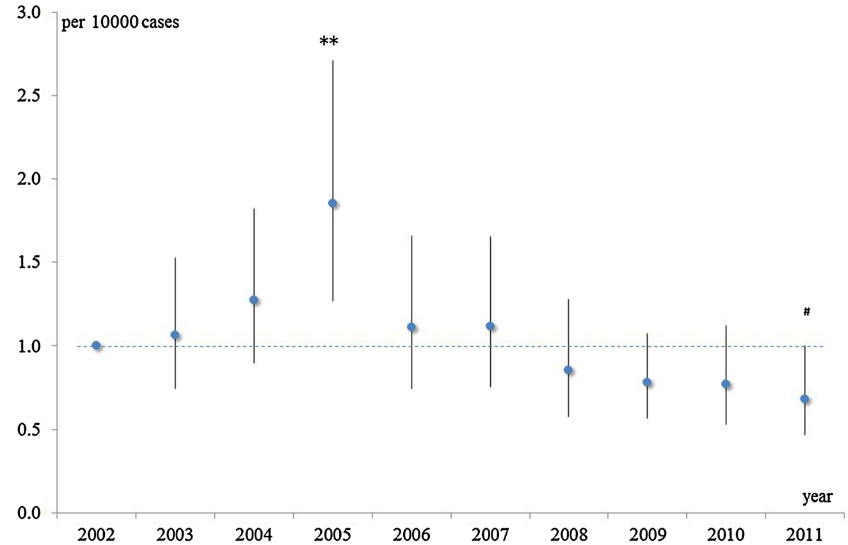

Table 2 Incidence of perioperative symptomatic pulmonary thromboembolism in each condition

	Total no. of cases	Estimated no. of surgeries	Incidence[a]	Relative risk (95 % CI)[b]
Age (years)				
0-5	4	641,700	0.1	0.0 (0.0–0.1)
6-18	24	749,763	0.3	0.1 (0.1–0.2)
19-65	1,514	6,108,562	2.5	1.0
66-85	1,924	3,939,037	4.9	2.0 (1.9–2.1)
86-	218	347,427	6.3	2.5 (2.2–2.9)
Sex[c]				
Male	940	4,912,668	1.9	1.0
Female	1,934	5,111,021	3.8	2.0 (1.9–2.1)
Surgical site				
Head, pharynx, larynx	86	412,383	0.5	1.0
Chest/abdominal wall/perineum	154	410,359	0.9	1.7 (1.4–2.0)
Heart and/or major vascular	78	274,437	2.0	4.0 (3.2–5.0)
Cesarean section	93	63,665	2.2	4.3 (3.5–5.3)
Thorax	129	3,526,578	3.1	6.2 (5.2–7.4)
Abdomen	1,319	421,785	3.7	7.4 (7.0–7.8)
Brain	182	1,696,347	4.4	8.7 (7.5–10.1)
Thorax and abdomen	37	1,801,146	5.8	11.5 (8.3–15.8)
Spine	305	499,289	6.1	12.0 (10.8–13.5)
Hip, upper/lower limbs	1,359	2,261,899	6.0	11.9 (11.2–12.5)

[a] Incidence was estimated for patients per 10,000 surgeries

[b] Each relative risk was estimated based on the 19–65 years age subgroup, male sex subgroup, and head/pharynx/larynx surgical site subgroup. *CI* confidence interval

[c] Incidence of male/female were calculated without data of 2002 and 2003 because data were not available (see Appendix B)

The estimated incidence of PS-PTE increased with age. The incidence of PS-PTE in the group aged 66–85 years was almost twice as high as that of the group aged 19–65 years. In addition, the PS-PTE incidence of the group aged ≥ 86 years was almost 2.5 times higher than that of the group aged 19–65 years (Table 2). The incidence of PS-PTE in women was twice as high as that in men (Table 2). According to the surgery site, the incidence of PS-PTE was

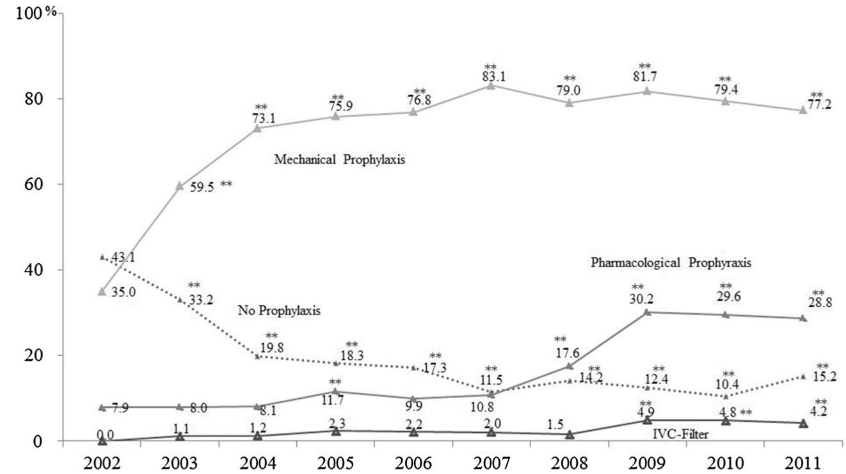

Fig. 3 Changes in the incidence of types of prevention methods implemented in perioperative symptomatic pulmonary thromboembolism patients

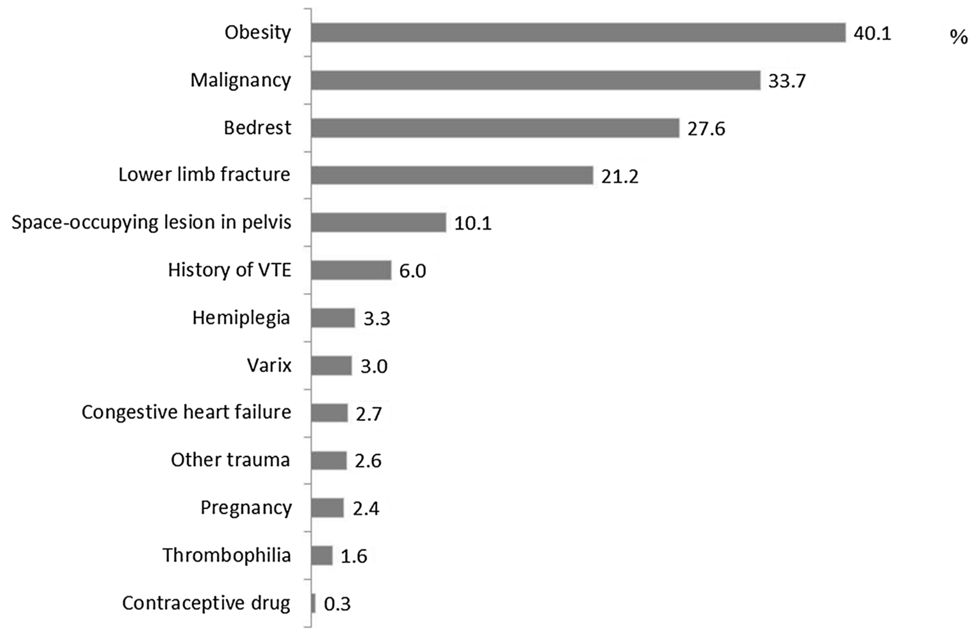

Fig. 4 Risk factors for perioperative symptomatic pulmonary thromboembolism except for age

highest in surgeries involving the spine, hip, and upper/lower limbs, and successively decreased in thoracic and abdominal (combined), brain, and abdominal surgeries (Table 2).

Although the rate of "no prevention" in patients with PS-PTE was highest immediately after starting the investigation period, it subsequently decreased (43.1 % in 2002 vs. 33.2 % in 2003: $p < 0.01$). On the other hand, the rate of mechanical prophylaxis in patients with PS-PTE started out low and then increased, exceeding 70 % in 2004 (59.5 % in 2003, 73.1 % in 2004: $p < 0.01$ vs. 2002). The rate of pharmacological prophylaxis did not change much from 2002 to 2007; however, it began increasing significantly in 2008 (17.6 %: $p < 0.01$) compared with that of 2002 and was maintained just above or below 30 % from 2009 to 2011 (Fig. 3).

Risk factors for PS-PTE (percentages), except age, are shown in Fig. 4. Obesity (40.1 %), malignancy (33.7 %), bed rest (27.6 %), and lower limb fracture (21.2 %) were frequently noted in PS-PTE cases.

Discussion

The results of this study of changes in PS-PTE incidence, case fatality rate, and prevention methods between 2002 and 2011 allowed for identification of several factors that may account for the changes observed over the years. The results of the 10-year survey showed several characteristics that may be related to the changes in the incidence and case fatality rate of PS-PTE. The incidence of PS-PTE over time has significantly decreased since 2004 and remained low until 2011. There are two possible reasons for this. First, in Japan, the primary domestic guideline of prevention of venous thromboembolism was published by agreement with ten major medical societies, including the JSA in 2004 [10]. Second, the department of national health care (the Ministry of Health, Labor and Welfare) coincidentally agreed to support the payment of the management fee to health care institutions for the prevention of VTE if they used elastic stockings and/or mechanical prophylaxis. Hence, the reduction in the incidence of PS-PTE may be due to increasing measures of thromboprophylaxis in hospitals in Japan. In fact, in 2003, the rate of mechanical prophylaxis began to increase, and reached a plateau after 2004, and the rate of implementing no prevention measures showed the reverse trend. In accordance with this finding, Haut et al. suggested that improvements in compliance with prophylaxis guidelines have led to a significant decrease in the incidence of PS-PTE [11]. However, our results regarding the distribution of prophylaxes were derived from data on PS-PTE cases only, and did not include overall perioperative patients; the same tendency was not always observed in overall perioperative patients. In addition, our study could not analyze the direct relationship between the incidence and the application of preventive manners. In the future, sub-analysis of these factors from the data of our 10-year study should be performed.

On the other hand, the current incidence of PS-PTE is slightly greater than that of 2006. According to their 10-year analysis, Shackford et al. [12] showed that the incidence of perioperative VTE increased even with a high rate of compliance with the American College of Chest Physicians (ACCP) guidelines. They suggested that the increased rate was due to a more aggressive diagnostic approach to symptomatic patients that is facilitated by the low risk and high sensitivity of rapid computed tomography scanning for the diagnosis of PTE. Additionally, the proportion of high-risk patients with advanced age and the comorbidity burden of patients undergoing elective surgeries had increased.

The decrease in the case fatality rate of PS-PTE began in 2008 and became nearly significant in 2011 ($p = 0.05$), as compared to that in 2002. This could have been due to the increasing rate of anticoagulant prophylaxis, which started increasing in 2008. In fact, the ninth edition of the ACCP guidelines reports that case fatality rate decreases with anticoagulant use [8]. Because the domestic guideline recommended mechanical prophylaxis, unlike the ACCP or International Union of Angiology (IUA) [13], the rate of pharmacological prophylaxis did not vary until 2008. The main reason for the increase in the rate of pharmacological prophylaxis in Japan is that new drugs such as fondaparinux (2008), enoxaparin (2009), and edoxaban (2011) were approved for perioperative use in the prevention of VTE. Therefore, according to our results, the increase in pharmacological prophylaxis did not influence the incidence of PS-PTE, but it may have decreased the case fatality rate. On the other hand, the increase in the rate of pharmacological prophylaxis among patients who developed PS-PTE suggests that the number of PS-PTE cases is increasing in spite of the actions taken for pharmacological prophylaxis. In addition, another potential factor reducing the case fatality rate of PS-PTE is the reduction of bed rest. Shoda et al. mentioned that surgery after 5 or more days post-trauma is one of the factors contributing to in-hospital case fatality rate, after investigating the prognosis of 80,800 patients with hip fractures (odds ratio 1.34, 95 % CI 1.2–1.5) [14]. However, our study did not clarify whether reducing bed rest improved prognosis. Therefore, it is necessary to sub-analyze the factors that may have contributed to the case fatality rate in our study.

One of the features of our survey was that the methodology remained consistent throughout the annual investigation; therefore, we detected changes in annual incidence and case fatality rate. Another feature was comparison of PTE incidence of the entire surgical site with the same condition. As no previous study had reported differences in the incidence of PS-PTE compared to the entire surgical site at the same time, this comparison filled an important research gap. Accordingly, a high frequency of VTE cases was observed in orthopedic (hip, upper/lower limbs), neurological (spine, brain), and thorax and abdominal surgery (mostly, esophagus cancer surgery). Gangireddy et al. reported that total hip arthroplasty, colectomy, and lobe/pneumonectomy were related to a high frequency of VTE, compared with carotid endarterectomy [15]. However, unlike our results, they reported a high risk of VTE with abdominal aortic aneurysm surgery and lower extremity bypass surgery. The reason for the differences in these results may be that their survey was conducted in Veteran hospitals, and there were diagnostic (PTE or VTE), ethnical, and timing (1996–2002) differences. The high incidence of PS-PTE among patients who underwent thoracic and abdominal surgery, which is mainly performed in cases of esophagus cancer, was comparable to that of other malignancy surgeries involving the abdomen, thorax, and neck. De Martino et al. investigated 43,808 cancerous postoperative patients using data from the National Surgical Quality Improvement Program; the highest frequency of VTE was observed in patients who underwent esophagectomy [16]. They also found a high incidence of VTE in cystectomy and pancreatectomy cases. In an investigation of VTE incidence among

40,787,000 patients hospitalized for malignancies, Stein et al. found the highest incidence in patients with malignancies of the stomach, uterus, and pancreas [17]. An important difference between the studies conducted by De Martino et al. and Gangireddy et al. was the use of surgical procedures, as the surgical intervention required for the treatment of some cancers, such as esophageal cancer, may increase the risk of VTE [15, 16].

In the ACCP guideline, the aged-related risk is differentiated into three categories: <40 years, 40–60 years, and >60 years. However, in the present study, we used categories that were different from those used in the ACCP guidelines [8]. In the elderly aged ≥86 years, the incidence of PS-PTE was almost 2.5 times higher than that of patients aged 19–65 years. Using the database of the Quality Indicator/Improvement Project of the Japanese, Kunisawa et al. showed a similar incidence of PS-PTE to that found in our study (40–64 years of age, 0.04 %; 65–84 years of age, 0.06–0.07 %; and ≥85 years of age, 0.11 %) [18]. Increasing age is an evident risk factor for PS-PTE, and the risk increases considerably after 85 years of age.

Our study clearly showed a difference in PS-PTE incidence according to sex. However, a higher incidence of PS-PTE in women than in men has not been reported in Western studies. Moreover, major guidelines such as the ACCP, IUA, and National Institute for Health and Care Excellence guidelines do not specify a difference in PS-PTE risk according to sex [8, 13, 19]. Some studies on VTE in Japan have suggested differences in the risk factor according to sex. Kunisawa et al. reported a higher incidence of PS-PTE in women than that in men (0.07 vs. 0.04 %) [18]. In addition, Yamada et al. reported that the odds ratio of PTE in women was 2.4 (95 % CI 1.5–4.0), and Sakon et al. showed that VTE risk was significantly higher in women than in men (3.17 times higher) [20, 21]. Yu et al. reported a high risk of PS-PTE in women in Chinese Taipei; however, Yang et al. did not find any sex-related differences in patients undergoing colectomy in South Korea [22, 23]. Moreover, Asian VTE guidelines for prevention mention that there are no sex-related differences in risk and that further studies are needed to confirm this [24].

PS-PTE occurs in approximately 0.3–4.2 % of abdominal surgeries and in 0.7–30 % of orthopedic surgeries [25]. The incidence of PS-PTE according to our survey was generally low as compared with recent studies, for several reasons. First, current reports showed that the incidence of symptomatic PTE is much lower than that of asymptomatic PTE. Spyropoulos et al. showed that the incidence of symptomatic PTE after orthopedic and abdominal surgery was 1.1 and 0.8 %, respectively. McNamara et al. reported that the incidence of symptomatic PTE with thromboprophylaxis, following hip fracture, was 0.7 % [26, 27]. In addition, Milbrink et al. recently reported a much lower incidence of symptomatic PTE, approximately 0.25 %, in patients receiving thromboprophylaxis following hip fracture surgery [28]. Second, the incidence of thrombotic disease varies among human races. There are reports that the PTE incidence in African Americans or Caucasians is 5–6 times higher than that in Asians [29] and the VTE risk is five times higher in Caucasians than in Asians [30]. Genetic differences have also been suggested. The Factor V Leiden genetic variation and G20210A gene abnormality have not been recognized in Japanese subjects, but have been found in Europeans and Americans with VTE. Therefore, the incidence and the characteristics of PS-PTE patients in Japan are not the same as those found in Western countries.

Some of the limitations of our study include the use of methodology involving a questionnaire, since the answers depended on the responder's motivation. In addition, there is the possibility that some PS-PTE cases were not detected and recorded. There was not enough evidence of the absolute value of estimated incidence in our study compared to clinically detailed investigations. Finally, our survey was retrospective in nature, making it susceptible to selection bias.

Conclusions

The results of this study suggest that the reduction in PS-PTE incidence and case fatality rate that occurred between 2002 through 2011 may be related to the increasing administration of thromboprophylaxis in hospitals, indicating its importance in improving outcomes. Variations in incidence according to age, sex, and surgical site were also identified, with a higher incidence found in older patients, female patients, and patients who had undergone orthopedic surgery of the hip or of the upper or lower limbs. According to the results, neurosurgery should be considered a high-risk surgery in addition to orthopedic surgery and abdominal surgery, which are suggested as high-risk surgeries in clinical practice guidelines. Preventive measures should be implemented in women and the elderly because of the high incidence of PS-PTE in these populations; however, regarding other risk factors, it is necessary to consider future matched-control studies. It appears that the case fatality rate was reduced after anti-coagulants became popular; however, in order to aggressively recommend anti-coagulation therapy for mortality reduction, in the future, it is necessary to perform the sub-analysis of factors that affect outcomes such as the case fatality rate.

Appendix A: The percentage of surgeries in each condition

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Age (years)											
0-5	6.2	6.1	6.0	6.0	6.0	6.0	5.2	4.8	4.8	4.5	5.5
6-18	7.0	6.8	6.6	6.6	6.6	6.6	6.1	6.0	5.9	6.0	6.4
19-65	54.7	53.8	53.4	53.4	53.4	53.4	50.7	50.0	49.5	49.5	52.2
66-85	29.8	30.9	31.5	31.5	31.5	31.5	34.9	35.9	36.2	36.4	33.0
86-	2.3	2.4	2.6	2.6	2.6	2.6	3.1	3.3	3.6	3.7	2.9
Sex											
Male	No data	no data	49.6	49.6	49.6	49.6	48.5	48.8	48.5	48.5	49.1
Female	No data	no data	50.4	50.4	50.4	50.4	51.5	51.2	51.5	51.5	50.9
Surgical site											
Brain	3.8	3.7	3.6	3.6	3.6	3.6	3.3	3.2	3.3	3.6	3.5
Thorax	3.5	3.6	3.5	3.5	3.5	3.5	3.3	3.4	3.5	3.4	3.5
Heart and/or major vascular	3.4	3.4	3.3	3.3	3.3	3.3	3.1	3.0	3.2	3.4	3.3
Thorax and abdomen	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.4	0.5	0.5	0.6
Abdomen	29.4	29.1	30.1	30.1	30.1	30.1	29.2	29.1	28.7	33.0	29.9
Cesarean section	3.5	3.5	3.5	3.5	3.5	3.5	3.7	3.7	3.6	3.6	3.6
Head, pharynx,larynx	15.2	15.0	14.9	14.9	14.9	14.9	14.2	14.0	13.9	13.0	14.5
Chest/abdominal wall/perineum	15.6	16.3	15.7	15.7	15.7	15.7	15.5	15.8	15.6	12.0	15.4
Spine	3.6	3.7	3.7	3.7	3.7	3.7	4.6	4.8	5.0	4.9	4.1
Hip, upper/lower limbs	18.0	18.0	18.5	18.5	18.5	18.5	19.6	20.2	20.1	20.3	19.0

The data were collected from a nationwide survey of anesthesia-related mortality and morbidity in Japan conducted annually between 2002 and 2011 by the Japanese Society of Anesthesiologists, and have been published partially [9]

Appendix B: The estimated number of surgeries in each condition

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
Total number of surgeries	837,540	925,260	1,131,154	922,453	1,209,135	1,150,783	1,177,626	1,422,034w	1,560,987	1,449,517	11,786,489	1,178,649
Age (years)												
0-5	51,901	56,176	67,499	55,046	72,153	68,671	61,452	68,288	75,167	65,347	641,700	64,170
6-18	58,295	63,070	74,935	61,109	80,101	76,236	71,816	85,517	91,812	86,873	749,763	74,976
19-65	458,487	497,691	603,742	492,350	645,363	614,219	596,468	710,718	772,573	716,952	6,108,562	610,856
66-85	249,985	285,994	355,925	290,256	380,462	362,101	411,266	510,675	565,447	526,928	3,939,037	393,904
86-	18,873	22,329	29,053	23,693	31,056	29,557	36,625	46,836	55,988	53,417	347,427	34,743
Male	N/A	N/A	560,509	457,094	599,150	570,236	571,676	694,260	756,960	702,783	4,912,668	614,084
Female	N/A	N/A	570,645	465,359	609,985	580,547	605,950	727,774	804,027	746,734	5,111,021	638,878
Surgical site												
Brain	31,831	34,439	40,519	33,043	43,312	41,222	38,776	46,185	51,308	51,748	412,383	41,238
Thorax	29,417	33,613	39,788	32,447	42,531	40,479	39,303	48,112	55,360	49,308	410,359	41,036
Heart and/or major vascular	28,483	31,060	37,443	30,535	40,024	38,093	37,091	42,318	50,176	49,702	384,924	38,492
Thorax and abdomen	5,373	5,594	6,732	5,490	7,196	6,849	5,786	6,176	7,659	6,811	63,665	6,367
Abdomen	246,621	269,105	340,032	277,295	363,474	345,933	344,175	413,200	448,640	478,104	3,526,578	352,658
Cesarean section	29,426	32,784	39,862	32,507	42,610	40,553	44,140	52,489	55,447	51,967	421,785	42,178
Head, pharynx, larynx	127,209	138,648	168,741	137,608	180,374	171,669	167,179	198,841	217,726	188,351	1,696,347	169,635
Chest/abdominal wall/perineum	130,924	150,695	177,753	144,957	190,008	180,838	182,888	224,855	244,127	174,100	1,801,146	180,115
Spine	30,312	34,199	41,755	34,051	44,633	42,479	54,676	68,396	77,778	71,009	499,289	49,929
Hip, upper/lower limbs	150,541	166,723	209,660	170,977	224,114	213,299	231,085	286,974	314,499	294,028	2,261,899	226,190

These data were calculated by multiplying the percentage of each condition (Appendix A) and the total number of surgeries each year

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