Multidisciplinary Cancer Investigation Original Article

January 2022, Volume 6, Issue 1

Incidental Pulmonary Embolism in Cancer Patients: A Single-Institution Analysis in Panama

Jorge Sinclair De Frías[1,*], Moisés Cukier[1,2], Lorenzo Olivero[1], Daniella Vázquez[1], Héctor Tapia[3]

[1] Faculty of Medicine, University of Panama, Panama City, Panama
[2] Department of Surgical Oncology, National Institute of Oncology, Panama City, Panama
[3] Department of Radiology, National Institute of Oncology, Panama City, Panama
**Corresponding author: Jorge Sinclair De Frías, Ciudad University, Estafeta University, Apartado 3366, Panama 4, Panama. Tel: +50769972006; Fax: +5072600494. E-mail: jorge-sinclair@outlook.com*

DOI: 10.30699/mci.6.1.559-1

Submitted: 11 August 2021
Revised: 18 January 2022
Accepted: 13 February 2022
e-Published: 16 March 2022

Keywords:
Venous Thromboembolism
Multidetector Computed Tomography
Medical Oncology
Anticoagulants

Introduction: Incidental pulmonary embolisms (iPE) are common in cancer patients. Studies addressing iPE in oncology are increasing; however, few of these investigations have been conducted in a Latin-American population. This study aims to describe the incidence and characteristics of iPE in cancer patients in a comprehensive cancer center from Panama.

Methods: A single-center, retrospective study was conducted at the National Institute of Oncology during a period of 7 months. Every contrast-enhanced CT scan was reviewed. Electronic records and CT reports were reviewed for demographic, clinical, and radiological information.

Results: We reported 46 iPEs in 4065 scans (incidence=1.13%). The mean±SD age was 6413± years. Most patients were female (63.0%) and were outpatients (73.9%) when the CT scan was performed. Central iPEs were found in thirty-one patients (67.4%). Thirty patients were receiving chemotherapy (54.3%) or hormone therapy (10.9%); two-thirds had metastatic disease. The most frequently reported tumors were gastrointestinal, breast, and gynecologic cancers. More than 70% were reported as asymptomatic, and 78% were initially managed with anticoagulation.

Conclusions: Our study reported a low incidence of iPE in oncologic patients (1.13%) which is consistent with what has been observed in previous studies (0.34%-7.3%). The true incidence is still uncertain, and it might be underestimated; especially the rate of subsegmental embolism.

INTRODUCTION

Incidental pulmonary embolism (iPE) is defined as a filling defect in the pulmonary artery detected on an imaging study performed for purposes other than ruling out PE. The diagnosis of iPE is more common in cancer patients than in the general population [1]. Cancer itself and its treatment are considered major risk factors for thromboembolic events, including iPE [14-]. Moreover, oncologic patients often undergo multiple routine staging and re-staging computed tomography (CT) examinations [5], thereby, increasing the probability of incidental detection of PE. When performing routine CT scans, detection of PE is lower than with computed tomography pulmonary angiography (CTPA), due to poorer contrast of the pulmonary arteries. However, with the introduction of modern multi-

detector computed tomography (MDCT) scanners, obtained contrast is sufficient for diagnosis of PE in most cases, even in peripheral pulmonary arteries [6]. With the introduction of MDCT machines along with the increasing use of routine chest CTs in oncologic and non-oncologic patients, the incidence of iPE has drastically increased in recent years [7]. The presence of PE is associated with the worst outcomes and higher mortality rates in cancer patients [8]. Venous thromboembolism is considered an independent prognostic factor of mortality in oncologic patients. Recent studies have shown that iPE has similar rates of complications and mortality compared to suspected PE [8]. Despite its clinical relevance, therapeutic guidelines are not well established. Currently, due to the lack of evidence, patients with iPE receive the same initial and long-term treatment as patients with suspected PE [9, 10]. The current standard of care for both incidental and suspected PE is anticoagulation therapy. Literature addressing iPE in oncologic patients has recently increased; however, few of these studies were conducted in Latin-American countries [11, 12]. Therefore, this study aims to describe the incidence rate and clinical and radiological characteristics of iPE in cancer patients in a comprehensive cancer center in Panama.

METHODS

A single-center, descriptive cross-sectional study was conducted at the National Institute of Oncology from January 2019 to July 2019. The study protocol was approved by the institute's ethics committee. We searched the electronic database (Picture archiving communication system) of the radiology department for CT scans performed on oncology patients during the study period. CT scans were performed; using two MDCT systems (GE light speed VCT 64 slice scanner, and Toshiba Aquilion Prime 80 slice scanner). Contrast-enhanced CT scans that included the chest evaluation were identified. CT scans with no intravenous contrast, incomplete CT scans of the thorax, and/or scans performed to rule out a suspected PE were excluded. Initial CT reports were reviewed for identification of PE. Consecutive cancer patients, older than 18 years old with a newly detected iPE were included. iPE was defined as a filling defect in one or more pulmonary arteries in a contrast-enhanced chest CT performed for reasons other than ruling out PE. Indications for CT scans included: initial or follow-up staging workup, monitoring of therapeutic response, and surveillance of metastasis. Follow-up examinations in patients with known PE and examinations with second PE event were excluded; ensuring that a maximum of one PE event per patient remained in the study. this was performed as follow-up examinations must not influence the calculated incidence of iPE. Patients with prior history of venous thromboembolism, primary thrombophilia, or missing information were also excluded. Medical electronic charts were comprehensively reviewed by two primary investigators (J.S. and L.O.) to determine the following baseline characteristics: age, gender, hospitalization status, comorbidities, smoking history, anticancer therapy, presenting manifestations, and initial PE management. Tumor type and presence of metastasis were also reviewed. In case of multiple malignancies, the patient was classified based on the most advanced malignancy. Disagreements were resolved by consensus. Radiology reports were reviewed to determine the location of the emboli. Central iPE was defined as a filling defect in the main stem, pulmonary arteries, and/or lobar arteries with or without peripheral vessels involvement; while peripheral PE is a filling defect in segmental and/or subsegmental arteries. Categorical variables were described as frequencies and percentages, and continuous variables by means and standard deviations (SD). The incidence rate was calculated by dividing the number of iPE cases over the number of chest CT scans performed during a 7-months period.

RESULTS

During the study period, 4574 contrast-enhanced chest CT scans were identified. Of these, 4065 were included in the study. A total of 61 cancer patients were diagnosed with iPE. Once applying the exclusion criteria, the final group consisted of 46 patients; giving an incidence rate of 1.13%. The detailed procedure of how the final study group was composed is shown in Figure 1. Demographic, clinical, and radiological characteristics are summarized in Table 1.

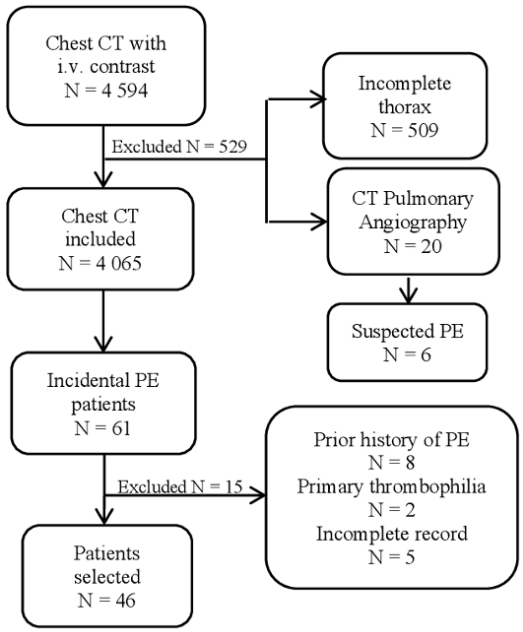

Figure 1: Flow Chart of Patient Selection in the Study

Table 1: Characteristics of Cancer Patients With Incidental Pulmonary Embolisms (n=46)[a]

	Patients With Incidental PE, No.(%)
Sex	
Female	29 (63.0)
Male	17 (37.0)
Status	
Outpatient	34 (73.9)
Inpatient	12 (26.1)
Comorbidities	
Hypertension	21 (45.7)
Diabetes Mellitus	5 (10.9)
Chronic Heart Failure	2 (4.3)
Smoking History	11 (23.9)
Major Surgery Within 30 days	0 (0.0)
Active Cancer Treatment	
Chemotherapy	25 (54.3)
Radiotherapy	0 (0.0)
Hormone Therapy	5 (10.9)
Symptoms Within 7 days	
Dyspnea	8 (17.4)
Chest Pain	0 (0.0)
Hemoptysis	0 (0.0)
Syncope	0 (0.0)
SO2<94%	4 (8.7)
SBP<90 mmHg	3 (6.5)
Heart Rate>100 bpm	5 (10.9)
Respiratory Rate >20	4 (8.7)
Asymptomatic	33 (71.7)
Anatomical Location	
Central	31 (67.4)
Peripheral	15 (32.6)
Initial Therapy	
Anticoagulation	36 (78.3)
Thrombolysis	0 (0.0)
Inferior Vena Cava Filter	1 (2.2)
Surgery	0 (0.0)
No Initial Treatment	9 (19.6)

[a] Abbreviations: PE, Pulmonary Embolisms; SBP, systolic blood pressure, SO2, oxygen saturation;

There were 17 male and 29 female patients with a mean±SD age of 6413± years (range: 3086-). The largest number of emboli were seen in patients with gastrointestinal cancer (n=15); followed by gynecologic cancer (n=8) and breast cancer (n=7) (Table 2). Most patients had metastatic disease (65.2%) and received oncologic therapy (65.2%) within 30 days before iPE diagnosis. Almost 70% of cases had at least one comorbidity from which hypertension and type 2 diabetes mellitus were the most frequently observed diseases. None of the patients had chronic obstructive pulmonary disease, chronic kidney disease, and/or chronic heart failure.

Table 2: Tumor Type and Stage Distribution.

	Stage of the Disease		Total, No.(%)
	Metastatic	No Metastatic	
Gastrointestinal (Esophageal, Gastric, Small Bowel, Colon, Rectum)	9	6	15 (32.6)
Gynecological (Cervical, Endometrial, Ovarian)	5	3	8 (17.4)
Breast	3	4	7 (15.2)
Genitourinary (Bladder, Kidney, Prostate)	3	2	5 (10.9)
Lung	3	0	3 (6.5)
Hepatobiliary and Pancreatic	3	0	3 (6.5)
Others (Sarcoma, Head And Neck, Melanoma, Primary Unknown)	4	1	5 (10.9)
Total	30	16	46 (100)

Central iPEs were more common; 31 patients (67.4%) had a saddle, main, and/or lobar pulmonary embolism. More than 70% of the patients were reported as asymptomatic. Respiratory symptoms

(dyspnea, chest pain, hemoptysis, or respiratory rate > 20 bpm alone or in combination) were observed in less than 20%. Clinical manifestations were more frequently observed in central compared to peripheral iPEs (38.7% vs 6.7%). The most common presenting manifestation was shortness of breath (17.4%); followed by tachycardia (10.9%) and oxygen saturation (SO2) <94% (10.9%). All patients with SO2 <94% had central iPE. Following the diagnosis of PE, 36 individuals (78.3%) had initially treated with anticoagulant. One patient with gastric cancer and upper gastrointestinal hemorrhage required inferior vena cava (IVC) filter insertion since anticoagulation was contraindicated. The remaining 9 patients did not receive any treatment.

DISCUSSION

Due to its silent nature, the incidence of iPE in cancer patients is usually underestimated [13]. In our study, the reported incidence was 1.13% which is consistent with what has been observed in previous studies [1, 11, 14]. With the initiation of modern MDCT scanners, and with the increasing use of routine CT scans, the incidence of iPE has increased over the years. A recent meta-analysis enrolled more than 28 000 oncologic patients undergoing routine staging with CT [14]. A total of 963 iPE cases were identified with an overall incidence of 3.36%. However, its incidence varied significantly from 0.34% to 7.3%. among studies included in the analysis Another meta-analysis by Dentali et al. [1] reported an overall incidence of 3.1% in cancer patients undergoing chest CT; ranging from 1.0% to 5.7%. A retrospective study conducted by Callejas et al. [11] reported an incidence of 0.68% in cancer patients undergoing PET-CT in Chile. The wide range of variation in the incidence of iPE can be explained by the high heterogeneity between studies. Additionally, different CT scanners, techniques, and slice thicknesses were used. Modern scanners have better speed and resolution compared to older generation scanners. Klok and Huisman [7] compared MDCT with older CT scanners; reporting a weighted-pooled incidence of 3.3% and 1.8%, respectively. Another study also reported a higher incidence of iPE when using CT scans with <5 mm slice thickness compared to >5 mm slice thickness (3.0% vs 2.0%) [1]. Diagnosis of iPE is also radiologist-dependent. Incidence may be affected by radiologist expertise and skills, and by the fact that PE evaluation is not the primary goal of contrast-enhanced CT scans. In a retrospective cohort study by Engelke et al., 2412 contrast-enhanced CT images of 1869 patients were reassessed; finding an overall false-negative rate of 69.4% [3]. Other factors that may have contributed to this variation are the distribution of primary tumors and tumor stage, hospitalization status, and the presence of additional risk factors. Moreover, patients receiving thromboembolic prophylaxis were not excluded from our study, possibly decreasing the likelihood of developing PE.

iPE was more frequently observed in females (63%) than in males (37%); which is similar to several results reported in the literature [15-17]. However, this finding is not consistent with other previous studies where the majority of patients were males [6, 18, 19]. The female predominance in our study might be explained by the fact that 61.6% of the almost 20 000 newly diagnosed cancer patients from 2015 to 2019 in Panama were females [20-24]. Distribution according to primary cancer was as follows: the most common existing malignancy was gastrointestinal cancers; followed by breast and gynecologic cancers. However, in previous studies, primary cancer distribution was different. In a recent study, incidentally detected PE was more common in gastrointestinal, lung, and breast cancer [18]. In a study by Abdel-Razeq et al., the highest number of iPEs were observed in gastrointestinal cancer, lung cancer, and lymphomas [16]. Primary cancer distributions may vary depending on the prevalence of different malignancies in the studied population. In Panama, 20.4%, 19.0%, and 15.0% of the newly diagnosed cancer patients had breast, gastrointestinal, and gynecological cancer, respectively from 2015 to 2019 that can explain our findings [20-24]. The tumor stage and oncologic treatment are important factors related to iPE. We observed that most of our patients had metastatic disease and/or were on active chemotherapy at the time of diagnosis. In a retrospective study performed in Brazil, 48 patients with iPE were reported; of whom 66.7% had metastatic disease and 60.4% were undergoing chemotherapy which is similar to what was observed in our study [12]. Similar findings were also found in three other studies [1, 16, 25]. These findings were as expected

since the risk of venous thromboembolism is higher in metastatic disease [26]. Bach et al., demonstrated that patients with metastatic disease had a -1.5fold higher incidence of PE compared to patients without metastases [27]. In addition, recent chemotherapy has been identified as a significant predictor of incidental PE [26]. Moreover, CT scans are performed more frequently in patients with metastatic disease who are undergoing active treatment, thus increasing the likelihood of detecting iPE. Therefore, we suggest that when a contrast-enhanced chest CT is performed, pulmonary vasculature should be carefully assessed for iPE, particularly in patients with metastatic disease; undergoing active cancer treatment.

Most of our patients had central iPEs which are similar to what has been seen in previous studies [15, 17, 25]. This finding is relevant since patients with central iPEs have worse overall survival than those with peripheral emboli. However, peripheral iPE could be underdiagnosed in our study due to factors such as underreporting and poor contrast of the small pulmonary arteries. Despite being defined as incidental, some of our patients' reported signs and symptoms commonly associated with PE. Respiratory symptoms were identified in nine patients; however, these symptoms did not raise any suspicion of a possible PE. Interestingly, during the seven months, only 6 patients were diagnosed with suspected PE; sustaining the fact that most PEs are not suspected in cancer patients. This could be explained by the poor specificity of PE signs and symptoms which are commonly attributed to the underlying malignancy, anti-cancer therapy, and/or comorbidities. More than %70 of our patients were reported as asymptomatic; however, due to the retrospective design of our study, we do not know how many of these patients were truly asymptomatic.

The clinical relevance of iPE is non-negligible; a large retrospective case-control study reported a reduced overall survival in cancer patients with iPE, especially in patients with central PE [18]. Regarding its adverse impact on the patient's survival [8], most physicians choose to treat incidentally detected PE [15, 18, 25, 28]. Similar findings were observed in our study, where detection of iPE changed management in almost %80 of the cases. Several guidelines [9, 10] currently recommend the same initial and long-term treatment for iPE as for patients with suspected PE, nonetheless, these recommendations have a low level of evidence and are based on informal consensus.

Whether to treat or not, subsegmental emboli are still uncertain. The American Society of Clinical Oncology suggests treatment of isolated PE on a case-by-case basis [9]. On the other hand, The American College of Chest Physicians (AT10) recommends that in patients with subsegmental PE with no proximal deep vein thrombosis (DVT) in the legs, and low risk of recurrent vein thromboembolism (VTE), observation is preferred over anticoagulation (grade 2C recommendation); while in high-risk patients, anticoagulation is preferred over observation (grade 2C recommendation) [10]. Interestingly, of the nine patients that did not receive anticoagulation, only one had a peripheral PE; suggesting that in our institution, patients with iPE reveive anticoagulant irrespective of the location of the embolus, unless anticoagulation is contraindicated. Detection of emboli may change patient management; therefore, the radiologist should be aware of the possibility of detecting even small emboli, even in patients who are reported as asymptomatic. Current guidelines do not recommend thromboprophylaxis in ambulatory cancer patients. However, in our study, almost %75 of the patients were ambulatory patients at the time of diagnosis. Similar results were observed in past studies [16,15,12]; suggesting that ambulatory cancer patients are also at risk of venous thromboembolism.

There are several limitations to our study. First, its retrospective design with a possible known bias. Second, not optimizing routine CT scan techniques for the detection of pulmonary embolism may have prevented the detection of small emboli; especially in subsegmental arteries. In addition, only radiology reports were used without reviewing the CT images to exclude any iPE that might have been missed in initial reports. Moreover, patients receiving thromboembolic prophylaxis were not excluded from our study, possibly decreasing the likelihood of developing PE. Therefore, the frequency rate of iPE may have been underestimated in our study. The small sample size may limit the applicability of our findings; however, despite a single-center analysis have been performed, the National Institute of Oncology is the only public specialized medical center for cancer treatment in Panama; attending more than %80 of Panama's cancer patients, from all around the country.

Our study adds to the growing evidence that iPEs have a relatively low incidence in oncologic patients (1.13%), however, its true incidence remains uncertain. IPE was most frequently observed in patients with gastrointestinal, breast, and gynecologic cancer; mainly in those with metastatic disease or receiving chemotherapy.

ACKNOWLEDGMENTS

None declared.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

ETHICS APPROVAL

The ethical approval of the study was obtained from the Ethics Committee of the National Institute of Oncology, Panama.

REFERENCES

1. Dentali F, Ageno W, Becattini C, Galli L, Gianni M, Riva N, et al. Prevalence and clinical history of incidental, asymptomatic pulmonary embolism: a meta-analysis. Thromb Res. 2010;125(6):51822-. PMID: 20451960 DOI: 10.1016/j.thromres.2010.03.016
2. Navi BB, Reiner AS, Kamel H, Iadecola C, Okin PM, Tagawa ST, et al. Arterial thromboembolic events preceding the diagnosis of cancer in older persons. Blood. 2019;133(8):781-9. PMID: 30578253 DOI: 10.11827 blood-2018860874-06-
3. Engelke C, Manstein P, Rummeny EJ, Marten K. Suspected and incidental pulmonary embolism on multidetector-row CT: analysis of technical and morphological factors influencing the diagnosis in a cross-sectional cancer centre patient cohort. Clin Radiol. 2006;61(1):7180- PMID: 16356819 DOI: 10.1016/j.crad.2005.09.001
4. Timp JF, Braekkan SK, Versteeg HH, Cannegieter SC. Epidemiology of cancer-associated venous thrombosis. Blood. 2013;122(10):1712-23. PMID: 23908465 DOI: 10.1182/ blood-2013460121-04-
5. Carmona-Bayonas A, Jimenez-Fonseca P, Font C, Fenoy F, Otero R, Beato C, et al. Predicting serious complications in patients with cancer and pulmonary embolism using decision tree modelling: the EPIPHANY Index. Br J Cancer. 2017;116(8):994-1001. PMID: 28267709 DOI: 10.1038/ bjc.2017.48
6. den Exter PL, van der Hulle T, Hartmann IJ, Jimenez D, Klok FA, Huisman MV, et al. Reliability of diagnosing incidental pulmonary embolism in cancer patients. Thromb Res. 2015;136(3):5314-. PMID: 26254194 DOI: 10.1016/j. thromres.2015.06.027
7. Klok FA, Huisman MV. Management of incidental pulmonary embolism. Eur Respir J. 2017;49(6). PMID: 28663318 DOI: 10.11832017-13993003.00275/
8. O'Connell C, Razavi P, Ghalichi M, Boyle S, Vasan S, Mark L, et al. Unsuspected pulmonary emboli adversely impact survival in patients with cancer undergoing routine staging multi-row detector computed tomography scanning. J Thromb Haemost. 2011;9(2):30511-. PMID: 20955348 DOI: 10.1111/j.15387836.2010.04114-.x
9. Key NS, Khorana AA, Kuderer NM, Bohlke K, Lee AYY, Arcelus JI, et al. Venous Thromboembolism Prophylaxis and Treatment in Patients With Cancer: ASCO Clinical Practice Guideline Update. J Clin Oncol. 2020;38(5):496-520. PMID: 31381464 DOI: 10.1200/JCO.19.01461
10. Kearon C, Akl EA, Ornelas J, Blaivas A, Jimenez D, Bounameaux H, et al. Antithrombotic Therapy for VTE Disease: CHEST Guideline and Expert Panel Report. Chest. 2016;149(2):31552-. PMID: 26867832 DOI: 10.1016/j.chest.2015.11.026
11. Callejas MF, Errazuriz JI, Castillo F, Otarola C, Riquelme C, Ortega C, et al. Incidental venous thromboembolism detected by PET-CT in patients with cancer: prevalence and impact on survival rate. Thromb Res. 2014;133(5):7505-. PMID: 24565275 DOI: 10.1016/j.thromres.2014.02.005
12. Carneiro RM, van Bellen B, Santana PRP, Gomes ACP. J Vasc Bras. 2017;16(3):2328-. PMID: 29930652 DOI: 10.1590/1677-5449.002117
13. Otten HM, Mathijssen J, ten Cate H, Soesan M, Inghels M, Richel DJ, et al. Symptomatic venous thromboembolism in cancer patients treated with chemotherapy: an underestimated phenomenon. Arch Intern Med. 2004;164(2):1904-. PMID: 14744843 DOI: 10.1001/archinte.164.2.190
14. Meyer HJ, Wienke A, Surov A. Incidental pulmonary embolism in oncologic patients-a systematic review and meta-analysis. Support Care Cancer. 2021;29(3):1293302-. PMID: 32621266 DOI: 10.1007/s0052005601--020-y
15. Myat Moe MM, Redla S. Incidental pulmonary embolism in oncology patients with current macroscopic malignancy: incidence in different tumour type and impact of delayed treatment on survival outcome. Br J Radiol. 2018;91(1088):20170806. PMID: 29688026 DOI: 10.1259/bjr.20170806
16. Abdel-Razeq HN, Mansour AH, Ismael YM. Incidental pulmonary embolism in cancer patients: clinical characteristics and outcome--a comprehensive cancer center experience. Vasc Health Risk Manag. 2011;7:1538-. PMID: 21468175 DOI: 10.2147/VHRM.S17947
17. Deniz MA, Deniz ZT, Adin ME, Akil F, Turmak M, Urakci Z, et al. Detection of incidental pulmonary embolism with multi-slice computed tomography in cancer patients. Clin Imaging. 2017;41:10611-. PMID: 27840261 DOI: 10.1016/j.clinimag.2016.10.018
18. Qdaisat A, Kamal M, Al-Breiki A, Goswami B, Wu CC, Zhou S, et al. Clinical characteristics, management, and outcome of incidental pulmonary embolism in cancer patients. Blood Adv. 2020;4(8):160614-. PMID: 32311012 DOI: 10.1182/bloodadvances.2020001501
19. Thaker DA, Douglas E, Blazak J, Xu W, Hughes B, Burge M, et al. An analysis of incidental and symptomatic pulmo-

nary embolism (PE) in medical oncology patients. Asia Pac J Clin Oncol. 2017;13(3):243-8. PMID: 27966288 DOI: 10.1111/ajco.12650

20. Hospital cancer registry Panama: National Oncology Institute; 2015 [cited 2022 Mar 14]. Available from: https://www.ion.gob.pa/site/wp-content/uploads/2018/03/BOLETIN-2015.pdf.
21. Hospital cancer registry Panama: National Oncology Institute; 2016 [cited 2022 Mar 14]. Available from: https://www.ion.gob.pa/site/wp-content/uploads/2018/03/BOLETIN-2016.pdf.
22. Hospital cancer registry Panama: National Oncology Institute; 2017 [cited 2022 Mar 14]. Available from: https://www.ion.gob.pa/site/wp-content/uploads/2015/05/BOLETIN-2017.pdf.
23. Hospital cancer registry Panama: National Oncology Institute; 2018 [cited 2022 Mar 14]. Available from: https://www.ion.gob.pa/site/wp-content/uploads/2015/05/BOLETIN-2018.pdf.
24. Hospital cancer registry Panama: National Oncology Institute; 2019 [cited 2022 Mar 14]. Available from: https://www.ion.gob.pa/site/wp-content/uploads/2015/05/BOLETI%cc%81N-2019.pdf.
25. Font C, Carmona-Bayonas A, Beato C, Reig O, Saez A, Jimenez-Fonseca P, et al. Clinical features and short-term outcomes of cancer patients with suspected and unsuspected pulmonary embolism: the EPIPHANY study. Eur Respir J. 2017;49(1). PMID: 28052954 DOI: 10.1183/13993003.00282-2016
26. Browne AM, Cronin CG, English C, NiMhuircheartaigh J, Murphy JM, Bruzzi JF. Unsuspected pulmonary emboli in oncology patients undergoing routine computed tomography imaging. J Thorac Oncol. 2010;5(6):798-803. PMID: 20421822 DOI: 10.1097/JTO.0b013e3181d6153a
27. Bach AG, Schmoll HJ, Beckel C, Behrmann C, Spielmann RP, Wienke A, et al. Pulmonary embolism in oncologic patients: frequency and embolus burden of symptomatic and unsuspected events. Acta Radiol. 2014;55(1):45-53. PMID: 23864061 DOI: 10.1177/0284185113491569
28. den Exter PL, Hooijer J, Dekkers OM, Huisman MV. Risk of recurrent venous thromboembolism and mortality in patients with cancer incidentally diagnosed with pulmonary embolism: a comparison with symptomatic patients. J Clin Oncol. 2011;29(17):2405-9. PMID: 21555690 DOI: 10.1200/JCO.2010.34.0984