RESEARCH ARTICLE

Prevalence Of Pulmonary Embolism (Pe) Among Cancer Patients As Incidental Finding Using Computed Tomography (CT): A Single Centre Retrospective Study

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Abstract:

Incidental pulmonary embolisms (PE) are defined as an unsuspected filling defect of the pulmonary arteries identified on the computed tomography (CT) images. Due to its nature as non-specific symptoms and some patients may even asymptomatic, PE was knowns as the most common cause of death for patients who are bedridden and the second most common cause of death for cancer patients. This study aimed to assess the prevalence of incidental PE in cancer patients undergoing routine CT scans at a single institution. This study seeks to categorize primary cancer types, assess the prevalence of incidental PE, and identify the typical locations of emboli within the branches of the pulmonary artery. The relationship between risk factors and the occurrence of PE was subsequently assessed. 534 cancer patients' data who underwent CT scans from January to June 2023 were reviewed. The results indicated that accidental PE was most prevalent in lung cancer (25.6%), followed by gastrointestinal tract cancer (21%) and breast cancer (16.3%). The right lower pulmonary artery was the most frequently affected arterial site, accounting for 25.6%. The findings underscored the importance of thorough physical examination screening for cancer patients to facilitate early detection and intervention of incidental PE.

Keywords: computed tomography (CT), incidental findings, oncology patients, pulmonary embolism

1. INTRODUCTION

Over the years, Computed Tomography (CT) scanning has become a standard procedure for many patients, particularly those with cancer, for purposes including diagnosis, staging, or treatment evaluation. CT examinations are commonly conducted for oncology patients for various purposes, including staging the disease by evaluating its extent, monitoring treatment response, and conducting regular follow-ups to detect recurrence or metastasis. Incidental pulmonary embolism (PE) frequently emerged as a finding during examinations, particularly in cancer patients who exhibit an elevated risk of venous thromboembolism. This increased risk is attributed to factors such as cancer-related hypercoagulability, immobility, and the effects of treatment (Poenou et al., 2022)

Incidental PE refer to an unexpected filling defect in the pulmonary arteries detected on a CT scan (Ahuja et al.2020). In adults, PE account for 10-15% of deaths (Deniz et al., 2017). It ranks as the second leading cause of mortality among hospitalized cancer patients and is the primary cause of death for individuals who are bedridden. Furthermore, following coronary artery disease and stroke, it ranks third in terms of the frequency of cardiovascular disease-related deaths. Samra et al. (2022) reported an estimated incidence of PE at 4.4% among 540 patients suffering from various cancer types.

Moreover, the incidence of thromboembolic disease among cancer patients ranges from 4% to 28%, depending on the specific types and stages of cancer (Luo et al, 2023). Cancer patients are at an increased risk of pulmonary thromboembolism, particularly due to factors such as chemotherapy, surgery, radiotherapy, or the ongoing progression of the disease. These embolic events are clinically asymptomatic, yet they result in significant morbidity and

mortality in untreated patients. Identifying and addressing risk factors in cancer patients is essential for implementing preventive measures to decrease the incidence of PE and enhance patient outcomes. The mortality rate in untreated PE is significant, which is at 30%; however, with effective treatment, it can reduce this rate to between 2% and 18% (Bach et al., 2015).

This single-centre study provides insights into the prevalence of PE as an incidental finding in cancer patients, with potential implications for improving oncology patient outcomes and treatment. The researcher hypothesized that the study's outcomes could improve the understanding of the relationship between cancer and PE, therefore optimizing the management of this significant comorbid condition in cancer treatment.

2. MATERIALS AND METHODS

From January to June 2023, 534 cancer patients underwent CT scans. The study utilized specific exclusion and inclusion criteria. The data were retrieved from the Radiology Information System (RIS). The original radiological reports for the CT scan of the thorax from January until June 2023 reported by the radiologists that were stationed at the CT suite (for the stipulated time frame) were retrieved and reviewed by the 1st author. The review process was to filter all CT thorax result with the confirmation of PE, identify the primary cancer types, determine the common locations of emboli in pulmonary artery branches, and assess the association between risk factors and pulmonary embolism. Statistical analysis was performed utilizing SPSS 27.0 to obtain statistical insights. Descriptive statistics consists of the computation of means and standard deviations (SD) for various key variables. The Chi-Square test assessed the relationship between various risk factors and the incidence of PE across different cancer types. The variables contained the items pertinent to the study, including patient age, gender, and the type of cancer diagnosed in the individuals being examined. The methodological framework used in this study is based on earlier research by Deniz et al. (2017) and Samra et al. (2022), which is cited in the current study.

2.1 Inclusion criteria

Oncology patients who had tissue biopsies with easily accessible biopsy results are included in the sample group. The samples must also have received continuous treatment over the six months during the data collecting period, and they must have had routine CT scans of the thorax with contrast.

2.2 Exclusion Criteria

Oncology patients with a prior history of pulmonary embolism (PE) or deep vein thrombosis (DVT), those exhibiting dense scanning artefacts, and cases where pulmonary arteries could not be traced due to conditions such as pleural effusion or large masses, and who underwent CTPA examination, were excluded from this study**.** CT thorax images that were degraded by artefacts due to the treatment received for more than six months by the oncology patients during the data collection period, the images were then excluded from the study.

Ethical approval for this study was acquired from the Universiti Teknologi MARA (UiTM) ethics committee, with reference number FERC/FSK/MR/2024/00145. Ethical approval was also obtained from the Medical Research and Ethics Committee (MREC), with the reference number NMRR ID-24-01411-NH1 (IIR). The data from this study was not manipulated for other non-related purposes and patients' identities were kept safe and confidential.

3. RESULTS AND DISCUSSION

3.1 Demographic data and samples distribution by types of cancer

Out of the 534 patients that participated in the study, 327 (61.2%) were female and 207 (38.8%) were male. This study indicates that female patients had a higher cancer prevalence than male patients, as demonstrated by a gender ratio of 1.58:1, consistent with various findings in the literature. A primary factor contributing to the rise in female patients is breast cancer. The overall number of female cancer patients includes additional illnesses exclusive to women, such as ovarian and cervical cancers within the reproductive cancer category. The patients' age range was 12 to 87 years, with a mean age of 56 ± 13.6 years. Figure 1 below illustrates the distribution of subjects categorized by primary cancer types. The majority of the subjects consist of primary cancers originating from the breast (26.8%), followed by gastrointestinal tract (GIT) cancer (20.2%), lung cancer (19.7%), reproductive system cancers (17.4%), bone-soft tissue cancers (4.9%), nasopharyngeal carcinoma (NPC) (4%), kidney cancer (3.2%), biliary system cancers (1.7%), thyroid cancer (1%), germ cell tumors (0.7%), and lymphatic system cancers (0.4%).

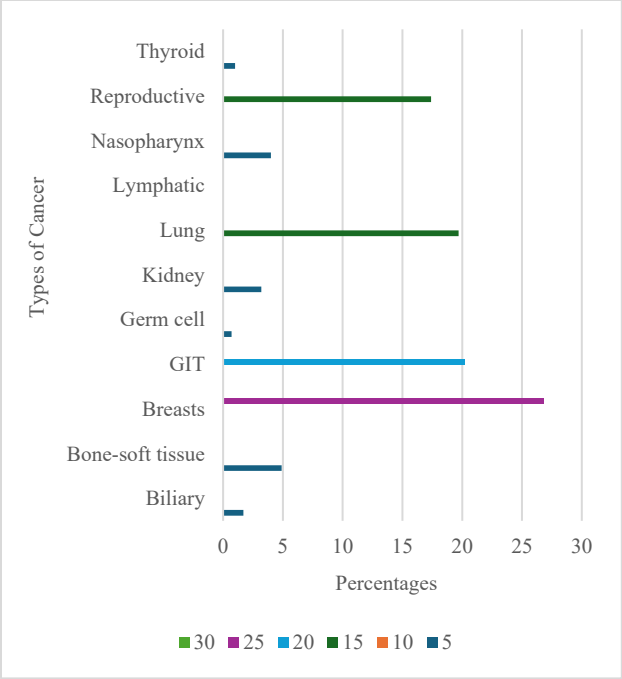

Figure 1. Subject Distribution by Types of cancer

3.2 Prevalence of patients with incidentally detected PE by cancer type

Table 1 below showed that lung cancer patients exhibited the highest prevalence of incidental PE (25.60%), with 11 cases found within the research cohort. This result supported by case study conducted by Dong, H. Y.,(2023) where they suggested the risk of getting PE in lung cancer patients will increase when the patient was known to have deep venous thrombosis. The incidence rate of gastrointestinal tract (GIT) cancer among patients was 21%, accompanied by 9 cases of incidental PE. The reproductive system and breast malignancies, which collectively represented 7 cases in the study, exhibited incidental PE rates of 16.30%. Basaran et al (2021) did relate the ovarian cancer patients that received neoadjuvant chemotherapy treatment in the risk of getting venous thromboembolism which could possibly lead to PE. In contrast, patients with bone-soft tissue cancer exhibited an incidence rate of 9.30%, with 4 instances of incidental PE identified. The prevalence of incident PE in patients with renal cancer progressively declined; the study group reported 2 cases, constituting 4.70%. The results indicated a consistent link yielding a singular outcome for the frequencies of incidental PE for biliary system, thyroid, and nasopharyngeal malignancies, totaling 2.30%. No predominance was identified in the lymphatic and germ cell types. The findings of this research contradicted those of other studies. Sinclair De Frías et al. (2022) found that the gastrointestinal cancer cohort of oncology patients exhibited the highest incidence of incidental PE (6.9%), with 15 out of 46 patients affected. This suggests variability in PE rates among diverse populations, potentially attributable to differences in clinical practices or patient demographics. In a separate article by Samra et al. (2022), unintentional PE was predominantly observed in persons with lung, uterus, and pancreatic malignancies.

Table 1. The rates of patients with incidentally detected pulmonary embolism (PE) by cancer type.

Primary cancer types	Number of patients	Number of patients with detected incidental PE	Incidental PE according to primary cancer	The rates of patients with incidentally detected PE according to cancer type
Breast	143	7	4.90%	16.30%
Gastrointestinal Tract (GIT)	108	9	8.30%	21%
Lung	**105**	**11**	**10.50%**	**25.60%**
Reproductive system	93	7	7.50%	16.30%
Bone-soft tissue	26	4	15.40%	9.30%
Nasopharyngeal (NPC)	21	1	4.80%	2.30%
Kidney	17	2	11.80%	4.70%
Biliary system	9	1	11.10%	2.30%
Thyroid	6	1	16.70%	2.30%
Germ cell	4	0	0%	0%
Lymphatic	2	0	0%	0%
	534	43		100

3.3 Incidence Distribution in Relation to Pulmonary Arterial Branches

An additional part of the study was the assessment of the incidence of distribution about the involvement of the pulmonary arterial section. This study offers insights into the structural patterns of PE inside the arterial branches. Referring to Table 2, the findings revealed that patients with identified PE involved the right upper branch including 10 patients, or 23.3% of the total cases. PE found at the right middle branch in 10 patients, representing 23.3% of the cases, whereas PE occurred at the right lower branch involved 11 patients, constituting 25.6% of the instances. 5 patients (11.6%)

exhibited detectable PE in the upper left pulmonary artery section, whereas 13 patients (30.2%) were identified in the lower left segment. Emboli were predominantly identified in the right upper branches of the right pulmonary artery, whereas they were least frequently observed in the left upper branch of the pulmonary artery. This was determined based on the engagement of the pulmonary artery segment. The results align with the data by Deniz et al., (2017) which indicated that the left lower pulmonary artery branch had the highest incidence, succeeded by the right upper and middle branches.

Table 2. Incidence Distribution in Relation to Pulmonary Arterial Branches

Pulmonary artery branches	Number of patients with detected PE	Incidence (%)
Right upper	10	23.3
Right middle	10	23.3
Right lower	11	25.6
Left upper	5	11.6
Left lower	13	30.2

3.4 Distribution of Patients with Incidental Pulmonary Embolism (PE) Diagnoses by Different Risk Factors

The data in Table 3 highlighted 4 most prevalence cancer and risk factors involved. indicates that chemotherapy administered over the past six months is prevalent, PE was detected present in 2.8% of breasts cancer patients 6.5% GIT cancer patients, 4.8% lung cancer patients and 4.3% with reproductive cancer. Chemotherapy is frequently offered to these patients due to the high occurrence. In the research conducted by Chlapoutakis., et al. (2022), the predominant risk factor for PE among cancer patients was recent chemotherapy, with 60% of patients having undergone this treatment in the preceding six months. Simultaneously, 1.4% of breast cancer patients, 1.9% GIT and lung cancer patients with PE exhibited metastases. The proportion of PE patients is marginally elevated, although it is not statistically distinct from the overall population. 0.7% of patients with breast cancer and 2.2% with reproductive cancer with PE had undergone surgery, in contrast to 43.2% of those without PE, underscoring a notable trend in post-surgical outcomes. This suggests that other factors may exert a more significant influence on the incidence of PE than surgical operations. Another factor to examine is the incidence of recent hospitalizations; 2.5% of patients with PE and 25.4% of individuals without PE had recent hospitalizations, respectively. This indicates that a recent hospitalization does not substantially influence the likelihood of developing PE. Finally, only 1.9% of patients with PE and 22.5% of patients without PE had radiation in the preceding six months. In a comparable scenario, radiation did not markedly distinguish those with PE from those without PE, based on nearly identical percentages.

Table 3. Distribution of Patients with Incidental PE diagnoses with different risk factors (*p*-value, *p*>0.05)

Type of primary cancer & total number of patients (N)	Various risk factors						Fisher Exact Tests (p-value, p>0.05)
	Yes/ No PE	Chemo within 6 mths = N (%)	Mets= N (%)	Post surgery = N (%)	Hosp stayed recently = N (%)	Radio within 6 mths = N (%)	
Breasts (135)	Yes	4(3)	2(1.5)	1(0.7%)	0(0)	0(0)	.886
	No	67(49.6)	18(13)	21(15.6)	13(9.6)	9(6.7)	
GIT (108)	Yes	7 (6.5)	2(1.9)	0(0)	0(0)	0(0)	.749
	No	62(57.4)	12(11)	13(12)	4(3.7)	6(5.6)	
Lung (105)	Yes	5(4.8)	2(1.9)	0(0)	1(0.95)	2(1.9)	.358
	No	58(55)	19(18)	4(3.8)	7(6.7)	5(4.8)	
Reproductive (93)	Yes	4(4.3)	0(0)	2(2.2)	1(1.1)	0(0)	.470
	No	50(54)	11(11)	11(11.8)	5(5.4)	5(5.4)	

Additionally, aside from the primary cancer types and associated risk factors outlined in the context, a significant risk factor associated with PE in oncology patients is the presence of central venous catheters (CVCs). CVCs are frequently employed in oncology patients for several functions, such as the delivery of chemotherapy, intravenous medications, and blood sampling. Nonetheless, the utilization of CVCs can increase the risk of thromboembolism, including pulmonary embolism (Qdaisat et al., 2020) (Jones.,2017).

Table 3 also shows the *p*-value for each of the four cancer types, the p-value is greater than 0.05 (p>0.05), hence the null hypothesis cannot be rejected. The examination of cancer type prevalence and related risk variables reveals no statistically significant association was found due to the limited population size. A bigger population size may lead to the acceptance of the proposed hypotheses in the study. In the article written in Fujieda et al., (2021), they stated that numerous clinical research and epidemiological studies had consistently established a strong association between these types of tumours and the occurrence of PE. Breast cancer, gastric cancer, hepatocellular carcinoma, esophageal squamous cell carcinoma, lung cancer, urothelial carcinoma,

and pancreatic adenocarcinoma were prominent cancer types frequently linked to PE (He et al., 2021). These risk variables are prevalent among patients. However, their similar prevalence in both groups indicates that none can independently predict the incidence of pulmonary embolism. The emergence of PE in these individuals may instead result from other or unexamined reasons, or a confluence of multiple ones.

4. CONCLUSION

This research highlights the necessity of identifying and mitigating risk factors in clinical practice to reduce the occurrence and consequences of PE. Although this study found no statistically significant association between the examined risk factors and incidental PE, maintaining awareness of PE as a potential complication remains essential. Healthcare providers should continue to implement comprehensive preventive measures and early detection protocols for at-risk populations to improve patient outcomes and reduce the burden of this life-threatening condition. The analysis revealed no statistically significant relationship between cancer types and associated risk factors, which may be attributable to the relatively small sample size. A larger cohort could potentially yield sufficient power to detect significant associations and support the hypotheses proposed. Future studies should also incorporate cancer staging as an additional variable, given its potential influence on risk factor associations.

Moreover, the development of PE in these individuals may be driven by other unmeasured or multifactorial contributors, underscoring the need for comprehensive investigations into alternative mechanisms.Future research with prospective studies is necessary to confirm and enhance the findings of this investigation. The findings from this study may inform evidence-based practices, guide decision-making in patient care, and advance knowledge in PE research. Proactively addressing risk factors and tailoring interventions to individualized risk profiles can lead to improved outcomes and enhanced quality of care for patients at risk of PE.

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