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Outcomes of Cancer Patients Undergoing Percutaneous Pericardiocentesis for Pericardial Effusion

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ABSTRACT

BACKGROUND Pericardial effusion (PE) is common in cancer patients, but the optimal therapeutic approach is not well defined. Percutaneous pericardiocentesis is less invasive than surgery, but its long-term effectiveness and safety have not been well documented.

OBJECTIVES The goal of this study was to evaluate outcomes of cancer patients undergoing percutaneous pericardiocentesis for PE and assess the procedure's safety in patients with thrombocytopenia.

METHODS Cancer patients who underwent percutaneous pericardiocentesis for PE between November 2009 and October 2014 at the MD Anderson Cancer Center were included. Procedure-related complications, effusion recurrence rate, and overall survival were analyzed.

RESULTS Of 1,645 cancer patients referred for PE, 212 (13%) underwent percutaneous pericardiocentesis. The procedure was successful in 99% of the cases, and there were no procedure-related deaths. Four patients had major procedure-related bleeding that did not vary by platelet count $<$50,000/μl or $\geq$50,000/μl ($p = 0.1281$). Patients with catheter drainage for 3 to 5 days had the lowest recurrence rate (10%). Median overall survival was 143 days; older age (i.e., $>$65 years), lung cancer, platelet count $<$20,000/μl, and malignant pericardial fluid were independently associated with poor prognosis. Lung cancer patients with proven malignant effusions had a significantly shorter median 1-year survival compared with those with nonmalignant effusions (16.2% vs. 49.0%, respectively; log-rank test $p = 0.0101$). A similar difference in 1-year survival was not observed in patients with breast cancer (40.2% vs. 40.0%; log-rank test $p = 0.4170$).

CONCLUSIONS Percutaneous pericardiocentesis with extended catheter drainage was safe and effective as the primary treatment for PE in cancer patients, including in those with thrombocytopenia. Malignant PE significantly shortened the survival outcome of patients with lung cancer but not those with breast cancer. (J Am Coll Cardiol 2015;66:1119–28)

Pericardial effusion (PE), which commonly occurs in patients with cancer, has been reported in up to 21% of patients with underlying malignancy (1) and has been shown to affect patient survival (2–5). The clinical presentation may range from absence of any symptoms to life-threatening tamponade/shock. The best approach for draining effusion is controversial, with procedure selection often depending on patient characteristics and local hospital expertise. Surgery is the most studied modality, with different approaches including pericardial window construction, pericardioperitoneal shunt creation, and/or pericardiectomy. The other well-established approach, which is less invasive, is

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ABBREVIATIONS AND ACRONYMS

CI = confidence interval

PE = pericardial effusion

PT = prothrombin time

RBC = red blood cell

percutaneous pericardiocentesis with or without extended catheter drainage. Sclerosing agents and balloon pericardiectomy have also been used and reportedly reduce the risk for PE recurrence.

Several studies have suggested that the surgical method provides more definitive primary treatment of malignant PE compared with pericardiocentesis (6–8); however, this approach is associated with significant morbidity (4,9–12). As instruments and techniques have improved (especially the use of echography guidance for percutaneous and catheter-based procedures), the clinical application of minimally invasive techniques has often outpaced the published data regarding their safety and efficacy. The purpose of the present study was to evaluate the outcomes of cancer patients with PE who underwent percutaneous pericardiocentesis.

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Thrombocytopenia is a common finding in cancer patients and traditionally has been considered a relative contraindication to pericardiocentesis (13). However, because there are limited data regarding the safety of the procedure in these patients, we also assessed the safety of pericardiocentesis in patients with thrombocytopenia.

METHODS

This retrospective study of cancer patients undergoing percutaneous pericardiocentesis for PE at The University of Texas MD Anderson Cancer Center was conducted from November 2009 to October 2014. The study protocol was reviewed and approved by the institutional review board, and a waiver of informed consent was obtained. Patients were selected by searching the main institutional database for hospital discharge diagnostic codes and matching the selected patients with records in the cardiac catheterization laboratory database. Patients were included in the study if they had undergone primary percutaneous pericardiocentesis and were excluded if they had primary surgical pericardial window placement.

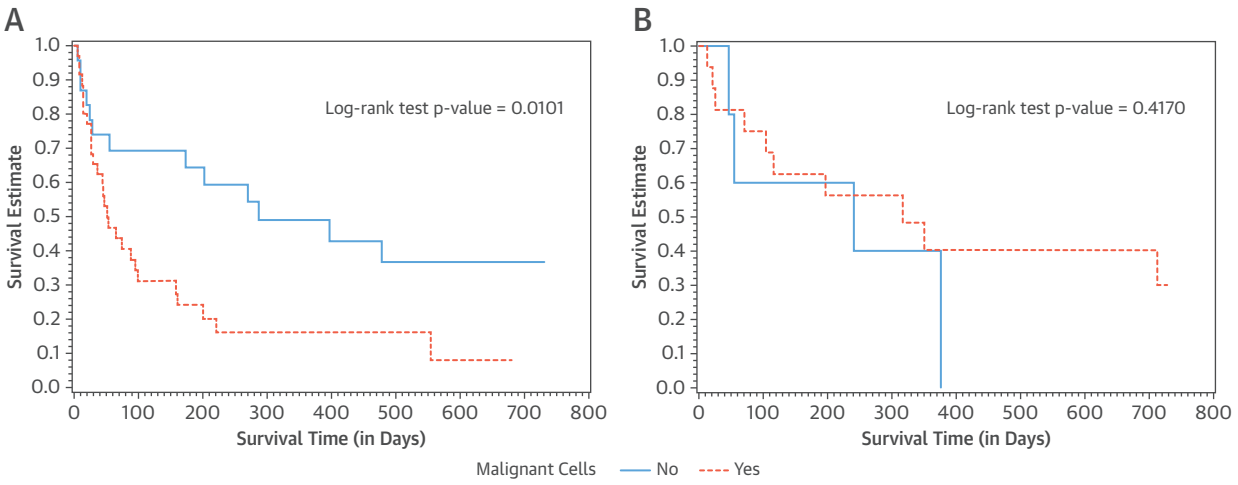
PATIENT ANALYSIS. Data were collected on patient clinical characteristics, including age, sex, type of malignancy, prior cancer therapy (e.g., chemotherapy, radiation therapy), and use of anticoagulant agents at the time of the procedure. Clinical and echocardiographic findings of patients presenting with PEs were also documented. These included clinical symptoms (e.g., dyspnea, syncope, chest pain, palpitations) and clinical signs (e.g., tachycardia, hypotension, shock, presence or absence of pulsus paradoxus). Echocardiographic findings documented included PE size and the absence or presence of chamber collapse, mitral and tricuspid valve inflow variation on Doppler images, and inferior vena cava size and respiratory variation. A large PE was defined as ≥2 cm (14). The effusion pathology and microbiology results obtained at the time of pericardiocentesis were also reviewed.

Patients underwent primary percutaneous pericardiocentesis (guided by echocardiography, computed tomography scan, or fluoroscopy) for therapeutic or diagnostic purposes. Percutaneous pericardiocentesis was performed by using the shortest distance to the pericardial cavity from the subxiphoid or intercostal space (**Figure 1**). In order to reduce bleeding risks, a 5-F micropuncture kit (Micropuncture Introducer Kit, Silhouette Transitionless Push-Plus Design, Cook Medical, Bloomington, Indiana) was typically used in patients with a higher risk of bleeding (15). Both needle and catheter positions were confirmed by using saline contrast injection when echocardiography guidance was used. After accessing the pericardial space, the needle was exchanged over a wire to a dilator, followed by a multihole pigtail catheter. The catheter was then sutured and affixed to the chest wall, where it was kept for several days. A sample (80 ml) of aspirated fluid was sent for pathology, chemistry, and microbiology testing. Post-procedure chest radiographs were performed regularly to assess catheter position and any immediate complication (e.g., pneumothorax). The catheter was removed earlier if fluid drainage dropped below 25 to 50 ml with no residual effusion seen by follow-up echocardiography; it was rarely maintained beyond 7 days. Any use of sclerosing agents was documented.

Recurrence of PE and its subsequent management were reviewed. Recurrent PE was defined as reaccumulation of pericardial fluid within 3 months' post-procedure, documented by echocardiography. Management of such recurrence included repeated simple percutaneous pericardiocentesis, use of sclerosing agents, or placement of a surgical pericardial window.

DATA ANALYSIS. Complications (type and rate) were reviewed and divided into major and minor categories. Procedural bleeding complications were divided into 4 grades: minor or no bleeding (grade 1), major bleeding requiring blood transfusion (grade 2), major bleeding requiring emergent surgery (grade 3), and major bleeding leading to the patient's death (grade 4). The source of bleeding was recorded only if identified. The need to transfuse platelets, fresh frozen plasma, or red blood cell (RBC) units was also

FIGURE 1 Survival in Patients With Lung and Breast Cancer



Although the presence of malignant cells in pericardial effusion (PE) in **(A)** lung cancer patients led to significantly worse survival than for those without (median overall survival: 51 days [95% confidence interval (CI): 29 to 99] vs. 287 days [95% CI: 55 to not estimable]), there was no significant survival difference in **(B)** patients with breast cancer (median overall survival: 317 days [95% CI: 71 to not estimable] vs. 241 days [95% CI: 46 to 376]).

recorded. Patients with thrombocytopenia were classified into 4 subgroups: <20,000/μl, 20,000/μl to 49,999/μl, 50,000/μl to 99,999/μl, and 100,000/μl to 150,000/μl. Prophylactic platelet transfusion refers to platelet transfusion given to prevent spontaneous bleeding. A therapeutic platelet transfusion is given usually to patients with active bleeding or to those with platelet levels <50,000/μl before an invasive procedure is performed (16). The incidence of bleeding related to pericardiocentesis and the odds ratio of bleeding for a platelet count <50,000/μl relative to a platelet count ≥50,000/μl were estimated. The Fisher exact test was used to compare the incidence of bleeding for platelet counts <50,000/μl and ≥50,000/μl. Bleeding was defined as a documented bleeding event related to the procedure or transfusion of RBCs for unexplained acute anemia. Bleeding was attributed directly to the procedure when no other source of bleeding was identified. Transfusions given routinely because of low hemoglobin levels related to chemotherapy or hematologic malignancies were excluded and not considered associated with procedural complications.

All continuous variables were described as mean ± SD, and categorical variables were described in terms of counts and percentages. Because patients may have undergone >1 pericardiocentesis during the study period, only the first procedure was considered in the study; the second procedure was classified as treatment for recurrence and was excluded from further analysis.

We studied overall survival, defined as the time from the date of the procedure to date of death or last follow-up, all within 2 years' post-procedure. Univariate Cox proportional hazards regression analysis was performed to assess any relationship between clinical variables and overall survival. A multivariable model initially included variables with a p value <0.15; a final multivariable model was then chosen by using a backward elimination process. The parameters included in this analysis were age, sex, platelet count subgroups, tumor type, stem cell transplantation, presence or absence of malignancy in the PE, chest radiation within 1 year before the procedure, clinical or echocardiographic tamponade, PE size (<2, 2, or >2 cm), hemorrhagic tamponade, use of blood thinners, and duration of drainage. Hazard ratios were estimated, and 95% confidence intervals (CIs) are provided as appropriate. All p values were considered statistically significant if <0.05. SAS version 9.4 (SAS Institute, Inc., Cary, North Carolina) was used for data analysis.

RESULTS

PATIENT CHARACTERISTICS. From a total of 1,645 cancer patients with PE documented by echocardiography and seen by the cardiology service, 217 patients were identified whose condition needed drainage. Of those, 5 patients had primary surgical pericardial window placement and were excluded

from the study; 212 patients underwent percutaneous pericardiocentesis and were analyzed.

Patient clinical characteristics are summarized in Table 1. Lung cancer was the most common malignancy (n = 61 [29% of all cases]), followed by acute myeloblastic leukemia and lymphoma. Breast cancer was seen in 10% of the cases; the remainder comprised cancers of the gastrointestinal tract, cancers of the genitourinary tract, other hematologic disorders (acute lymphoblastic leukemia, chronic myeloblastic leukemia, multiple myeloma, and myelodysplastic syndrome), mesothelioma, osteogenic sarcoma, thymoma, ovarian cancer, prostate cancer, squamous cell carcinoma of the head and neck, and adenocarcinoma of unknown origin. One hundred eighty-six patients (88%) were exposed to chemotherapy, including 122 patients (58%) who received chemotherapy within 6 weeks before pericardiocentesis. The most commonly used chemotherapeutic agents were doxorubicin (30%), cyclophosphamide (29%), and carboplatin (27%). Thirty-three patients (16%) were receiving different types of tyrosine kinase inhibitors at the time of PE diagnosis, the most common of which were pazopanib and erlotinib (n = 6 each) and dasatinib and sorafenib (n = 3 each). Thirty-three patients (16%) received radiation therapy to the mediastinum within 1 year before the procedure.

TABLE 1 Patient Characteristics (N = 212)

Age, yrs	54.9 ± 16.4
Sex	
Male	111 (52)
Female	101 (48)
Cancer type	
Lung	61 (29)
Acute myeloblastic leukemia	34 (16)
Lymphoma	27 (13)
Breast	22 (10)
Gastrointestinal	16 (8)
Other	52 (25)
Chemotherapy within 6 weeks	122 (58)
Mediastinal radiation therapy	
≤1 yr	33 (16)
>1 yr	35 (17)
Stem cell transplantation	39 (18)
Blood thinners	
Heparin derivative	76 (36)
Antiplatelet	39 (18)
Oral anticoagulant	10 (5)
Baseline abnormal coagulation profile	
Prothrombin time >16 s	91 (43)
Thrombocytopenia (<150,000/μl)	79 (37)
Access catheter size	
5-F micropuncture kit	187 (88)
>5-F	25 (12)

Values are mean ± SD or n (%).

Three iatrogenic effusions were the consequences of endomyocardial biopsies for cardiomyopathy (2 cases) or a cardiac tumor biopsy (1 case). Evidence of tamponade was seen clinically in 83 patients (39%) and via echocardiography in 144 patients (68%). Of all patients, 18 (8.5%) had small to moderate PE (<2 cm); 6 of them underwent pericardiocentesis for diagnostic purposes and 12 to manage tamponade. Of 194 patients (91.5%) with large PEs, two-thirds had clinical and/or echocardiographic evidence of tamponade.

Within 2 days before the procedure, 37% of patients were taking steroids or nonsteroidal anti-inflammatory drugs, and 29% of patients were receiving antiplatelet or anticoagulant agents. Seventy-nine patients (37%) had a low platelet level (<150,000/μl) at the time of the procedure. Thirty-five patients (17%) had platelet counts <50,000/μl, and 9 cases (4%) had platelet counts <10,000/μl; the lowest level reported was 3,000/μl. All 35 patients had a platelet transfusion to minimize bleeding risk. Post-transfusion platelet counts, obtained within 24 h after transfusion, demonstrated a mean platelet count increase of 20,700/μl. Ninety-one patients (43%) had a prothrombin time >16 s, and 20 patients had both a platelet count <150,000/μl and a prothrombin time >16 s. The highest prothrombin time reported was 56.4 s. Eighteen patients (9%) needed a prophylactic transfusion and/or therapeutic fresh frozen plasma transfusion.

PROCEDURES. Our success rate for pericardiocentesis (percentage of patients who had successful initial drainage of pericardial fluid clinically and echocardiographically) was 99%. In 2 cases, the procedure failed; 1 necessitated surgical window placement, and the other was clinically observed. Pericardiocentesis was usually performed by cardiologists (91%) using echocardiographic guidance (93%) or combined echocardiographic and fluoroscopic guidance (42%); 16 procedures (8%) were performed by interventional radiologists with computed tomography scan guidance. A subxiphoid method was used in 63% of cases and intercostal site entry in 37%. Most patients had extended catheter drainage for 3 to 5 days (n = 119 [56%]); 40 patients (19%) required ≤2 days; 36 (17%) required 6 to 7 days; 7 (3%) continued catheter drainage >8 days; and 10 (5%) had no catheter placement. A 5-F micropuncture kit was used in 187 patients (88%), and 36% of these patients had thrombocytopenia.

The mean initial volume of pericardial fluid drained was 590 ± 270 ml (range 2.5 to 1,800 ml). The most common type of initial pericardial fluid aspirated was macroscopically hemorrhagic (48%). One case had initial purulent drainage secondary to lung abscess with pneumopericardial fistula. Of 52 pericardial fluid samples sent for viral analysis, 1 sample came back positive for adenovirus (500 copies/ml). Of 204 samples sent for pathological evaluation, 84 (41%) were malignant with positive cytology results, and 120 (59%) were nonmalignant.

CLINICAL OUTCOMES. Thirty-eight patients (18%) died within 1 month after the procedure, and 130 patients (61%) died within 2 years of the procedure. For the entire group, the median overall survival time from the procedure date was 143 days (95% CI: 95 to 221). In a multivariable analysis model, older age (i.e., >65 years), lung cancer compared with lymphoma, platelet count <20,000/μl versus ≥100,000/μl, and the presence of malignant cells in the pericardial fluid were independently associated with poor prognosis (**Table 2**). Median overall survival was 344 days (95% CI: 166 to not estimable) for patients with nonmalignant PE and 71 days (95% CI: 45 to 104) for patients with malignant PE (**Central Illustration**). One-year survival post-procedure was 50% for patients with PE with no malignant cells compared with 12% for patients with malignant effusions.

When stratified according to cancer type, patients with lung cancer had a median overall survival time of 95 days (95% CI: 45 to 202), whereas patients with other cancer types had a median overall survival time of 166 days (95% CI: 104 to 350). Lung cancer patients with proven malignant effusions had a significantly shorter median overall survival compared with those with nonmalignant effusions (24 patients [39% of lung cancer patients]): 1-year survival estimates of 16.2% (95% CI: 5.6 to 31.6) versus 49.0% (95% CI: 26.7 to 68.0), respectively; log-rank test p value = 0.0101 (**Figure 2A**). No significant difference was observed in the subgroups of breast cancer patients: 1-year survival estimates of 40.2% (95% CI: 16.0 to 63.6) versus 40.0% (95% CI: 5.2 to 75.3) (log-rank test p = 0.4170) (**Figure 2B**). Of note, 80% of lung cancer patients and 91% of breast cancer patients had active disease (i.e., chemotherapy within 6 weeks or newly diagnosed with de novo or recurrent lung or breast cancer). As for the hematologic malignancies, only 4 of the patients with lymphoma and none of the patients with leukemia had proven/confirmed malignant cells in their effusion specimens.

Among 212 patients, 4 patients experienced procedure-related bleeding; none died of bleeding (grade 4 bleeding). Of these 4 patients with procedure-related bleeding, 2 (5.7%) of 35 had a platelet count <50,000/μl, and 2 (1.1%) of 177 had a platelet count ≥50,000/μl. The odds ratio of bleeding for a platelet count <50,000/μl relative to ≥50,000/μl was 5.3. There was no strong evidence that procedure-related bleeding differed between the <50,000/μl platelet count group and the ≥50,000/μl platelet count group (p = 0.1281); however, the lack of a difference can be explained by the lack of statistical power to detect bleeding events of low incidence. The 2 patients with platelet counts <50,000/μl (14,000/μl and 29,000/μl) had grade 2 bleeding and both did well after RBC and platelet transfusions. The other 2 patients with platelet counts >50,000/μl experienced grade 3 bleeding and underwent surgical intervention to stop the bleeding.

Major procedural complications occurred in 5 cases (2%): 1 patient had a liver laceration requiring emergent surgical repair; 1 had an intercostal artery laceration requiring emergent cauterization; 1 developed a pneumothorax requiring chest tube placement; and 2 cases of catheter-related infections were documented among the 7 patients whose catheter drainage lasted >7 days. They were treated with catheter withdrawal and antibiotics; the first patient fully recovered, but the second patient was transferred to hospice care and died several weeks later from cancer progression. Minor procedural complications occurred in 72 patients (34%) (**Table 3**). Nonsustained supraventricular tachycardia was the most common complication (17%), with paroxysmal atrial fibrillation accounting for 60% of these arrhythmias. Pericardial catheter occlusion occurred in 20 cases (9%).

Among the 50 patients who had either simple pericardiocentesis without an indwelling catheter (n = 10) or <3 days' drainage (n = 40), the recurrence rate was 23%. In contrast, longer periods of drainage were associated with recurrence rates of 10%, 11%, and 14% when the catheter was left in place for 3 to 5 days, 5 to 7 days, or >7 days, respectively. Overall, 26 patients (12%) had recurrent PE; 16 (62%) had subsequent repeated pericardiocentesis. Sclerosing agents were used in 5 of these cases (thiotepa in 4 cases and talc in 1 case). Two of these 16 patients had a second recurrence and subsequently underwent surgery. Surgical window placement was also performed after the first recurrence in 5 cases. The remaining 5 patients were observed clinically and recovered without any further treatment of their effusion.

DISCUSSION

Our results found that percutaneous pericardiocentesis with extended catheter drainage for 3 to 5 days is

TABLE 2 Peri-Treatment Variables and Their Association With Overall Survival

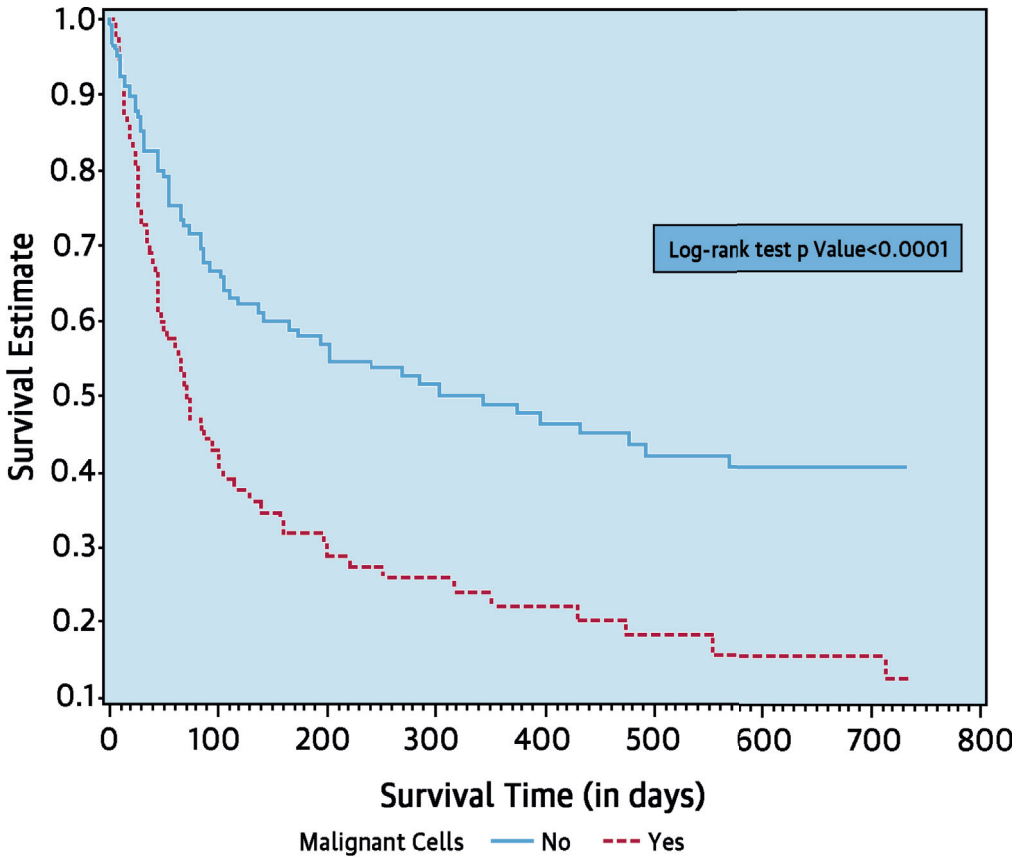
	Survivors (n/N)	2-Year Kaplan-Meier Survival Estimate (%)	Univariate				Multivariable			
			HR	95% CI		p Value	HR	95% CI		p Value
Age, yrs	82/212	28	1.02	1.00	1.03	**0.0060**	1.01	1.00	1.02	**0.0473**
Platelet group/μl						**0.0460***				**<0.0001***
≥100,000	64/156	31	1.00				1.00			
50,000-100,000	10/21	34	1.09	0.58	2.04	0.7807	4.49	0.71	3.12	0.2880
20,000-50,000	6/15	31	1.28	0.65	2.54	0.4774	1.58	0.78	3.23	0.2050
<20,000	2/20	5	2.06	1.24	3.42	**0.0051**	1.49	2.37	8.52	**<0.0001**
Male										
Yes	48/111	36	0.89	0.63	1.25	0.4990				
No	34/101	20	1.00							
Tumor type						**0.0040***				**0.0121***
Lung cancer	20/61	21	1.00				1.00			
Breast cancer	7/22	23	0.71	0.40	1.29	0.2650	0.55	0.30	1.02	0.0581
Lymphoma	20/27	67	0.23	0.11	0.52	**0.0004**	0.27	0.11	0.68	**0.0053**
Other	35/102	24	0.89	0.60	1.32	0.5600	0.89	0.57	1.39	0.6124
Stem cell transplantation										
Yes	21/39	49	0.63	0.38	1.03	0.0650				
No	61/173	24	1.00							
Malignant cells in effusion										
Yes	21/84	12	2.10	1.47	3.00	**<0.0001**	2.71	1.73	4.24	**<0.0001**
No	60/120	41	1.00				1.00			
Chest radiation within 1 yr										
Yes	12/33	24	1.31	0.82	2.09	0.2620				
No	70/179	29	1.00							
Clinical tamponade										
Yes	26/82	24	1.38	0.98	1.96	0.0670				
No	56/130	31	1.00							
Echocardiographic tamponade										
Yes	52/144	25	1.29	0.89	1.89	0.1820				
No	30/68	34	1.00							
Pericardial effusion size, cm										
<2	11/18	52	1.89	0.88	4.06	0.1020				
≥2	71/194	26	1.00							
Macroscopic findings										
Hemorrhagic	40/102	31	1.02	0.72	1.44	0.9070				
Nonhemorrhagic	42/110	26	1.00							
Blood thinner usage										
Yes	41/107	30	0.84	0.59	1.18	0.3080				
No	41/105	27	1.00							
Drainage duration, days						**0.0198***				**0.0128***
≤2	16/50	25	1.00				1.00			
3-5	55/119	33	0.70	0.46	1.06	0.0900	0.59	0.37	0.94	**0.0268**
≥6	11/43	18	1.25	0.77	2.03	0.3690	1.08	0.63	1.86	0.7770

*Overall significance of the parameter. p values <0.05 are in **bold**.
CI = confidence interval; HR = hazard ratio.

an effective treatment modality with a low recurrence rate. The low complication rates that we observed showed that the procedure is well tolerated and safe, even in patients with thrombocytopenia. In addition, we found that malignant PE seems to significantly affect the survival outcome of patients with lung cancer but not those with breast cancer.

Previously published data showed that surgical approaches (pericardial window, pericardioperitoneal shunt creation, and/or pericardiectomy) are associated with the highest success rate, ranging from 87% (17) to 100% (18), with a complication rate of 4.7% and rare mortality (1). In contrast, Jama et al. (1) reported that percutaneous pericardiocentesis with or without extended catheter drainage had an overall low success rate of 60%, and many patients required further intervention for effusion recurrence. They also noted a high procedure-related complication

CENTRAL ILLUSTRATION **Pericardiocentesis in Cancer Patients: Overall Survival Based on Presence of Malignant Cells in PE**



El Haddad, D. et al. J Am Coll Cardiol. 2015; 66(10):1119–28.

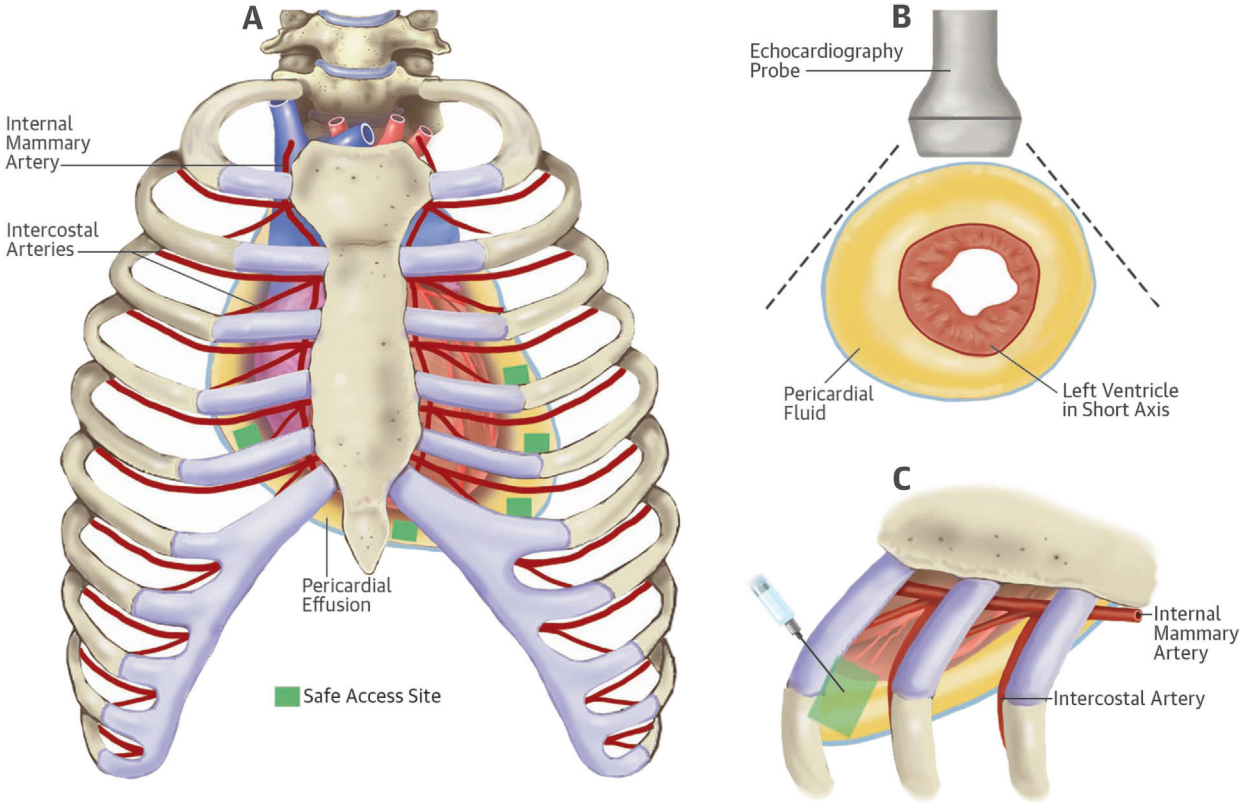
As seen in the Kaplan-Meier curve for the entire cohort, patients without malignant cells in pericardial effusion (PE) survived significantly longer than those with malignant cells: 344 days (95% confidence interval: 166 to not estimable) versus 71 days (95% confidence interval: 45 to 104).

rate (8%). Although administration of sclerosing agents after pericardiocentesis was associated with an overall higher success rate (88%), the use of these agents was linked to a higher rate of complications and morbidities (20%). Our percutaneous pericardiocentesis success rate of 99%, low recurrence rate of 12%, and acceptable major complications rate of 2.5% all compare favorably with those of surgery.

CLINICAL CHARACTERISTICS. In our institution, lung cancer was the most common malignancy associated with PE, followed by hematologic malignancies, including leukemia and lymphoma; these outcomes are similar to findings of other studies (4,11,19). Unlike previously published data (4,10,11), however, breast cancer was responsible for only 10% of PEs in our patient population. These findings are possibly related to referral pattern (a very high number of leukemia and lymphoma patients are treated at our institution).

The mechanism of effusion was proven to be related to direct cancer involvement of the pericardium in only 41% of cases. Beyond these, 4 (2%) patients had infectious etiologies (2 bacterial, 1 viral, and 1 fungal). PE etiology was undetermined in the remaining cases (57%). It has been suggested that the etiologic mechanism of nonneoplastic and noninfectious effusions in cancer patients is related to obstruction of the mediastinal lymphatic system by tumor infiltration or radiotherapy-induced fibrosis. Other suggested mechanisms include inflammation or fluid retention triggered by

FIGURE 2 Left Ventricle in Short Axis Access Site Selection for Percutaneous Pericardiocentesis



Access site selection for percutaneous pericardiocentesis is based on the detection of the shortest distance to the largest fluid pocket within the pericardial space detected by echocardiography. This site selection can be achieved after careful bedside scanning from multiple directions. Needle and catheter insertion are performed while avoiding the intercostal and internal mammary artery structures. **(A)** The anterior view of the rib cage with the internal mammary arteries and intercostal arteries in **red** and pericardial fluid in **yellow**. The **small green squares** mark the location of the safe access sites. **(B)** Sample of short-axis echocardiographic views to help select the shortest distance to the largest fluid pocket. **(C)** The needle and catheter insertion site performed while avoiding the intercostal and the internal mammary arteries.

certain chemotherapies (e.g., anthracyclines, dasatinib) (20–22).

Procedural indications included symptomatic PE with overt or impending tamponade (72%), large asymptomatic effusions (25%), and need for tissue diagnosis to guide cancer management (3%). Thus, most of the procedures were performed under emergent circumstances. Draining large asymptomatic PE is part of the clinical practice algorithm at our cancer center and is based on clinical experience, and it is extrapolated from published data (23) showing that up to one-third of large asymptomatic PEs can progress into tamponade without earlier symptoms. We commonly observed this outcome in our patient population, in whom significant fluid shift often occurs with cancer therapy.

TABLE 3 Complications Related to Percutaneous Pericardiocentesis

Minor	Nonsustained supraventricular tachycardia	37 (17.0)
	Pericardial catheter occlusion	20 (9.0)
	Vasovagal response	7 (3.0)
	Ventricular tachycardia	6 (3.0)
	Small pneumothorax (on radiograph)	1 (0.5)
	Transient chamber entry	1 (0.5)
Major	Bacteremia due to catheter placement	2 (1.0)
	Intercostal artery laceration requiring surgery	1 (0.5)
	Pneumothorax requiring chest tube placement	1 (0.5)
	Liver laceration requiring surgery	1 (0.5)

Values are n (%).

PROCEDURE-RELATED COMPLICATIONS. Similar to the findings of Lindenberger et al. (24), supraventricular arrhythmia was the most common procedure-related complication. This complication is likely related to mechanical irritation or inflammation triggered by the draining catheter. The 2 catheter-related

infections observed were due to prolonged catheter placement (>7 days). Overall, 79 (37%) patients had thrombocytopenia (platelet counts <150,000/μl), including 35 (17%) patients with severe thrombocytopenia (platelet counts ≤50,000/μl). Following the standard transfusion guidelines (16,25-27), all 35 patients had platelet transfusions before, during, or immediately after pericardiocentesis. No major bleeding complications requiring surgery were noted in these patients; 2 other patients with platelet counts of 87,000/μl and 205,000/μl experienced grade 3 bleeding. Although the low number of bleeding events did not allow meaningful comparison between the different platelet subgroups, it is clinically important to note the low incidence of bleeding complications in those with thrombocytopenia.

Recurrence rates vary according to type of procedure and duration of follow-up. Simple pericardiocentesis without pericardial drainage has been shown to be associated with the highest rate of effusion recurrence, ranging from 33% to 55% (4,10,24), whereas extended catheter drainage is reportedly associated with a recurrence rate of 13% to 45% (1,4,28). In contrast, chemical pericardiodesis was associated with a recurrence rate of 12% but was responsible for a much higher complication rate (21%). The surgical method has shown the best overall recurrence rate (7%) reported thus far (1). Of our patients, 95% had extended catheter drainage, and 5% had simple pericardiocentesis without any drain placement. Of those with no extended drainage, 23% had recurrence, in contrast to the lowest recurrence rate (10%) observed when the draining catheter was kept in place for 3 to 5 days. Thus, a catheter drainage duration of 3 to 5 days seems ideal, with optimal efficacy and lowest risk for pericardial infection. In cases of recurrence, a more definitive therapy is usually needed, such as repeated pericardiocentesis; of the 26 patients with recurrent PE in our study, 62% had malignant PE.

Thirty-eight patients died within 30 days of the procedure, but their deaths were related to cancer disease progression or other severe comorbidities (e.g., sepsis, pulmonary embolism, multiple organ failure). No procedure-related deaths were reported. The overall median survival of the cohort was 143 days (95% CI: 95 to 221), and 130 patients died within 2 years of the procedure. Patients with malignant cells in their effusion specimens reportedly have shorter overall survival compared with patients with nonmalignant findings (29). However, our data suggest that this observation varies according to type of malignancy. The presence of pathologically proven malignant effusion seemed to significantly affect the survival of patients with lung cancer but not those with breast cancer. This difference was observed despite the fact that breast cancer was associated with a higher incidence (76%) of malignant effusions than was lung cancer (61%).

STUDY LIMITATIONS. Being a retrospective chart review, the choice of method and entry site, imaging guidance, and placement of catheter for extended drainage were all dependent on the operator and the patient's general status (possible selection bias). Our patient population's initial performance status could not be obtained from the data collected, and whether patients experienced a benefit of symptom relief or an improved short-term quality of life after pericardiocentesis could not be measured, especially in those with end-stage tumors.

CONCLUSIONS

Percutaneous pericardiocentesis with extended catheter drainage, as the primary treatment of PE in cancer patients, was safe and effective even in those with thrombocytopenia. It was associated with an acceptable recurrence rate, and our data suggest that catheter drainage for 3 to 5 days is associated with the most optimal efficacy/risk ratio. The presence of proven malignant cells in PE seemed to significantly affect the survival of patients with lung cancer but not those with breast cancer.

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PERSPECTIVES

COMPETENCY IN PATIENT CARE AND PROCEDURAL SKILLS: Percutaneous pericardiocentesis with continuous drainage for 3 to 5 days is generally a safe and effective strategy for PE management in patients with cancer, even when thrombocytopenia is present.

TRANSLATIONAL OUTLOOK: Further studies are needed to assess the safety and efficacy of continuing systemic anticoagulant therapy during extended catheter drainage of PE in patients with cancer, given the concurrent risk of venous thromboembolism.

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