

Risk Factors Associated with Mortality After Pericardial Window in Hospitalized Patients — A Retrospective Analysis

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ABSTRACT

Introduction: Chronic pericardial effusion is a common pericardial syndrome associated with multiple etiologies. Most studies report good outcomes and success rate after pericardial window, although mortality varies. This study aimed to identify risk predictors for mortality in addition to determining factors associated with in-hospital mortality over a 30-day period in patients who underwent surgical pericardial window.

Methods: We retrospectively reviewed case files from patients who underwent pericardial window for the treatment of pericardial effusion from 2007 to 2023.

Results: One hundred and two patients were included in our analysis, with an overall hospitalized mortality after pericardial window of 28% (n = 29). When assessing etiology, mortality was similar between all causes of effusion

($P = 0.359$). In echocardiography, there was a significantly lower left ventricular ejection fraction ($P = 0.016$) in patients who died after the surgical procedure. Similarly, the presence of cardiac cavity collapse before the procedure was significant for an increase in mortality ($P \leq 0.0001$). Logistic and Cox regression analysis showed that cardiac cavity collapse, complications, and lung cancer were associated with increased postoperative mortality following pericardial window.

Conclusion: Although surgical pericardial window offers feasible treatment with good success rates, in-hospital mortality is elevated, particularly in patients with cardiac cavity collapse and complications.

Keywords: Pericardial Effusion. Tamponade. Hospital Mortality. Stroke Volume.

Abbreviations, Acronyms & Symbols

AHT	= Arterial hypertension
CCC	= Cardiac cavity collapse
CI	= Confidence interval
CKD	= Chronic kidney disease
DM	= Diabetes mellitus
HR	= Hazard ratio
INER	= Instituto Nacional de Enfermedades Respiratorias “Dr Ismael Cosío Villegas”
IQR	= Interquartile range
LAC	= Left atrial collapse
LVC	= Left ventricular collapse
LVEF	= Left ventricular ejection fraction
OR	= Odds ratio
PASP	= Pulmonary artery systolic pressure
RAC	= Right atrial collapse
RVC	= Right ventricular collapse
VATS	= Video-assisted thoracic surgery

INTRODUCTION

Chronic pericardial effusion is a common pericardial syndrome that is associated with multiple etiologies, which include oncological, uremic, autoimmune, or metabolic^[1,2]. Patients with pericardial effusion may present clinically with dyspnea, orthopnea, chest pain, or fatigue. In severe cases, patients may progress to clinical tamponade with imminent circulatory collapse^[3]. Diagnosis for chronic pericardial effusion may be clinical, although the mainstay approach is through echocardiography due to its high sensitivity and specificity^[4,5]. Multiple therapies have been developed to treat pericardial effusion in order to prevent tamponade. Treatment options include pericardiocentesis and surgery. Surgery, particularly pericardial window, is favored for large effusions and recurrent cases, offering a definitive solution by enabling continuous effusion drainage^[6]. Most studies report good outcomes after surgical drainage with a success rate after pericardial window of 98 - 99% and with an overall postprocedural mortality of 5 - 13%, although it varies between studies^[7]. Similarly, 30-day postoperative mortality has been reported to reach 25%^[8,9]. This study aimed to identify risk predictors for mortality in addition to determine factors associated with in-hospital mortality over a 30-day period in patients who underwent surgical pericardial window.

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METHODS

This study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Our research project was approved by the Ethics and Research Committee of the Instituto Nacional de Enfermedades Respiratorias “Dr Ismael Cosío Villegas” (INER) with the following approval number: C41-24. We retrospectively reviewed case files from patients who underwent pericardial window for the treatment of pericardial effusion at INER from 2007 to 2023. We included patients with chronic pericardial effusion, regardless of etiology, who underwent drainage through a surgical pericardial window. Consent was waived by the Ethics Committee of our institution. Demographic data obtained from files were age and sex. In contrast, clinical and surgical data gathered were diagnosis at admission, comorbidities, pericardial window technique, pericardial and pleural fluid quantification in the operating room, and cause of death. Echocardiographic information obtained was calculated effusion, left ventricular ejection fraction (LVEF), pulmonary artery systolic pressure (PASP), and the presence of cardiac cavity collapse (CCC). The primary outcome that was evaluated in our study was predictors for mortality after pericardial drainage and factors associated with a 30-day postprocedural mortality.

Statistical Analysis

Categorical variables were presented as frequencies with percentages (%), while continuous data was presented as means with standard deviation/standard error when data was normally distributed or median with interquartile range when data had a non-normal distribution. Data distribution was ascertained through the Kolmogorov-Smirnov test. Data from patients with hospital discharge was compared vs. patients with in-hospital mortality after pericardial window. Bivariate analysis was performed using unpaired two-tailed Student's *t*-test (Mann-Whitney U for skewed data) or Chi-square test and Fisher's exact test. For the

primary outcome, multivariate logistic regression was conducted to determine the odds ratio between variables and mortality, in addition to the Cox proportional hazards model to determine the hazard ratio (HR) of variables over 30-day postoperative mortality. Regression analysis was carried out with a stepwise significance method, including those variables that resulted in significant differences in the bivariate analysis. Results were plotted in survival curves. Missing data were imputed based on variable type and distribution, but only when preoperative ultrasound data were available. Imputation was fulfilled only when the missing values did not exceed 10%. Values were replaced by the variable median when data was skewed, with the mean when there was a normal distribution, and with the mode for categorical variables^[10]. Statistical analysis was carried out with IBM Corp. Released 2017, IBM SPSS Statistics for Windows, version 25.0, Armonk, NY: IBM Corp. Statistical significance was defined by a confidence interval (CI) of 95% and a *P*-value of < 0.05.

RESULTS

A total of 123 cases were reviewed for analysis, and 21 patients were excluded from our study due to missing data from their files. One hundred and two patients were included in our analysis, with an overall hospitalized mortality after pericardial window of 28% (*n* = 29). Patients' demographics and baseline characteristics are presented in Table 1. The conditions associated with pericardial effusion included oncological in 80 patients (78%), rheumatological in 10 (10%), and other causes (infectious, uremic) in 12 (12%). Malignancies in our cohort included lung cancer (*n* = 63), lymphoma (*n* = 6), breast cancer (*n* = 4), and other malignancies (mesothelioma, sarcoma, and mediastinal tumors) (*n* = 7). Prior to drainage, eight patients presented with pneumonia. All of the patients included underwent perioperative echocardiographic evaluation. The median amount of estimated pericardial fluid was 500 ml (317 - 777). CCC was present in 67 patients (65%), which was reflected in a median PASP of 33 mmHg (23 - 40),

Table 1. Patients' demographics.

		Patients (n = 102)
Age [§]		55 (41 - 63)
Sex, female (%)		53 (51)
DM, n (%)		14 (13.7)
CKD, n (%)		6 (5.8)
AHT, n (%)		20 (19.6)
Etiology, n (%)	Oncological	80 (78)
	Rheumatological	10 (9.8)
	Other	12 (11.7)
Pericardial effusion, ml [§]		500 (300 - 700)
Complications, n (%)		58 (56.8)
Hospitalization [§]		17 (14 - 22)
Death, n (%)		29 (28.4)

AHT=arterial hypertension; CKD=chronic kidney disease; DM=diabetes mellitus

[§]values are median (25 - 75th)

although no apparent impact was observed in LVEF with an overall mean of 70% (± 8.9). The most commonly collapsed heart chamber was the right atrium (61%), followed by the left atrium (27%), right ventricle (23%), and the left ventricle (5%).

The indications for drainage in our study were hemodynamic instability in 67%, clinical effusion in 23%, and diagnostic purposes in 11%. Surgical variables analyzed were pericardial effusion, pleural effusion, and surgical technique. Similarly to what was observed in the echocardiographic evaluation, the median amount of pericardial fluid drained was 530 ml (300 - 700). In addition to pericardial effusion, 75 (74%) patients presented with associated pleural effusion with an overall median drained fluid of 728 ml (10 - 1000). Surgical pericardial window was obtained in our patients through thoracotomy (62%), subxiphoid (25%), thoracoscopy (11%), and sternotomy (2%) approach. Postoperatively, 58 (57%) patients presented complications. The hospitalization period in our study ranged from 14 to 23 days, with a median of 17 days.

When evaluating demographic variables, there was no difference between hospital discharge and in-hospital mortality. Furthermore, we decided to evaluate the impact of age groups by comparing mortality between patients aged < 60 vs. > 60 years, although this did not differ significantly ($P = 0.458$). When assessing etiology, mortality was similar between all causes of pericardial effusion ($P = 0.359$), oncological causes of pericardial effusion ($P = 0.316$), and when comparing oncological vs. non-oncological causes of effusion ($P = 0.229$).

In echocardiography, there was a significantly lower LVEF ($P = 0.016$) in patients who died after the surgical procedure, with a comparative mean of 71% (± 8) vs. 66% (± 10). Results are presented in Table 2. Similarly, the presence of CCC before the procedure was statistically significant for an increase in mortality ($P \leq 0.0001$), which was present in 96% ($n = 28$) of patients who died after surgery (Figure 1), compared to 53% ($n = 39$) of patients that were discharged. In addition, when evaluating the presence of a collapsed heart chamber individually, these were significant, with the exception of left atrial collapse. In the patients that died following pericardial window, the median volume of pericardial fluid drained was significantly higher ($P = 0.011$), in addition to the complication rate, which was statistically higher in patients of the

mortality group (85% vs. 45%, $P \leq 0.0001$). Our comparative analysis of patient variables and mortality is presented in Table 3.

Risk Factors For Increased In-Hospital Mortality

Logistic regression results are presented in Table 4A. Variables included for multivariate analysis were considered when a relationship was encountered in bivariate analysis. This resulted in the following variables being included: CCC, LVEF, right atrial collapse, right ventricular collapse, left ventricular collapse, volume of pericardial fluid, and presence of complications. The analysis resulted in significant findings for CCC and complications, which were associated with increased postoperative mortality following pericardial window. We also decided to conduct a multivariate analysis for the collapsed cardiac cavities, which resulted in significant findings for right atrial and left ventricular collapse. Results are presented in Table 4B.

Factors Associated With 30-Day In-Hospital Mortality

When evaluating mortality over the described period, both CCC and complications after surgery were statistically significant, in addition to patients who presented with lung cancer, although mortality in oncological vs. non-oncological causes of effusion remained without a statistical difference (HR .711; 95% CI .357 - 4.53; $P = 0.711$) (Table 5). Survival curves are plotted in Figure 2.

DISCUSSION

This study determined the variables associated with postoperative mortality in hospitalized patients with chronic pericardial effusion following surgical pericardial window. Our cohort exhibited a higher postoperative in-hospital mortality (28%) than reported in the literature (16.3% - 24%)^[9,11,12]. The elevated postoperative mortality in our study may be due to the proportion of patients that presented with CCC, which reached 65% in our cohort, compared to other studies, such as the one by Langdon et al.^[6], in which the overall rate for CCC was 50%, with an overall mortality of 7%. However, mortality was reported in the perioperative setting in this

Table 2. Analysis comparing mortality with preoperative echocardiographic findings.

	Death (n = 29)	Discharge (n = 73)	P-value
Effusion [§]	701 (300 - 700)	548 (400 - 900)	0.051
LVEF	66 $\pm$ 10	71 $\pm$ 8	0.016*
PASP [§]	35 (25 - 41)	33 (21 - 38)	0.282
CCC, n (%)	28 (96)	39 (53)	$< 0.0001^*$
RAC, n (%)	25 (86)	37 (50)	0.001*
RVC n (%)	12 (41)	11 (15)	0.004*
LAC, n (%)	11 (37)	16 (21)	0.098
LVC, n (%)	4 (13)	1 (1.3)	0.0022*

CCC=cardiac cavity collapse; LAC=left atrial collapse; LVC=left ventricular collapse; LVEF=left ventricular ejection fraction; PASP=pulmonary artery systolic pressure; RAC=right atrial collapse; RVC=right ventricular collapse

[§]median (25 - 75th), * $P < 0.05$

Mortality After Pericardial Window

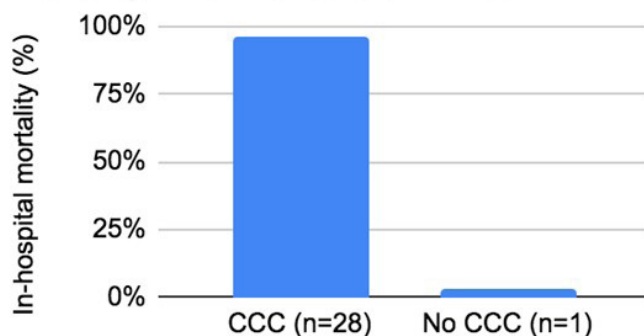


Fig. 1 - Comparison between the presence or absence of cardiac cavity collapse (CCC) in patients who died following pericardial window.

study. In our set of patients, oncological effusions predominated, with lung cancer being the most common associated malignancy. However, this may not accurately reflect the true prevalence of diseases causing pericardial effusion, as our hospital is a tertiary care center for lung cancer, which has been previously identified as the most common cause of oncologic pericardial effusion^[5]. When evaluating mortality with regards to the different etiologies, this did not differ, which contrasts with the report from Dosios et al.^[11] and Mirhosseini et al.^[13], in which the authors describe increased overall mortality for patients with pericardial effusion associated with oncological causes in addition to increased mortality for patients

with lung cancer associated with the effusion. In our cohort, only the latter was observed. Interestingly, when evaluating 30-day postoperative mortality in the oncological group in the former, it reached 28%, similar to our results^[11].

In our study, oncological patients had an overall mortality of 31%, compared to the mortality of non-oncological causes of effusion, which was only 18%. Even though this result was not significantly different, this may be associated with the small number of patients with non-oncological causes of effusion that were included in this study. In addition, differences in mortality between causes of effusion may lack significance because of the acute setting in which this study was undertaken. In contrast, studies with extended follow-up durations are better positioned to capture the natural course of advanced malignant disease, which may contribute to an increased overall mortality in oncological patients, but independent to the presence of effusion or the drainage method. This is further reflected in our analysis for 30-day mortality in lung cancer patients, which showed higher mortality rates following pericardial window, owing to the association between advanced oncological disease and effusion^[5]. Nonetheless, the increased mortality may also be explained by the fact that cardiac tamponade is a common manifestation of oncological effusions, particularly in lung cancer^[14]. Both factors likely contributed to the increased postoperative mortality observed in this set of patients in our study.

Treatment Strategies

Overall mortality did not differ significantly between surgical techniques, with the exception of the two patients who underwent sternotomy, both of whom were discharged after successful pericardial window. This apparent difference in mortality should be

Table 3. Comparative analysis.

		Death (n = 29)	Discharge (n = 73)	P-value
Age ^s		56 (46 - 62)	55 (42 - 64)	0.853
Sex, female (%)		14 (48)	39 (53)	0.639
Comorbidities, n (%)		8 (27)	24 (32)	0.603
Etiology, n (%)	Oncological	25 (86)	55 (75)	0.359
	Rheumatological	1 (3.4)	9 (12)	
	Other	3 (10)	9 (12)	
Oncological, n (%)		25 (86)	55 (75)	0.229
Lung cancer, n (%)		18 (62)	45 (61)	0.968
Effusion, ml [§]		600 (400 - 800)	400 (300 - 600)	0.014*
Pleural effusion, ml (IQR)		500 (10 - 1200)	500 (50 - 900)	0.590
Surgery (%)	Thoracotomy	19 (65)	45 (61)	0.837
	Subxiphoid	7 (24)	18 (24)	
	Sternotomy	0	2 (2.7)	
	VATS	3 (10)	8 (10)	
Complications (%)		25 (86)	33 (45)	< 0.0001*

IQR=interquartile range; VATS=video-assisted thoracic surgery

[§]Pericardial effusion is equivalent to the quantification during surgery

^smedian (25 - 75th); *P < 0.05

Table 4A. Multivariate analysis for variables associated with mortality.

	OR	95% CI	P-value
Pericardial effusion [†]	1.001	0.999 - 1.003	0.162
LVEF	.942	0.877 - 1.013	0.107
CCC	38	4.51 - 332.05	0.001*
Complications	11.7	3.189 - 43	< 0.0001*

CCC=cardiac cavity collapse; CI=confidence interval; LVEF=left ventricular ejection fraction; OR=odds ratio

*P < 0.05; [†]Pericardial effusion is equivalent to the quantification during surgery**Table 4B.** Multivariate analysis showing the impact of each cardiac cavity that was collapsed.

	OR	95% CI	P-value
RAC	6.24	1.603 - 24.3	0.008*
RVC	1.69	.568 - 5	0.343
LVC	18	1.36 - 240	0.028*

CI=confidence interval; LVC=left ventricular collapse; OR=odds ratio; RAC=right atrial collapse; RVC=right ventricular collapse

*P < 0.05

Table 5. Multivariate analysis of factors associated with 30-day postoperative mortality.

	HR	95% CI	P-value
CCC	29.34	2.87 - 299.43	0.004*
Complications	6.33	1.7 - 22.87	0.005*
Lung cancer	3.4	1.16 - 9.96	0.025*
Oncological	1.27	0.357 - 4.53	0.711

CCC=cardiac cavity collapse; CI=confidence interval; HR=hazard ratio

*P < 0.05

interpreted cautiously given the small number of sternotomies (n = 2) compared to other techniques (thoracotomy, n = 64; subxiphoid, n = 25; video-assisted thoracic surgery, n = 11). In chronic pericardial effusion, treatment strategies are usually focused not only on immediate symptom relief and life-saving maneuvers but also on preventing recurrence, in which surgical pericardial window appears to offer the best long-term results^[15]. Unfortunately, treatment for chronic pericardial effusion is still based solely on institutional experience. In contrast, for life-threatening cardiac tamponade, treatment strategies tend towards pericardiocentesis. However, emergency drainage should be implemented through the institutions' experience without delaying treatment^[2,16].

Even though most centers prefer treating patients through sole surgical drainage or pericardiocentesis, opting for pericardiocentesis prior to surgical drainage may benefit patients by preventing complications and mortality by decreasing intrapericardial pressure gradually, alternatively to an abrupt change in pressure^[17]. For both chronic pericardial effusion and tamponade, our institution prefers surgical pericardial window, in addition to pericardiocentesis for patients too hemodynamically unstable to be submitted to general anesthesia, followed by surgical drainage.

Factors Associated with Mortality

The increased proportion of CCC and postoperative complications in relation to mortality have been previously presented by Mirhosseini et al.^[13] who described a positive correlation between mortality and the presence of preoperative cardiac tamponade. Consistent with our findings, their study did not identify the amount of pericardial fluid drained as a significant predictor of survival, which differs from the findings of Wagner et al.^[18]. This difference in results regarding the impact of pericardial fluid volume is probably more associated with the presence of tamponade than with fluid collection itself. In chronic pericardial effusion, slow accumulation of fluid allows for the distention of the pericardial layers, which can reach volumes of 1 – 2 L, until fluid accumulation reaches a critical point and tamponade occurs, leading to an apparent increase in mortality associated with the fluid volume^[13,19].

To our knowledge, the utilization of cardiac cavities as a prognostic measure has not been widely done. However, its utilization in diagnosing cardiac tamponade is commonly implemented^[20]. This has been shown in the report by Mercé et al.^[21], who found a good correlation between the absence of CCC and tamponade.

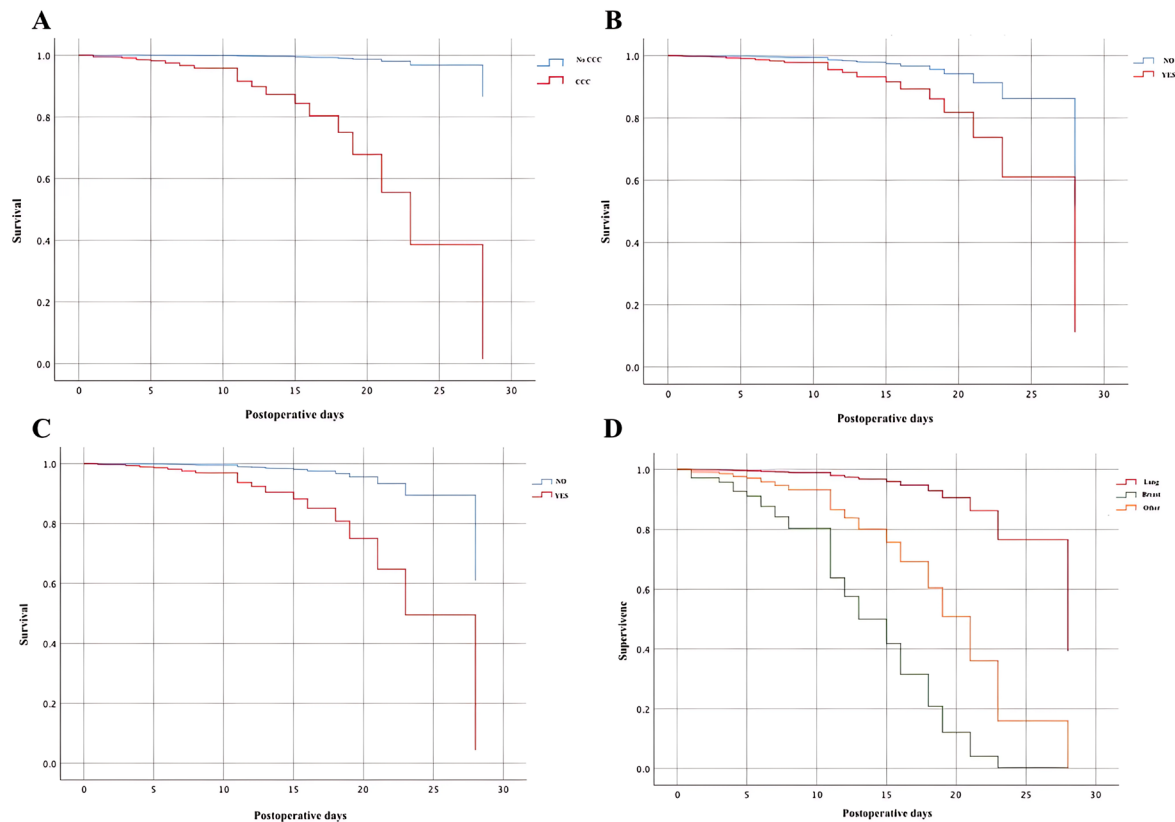


Fig. 2 - Survival curves. A) Overall survival of patients with cardiac cavity collapse (CCC) vs. no CCC after pericardial window ($P = 0.004$). B) Postoperative survival of patients with lung cancer vs. no lung cancer ($P = 0.025$). C) Survival curves for postoperative mortality in patients with and without complications ($P = 0.005$). D) Overall survival comparing oncological causes of effusion ($P = 0.711$).

Regarding the impact of the collapsed cavities on patient survival, we hypothesize this may be similar to the deleterious effects of acute heart failure. Collapse of the chambers leads to systemic hypoperfusion and fluid overload, further compromising patients' hemodynamics^[22]. These detrimental effects may be perpetrated by the stress exerted on patients by surgery, leading to systemic impairment beyond the postoperative period that influences overall mortality.

Limitations

Several limitations should be acknowledged in our study. The retrospective nature introduces potential biases related to data collection and patient selection. Furthermore, the absence of postoperative ultrasound limits our ability to assess changes in cardiac contractility following drainage. Finally, the study's shortened follow-up period limits our knowledge of long-term factors associated with patient survival.

CONCLUSION

Although surgical pericardial window offers feasible treatment with good success rates, in-hospital mortality is elevated in advanced

oncological disease, particularly in lung cancer, patients with CCC, and complications. Future treatment strategies and guidelines should prioritize not only symptom management and recurrence prevention but also the implementation of strategies that minimize hemodynamic impact and optimize patient-centered outcomes. This may prevent prolonged hospitalization periods and have a positive influence on patients in whom end-of-life care becomes crucial in treatment decisions.

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Authors' Roles & Responsibilities

PGSR	Substantial contributions to the conception and design of the work; and the acquisition and analysis of data for the work; drafting the work and revising it; final approval of the version to be published
JCRM	Substantial contributions to the design of the work; and the acquisition of data for the work; final approval of the version to be published
OMDC	Substantial contributions to the conception and design of the work; and the interpretation of data for the work; revising the work; final approval of the version to be published

REFERENCES

- Kabukcu M, Demircioglu F, Yanik E, Basarici I, Ersel F. Pericardial tamponade and large pericardial effusions: causal factors and efficacy of percutaneous catheter drainage in 50 patients. *Tex Heart Inst J*. 2004;31(4):398-403.
- Lazaros G, Imazio M, Tsioufis P, Lazarou E, Vlachopoulos C, Tsioufis C. Chronic pericardial effusion: causes and management. *Can J Cardiol*. 2023;39(8):1121-31. doi:10.1016/j.cjca.2023.02.003.
- Adler Y, Ristić AD, Imazio M, Brucato A, Pankuweit S, Burazor I, et al. Cardiac tamponade. *Nat Rev Dis Primers*. 2023;9(1):36. doi:10.1038/s41572-023-00446-1.
- Baqi A, Ahmed I, Shams P. Best management of patients with malignant pericardial effusion: a comparative study between imaging-guided pericardiocentesis and surgical pericardial window. *J Clin Transl Res*. 2023;9(3):206-11.
- Mori S, Bertamino M, Guerisoli L, Stratoti S, Canale C, Spallarossa P, et al. Pericardial effusion in oncological patients: current knowledge and principles of management. *Cardiooncology*. 2024;10(1):8. doi:10.1186/s40959-024-00207-3.
- Langdon SE, Seery K, Kulik A. Contemporary outcomes after pericardial window surgery: impact of operative technique. *J Cardiothorac Surg*. 2016;11(1):73. doi:10.1186/s13019-016-0466-3.
- Horr SE, Mentias A, Houghtaling PL, Toth AJ, Blackstone EH, Johnston DR, et al. Comparison of outcomes of pericardiocentesis versus surgical pericardial window in patients requiring drainage of pericardial effusions. *Am J Cardiol*. 2017;120(5):883-90. doi:10.1016/j.amjcard.2017.06.003.
- Omran T, Elgariah M. Surgical pericardial window versus pericardiocentesis in patients with pericardial effusion indicated for drainage. *Egypt J Hosp Med*. 2023;91(1):5130-4. doi:10.21608/ejhm.2023.303643.
- Lee J, Kim K, Gwak SY, Lee HJ, Cho I, Hong GR, et al. Pericardiocentesis versus window formation in malignant pericardial effusion: trends and outcomes. *Heart*. 2024;110(12):863-71. doi:10.1136/heartjnl-2023-323542.
- Talavera JO, Roy-García I, Díaz-Torres ST, Palacios-Cruz L, Noguez-Ramos A, Pérez-Rodríguez M, et al. Expresión numérica del curso clínico de la enfermedad. Manejo de datos. *Rev Med Inst Mex Seguro Soc*. 2023;61(Suppl 3):S503-9. doi:10.5281/zenodo.8319834.
- Dosios T, Theakos N, Angouras D, Asimacopoulos P. Risk factors affecting the survival of patients with pericardial effusion submitted to subxiphoid pericardiostomy. *Chest*. 2003;124(1):242-6. doi:10.1378/chest.124.1.242.
- Lieberman M, Labos C, Sampalis JS, Sheiner NM, Mulder DS. Ten-year surgical experience with nontraumatic pericardial effusions: a comparison between the subxiphoid and transthoracic approaches to pericardial window. *Arch Surg*. 2005;140(2):191-5. doi:10.1001/archsurg.140.2.191.
- Mirhosseini SM, Fakhri M, Mozaffary A, Lotfaliany M, Behzadnia N, Ansari Aval Z, et al. Risk factors affecting the survival rate in patients with symptomatic pericardial effusion undergoing surgical intervention. *Interact Cardiovasc Thorac Surg*. 2013;16(4):495-500. doi:10.1093/icvts/ivs491.
- Imazio M, Demichelis B, Parrini I, Favro E, Beqaraj F, Cecchi E, et al. Relation of acute pericardial disease to malignancy. *Am J Cardiol*. 2005;95(11):1393-4. doi:10.1016/j.amjcard.2005.01.094.
- Petrella F, Radice D, Colombo N, Mariolo AV, Diotti C, de Marinis F, et al. Pericardial-peritoneal window for malignant pericardial effusion. *Shanghai Chest*. 2018;2:45-45. doi:10.21037/shc.2018.06.03.
- Adler Y, Charron P, Imazio M, Badano L, Barón-Esquivias G, Bogaert J, et al. 2015 ESC guidelines for the diagnosis and management of pericardial diseases: the task force for the diagnosis and management of pericardial diseases of the European society of cardiology (ESC) endorsed by: the European association for cardio-thoracic surgery (EACTS). *Eur Heart J*. 2015;36(42):2921-64. doi:10.1093/eurheartj/ehv318.
- Celik S, Celik M, Aydemir B, Tanrikulu H, Okay T, Tanrikulu N. Surgical properties and survival of a pericardial window via left minithoracotomy for benign and malignant pericardial tamponade in cancer patients. *World J Surg Oncol*. 2012;10:123. doi:10.1186/1477-7819-10-123.
- Wagner PL, McAleer E, Stillwell E, Bott M, Rusch VW, Schaffer W, et al. Pericardial effusions in the cancer population: prognostic factors after pericardial window and the impact of paradoxical hemodynamic instability. *J Thorac Cardiovasc Surg*. 2011;141(1):34-8. doi:10.1016/j.jtcvs.2010.09.015.
- Imazio M, Adler Y. Management of pericardial effusion. *Eur Heart J*. 2013;34(16):1186-97. doi:10.1093/eurheartj/ehs372.
- Sagrístá Sauleda J. Decisiones clínicas basadas en técnicas de imagen (I). Diagnóstico y guía terapéutica del paciente con taponamiento cardíaco o constricción pericárdica. *Rev Esp Cardiol*. 2003;56(2):195-205. doi:10.1016/s0300-8932(03)76845-6.
- Mercé J, Sagristá-Sauleda J, Permanyer-Miralda G, Evangelista A, Soler-Soler J. Correlation between clinical and Doppler echocardiographic findings in patients with moderate and large pericardial effusion: implications for the diagnosis of cardiac tamponade. *Am Heart J*. 1999;138(4 Pt 1):759-64. doi:10.1016/s0002-8703(99)70193-6.
- Arrigo M, Parissis JT, Akiyama E, Mebazaa A. Understanding acute heart failure: pathophysiology and diagnosis. *Eur Heart J Suppl*. 2016;18(suppl G):G11-8. doi:10.1093/eurheartj/suw044.

