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ORIGINAL ARTICLE

Differentiation between Transudate and Exudate in Pericardial Effusion has almost no Diagnostic Value in Contemporary Medicine

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SUMMARY

Background: **The biochemical analysis of pericardial fluid for differentiating transudate from exudate is often ordered and interpreted according to the criteria extrapolated from pleural effusions. However, the validity of this discrimination when applied to pericardial effusion is under question.**
Methods: **Patients who underwent pericardiocentesis between January 2004 and February 2014 were identified. Among them, 216 had essential medical records available and constituted the study population. The parameters specifically analyzed were the following: lactate dehydrogenase, total protein and glucose concentrations in both pericardial fluid and serum; pericardial fluid/serum ratios of lactate dehydrogenase and total protein content; and pH and specific gravity of pericardial fluid.**
Results: **Eighty-one percent of pericardial effusions were classified as exudate according to Light's criteria. Both exudate and transudate fluid characteristics were possible for all etiological causes except for tuberculosis in which all were exudates. Although multiple cutoff points for all parameters were tested, significant overlap between different causes persisted (all having an area under the receiver operating characteristic curve of < 0.7). Thus, a reasonable accuracy to differentiate one cause from another could not be achieved.**
Conclusions: **Although often ordered, the biochemical analysis of pericardial fluid has almost no diagnostic value to distinguish among causes of pericardial effusion in contemporary medicine.**
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KEY WORDS

cardiac tamponade, differential threshold, exudates and transudates, pericardial effusion, pericardiocentesis

INTRODUCTION

In most cases with clinically significant pericardial effusion (moderate to large effusion with or without cardiac tamponade), the underlying etiological cause is simple to identify by the clinical setting in which it occurs. However, it may sometimes be challenging; thus, the biochemical analysis of pericardial fluid for differentiating transudate from exudate is often ordered. The results are interpreted according to Light's criteria extrapolated from pleural effusions for which the ability to

identify the underlying cause has been well-documented [1,2]. However, the validity of this approach when applied to pericardial effusion is under question because of lack of adequate evidence [3-5]. The purpose of this study is to assess the discriminatory power of biochemical analysis of pericardial fluid for the differential diagnosis among various etiologies.

MATERIALS AND METHODS

Patient population

The work undertaken is a substudy of a previously reported study focusing on pericardiocentesis [6]. Patients who underwent pericardiocentesis in a tertiary referral center between January 2004 and February 2014 were identified using hospital records. Among 318 patients, 85 did not have fluid samples sent for analysis due to known medical conditions and 17 had incomplete test results. Thus, 216 had essential medical records available and constituted the study population. The patients or their legally designated surrogates were contacted, given all the elements of informed consent, and consented to study participation. Additional data for death and diagnoses established during the following years was obtained by interviewing patients or their relatives (directly or by phone). The study was approved by the institutional review board.

Laboratory investigations

Complete blood cell count, serum creatinine, thyroid function tests, C-reactive protein, and chest X-rays were routinely ordered. Where clinically relevant, computerized tomography, magnetic resonance imaging, Gram and acid-fast staining, fluid culture for microorganisms, polymerase chain reaction and fluid concentration of adenosine deaminase for M. tuberculosis, serological testing for unusual microorganisms, serum concentrations of antinuclear antibody, rheumatoid factor and anti-dsDNA, and cytology for the presence of neoplastic cells in the fluid were done. Pericardial fluid, together with serum collected at the same time, were analyzed using standard laboratory methods for lactate dehydrogenase (LDH; using colorimetric enzymatic method with the upper limit of normal for serum being < 225 U/L), total protein (using a colorimetric biuret method with the upper limit of normal for serum being < 8.2 g/dL), glucose (using a colorimetric enzymatic method with hexokinase), pH and specific gravity.

Clinical definitions

According to Light's criteria, an exudate was defined as fulfilling any of the following: fluid LDH level > 2/3 of upper limit of normal for serum, fluid/serum LDH ratio > 0.6, and fluid/serum total protein ratio > 0.5. If none of these properties were met, the effusion was considered to be transudate. The specific diagnosis was defined according to the underlying cause in the absence of an alternative etiology. These definitions could be found elsewhere [4-6], but the ones that may be confused with each other and need to be emphasized are the following:

Acute viral/autoimmune pericarditis: Presence of two or more of the following: typical pericardial chest pain, diffuse ST segment elevation in electrocardiogram except in leads aVR and V_1, fever of > 37°C, and friction rub.

Idiopathic effusion: Inability to identify a cause consistent with effusion despite an adequate work up and a follow up of ≥ 6 months.

Indeterminate effusion: Death of a given patient in a short time period without a chance for identification of the cause, or presence of 2 or more medical conditions existing simultaneously, or patient lost to follow-up.

Statistical analysis

Continuous variables were defined as mean ± standard deviation or median [range], and categorical variables were defined as percentages. Continuous variables were checked for the normal distribution assumption using Kolmogorov-Smirnov statistics. Differences between patients and control subjects were evaluated using the Kolmogorov-Smirnov *Z* test or Student's *t*-test when appropriate. Categorical variables were tested by Pearson's $\chi 2$ test or Fisher's Exact test. Receiver-operator characteristic curves were plotted to define cutoff values of variables. Two-sided p values < 0.05 were considered statistically significant. All analyses were carried out using SPSS 18.0 for Windows (SPSS Inc., Chicago, IL, USA).

RESULTS

The clinical characteristics of the patients by etiology of effusion are presented in Table 1. Eighty-one percent (176 of 216) of pericardial effusions were classified as exudate according to Light's criteria (Table 2). The causes of *purported* transudate effusions (i.e., heart failure/severe valve disease, hypothyroidism and chronic kidney disease), which are traditionally considered to be the underlying etiological cause when a transudate effusion is present, were indeed classified as an exudate in a significant portion of the patients, whereas some patients with causes of *purported* exudate effusions (e.g., malignancy and cardiothoracic surgery) had indeed a transudate effusion (Figure 1).

None of the parameters with conventional cutoff points proved helpful to safely distinguish among various causes (Figure 2 and *e*-Figures 1-2). Thus, subsequently multiple cutoff points for all parameters including glucose concentrations, pH, and specific gravity were also tested (*e*-Figures 1-8). However, considerable overlap between different causes persisted to a degree that a reasonable accuracy to differentiate one cause from another could not be achieved. All had an area under the receiver operating characteristic curve of < 0.7. As a relevant example, median fluid/serum LDH ratio was 2.8

Table 1. Clinical characteristics of the patients by etiology of pericardial effusion.

Cause		n (%)	Age (year)	Female n (%)	Volume drained (mL)
Malignancy	Lung cancer	62 (29)	33 (15)	59.8 ± 13.1	58.1 ± 10.6	22 (35)	6 (40)	1000 [790]	1000 [810]
	Breast cancer		6 (3)		61.3 ± 11.3		6 (100)		900 [630]
	Lymphoma		2 (1)		40.5 ± 13.4		2 (100)		850 ± 210
	Other *		21 (10)		63.9 ± 15.4		8 (38)		1150 [1300]
Acute viral/autoimmune pericarditis		21 (10)		50.2 ± 19.9		11 (52)		1000 [520]	
Chronic kidney disease		17 (8)		62.1 ± 19.8		10 (59)		1280 [920]	
Tuberculosis		15 (7)		56.5 ± 19.3		5 (33)		1450 [700]	
Heart failure/Severe valve disease		11 (5)		78.3 ± 7.4		7 (64)		1000 [650]	
Hypothyroidism		10 (5)		57.8 ± 18.1		8 (80)		1100 [700]	
Cardio-thoracic surgery		9 (4)		50.1 ± 20.4		3 (33)		950 [850]	
Bacterial infection		3 (1.4)		41.0 ± 17.1		0		2100 ± 1050	
Catheter-based procedure		2 (1)		81.5 ± 12.0		1 (50)		800	
Post-myocardial infarction		2 (1)		76.0 ± 5.7		0		430 [110]	
Connective tissue disease †		2 (1)		56.5 ± 2.1		2 (100)		1050	
Crohn's disease		1 (0.4)		55		1 (100)		1650	
Idiopathic		21 (10)		66.7 ± 14.8		15 (71)		1200 [600]	
Indeterminate		40 (19)		68.9 ± 17.3		24 (60)		1000 [700]	
Total ‡		216 (100)		61.7 ± 17.6		109 (50.5)		1100 [700]	

Values are expressed as mean ± standard deviation or median [interquartile range].
*** - Kidney, stomach, and rectum (n = 2 for each); thyroid, testis, prostate, endometrium, ovary, tongue, brain, urinary bladder, and right atrium (n = 1 for each); and unknown primary origin (n = 6).**
† - Rheumatoid arthritis (n = 1) and systemic lupus erythematosus (n = 1).
‡ - The sum of the individual numbers may differ from the total number, because the indication for pericardiocentesis was not available in 1 patient with prostate cancer; pericardiocentesis was performed for only diagnostic purposes in 2 patients; and the appearance of pericardial fluid upon gross inspection was not available in 6 patients.

[range: 0.8 - 30.0] in tuberculous effusions compared to 2.6 [range: 0.1 - 14.9] in malignant effusions (p = 0.47). The corresponding area under the receiver-operating characteristic curve was 0.55 (95% confidence interval 0.40 to 0.69, p = 0.58) (Figure 3).

Of note, all tuberculous patients (n = 15) had exudate effusions with either serosanguineous or bloody appearance, in other words, none had a transudate and/or serous effusion. Whatever the underlying disease process, all bloody effusions (n = 114) were exudate as well.

Patients were followed-up for a median of 36 [range: 0 - 121] months. The reasons for an assignment as indeterminate effusion were as follows: Lost to follow-up (n = 31), death in a short time period (n = 7), and the presence of two disorders concurrently (n = 2).

DISCUSSION

Transudate fluid accumulation occurs when there is an imbalance between the hydrostatic and oncotic pressures [2]. In contrast, an exudate occurs when the local factors are altered. This mechanism is the basis for the exudate-transudate paradigm. Among several tests including fluid concentrations of cholesterol, albumin, and bilirubin, Light's criteria remain the best method for making this distinction with a sensitivity of 98% and a specificity of 74% for identifying exudates [7]. However, this is valid for pleural effusion [1]. Validity for pericardial effusion, although often ordered, is not well established.

Prior studies

To date, there have been 3 studies on the biochemical analysis of pericardial fluid [3-5]. In the studies by Meyers et al. and Burgess et al., the diagnostic accuracy of the tests was evaluated for differentiating causes of *purported* transudate effusions from the exudate ones

Table 2. Biochemical composition of pericardial fluid.

Cause		LDH				Protein				Glucose		Ph		Specific gravity	
		Fluid/Serum		Fluid/Upper limit of normal for serum		Fluid/Serum		Fluid/Upper limit of normal for serum		Fluid/Serum					
Malignancy	Lung cancer	2.6 [0.1 - 14.9]	3.3 [0.1 - 14.9]	3.9 [0.5 - 36.2]	6.2 [0.5 - 36.2]	0.8 [0.1 - 1.1]	0.9 [0.1 - 1.1]	0.6 [0.1 - 1.0]	0.6 [0.1 - 1.0]	0.7 [0.1 - 2.0]	0.7 [0.1 - 1.8]	7.6 ± 0.9	7.4 ± 1.0	1008 ± 7	1008 ± 7
	Breast cancer		2.0 [0.6 - 4.4]		3.4 [0.7 - 7.1]		0.9 [0.8 - 1.1]		0.7 [0.5 - 0.9]		0.7 [0.1 - 2.0]		7.9 ± 0.7		1010 ± 5
	Lymphoma		2.2 [1.6 - 2.9]		2.5 [1.9 - 3.2]		0.9 [0.7 - 1.1]		0.7 [0.5 - 1.0]		0.4 [0.1 - 0.8]		8.0		1010
	Other		1.6 [0.7 - 13.8]		1.8 [0.6 - 24.4]		0.8 [0.7 - 1.1]		0.6 [0.4 - 0.9]		0.9 [0.1 - 1.4]		7.6 ± 0.9		1008 ± 5
Acute viral/ autoimmune pericarditis		2.9 [0.5 - 5.7]		2.7 [0.4 - 9.1]		0.8 [0.4 - 1.1]		0.6 [0.3 - 0.8]		0.8 [0.5 - 1.5]		7.7 ± 1.3		1008 ± 8	
Chronic kidney disease		1.5 [0.2 - 21.6]		1.8 [0.3 - 28.9]		0.9 [0.3 - 1.6]		0.6 [0.3 - 0.7]		0.8 [0.1 - 1.3]		7.8 ± 1.1		1005 ± 4	
Tuberculosis		2.8 [0.8 - 30.0]		2.9 [0.8 - 44.0]		0.8 [0.6 - 1.2]		0.6 [0.4 - 0.8]		0.8 [0.2 - 1.1]		7.9 ± 1.2		1006 ± 8	
Heart failure/Severe valve disease		0.9 [0.5 - 6.3]		1.0 [0.4 - 9.8]		0.8 [0.5 - 1.1]		0.6 [0.3 - 0.8]		1.0 [0.6 - 1.3]		7.9 ± 1.1		1005 ± 5	
Hypothyroidism		0.7 [0.3 -10.1]		0.8 [0.3 - 4.8]		0.9 [0.5 - 1.3]		0.7 [0.4 - 1.0]		1.1 [0.5 - 1.5]		7.7 ± 0.8		1010 ± 8	
Cardio-thoracic surgery		1.0 [0.6 - 4.2]		1.3 [0.7 - 5.4]		0.9 [0.6 - 1.1]		0.7 [0.4 - 0.9]		0.9 [0.1 - 1.2]		8.2 ± 0.7		1003 ± 3	
Bacterial infection		2.9 [2.4 - 4.8]		5.3 [2.0 - 49.8]		0.9 ± 0.1		0.6 ± 0.1		0.1 [0.02 - 1.2]		7.2 ± 1.0		1011 ± 7	
Post-myocardial infarction		1.4 [0.1 - 2.6]		3.2 [2.0 - 4.4]		0.8 ± 0.3		0.5 ± 0.2		1.0 ± 0.1		8.0		1010	
Catheter-based procedure		4.1 ± 1.4		4.5 ± 1.1		0.8 ± 0.1		0.7 ± 0.1		1.0 ± 0.2		6.0 ± 1.4		1002 ± 3	
Connective tissue disease		2.6 [0.5 - 4.7]		2.9 [0.6 - 3.6]		0.9 ± 0.1		0.7 ± 0.1		0.8 ± 0.1		8.5 ± 0.7		1002 ± 3	
Crohn's disease		9.4		14.7		1.1		0.6		0.3		7.5		1015	
Idiopathic		3.8 [0.4 - 18.3]		4.2 [0.3 - 24.5]		0.8 [0.6 - 1.2]		0.6 [0.5 - 0.9]		0.9 [0.1 - 1.2]		7.7 ± 1.2		1006 ± 4	
Indeterminate		2.6 [0.3 - 12.9]		3.3 [0.4 - 21.0]		0.9 [0.3 - 1.3]		0.6 [0.2 - 0.9]		1.0 [0.1 - 2.5]		7.6 ± 1.2		1008 ± 9	

Values are expressed as mean ± standard deviation or median [range]. LDH - *lactate dehydrogenase*.

[4,5]. In the years these two articles were published, it used to be generally assumed or believed that normal (physiological) pericardial fluid was transudate because of a clear appearance upon gross inspection. Accordingly, normal pericardial fluid obtained during routine open-heart surgery was used in a considerable number of the patients assigned to the purported transudate group (The proportion of the patients allocated to the transudate group in this way was 21% and 66% in the studies by Meyers et al. and Burgess et al., respectively). During the following years, normal pericardial fluid proved indeed to be an exudate [8]. Thus, the results of these studies should be interpreted in the context of the current knowledge.

The study by Ben-Horin et al. (n = 120) questioned for the first time the validity of the exudate-transudate paradigm for pericardial effusion [3]. The authors concluded that differentiating transudate from exudate was generally not helpful. The present study is in keeping with that study but differs in sample size (n = 216) with the

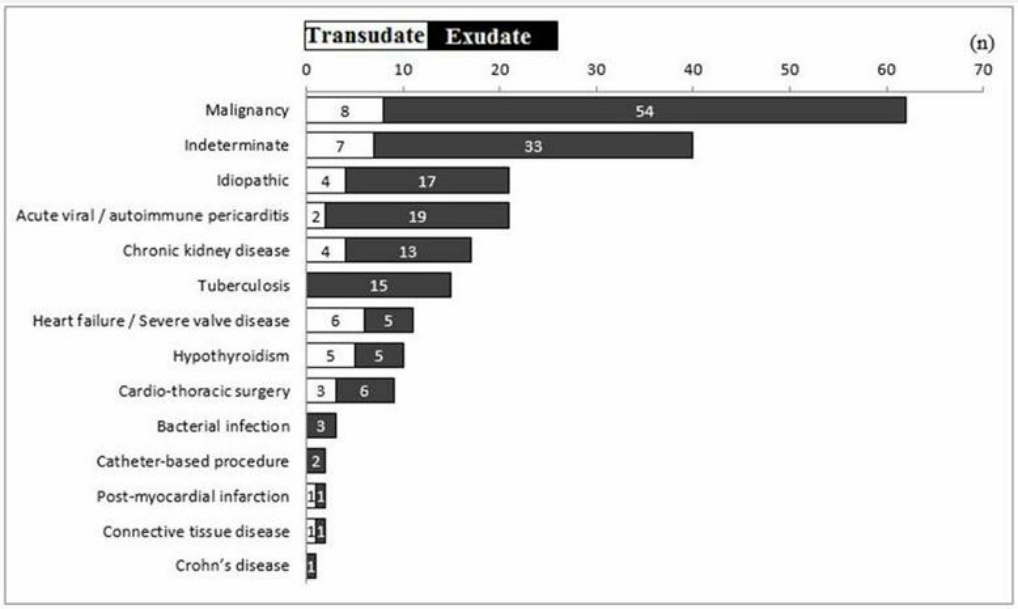

Figure 1. Relative proportion of transudates and exudates according to Light's criteria by etiology of pericardial effusion.

Note the predominance of exudates among different causes.

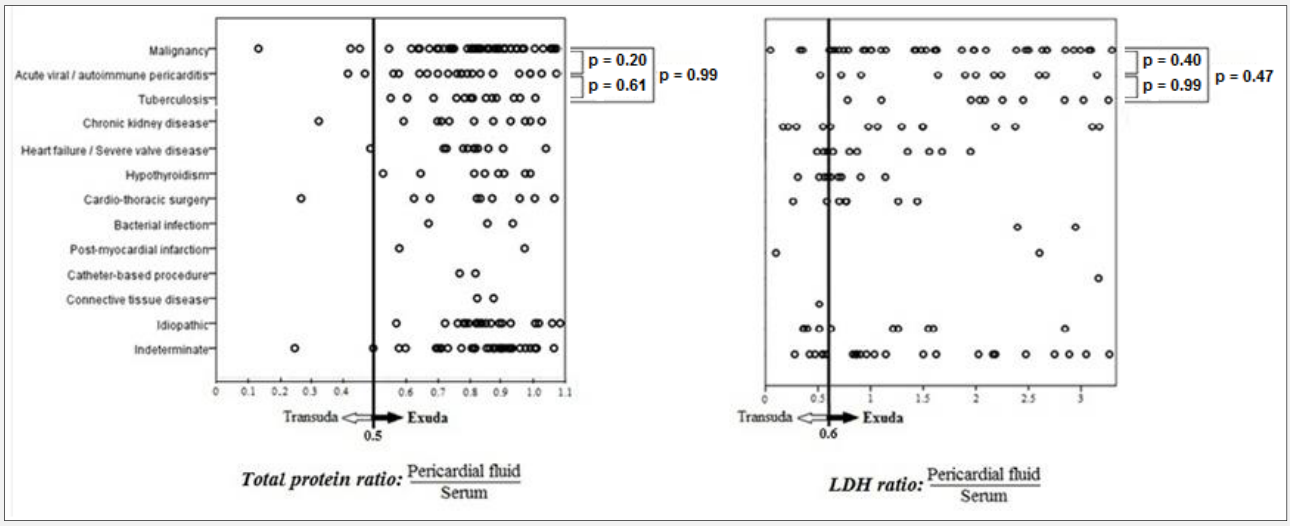

Figure 2. Distribution of pericardial fluid to serum ratios of LDH and total protein.

Note that when the cutoff point (the vertical bold line) is moved to the left or right, significant overlap between different causes persists. P values at the right upper corner indicate the differences between the median values of the most relevant causes (i.e., malignancy vs. tuberculosis or vs. acute viral/autoimmune pericarditis). The plots of the patients who have an LDH ratio > 3.4 or a total protein ratio > 1.1 are not shown.

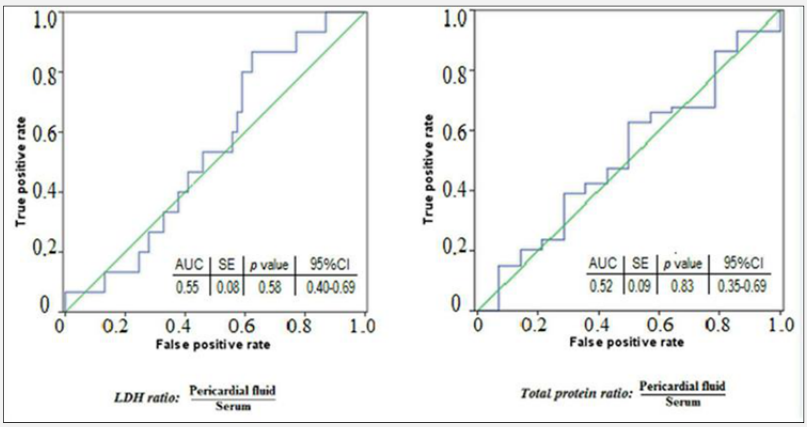

Figure 3. The receiver-operating characteristic curves for pericardial fluid to serum ratios of LDH and total protein to distinguish malignancy from tuberculosis.

AUC - area under the curve, CI - confidence interval, SE - standard error.

analysis of the greater number of cases with tuberculosis (n = 15 vs. n = 2), heart failure/severe valve disease (n = 11 vs. n = 1), and hypothyroidism (n = 10 vs. n = 0).

All bloody effusions were exudate in the present study. On the contrary, in the study by Meyers et al., 72% of the transudate effusions had bloody appearance [4]. This discrepancy possibly resulted from the fact that, in that study, the effusions were assumed to be transudate according to the etiological diagnosis given at the beginning of the study.

Clinical appraisal

At first view, since none of the transudate effusions had bloody appearance in the present study, it makes sense to consider it could be a useful finding to exclude the causes of purported transudate effusions in case of a bloody effusion. It was only helpful for the diagnosis of the patients with heart failure/severe valve disease because none had a bloody effusion, but echocardiography performed for the diagnosis of the effusion could also ascertain the presence of heart failure/severe valve disease at the same time and made this knowledge clinically irrelevant. Also, 2 of 10 patients with hypothyroidism and 10 of 17 patients with chronic kidney disease had indeed a bloody effusion (accordingly had exudate effusion) (all data not shown). Thus, a bloody effusion cannot exclude the possibility of hypothyroidism and chronic kidney disease, and these etiologies pose little diagnostic challenge in practice as well.

Since all tuberculous effusions were exudate, the only useful finding in the present study, in our opinion, might be that once the presence of a transudate is determined, the diagnosis of tuberculosis is unlikely and further diagnostic procedures for tuberculosis would not be necessary. This is consistent with the characteristics of tuberculous *pleural* fluids [9]. However, the finding of absence of serous appearance in tuberculous pericardial effusions in the present study is contradictory to the fact that most tuberculous pleural effusions have serous appearance [9]. Predominance of the specific underlying mechanism by which the pleural and pericardial spaces may become involved in tuberculosis may be the reason for this discrepancy (i.e., delayed-type hypersensitivity response to M. tuberculosis in pleura versus breakdown and contiguous spread from a tuberculous lesion to the pericardium) [10]. More importantly, it should be noted that the color of the fluid is indeed a subjective characteristic [9].

In practice, most underlying causes of effusions are clear by the clinical setting in which it occurs. These are hypothyroidism, hemodialysis, recent history of myocardial infarction, trauma or catheter-based procedures, and a known disease consistent with the effusion. If not, the next step may determine or exclude several causes (e.g., serum creatinine for chronic kidney disease, thyroid function tests for hypothyroidism, and echocardiography for heart failure/severe valve disease). If these evaluations are normal, then the clinical picture of the patient becomes a diagnostic challenge between the remaining causes, namely malignancy, tuberculosis, connective tissue disease, and bacterial infection (It is a common practice that acute viral/autoimmune pericarditis is a diagnosis of exclusion). At this stage, a diagnosis can be established in an additional number of patients by microbiological and cytological examination of the fluid revealing positive test results for bacteria or tuberculosis or neoplastic cells, by blood tests for specific

antibodies for connective tissue diseases, or by imaging studies for malignancies, in conjunction with the *physician's clinical appraisal*. If these are all negative, then the biochemical analysis of pericardial fluid becomes a matter of consideration for the remaining causes. However, all above-mentioned remaining causes are traditionally considered to have an exudate effusion. This is the reason for testing at multiple cutoff points for all parameters in the present study. Unfortunately, none of the cutoff points yielded a reasonable accuracy to differentiate one cause from another. The overlap between most causes was so large with all tests that discriminating ability was not statistically significant. It should be emphasized that even if statistically significant results were obtained it would not necessarily have practical significance since all causes need to be definitely identified due to different prognoses and therapeutic approaches. Also, even if the biochemical analysis would differentiate transudate from exudate, what is more relevant is indeed to differentiate one cause from another.

Clinical implications

Avoiding an order for this biochemical analysis which has a low diagnostic yield may prevent a physician's effort for clinical appraisal and loss of time and money.

Limitations

The present study had several limitations. This was a single-center, retrospective design and the hospital clinical records were assumed to be accurate. Differential cell count of the fluids was not available, but seems not to be directly diagnostic [3]. Finally, it should be acknowledged that a definite conclusion was precluded by the small number of patients with effusions related to catheter-based procedures, post-myocardial infarction, bacterial infection, connective tissue disease, and Crohn's disease. However, most of these causes could be diagnosed by other means [11].

CONCLUSION

In most patients, the underlying cause of pericardial effusion is clear by the clinical setting in which it occurs, or can be identified with simple blood tests or by imaging. For the remaining patients, although the biochemical analysis of the pericardial fluid is often ordered, it has almost no diagnostic value for differentiating one cause from another in contemporary clinical practice. The exception may be tuberculosis which is unlikely the etiological cause of pericardial effusion in case of a transudate.

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Proofs:

The present work has been accepted as an abstract [PB-129; 30UKK4102] for the 30th Turkish Cardiology Congress on October 23 - 26, 2014 in Antalya, Turkey. This is a substudy of a previously reported study focusing on pericardiocentesis (Akyuz S, Zengin A, Arugaslan E, et al. Echo-guided pericardiocentesis in patients with clinically significant pericardial effusion: Outcomes over a 10-year period. Herz. 2014 Dec 11. [Epub ahead of print]).

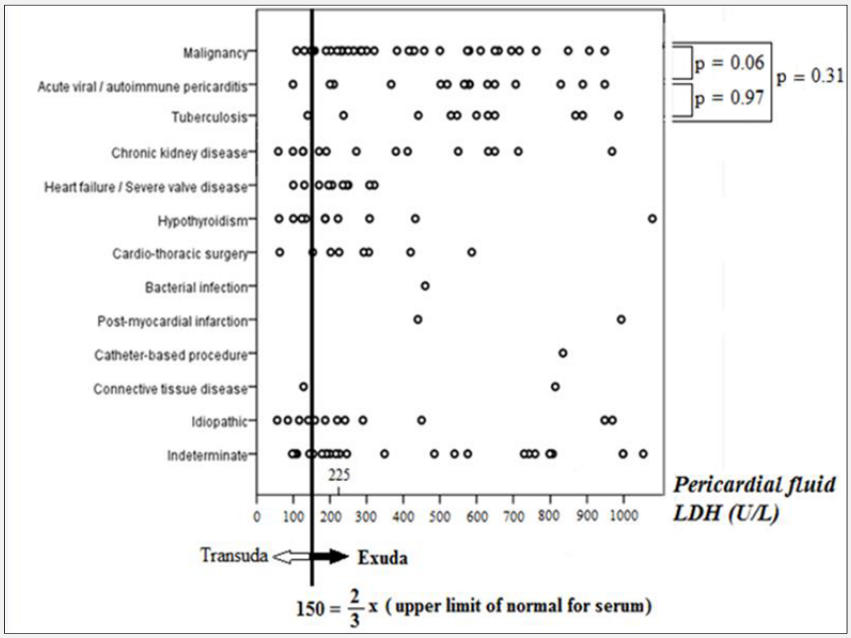
Declaration of Interest:

We, the authors, declare that there is no conflict of interest.

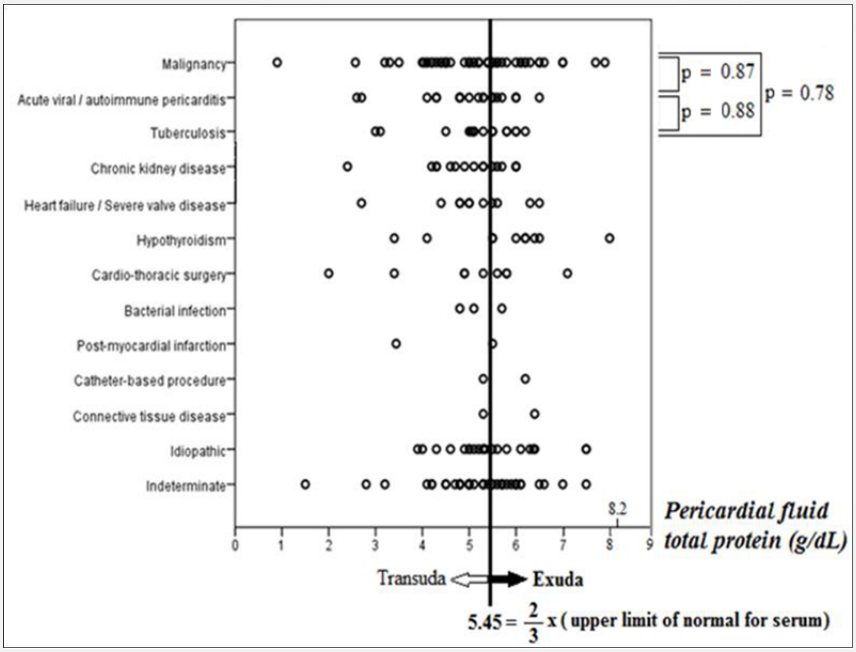
References:

1. Hassan T, Al-Alawi M, Chotirmall SH, McElvaney NG. Pleural fluid analysis: Standstill or a work in progress? Pulm Med 2012; 2012:716235.
2. Light RW. Pleural effusion. N Engl J Med 2002;346:1971-77.
3. Ben-Horin S, Bank I, Shinfeld A, Kachel E, Guetta V, Livneh A. Diagnostic value of the biochemical composition of pericardial effusions in patients undergoing pericardiocentesis. Am J Cardiol 2007;1;99:1294-97.
4. Meyers DG, Meyers RE, Prendergast TW. The usefulness of diagnostic tests on pericardial fluid. Chest 1997;111:1213-21.
5. Burgess LJ, Reuter H, Taljaard JJ, Doubell AF. Role of biochemical tests in the diagnosis of large pericardial effusions. Chest 2002;121:495-9.
6. Akyuz S, Zengin A, Arugaslan E, et al. Echo-guided pericardiocentesis in patients with clinically significant pericardial effusion: Outcomes over a 10-year period. Herz 2014 Dec 11. [Epub ahead of print].
7. Porcel JM. Pearls and myths in pleural fluid analysis. Respirology 2011;16:44-52.
8. Ben-Horin S, Shinfeld A, Kachel E, Chetrit A, Livneh A. The composition of normal pericardial fluid and its implications for diagnosing pericardial effusions. Am J Med 2005;118:636-40.
9. Villena V, López-Encuentra A, García-Luján R, Echave-Sustaeta J, Martínez CJ. Clinical implications of appearance of pleural fluid at thoracentesis. Chest 2004;125:156-9.
10. Schaaf HS, Zumla A. Tuberculosis: A comprehensive clinical reference. 1st ed. Philadelphia, PA: Saunders/Elsevier; 2009:342-60.
11. Ristić AD, Imazio M, Adler Y, et al. Triage strategy for urgent management of cardiac tamponade: a position statement of the European Society of Cardiology Working Group on Myocardial and Pericardial Diseases. Eur Heart J 2014 Jul 7. [Epub ahead of print].

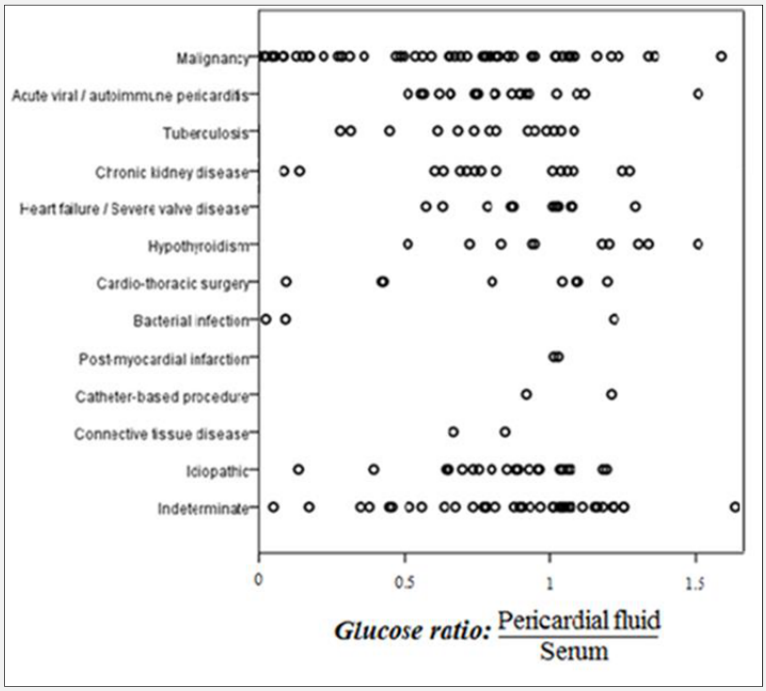
Supplement:



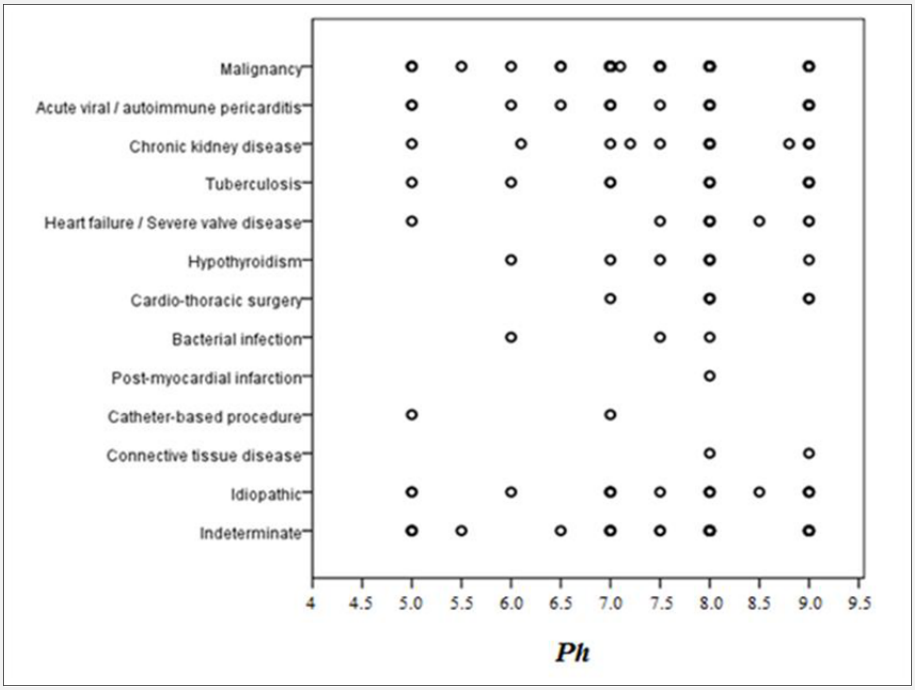
***e*-Figure 1. Distribution of pericardial fluid *LDH* levels.**



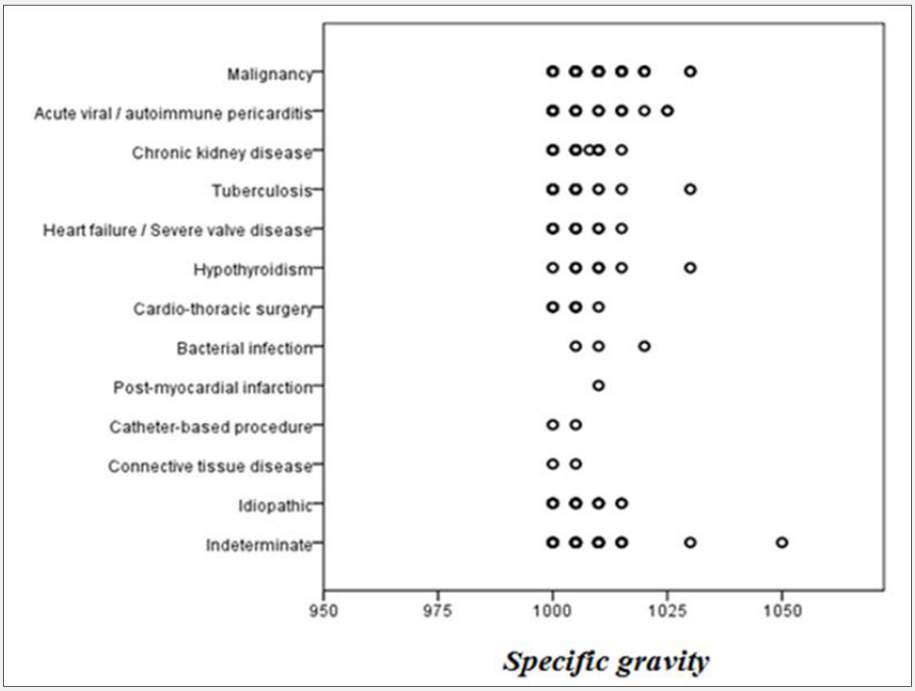
***e*-Figure 2. Distribution of pericardial fluid *total protein* levels.**



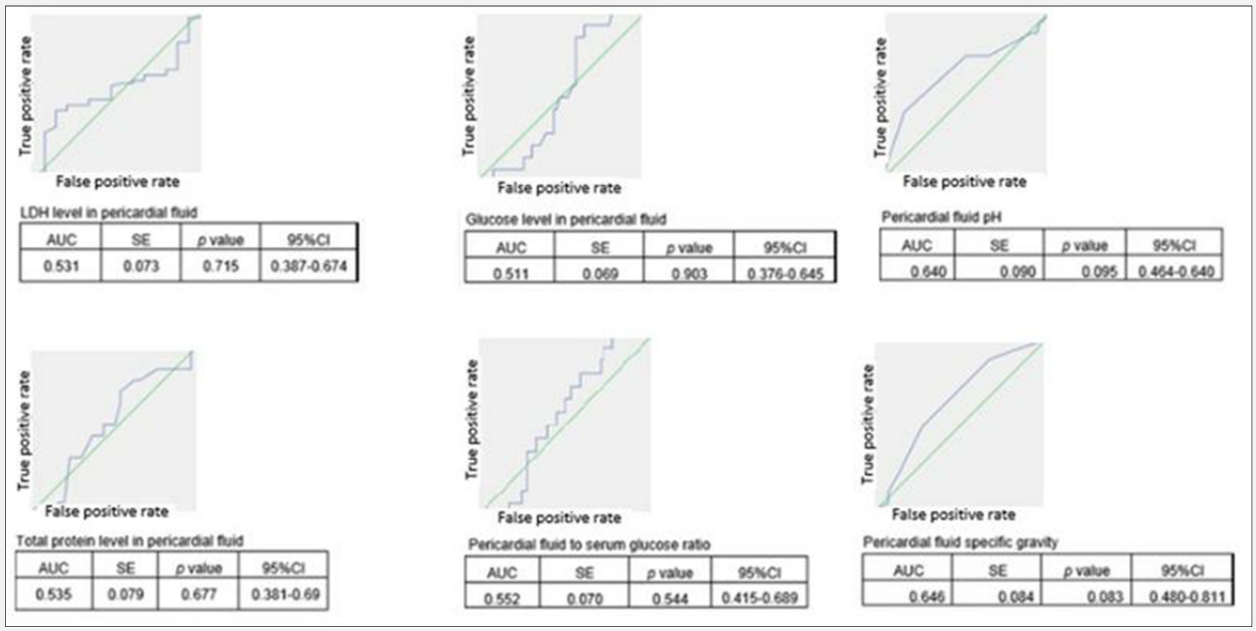
***e*-Figure 3. Distribution of pericardial fluid to serum *glucose* ratio**.



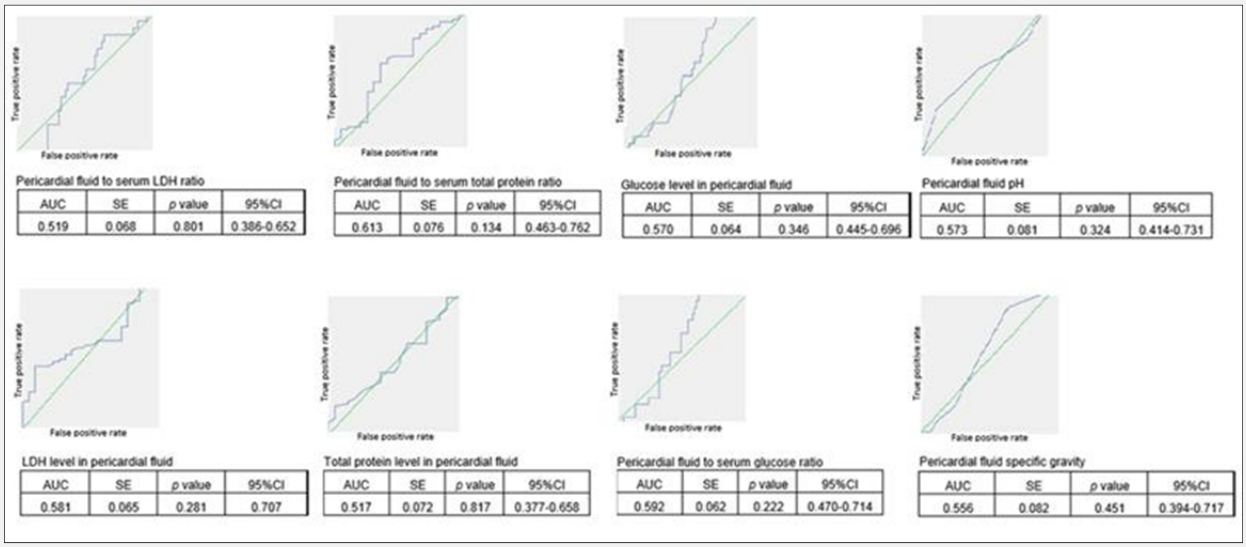
e*-Figure 4. Distribution of pericardial fluid *pH.



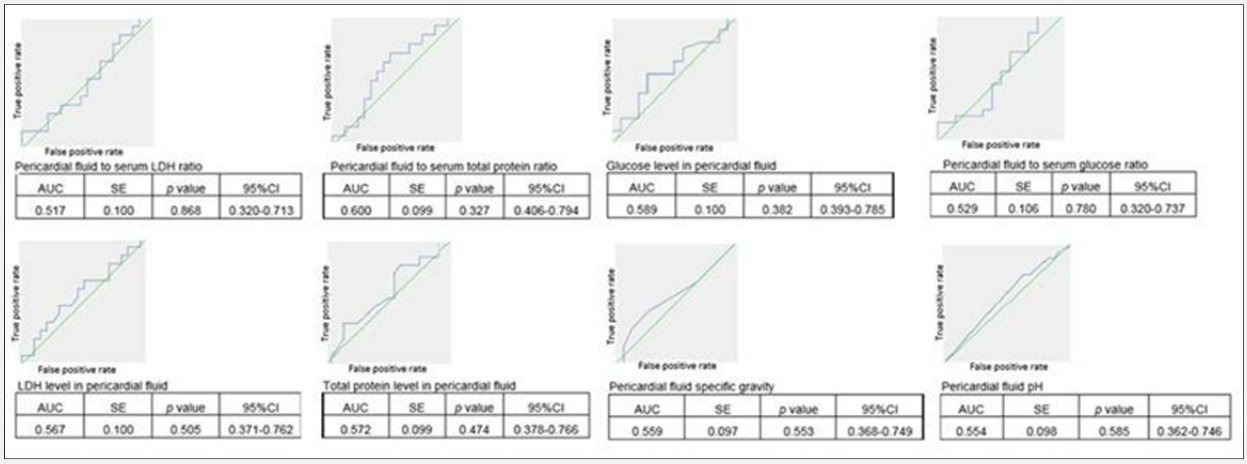
***e*-Figure 5. Distribution of pericardial fluid *specific gravity*.**



***e*-Figure 6. The receiver-operating characteristic curves to distinguish *malignant* effusion from *tuberculous* effusion.**



***e*-Figure 7. The receiver-operating characteristic curves to distinguish *malignant* effusion from effusion related to *acute viral/autoimmune* pericarditis.**



***e*-Figure 8. The receiver-operating characteristic curves to distinguish *tuberculous* effusion from effusion related to *acute viral/autoimmune* pericarditis.**