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Light's Criteria Versus Costa's Criteria in Differentiating Transudative & Exudative Pleural Effusions

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ABSTRACT

Introduction: Aim of this study is to compare COSTA'S and LIGHT'S criteria in identifying exudative from transudative pleural effusions.

Materials & Methods: A prospective study that is hospital-based was conducted at GHCCD, during Jan 2017 to August 2018 in 80 patients who presented with pleural effusion. Light's and Costa's criteria were applied to differentiate them into transudative and exudative effusions.

Results: Among the pleural effusions, 83.75% were exudates and 16.25% were transudates. Tuberculous effusion (45%) was the most common among exudates, and chronic kidney disease (10%) was the most common among the transudates. On biochemical analysis of effusions, the mean pleural fluid cholesterol levels were 74.02±20.51mg/dl and 29.23±7.44mg/dl in exudative and transudative effusions respectively. On ROC analysis, the cut-off value for pleural fluid cholesterol was considered >50mg/dl and <29mg/dl for exudative and transudative effusions respectively. The mean pleural fluid LDH cut-off values on ROC analysis was >231U/L for exudative effusions and <231U/L for transudative effusions. The sensitivity, specificity, PPV, NPV of Lights criteria observed to be 100%, 61.5%, 93.05% & 100% with accuracy of 93.75% whereas the values of Costa's criteria were 97%, 92%, 98%, 85.7% with accuracy of 96.25% in differentiating exudates and transudates. P-value was statistically significant for both criteria.

Conclusion: Pleural fluid LDH and cholesterol are found to be excellent parameters to differentiate transudates and exudates. Costa's criteria is simple, convenient with almost equal sensitivity and more specificity in comparison to Light's criteria, with fewer pleural fluid parameters compared to Light's criteria.

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Introduction

Pleural effusion is generally an abnormal or excessive accumulation of fluid in the pleural cavity . In about 15-20% of cases, the etiology of the effusion remains undiagnosed (1). Pleural effusion can be the result of many diseases. The initial evaluation of the effusion

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is to differentiate into transudative and exudative types which marks the primary diagnostic step and helps in narrowing down the diagnosis. In transudative effusions, we mainly aim to treat the underlying etiology. In an exudative effusion, additional workup is to be made for the underlying etiology (1). While malignant effusion and parapneumonic effusions are more common in the West, the most frequent cause of exudative pleural effusion in India is Tubercular effusion and Malignant effusion (2,3). Since age-old times, various criteria have been developed at different times, and following are some of the examples to delineate transudative from exudative effusions:

Light's Criteria: This criteria was reported in 1972 with a specificity of just 78% but a sensitivity of >95% for exudates. It differentiates exudates from transudates by applying the below mentioned criteria.

- Pleural fluid protein to serum protein ratio >0.5
- Pleural fluid lactate dehydrogenase (LDH) to serum LDH ratio >0.6
- Pleural fluid LDH >2/3rds of the upper limit normal of serum LDH.

To conclude an effusion to be exudative , it should fulfill at least one or more of the following standards.

Modified Light's Criteria: Include Light's criteria with pleural fluid cholesterol value >55mg/dl.

Costa's Criteria: To separate exudative from transudative effusions include the following:

- Pleural fluid LDH >200U/L
- Pleural fluid cholesterol >45mg/dl

At least one criteria should be met to define an exudate.

The hydrostatic and oncotic force imbalances , which are mostly brought on by systemic diseases, lead to transudative effusions. Exudative effusions can be due to the changes in localized factors influencing pleural fluid buildup (4).

Aim of The Study: To compare COSTA'S criteria and LIGHT'S criteria in identifying exudative from transudative pleural effusions.

Materials and Methods

This is a single-Centre observational and prospective study done on 80 patients with pleural effusion who presented to the pulmonary medicine department , Andhra Medical College during the time frame of January 2017 - August 2018.

Inclusion criteria: Patients aged 18 years and above diagnosed with pleural effusion after obtaining their consent.

Exclusion Criteria:

1. Patients with chylothorax and procedure related effusion.
2. Patients who are hemodynamically unstable. 3. Patients who are not consenting for the study.

Patients diagnosed with pleural effusion were took into the hospital for further workup. Demographic data, detailed history of presenting illness, past history, general physical examination, and systemic examination were noted. The pleural effusion was diagnosed with the help of chest x-ray and ultrasonography. Pleural fluid was aspirated under aseptic conditions and was sent for further analysis of pleural fluid LDH, protein and cholesterol. The venous blood samples for serum protein and LDH levels were also obtained. Application of Light's & Costa's criteria was done for all the samples to differentiate into transudative, and exudative effusions and comparison was done by using the ROC curves. Later the etiological diagnosis was made subjecting the patients to contrast enhanced computed tomography, pleural fluid cytology, cell block, pleural biopsy and thoracoscopy as and when needed.

Ethical Consent

The approval of institutional ethics committee was obtained .Informed written consent was obtained from all the subjects before enrolling into the study.

Statistical Analysis

The data analysis tools utilized were SPSS version 15.0, SAS 9.2, Stata 10.1, Medcalc 9.0.1, and Systat 12.0. In order to determine the predictability of research variables for result prediction, Receiver Operating Characteristic Curve analysis was carried out . Graphs , tables and other types of data have been produced using Microsoft Word and Excel sheets.

Results

80 participants with pleural effusion were included in the present study and was subjected to further analysis . The mean age group of the patients was 46.95±18.71 years (40-70). The male to female ratio was 3:2. Right sided effusions (52.5%) were common. The exudative effusions in the study were 83.75% with tuberculous as the most common etiology and the transudative effusions were 16.25% with chronic kidney disease as the most common etiology. Most of the effusions presented with moderate pleural effusion (45%) on assessment of the severity of effusion. On thoracentesis, 63.75% of the pleural effusion were straw colored on their physical appearance. On biochemical analysis, the mean pleural fluid protein values in exudative effusions were as follows (Table 1), in tubercular etiology it was 4.85±0.50g/dl, in parapneumonic it was 4.42±0.38g/dl, in empyema it was 5.28±0.74g/dl, in malignant effusions it was 4.35±0.94g/dl, in paraneoplastic it was 4.63±0.31g/dl and that of the transudative effusions were 2.37±1.0g/dl.

The mean pleural fluid LDH values of exudative effusion were observed to be 868.13±771.04U/L and in transudative effusions it was 134±34.2U/L and the p-value was 0.0010. The mean pleural fluid cholesterol levels in exudative effusions were 74.02±20.51U/L and that of transudative effusions were 29.23±7.44U/L (Table 2).

The analysis of the serum values was also done which included protein and LDH levels, the mean serum LDH levels in the exudative effusions was 220.98±43.49 and that of transudative effusions was 218.46±19.15. The mean serum protein values in the exudative effusions was 6.53±0.3 and that of the transudative effusions was 6.02±0.63 and the p-value was <0.0001. Exudative effusions ROC analysis showed (Table 3)(Figure 1), the cut-off limit for pleural fluid cholesterol >50mg/dl had a sensitivity of 92.54% and specificity of 92.31% and a p-value of <0.0001 which was significant whereas the cut-off value for pleural fluid LDH was >231 and had a sensitivity of 95.52% and specificity of 92.31% with a p-value of <0.0001.

Table 1. Analysis of parameters of pleural fluid in exudative effusionsd.

Variables	Type of Effusion					P-value
	Tubercular	Parapneumonic	Empyema	Malignant	Paraneoplastic	
PF Glucose	96.27±27.09	80.69±12.06	2.28±0.95	72±7.71	112.6±12.62	<0.0001
PF protein	4.85±0.50	4.42±0.38	5.28±0.74	4.35±0.94	4.63±0.31	0.006
PF LDH	616.97±45.51	378.61±12.73	2597.43±50.96	2298±171.82	224±34.95	<0.0001
PF Cholesterol	76.88±14.46	69.46±9.88	75.71±46.16	82.2±20.98	58.4±23.75	0.285
PF ADA	60.86±12.53	18.23±6.86	100.42±27.07	15.8±1.92	19.2±4.65	<0.0001
PF TLC	424.16±52.48	1857.54±100.83	1875.57±134.79	94.6±60.97	72±8.803	<0.0001
PF lymphocytes	80.19±6.88	50±22.04	36.14±18.42	79.4±5.72	78.8±8.01	<0.0001
PF Neutrophils	14.52±6.04	34.69±18.44	53±24.46	22±6.16	13.6±5.94	<0.0001

Table 2. Pleural fluid LDH and Pleural fluid cholesterol analysis in exudates and transudates.

Variables	Exudates	Transudates	Total	P-value
PF LDH	868.13±771.04	134±34.2	748.83±755.73	0.0010
PF Cholesterol	74.02±20.51	29.23±7.44	66.75±25.22	< 0.0001

Using ROC curve analysis, for transudative effusions, (Figure 2) the pleural fluid cholesterol had a cut-off value of <29mg/dl and had sensitivity of 92.31% and specificity of 95.52% with a p-value of <0.0001 and the cut-off value for pleural fluid LDH <231 had a sensitivity of 92.31% and specificity of 98.51% and a p-value of <0.0001 (Table 4).

On analysis, the sensitivity, PPV, specificity, and NPV of Light's criteria was 100% , 93.05%, 61.5%, and 100% respectively with certainty of 93.75% whereas sensitivity, PPV, specificity, and NPV of Costa's criteria was 97%, 98%, 92%, 85.7% respectively with accuracy of 96.25% for differentiating exudates and transudates. P value (<0.0001) was statistically significant for both criteria (Table 5).

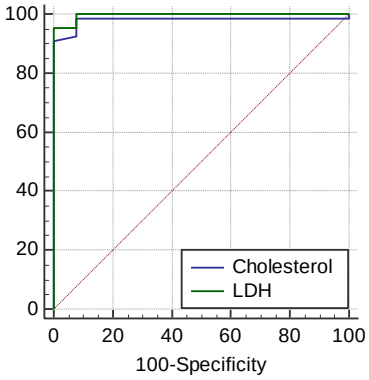

Figure 1. ROC Curve analysis in exudative effusions

Table 3. Exudative effusions ROC analysis.

Variables	ROC results to Exudate				Cut-off	AUROC	SE	P-value
	Sensitivity	Specificity	LR+	LR-				
PF LDH	95.52	92.31	12.42	0.049	>231	0.997	0.0039	<0.0001
PF Cholesterol	92.54	92.31	12.03	0.081	>50	0.980	0.015	<0.0001

Table 4. Transudative effusions ROC analysis.

Variables	ROC results to Transudate				Cut-off	AUROC	SE	P-value
	Sensitivity	Specificity	LR+	LR-				
PF LDH	92.31	95.52	20.62	0.081	≤231	0.997	0.0039	<0.0001
PF Cholesterol	92.31	98.51	61.85	0.078	≤29	0.980	0.0159	<0.0001

Table 5. Light's criteria and costa's criteria sensitivity (SE), positive predictive value (PPV), specificity (SP), negative predictive value(NPV) .

Criteria	Observation					Correlation					
	TP	FP	FN	TN	Total	Se	Sp	PPV	NPV	Accuracy	P value
Light's Criteria	67	5	0	8	80	100.0	61.5	93.05	100.0	93.75%	<0.0001
Costa's Criteria	65	1	2	12	80	97	92	98	85.7	96.25%	<0.0001

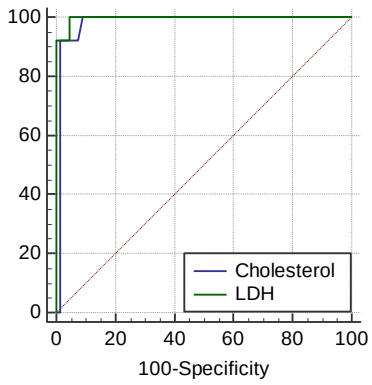

Figure 2. ROC Curve analysis in transudative effusions.

Discussion

Abnormal accumulation of pleural fluid occurs due to a number of factors like:

1. Diseases primarily involving the pleura.
2. Involvement of visceral pleura secondary to lung.
3. Involvement of parietal pleura secondary to diseases of chest wall, mediastinum, and diaphragm.
4. Factors causing generalized edema.

The transudative effusions are due to imbalances between hydrostatic and oncotic forces which are mainly due to systemic conditions. Exudative effusions, on the other hand, happen when the regional conditions driving the buildup of pleural fluid are changed (4).

Pleural fluid cholesterol in exudative effusions is presumed to come from deteriorating cells and vascular leaks due to increased permeability (5). Though exact reason is not known, two possible put forward explanations were extrahepatic synthesis of cholesterol and derivation from plasma when there is enhanced permeability of capillaries in the pleura. Pleural fluid LDH is a marker of cellular injury and inflammation which is a sensitive but nonspecific pathological marker, which helps in differentiating exudative effusions.

The present study was a prospective observational study done in patients with pleural effusion for comparing Light's criteria versus Costa's criteria in delineating pleural effusions into transudative and exudative effusions. The female to male ratio was 2:3 in the current study. The observations were similar to previous studies like Chakrabarti et al, Marel et al, Valdes et al, Rungta and Jha with male predisposition (6,7,8,9). Majority of patients in the present study (45%, n=36) had tubercular pleural effusion followed by parapneumonic effusion (16.25%, n=13), empyema (8.75%, n=7), malignant and paraneoplastic effusions (6.25%, n=5) and undiagnosed pleural effusions (1.25%, n=1) patients. The present study showed tubercular effusion as the most common cause. India has high prevalence of TB and hence tuberculous effusions appears to be the most common etiology for the effusion. In this study, most of the effusions were moderate pleural effusions (45%) based on the ultrasonography. 63.75% of patients had straw colored pleural fluid on physical appearance, with 88.8% of tuberculous etiology. This was similar to Majhi C et al study which had shown straw colored effusion to be more common (10) (table 6).

On biochemical analysis, the mean pleural fluid LDH among transudates in the current study was 134±34.20 , which was comparable to the study conducted by Rungta and Jha (9).

Pleural fluid LDH cutoff values were determined using ROC analysis, and they appear to be an excellent test for discerning exudative from transudative effusions due to their high sensitivity and specificity (AUC>99.7%). High values of Pleural fluid LDH in empyema was observed (2597.43±50.96 U/L) which is comparable to other studies like Philip-Joet F et al and Sahn SA et al (11,12). In the present study, mean pleural fluid protein among tubercular pleural effusion was 4.85±0.50, parapneumonic effusion 4.42±0.38, malignant effusion 4.35±0.94, and transudates was 2.37±1.02 and these values were similar to the study done by Rungta and Jha (9). In the present study mean cholesterol level in exudative pleural effusion was 74.03±20.51 and in transudative pleural effusion was 29.23±7.45. These values were similar to mean pleural fluid cholesterol among exudates in a study conducted by Rungta and Jha and in transudates 36.9+ 5.2 (9). In this study , the efficacy of pleural fluid cholesterol to distinguish between exudates and transudates yielded a sensitivity of

94.02%, a specificity of 92.30%, a PPV of 98.4%, and an NPV of 75% . Guleria et al. assessed pleural fluid cholesterol in 50 individuals (25 exudates and transudates each), reporting that it was 92% accurate at distinguishing exudates from transudates with a sensitivity of 88% and specificity of 100% (13). In a research by Rungta and Jha involving 56 patients, pleural fluid cholesterol and lactate dehydrogenase demonstrated a sensitivity of 99% and specificity of 98% in distinguishing between transudates and exudates (9). The 50 mg% threshold value for pleural fluid cholesterol from the current investigation was highly sensitive and specific with an AUC of >98% therefore it seems to be an effective test to distinguish between transudative and exudative effusions using ROC analysis. Light's criteria is the gold standard to distinguish exudative from transudative effusions . From the current study Sensitivity of 97% , Positive Predictive Value of 98 %, Specificity of 92 % and Negative Predictive Value of 85.7% were observed through Light's criteria and in Costa's Criteria for distinguishing exudates and transudates, sensitivity of 100% , specificity of 61.5% , PPV of 93.05% , NPV of 100% with statistically significant p-values were observed. A.B. Hamal et al 's study (14) observed that the pfP/sP ratio had a sensitivity and a specificity of 81.4% and 82.6% respectively, the pfLDH/sLDH ratio had a sensitivity and specificity of 86% and 94.7% respectively, and the pCHOL had a sensitivity and specificity of 97.7% and 100% respectively for delineating exudative from transudative pleural effusions. When distinguishing exudates from transudates, Costa's criteria is almost as sensitive and more precise than Light's criteria .In an identical study by Poongavanam Paranthaman et al (15), pleural fluid cholesterol and LDH was compared with the standard LIGHTS criteria and the results showed sensitivity , specificity, positive predictive value and negative predictive value of 95% , 80% , 95% , 80% respectively. In a similar study, Judith and Jorge investigated the role of pleural fluid cholesterol and lactate dehydrogenase (COSTA'S Criteria: Pleural fluid LDH >200 IU/L , Pleural fluid cholesterol>45mg/dl) in separating pleural effusions as transudates and exudates. They discovered that COSTA'S Criteria had a 73% sensitivity and 100% specificity when compared to the gold standard (LIGHT'S Criteria) (16). In comparison to the current study, the Judith and Jorge study displayed higher specificity but poorer sensitivity. Rungta and Jha, who also investigated the diagnostic use of pleural fluid cholesterol and LDH in separating transudates from exudates, the conclusion was that these two biomarkers had a 99% sensitivity and 98% specificity (9). Costa's Criteria, in comparison to the gold standard Light's criteria, is equally sensitive and specific in distinguishing exudates and transudates, as is evident from the literature and the results of the current investigation. According to observations by Manian RB et al. and Lépine P.-A. et al., pleural fluid lactate dehydrogenase and pleural fluid cholesterol can determine an exudate with a sensitivity and an overall diagnostic accuracy equivalent to Light's criteria (17,18).

Application of Costa's criteria is simple, as it included only two pleural fluid parameters which were less cumbersome and with less procedural complications compared to Light's criteria. Costa's criteria doesn't require serum sampling, calculation of protein, and LDH ratios with pleural fluid as done in Light's criteria, which made Costa's criteria a better cost-effective criteria.

Conclusion

The mean pleural fluid protein values in tubercular etiology was 4.85±0.50g/dl, in parapneumonic was 4.42±0.38g/dl and transudative effusions was 2.37±1.0g/dl. Pleural fluid LDH and Cholesterol are important parameters to differentiate exudates and transudates, their p-values were found to be statistically significant among both transudative and exudative pleural effusions in the present study, hence Costa's criteria is as sensitive and more specific in comparison to Light's criteria. Costa's criteria doesn't require serum parameters and is more easier to perform and to come to a definite conclusion (9,16).

Table 6. Comparative study on colour of pleural fluid.

Study	Most common appearance
Present study	Straw color
Majhi C et al (10)	Straw color

Abbreviations

LDH: Lactate Dehydrogenase ; **ADA:** Adenosine De Aminase ; **TLC:** Total Leucocyte Count; **TB:** Tuberculosis ; **ROC:** Receiver Operating Characteristic curve ; **PPV:** Positive Predictive Value ; **NPV:** Negative Predictive Value

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