Transudative and Exudative Pleural Effusion in Chronic Kidney Disease Patients: A Prospective Single-Center Study

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Abstract

Objective

The aim of the study is to assess the incidence of pleural effusion and to assess its etiology in admitted chronic kidney disease patients who were admitted secondary to various causes, i.e., fluid overload, sepsis, etc.

Material and methods

A prospective cross-sectional observational study was conducted at the Department of Nephrology, The Kidney Centre Postgraduate Training Institute, Karachi. A total of 789 patients were admitted between August 2020-February 2021. This study comprised 280 adult chronic kidney disease (chronic kidney disease and end-stage renal disease patients who were on dialysis) patients having pleural effusion (either unilateral or bilateral) secondary to various causes.

Results

Among 280 patients, the mean age was 55 years with 158 (56.4%) males and 122 (43.6%) females, diabetes (76%) was present in most of the patients along with hypertension (86.1%), and most of the patients were of stage IV and V. Transudative pleural effusion was present in 212 (75.7%) patients secondary to fluid overload and heart failure was the commonest cause while 68 (24.3%) patients had exudative pleural effusion with tuberculosis being the commonest etiology, 44 (15.7%) patients needed intervention while 236 (84.3%) were treated medically. The data was entered and analyzed on SPSS version 21 (IBM Corp, Armonk, USA). The cleaning and coding of data were done before analysis. Continuous variables were expressed in mean ± standard deviation, while the frequencies with percentages were obtained for categorical variables. The Chi-square test was applied to see the association between variables. A p-value of ≤ 0.05 was considered significant.

Conclusion

Clarification of the cause of pleural effusion is essential. Early diagnosis and prompt treatment like thoracocentesis or in the case of patients on hemodialysis, adequate dialysis may be necessary.

Categories: Internal Medicine, Nephrology
Keywords: exudative pleural effusion, transudative pleural effusion, hemodialysis, pleural effusion, chronic kidney disease

Introduction

Chronic kidney disease (CKD) is recognized as a major health problem. Globally, the load of CKD is swiftly increasing, its estimated prevalence is about 15.4%, while in Pakistan more than 17 million people are suffering from kidney diseases [1]. The current international consensus definition of CKD [2] states that CKD is defined as abnormalities of kidney structure or function, present for > three months, with implications for health. With time, patients with CKD develop various systemic complications and respiratory complications are of utmost importance and clinically significant. Pleural effusion (PE) and pulmonary edema are common clinical presentations in CKD patients [3], which occur mostly due to fluid overload and increased capillary permeability of visceral and parietal pleura.

PE is an excessive accumulation of fluid in the pleural spaces from a lack of balance between pleural fluid formation and evacuation. In patients with renal involvement, it is a common diagnostic dilemma as it may arise because of CKD itself. To treat PE, it's important to know its etiology. PE can be unilateral or bilateral and can vary from mild to massive.

PE can be transudative or exudative and this can be diagnosed according to the Lights criteria [4]. The
common causes of transudative pleural effusion are fluid overload, heart failure and nephrotic syndrome, while the causes for exudative pleural effusion are pneumonia, tuberculosis (TB), pulmonary embolisms or diseases causing pleuro-renal syndromes, like systemic lupus erythematosus. Another important cause is uraemic pleurisy (exudative PE) which is a diagnosis of exclusion, that persists or recurs despite aggressive hemodialysis (HD) [5].

Most studies looking into the incidence of PE in patients with CKD are retrospective studies and on long-term dialysis patients [6–8]. In the present study, we prospectively studied the occurrence, causes, clinical features and management issues of admitted CKD patients of all stages who had PE (stages II–V including dialysis population).

**Materials And Methods**

The study is a prospective cross-sectional observational analysis conducted at The Kidney Centre Post Graduate Training Institute, Karachi, Pakistan (TKC-PGTI) after getting approval from the hospital Ethical Review Committee (ERC Reference No. 94-NEPH-062020).

Inclusion criteria were all adult CKD (of all stages with or without dialysis) patients having PE (either unilateral or bilateral) who got admitted with various causes between August 2020 and February 2021. Patients who had acute kidney injury were excluded from the study. A total of 789 CKD patients were admitted to our institute for different reasons. We collected data from all admitted CKD patients on HD or not on HD with PE. Patients who met the inclusions criteria were included in the study. Patients’ demographic information and previous history were recorded using a pre-designed case report form. There was no direct interaction with patients in the study. Detailed demographic and clinical parameters including age, sex, smoking history, clinical symptoms with duration and clinical signs and other systemic examination for the comorbid illness were evaluated in all patients. Comorbid conditions were defined as the presence of coexisting cardiac failure, ischemic heart disease, chronic lung disease (COPD), chronic liver disease, malignancies and diabetes mellitus.

We gathered all the following data: clinical findings including shortness of breath (SOB), chest pain, fever, cough, sputum and laboratory data including complete blood count (CBC), urea, creatinine, electrolytes, troponin I, serum lactate dehydrogenase (LDH), serum protein, and pleural fluid study. If needed, pleural fluid was tested for diagnostic reasons and if needed, a therapeutic drainage was done. From this data, we identified the etiology in CKD patients (on HD or not on HD). We also observed the outcome of patients and conditions of patients on discharge. We divided the PE into exudative or transudative based on the Lights criteria. Exudative PE met at least one of the following criteria, whereas transudative PE met none of the Light’s criteria: pleural fluid protein divided by serum protein greater than 0.5, pleural fluid LDH divided by serum LDH greater than 0.6, and pleural fluid LDH greater than two-thirds of the upper normal limit of serum LDH.

The data was entered and analyzed on SPSS version 21 (IBM Corp., Armonk, USA). The cleaning and coding of data were done before analysis. Continuous variables were expressed in mean ± STD, while frequencies with percentages were obtained for categorical variables. The Chi-square test was applied to see the association between variables. A p-value of ≤ 0.05 was considered significant.

**Results**

There were 280 patients in the study, of which 158 (56.4%) were male and 122 (43.6%) were female. The mean age was 55.5±14.8 years. Hypertension (HTN) was the most common comorbidity in our patients [241 (86.1%)], while diabetes mellitus (DM) was present in 213 (76%) patients. A previous history of TB was present in 29 (10.4%) patients, and 99 (35.4%) patients had PE in the past. In our study, the majority of patients were not on dialysis (CKD stage II-V) [159 (56.8%)] (Table 1). The signs and symptoms at the time of admission are shown in Table 2.
| Variables                        | n (%) / Mean±SD |
|---------------------------------|-----------------|
| Male/Female                     | 158 (56.4)/122 (43.6) |
| Age                             | 55.5 ± 14.8     |
| Positive Smoking history        | 41 (14.6)       |
| DM                              | 213 (76)        |
| < 5 years                       | 115 (41.1)      |
| ≥ 5 years                       | 98 (35)         |
| HTN                             | 241 (86.1)      |
| IHD                             | 76 (27.1)       |
| Liver disease                   | 16 (5.7)        |
| Previous history of TB          | 29 (10.4)       |
| Treated                         | 15 (5.4)        |
| Untreated                       | 14 (5)          |
| History of malignancy           | 4 (1.4)         |
| Previous history of PE          | 99 (35.4)       |
| Unilateral                      | 46 (16.4)       |
| Bilateral                       | 53 (18.9)       |
| Hepatitis B +ve                 | 17 (6.1)        |
| Hepatitis C +ve                 | 14 (5)          |
| CKD stage                       | 159 (56.8)      |
| II-III                          | 20 (7.1)        |
| IV                              | 67 (23.9)       |
| V                               | 72 (25.7)       |
| Hemodialysis                    | 121 (43.2)      |
| one/week                        | 14 (5)          |
| two/week                        | 67 (23.9)       |
| three/week                      | 40 (14.3)       |
| Duration of HD <1 year          | 55 (19.6)       |
| Duration of HD ≥ 1 year         | 66 (23.6)       |

**TABLE 1: Demographic and clinical parameters of 280 patients**

DM: diabetes mellitus; HTN: hypertension; IHD: ischemic heart disease; TB: tuberculosis; PE: pleural effusion; HD: hemodialysis.
| Variables                      | n (%)   |
|-------------------------------|---------|
| Shortness of breath          | 225 (80.4) |
| Chest pain                   | 51 (18.2)  |
| Cough                        | 69 (24.6)  |
| Sputum                       | 48 (17.1)  |
| Fever: low grade/ high grade | 91 (32.5/11.8) |
| Weight loss                  | 64 (22.9)  |
| Anorexia                     | 221 (78.9) |
| Pallor                       | 108 (38.6) |
| Clubbing                     | 7 (2.5)    |
| Ascites                      | 44 (15.7)  |
| Edema                        | 202 (72.1) |

**TABLE 2: Signs and Symptoms**

Most of the patients had bilateral PE [234 (83.6%)], which was mainly transudative 212 (75.7%) and the most common cause of transudative effusion was fluid overload secondary to CKD [148 (63.2%)]. The most prevalent reason for exudative PE was TB [57 (54.4%)]. Diagnostic thoracocentesis was done in 234 (83.6%) patients and the majority of patients [236 (84.3%)] were medically treated. A total of 251 (89.6%) recovered, however, 18 (6.4%) patients died (Table 3). Laboratory parameters of patients are shown in Table 4.
| Clinical variables of patients                                      | n (%) / Mean±SD |
|--------------------------------------------------------------------|-----------------|
| Bilateral pleural effusion                                         | 234 (83.6)      |
| Unilateral pleural effusion                                        | 46 (16.4)       |
| Transudative effusion                                              | 212 (75.7)      |
| Fluid overload due to chronic kidney disease                       | 148 (63.2)      |
| Fluid overload due to heart failure                                | 39 (18.4)       |
| Fluid overload due to nephrotic syndrome                           | 25 (11.8)       |
| Exudative effusion                                                 | 68 (24.3)       |
| Tuberculosis                                                       | 37 (54.4)       |
| Uremic pleuritis                                                   | 21 (30.9)       |
| Empyema                                                            | 10 (14.7)       |
| Diagnostic thoracentesis done                                      | 234 (83.6)      |
| Therapeutic thoracentesis done                                     | 46 (16.4)       |
| Normal echocardiogram                                              | 169 (60.4)      |
| Low ejection fraction in echocardiogram                            | 67 (23.9)       |
| Valvular lesion                                                    | 44 (15.7)       |
| Abnormal ECG                                                       | 35 (12.5)       |
| Culture done and organism detected                                 | 10 (3.6)        |
| Pseudomonas                                                        | 5 (50)          |
| Staph aureius                                                      | 3 (30)          |
| Klebsiella                                                         | 2 (20)          |
| Total stay in hospital in days                                     | 5.8± 2.3        |
| Medically treated                                                  | 236 (84.3)      |
| Intervention required                                              | 44 (15.7)       |
| Improved                                                           | 255 (91.1)      |
| Resistant effusion                                                 | 13 (9.6)        |
| Recovered                                                          | 251 (89.6)      |
| Referred                                                           | 11 (3.9)        |
| Death                                                              | 18 (6.4)        |

**TABLE 3: Detailed clinical status of patients**
| Lab parameters     | Mean ± Std | Median | IQR | Minimum | Maximum |
|-------------------|------------|--------|-----|---------|---------|
| Hemoglobin        | 8.4 ± 2    | 8.9    | 3.3 | 5.2     | 16.8    |
| Total leukocyte count | 13 ± 8.9  | 10.6   | 9.4 | 2.9     | 98      |
| Platelet          | 252.9 ± 107.3 | 236  | 101 | 16      | 660     |
| Urea              | 191.3 ± 64.8 | 190  | 75  | 29      | 373     |
| Creatinine        | 7.7 ± 3.3  | 7      | 3.4 | 1.5     | 23.1    |
| Sodium            | 133.4 ± 6  | 133    | 7   | 114     | 156     |
| Potassium         | 4.7 ± 0.9  | 4.8    | 1.4 | 2.5     | 8       |
| Chloride          | 105 ± 5.6  | 105    | 10  | 85      | 118     |
| Bicarb            | 17.5 ± 3.6 | 18     | 5   | 6       | 28      |
| Calcium           | 8.3 ± 1    | 8.3    | 1.1 | 5.5     | 11.35   |
| Phosphorous       | 7.1 ± 2.5  | 6.8    | 3.8 | 2.9     | 12.9    |
| Albumin           | 3.2 ± 0.5  | 3.5    | 0.5 | 1.6     | 5.9     |

**TABLE 4: Laboratory parameters of patients**

CKD stage was significantly associated with the type of PE. Transudative effusion was predominantly present in patients who had advanced stages of CKD or had End-Stage Renal Disease (ESRD), while exudative effusion was common in patients who were on HD [61 (39.7%)]. A total of 39 (57.4%) patients were on > one year on HD and 30 (44.1%) were having twice-weekly sessions of HD.

Among all comorbidities, only Ischemic Heart Disease (IHD) was significantly associated with the type of effusion. The patients who had IHD primarily suffered from transudative effusion 64 (30.2%) as compared to patients without IHD, who typically developed exudative PE [56 (82.4%)]. Transudative effusion were all bilateral, while exudative was mostly unilateral 46 (67.6%). In both types of effusions, an equal number of patients died, while 201 (94.8%) patients recovered who had transudative effusion and 50 (73.5%) patients improved who had exudative PE (Table 5).
| Parameters of patients       | Exudate | Transudate | p value |
|------------------------------|---------|------------|---------|
| **Age**                      |         |            |         |
| ≤ 50 years                   | 18 (26.5) | 61 (28.8) |         |
| 51-65 years                  | 24 (35.3) | 91 (42.9) | 0.289   |
| > 65 years                   | 26 (38.2) | 60 (28.3) |         |
| II- III                      | 1 (1.5)  | 19 (9)     |         |
| **CKD stage**                |         |            |         |
| IV                           | 3 (4.4)  | 64 (30.2)  | <0.001  |
| V                            | 3 (4.4)  | 69 (32.5)  |         |
| ESRD                         | 61 (89.7) | 60 (28.3) |         |
| **Hemodialysis duration**    |         |            |         |
| Not on HD                    | 7 (10.3) | 152 (71.7) | <0.001  |
| < 1 year                     | 22 (32.4) | 33 (15.6) |         |
| ≥ 1 year                     | 39 (57.4) | 27 (12.7) |         |
| **Frequency of Hemodialysis**|         |            |         |
| Not on HD                    | 7 (10.3) | 152 (71.7) | <0.001  |
| one/week                     | 8 (11.8) | 6 (2.8)    |         |
| two/week                     | 30 (44.1) | 37 (17.5) |         |
| three/week                   | 23 (33.8) | 17 (8)    |         |
| **DM**                       |         |            | 0.678   |
| Yes                          | 53 (77.9) | 160 (75.5) |         |
| No                           | 15 (22.1) | 52 (24.5) |         |
| **HTN**                      |         |            | 0.554   |
| Yes                          | 60 (88.2) | 31 (14.6) |         |
| No                           | 8 (11.8) | 181 (85.4) |         |
| **IHD**                      |         |            | 0.043   |
| Yes                          | 12 (17.6) | 64 (30.2) |         |
| No                           | 56 (82.4) | 148 (69.8) |         |
| **Site of pleural effusion** |         |            | <0.001  |
| Unilateral                   | 46 (67.6) | 0 (0)      |         |
| Bilateral                    | 22 (32.4) | 212 (100) |         |
| **Treatment**                |         |            | <0.001  |
| Medicine                     | 33 (48.5) | 203 (95.8) |         |
| Intervention                 | 35 (51.5) | 9 (4.2)    |         |
| **Outcome**                  |         |            | <0.001  |
| Recovered                    | 50 (73.5) | 201 (94.8) |         |
| Expired                      | 9 (13.2) | 9 (4.2)    |         |
| Referred                     | 9 (13.2) | 2 (0.9)    |         |

**TABLE 5: Association of variables with the type of pleural effusion**

CKD: chronic kidney disease; DM: diabetes mellitus; HTN: hypertension; IHD: ischemic heart disease

**Discussion**

Pleuro-pulmonary problems are very common in the CKD population. On a frequent basis, it is observed that many CKD patients who were admitted due to various causes, had PE either bilateral or unilateral. Keeping in view the increased frequency of PE in CKD patients, we prospectively reviewed the data of these patients and found that in seven months period total of 789 patients were admitted due to various reasons, and out of them, 280 patients had PE. These patients were in different stages of CKD commonly in stage IV [67 (23.9%)] and V [72 (25.7%)] and 121 (43.2%) patients were undergoing HD. Several studies have been done that have evaluated the frequency of PE in the CKD population. One study showed the incidence of PE of 6.7% in various stages of CKD who were not on HD [9], while few studies have reported a higher incidence in patients on maintenance dialysis [6-7].
We found that transudative effusions due to any cause were bilateral [212 (75.7%)] and exudative effusions
patients concluded that 31.42% of patients developed PE due to heart failure.

A study done by Kumar et al in 2015 found 31 had PE (29 patients were of different stages of CKD and 2 post-renal transplant patients) and
incidence of heart failure to be 9.6% in their patients. Another study done in 430 CKD patients in
the high amount of fluid in the interstitial spaces

Current theories postulate that mostly patients with Congestive Heart Failure (CHF) have left ventricular
failure, which consequently leads to PE. The high amount of fluid in the interstitial spaces [16] enters the
pleural spaces through the highly permeable visceral pleura [17] and consequently causes PE.

In our study, PE due to CHF produced SOB, pedal edema, orthopnea and paroxysmal nocturnal dyspnea, and
chest X-ray which mostly showed bilateral PE. A study done by Kumar et al in 2015 [12] among 35 CKD
patients concluded that 31.42% of patients developed PE due to heart failure.

We found that transudative effusions due to any cause were bilateral [212 (75.7%)] and exudative effusions
were unilateral [46 (16.4%)], which is also similar to a study by Bakirci et al [7], which also showed bilateral PE with transudative etiology (66.7%).

A study done by Kumar et al [12] among 35 patients showed bilateral transudative effusions in 11 (31.42%) patients and exudative effusions were 24 (68.57%) out of which seven (29.16%) were bilateral and 17 (20.83%) were unilateral.

In our study we found three major causes for exudative effusion: TB was the most frequent cause 37 (80.4%) and its frequency has been reported in 1 to 58% of the patients with ESRD [21-22]. It is difficult to confirm TB in these patients because defective cell-mediated immunity caused difficulty in detecting mycobacterium TB and in many patients empirically antituberculous therapy started to cure the symptoms.

The second cause of exudative effusion in our study was uremic pleurisy [21 (50.9%)] and 19 patients were of HD. Other cases were empyema eight (2.9%) and two (0.7%) patients had parapneumonic effusion. Uremic pleurisy was first reported in 1955 by Hopps and Wissler in 20% of uremic patients at autopsy [23]. It is a diagnosis of exclusion. In our study, 21 patients had uremic pleurisy - the diagnosis was made on the basis of exudative effusion with lymphocytic predominance mostly [7 (10.4%)]. Among these patients, most were on twice-weekly HD, eight patients were on thrice-weekly, but their duration of dialysis of each session was 2.5 to 3 hours, which is less than adequate.

The pathogenesis of uremic pleurisy is still not clear, but toxins like uremic acid, phosphates and retained immune complexes might be implicated in its pathogenesis [24]. Uremic effusions can occur at any time and it has no specific association with the degree of uremia [5]. Uremic effusion can recur or progress despite improvement in dialysis frequency and duration. A study done in 2013 [9] showed 19.4% (six out of 31 cases) cases of uremic pleural effusion in CKD patients.

The third cause of exudative effusion was empyema, which is pus in the pleural space. We also found some cases of parapneumonic effusion, which is any effusion secondary to pneumonia, and can be unilateral or bilateral. A study done by Bakirci et al on 52 patients showed that 9.6% had parapneumonic effusion [7].

As already explained that total 10 patients developed empyema and parapneumonic effusion with different organisms growing in their pleural fluid culture. They needed drainage with chest tube placement. Among 10 patients, seven patients were on HD, two were in CKD stage IV and one in CKD stage IV who was not on dialysis. Due to reduced overall immunity, parapneumonic effusion and empyema are common in the CKD population [22].

Anaerobic gram-negative organisms [25] and aerobic gram-positive organisms [22] are the predominant pathogens in CKD patients. Organisms that grew in pleural fluid culture in our study included five cases of pseudomonas (50%), three cases of Staphylococcus aureus (30%) and two of Klebsiella pneumoniae (20%). This observation is slightly consistent with the study done by Ray et al [9], which also concluded similar results in their HD patients.

Conclusions

PE is common in CKD patients mainly in stages IV and V. These patients are immunocompromised due to reduced cell-mediated immunity. There are several etiologies for PE in CKD patients. Transudative and exudative both are common in these patients. Early diagnosis is mandatory to cure the cause. SOB is the most common clinical presentation; fluid overload and heart failure were the commonest causes of bilateral transudative PE; and TB was the common cause of exudative PE. In hemodialysis patients, PE most commonly occurs due to underdialysis state, which needs proper thrice weekly dialysis for longer duration.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. The Kidney Centre Ethical Review Committee issued approval reference no:94-NEPH-062020. Transudative and Exudative Pleural Effusion in Chronic Kidney Disease Patients. A Prospective Single Center Study This study has been approved by TKC-ERC. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors
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References

1. Hasan M, Sutradhar I, Gupta RD, Sarker M: Prevalence of chronic kidney disease in South Asia: a systematic review. BMC Nephrol. 2018, 19:291. 10.1186/s12882-018-1072-5
2. Eknayan G, Lameire N, Eckardt K, Kasiske B, Wheeler D, Levin A, et. al.: KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int. 2013, 5:5-14. 10.1038/ki.2013.60409-90007
3. Bintcliffe OJ, Lee GY, Rahman NM, Maskell NA: The management of benign non-infective pleural effusions . Eur Respir Rev. 2016, 25:303-16. 10.1183/16000617.0026-2016
4. Saguil A, Wyrick R, Hallgren J: Diagnostic approach to pleural effusion. Am Fam Physician.. 2014, 99-104.
5. Berger HW, Rammohan G, Neff MS, Buhain WJ: Uremic pleural effusion: a study in 14 patients on chronic dialysis. Ann Intern Med. 1975, 82:562-4. 10.7326/0003-4819-82-3-562.
6. Jarratt MJ, Sahn SA: Pleural effusions in hospitalized patients receiving long-term hemodialysis. Chest. 1995, 108:470-4. 10.1378/chest.114.4.1018
7. Bakiri T, Saxak G, Ozturk S, Akcay S, Sezer S, Haberal M: Pleural effusion in long-term hemodialysis patients. In. Transplantation proceedings. 2007, 39:889-91. 10.1016/transproceed.2007.02.020
8. Kwan BC, Chow KM, Pang WF, Leung CB, Li PK, Szeto CC: Unexplained exudative pleural effusion in chronic peritoneal dialysis patients. Peritoneal dialysis international. 2010, 30:535-40. 10.7374/pdi.2009.00135
9. Ray S, Mukherjee S, Ganguly J, Abhishek K, Mitras S, Kundu S: A cross-sectional prospective study of pleural effusion among cases of chronic kidney disease. Indian J Chest Dis Allied Sci. 2015, 55:209-15.
10. Birkeland SA: Uremia as a state of immune deficiency. Scandinavian journal of immunology. 1976, 5:107-15. 10.1111/j.1365-3083.1976.tb02997.x
11. Goldblum SE, Reed WP: Host defenses and immunologic alterations associated with chronic hemodialysis. Ann Intern Med. 1980, 93:597-613. 10.7326/0003-4819-93-4-597
12. Kumar AP, Pathrudu BM, Rani NU, Padmaja B, Naik BD, Narayana M: A study on etiology and profile of pleural effusion in chronic kidney disease. J Evol Med Dent Sci. 2015, 4:11785-97. 10.14260/jemds/2015/1700
13. Nitin G, Patel R, Shet T, Patil A, Mahajan S: Study of Pleural Effusion in Chronic Kidney Disease. JMSCR. 2019, 7:10.18555/jmscr/v7i5.62
14. Mogar V, Arun BS, Suresh H, Sagar Reddy SL: A study of respiratory manifestations in chronic kidney disease. Inter J Bio Res. 2017:70-4. 10.7493/ijbr
15. Gavelli G, Zompatori M: Thoracic complications in uremic patients and in patients undergoing dialytic treatment: state of the art. Euro Radiol. 1997, 7:708-17. 10.1007/BF 0279251
16. Wiener-Kronish JP, Broadducs VC: Interrelationship of pleural and pulmonary interstitial liquid. Ann Rev Physiol. 1995:209-26. 10.1186/s12882-018-1072-5
17. Pfister R, Schneider CA: Natriuretic peptides BNP and NT-pro-BNP: established laboratory markers in clinical practice or just perspectives? Clin Chim Acta. 2009:25-38. 10.1016/j.chima.2008.05.005.
18. Chia S, Karim M, Elwood RK, FitzGerald JM: Risk of tuberculosis in dialysis patients: a population-based study. Int J Tuberc Lung Dis. 1998:989-91.
19. Andrew OT, Schoenfeld PY, Hopewell PC, Humphreys MI: Tuberculosis in patients with end-stage renal disease. Am J Med. 1980:59-65. 10.1016/j.ampath.2018.05.005.
20. Hussein MM, Moeji JM, Roujouleh H: Tuberculosis and chronic renal disease. Semin Dial. 2003, 16:38-44. 10.1016/j.smd.2003.03010.x
21. Isoda K, Hamamotou Y: Uremic pleuritis, clinicopathological analysis of 26 autopsy cases-Bull. Osaka Med Sch 50: 72-80. 1984, 6571383;
22. Sarnaik MJ, Iaber BL: Pulmonary infectious mortality among patients with end stage renal disease. Chest. 2001, 120:1883-1887. 10.1378/chest.120.6.1883
23. Hoppes HC, Wisler RW: Uremic pneumonia. Am J Pathol. 1955, 51:261-73.
24. Maher IF: Uremic pleuritis. Am J Kidney Dis. 1987, 10:616-638. 10.1016/0272-6386(87)80005-7
25. Chen CH, Hsu WA, Chen HJ, et al.: Different bacteriology and prognosis of thoracic empyemias between patients with chronic end-stage renal disease. Chest. 2007, 132:532-9. 10.1378/chest.07-0005