# Acute Effects of Hemodialysis on Pulmonary Function in Patients With End-stage Renal Disease

Rayhaneh Rahgoshai,[1] Raham Rahgoshai,[2] Ardeshir Khosraviani,[2] Amir Ahmad Nasiri,[3] Mehrdad Solouki[4]

[1]Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2]Azad University of Medical Sciences, Tehran, Iran
[3]Division of Nephrology, Department of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[4]Department of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

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**Introduction.** Despite many beneficial effects, hemodialysis may cause pulmonary dysfunction. On the other hand, patients with end-stage renal disease are potentially prone to lung edema and respiratory dysfunction. This study was conducted to evaluate the alterations of pulmonary function indicators after hemodialysis, measured by spirometry.

**Materials and Methods.** A total of 26 patients on hemodialysis for at least 3 months were studied. They were all older than 18 years old. None of the patients was a current or recent smoker, and none of them had a history of respiratory diseases, current or recent respiratory infections, musculoskeletal disorders, or tuberculosis. All of the patients underwent the spirometry test before and after a 4-hour hemodialysis session, and the forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), vital capacity (VC), and FEV1/FVC ratio were measured.

**Results.** After hemodialysis, the FVC significantly increased ($P$ = .02), while no significant improvement in the FEV1, VC, and FEV1/FVC ratio were observed. Gender was related to the changes in VC, with better results in women ($P$ < .001). There was no association between the changes in spirometry parameters and age, body mass index, cause of kidney failure, type of anion used for hemodialysis, and weight changes.

**Conclusions.** According to our results, pulmonary function, especially the FVC, improves after a session of hemodialysis.

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## INTRODUCTION

Chronic diseases have become a major cause of global morbidity and mortality even in developing countries.[1] Regardless of the etiology, patients with end-stage renal disease (ESRD) would usually experience decreased quality of life.[2,3] They commonly encounter problems related to the metabolic complications of their kidney disease or hemodialysis complications. Various problems related to vascular access in patients on hemodialysis and to abdominal catheters in patients on continuous ambulatory peritoneal dialysis are also common.[4-6] Even patients undergoing kidney transplantation may experience a variety of transplant-related conditions.[7]

Respiratory disorders are one of the most common complications among patients with ESRD.[8,9] Some respiratory problems in this group of patients include coughing, wheezing, and sleep apnea that are mainly due to volume overload.[10] Impaired pulmonary function in patients on hemodialysis may be caused by an underlying pulmonary disease; however, the impact of uremia and the effects of hemodialysis treatment are not well understood. Several mechanisms may impair pulmonary function and alter bronchial responsiveness in patients on long-term regular hemodialysis treatment, some of which

are trapping of neutrophils, increased extravascular lung water, left ventricular hypertrophy, metastatic lung calcification, and iron deposition.[11-13] On the other hand, hemodialysis can result in better respiratory function.[14] Regarding this controversy about the acute effects of hemodialysis in ESRD sufferers, this study was conducted to address the definite short-term role of hemodialysis on pulmonary function tests in patients with ESRD on maintenance hemodialysis.

## MATERIALS AND METHODS

This study was performed as a before-after analytical research in patients on hemodialysis older than 18 years of age, in 2006, Imam-Hossein Hospital, Tehran, Iran. Only patients who were on hemodialysis for more than 3 months were included. The exclusion criteria were history of respiratory diseases, and cardiac insufficiency; being a currently or recently smoker; and current respiratory infections, musculoskeletal disorders, or tuberculosis. All the included patients were on hemodialysis 3 times per week in the morning shifts.

Dialysis was done using Fresenius 4008B dialysis machines (Fresenius Medical Care AG, Bad Homburg, Germany) which were kept on a strict maintenance regime. The water was treated by a reverse-osmosis de-ionizing system. The filters were single-use polysulphone highflux Dialyzers. The mean Kt/V was 1.38. Patients with shorter dialysis sessions, reduced ultrafiltration, and fluid infusion were approached at another dialysis session.

Spirometry was performed twice for the eligible patients who consented to participate in the study; before the hemodialysis session and immediately after it. All spirometry tests were done by the same person and in the mornings. The parameters measured before and after dialysis were forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), vital capacity (VC), and the FEV1/FVC ratio.

The collected data also included gender, age, cause of ESRD, serum parathyroid hormone level, serum ferritin level, hemoglobin, the anion used for hemodialysis, weight, body weight change, body mass index (BMI), hemodialysis vintage, and blood urea nitrogen before and after the dialysis session.

Data were analyzed using the SPSS software (Statistical Package for the Social Sciences, version 13.0, SPSS Inc, Chicago, Ill, USA). The paired *t* test and the Pearson correlation coefficient test were used for comparisons before and after dialysis and testing the correlation between continuous variables, respectively. *P* values less than .05 were considered significant.

## RESULTS

A total of 26 patients on hemodialysis (13 men and 13 women) were evaluated. Their mean age was 56.9 ± 13.5 years. The patients were on hemodialysis for a mean of 63.7 ± 47.0 months. The cause of ESRD was unknown in 13 patients (50.0%), hypertension in 8 (30.8%), diabetes mellitus in 2 (7.7%), and nephritic syndrome, autosomal dominant polycystic kidney disease, and glomerulonephritis each in 1 (11.5% in total).

The mean serum parathyroid hormone level of the patients was 226. ± 248.2 pg/mL. The mean hemoglobin and serum ferritin levels were 10.7 ± 1.7 g/dL and 115.2 ± 23.5 ng/mL, respectively. Before the dialysis session, the patients had a mean BMI of 24.3 ± 4.2 kg/m², and their mean weight was 64.1 ± 12.2 kg. They had a mean weight loss of 2900 ± 1269 g after hemodialysis; 19 (73.1%) had an alteration in their weight more than 2 kg. Eleven patients (42.3%) received bicarbonate dialysate for hemodialysis and 15 (57.7%) underwent hemodialysis with acetate dialysate.

Only the FVC of patients significantly improved comparing after the hemodialysis session (*P* = .02), and the other factors, including VC, FEV1, and FEV1/FVC ratio had no significant changes in comparison with those before hemodialysis (Table).

Mean Spirometry and Blood Urea Nitrogen Measurements Before and After Hemodialysis*

| Factor | Before Hemodialysis | After Hemodialysis | *P* |
|---|---|---|---|
| FEV1, L | 1.48 ± 0.23 (0.73 to 1.93) | 1.58 ± 0.29 (0.76 to 1.99) | .06 |
| FVC, L | 1.66 ± 0.29 (0.84 to 2.07) | 1.79 ± 0.38 (0.81 to 2.14) | .02 |
| VC, L | 1.70 ± 0.34 (0.88 to 2.19) | 2.09 ± 0.49 (0.92 to 2.38) | .10 |
| FEV1/FVC ratio | 0.89 ± 0.18 (0.56 to 1.15) | 0.889 ± 0.16 (0.52 to 1.04) | .74 |
| BUN, mg/dL | 59.73 ± 16.11 (34.0 to 83.0) | 55.68 ± 15.78 (30.0 to 71.0) | .27 |

*Values in parentheses are the minimum and maximum. FEV1 indicates forced expiratory volume in the first second; FVC, forced vital capacity; VC, vital capacity; and BUN, blood urea nitrogen.

Gender was related to the changes in VC, with better results in women (0.17 ± 0.22 L in the men versus 0.52 ± 0.63 L in the women, $P < .001$). There was no association between the changes in spirometry parameters and age, BMI, cause of ESRD, type of anion used for hemodialysis, and weight changes.

## DISCUSSION

Patients on hemodialysis are exposed to continuous pulmonary insults of multifactorial origin. Alterations in respiratory drive, mechanics, muscle function, and gas exchange are frequent in patients on hemodialysis. Pulmonary dysfunction may be the direct consequence of circulating uremic toxins or may result indirectly from volume overload, anemia, immune suppression, extra osseous calcification, malnutrition, electrolyte disorders, and/or acid-base imbalances.[14]

In the present study, only the FVC was significantly improved in patients on hemodialysis after a hemodialysis session ($P = .02$), and the other factors, including VC, FEV1, and FEV1/FVC ratio, had no significant changes in comparison with the before-hemodialysis stage. Conversely, Herrero and colleagues reported a decreased pulmonary function in patients on maintenance hemodialysis.[15] Our findings showed that spirometry is not sensitive enough to detect lung damage in chronic kidney failure. Moreover, acute changes of spirometric parameters have been reported to be generally negligible.[16] The probable explanation for the improvement in FVC, but not in VC after hemodialysis in this study, is an improvement in small airway resistance after hemodialysis.

Navari and colleagues evaluated spirometry parameters in 41 patients on hemodialysis.[17] They reported that improvement in spirometry parameters was only significant in patients undergoing dialysis with bicarbonate dialysate. However, dialysate had no impact in our study. Also, they showed that the significant increase in spirometry parameters was only prominent in the men. Postdialysis weight reduction and laboratory indexes had no significant correlation with improvement of spirometry parameters.

Kovacevic and associates evaluated 39 patients with chronic kidney failure, but without cardiac and pulmonary diseases, and showed that ventilatory function indicators, especially the VC and FEV1, significantly improved in the men, whereas in the women, the improvement was not significance.[18] However, our results showed a significant difference with a female predominance and only for FVC. Mahmoud and coworkers reported a significant reduction in the restrictive pattern of daily hemodialysis with no obstructive type of pulmonary function tests per se and reduction of blood urea nitrogen, but not serum creatinine.[19]

Wanic-Kossowska evaluated 18 patients on hemodialysis and observed ventilation disturbances of restrictive type which were demonstrated with a decreased VC, a reduced maximal breathing capacity, an increased residual volume, and a lower FEV1.[20] In contrast, the FEV1 and VC increased in our study.

## CONCLUSIONS

According to our findings, it can be concluded that patients with ESRD who receive hemodialysis may have a better pulmonary function after dialysis sessions, which is significant for FVC and nonsignificant for VC, FEV1, and FEV1/ FVC ratio. However, our results are only obtained from a sample of patients who underwent hemodialysis for a period of at least 3 months. It is recommended that further studies be carried out to obtain more detailed and documented results.

## CONFLICT OF INTEREST

None declared.

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Correspondence to:
Rayhaneh Rahgoshai, MD
No 62, Golestan St, Afrigha Ave, Tehran 19667, Iran
Tel: +98 21 2204 6181
E-mail: rayhaneh.rahgoshai@gmail.com

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