Proceedings of the 9th World Congress on Civil, Structural, and Environmental Engineering (CSEE 2024)
London, United Kingdom – April 14-16, 2024
Paper No. ICEPTP 106
DOI: 10.11159/iceptp24.106

Multielement Analysis of Pleural Effusion to Determine the Relationship between Air Pollution and Lung Cancer

Barbosa-Sánchez Ana Larissa.
Instituto Nacional de Salud Pública (INSP), Dirección de Salud Ambiental, 7a cerrada de Fray Pedro de Gante No. 50, Sección XVI, Tlalpan, CDMX.
lbarbosa@insp.mx [1],

Abstract **-** : Pleural effusion (PEf) is a pathophysiological condition that is associated with the accumulation of pleural fluid (Pfl), presenting itself in diseases such as:pneumonia Obstructive Pulmonary Disease (COPD), pulmonary fibrosis, lung cancer and also due to cardiac conditions. The elemental composition of the PEf can serve as a biomarker of the pathophysiological state of comorbidities PEf samples (N=129) were collected of the Metropolitan Area of the Valley of Mexico in the emergency room service of the National Institute of Respiratory Diseases (INER), during 2021-2022. The elemental composition of samples were analyzed by ICP-OES and ICP-MS, determining sixteen elements. Among the most abundant were essential elements such as: Fe median 1313.7 p5-p95 (201.5-4087ppb), Zn 381.0 (52.6-821ppb) ,Cr 23.3 (8.1-36.2 ppb), in addition to elements of anthropogenic origin in high concentrations such as Al 317.32 (104.5-505ppb), Ti 26.41 (11.2-61.9ppb), Sr 21.54 (10.3-41.9ppb), Sn 0.20 (0.02-1.3ppb). The presence and probably the differences among trace elements, metals and metalloids concentrations in PE could be associated with its essential function in the human body but the presence and high concentrations of someone could associated with anthropogenic activities from urban particles.

Keywords**:** Pleural fluid, ICP-MS, multielement, lung cancer

1. Introduction

Pleural fluid (Pfi) is a lubricant for the movement of the lungs during inhalation and exhalation. It lies in the pleural cavity between the visceral pleura lining the surface of the lung and the parietal pleura lining the inner surface of the chest wall. Sometimes too much fluid collects in the pleura, known as a Pleural Effusion (Pfi), making breathing difficult by limiting lung expansion during ventilation, this accumulation may be associated with hydrostatic pressure changes, colloidal pressure changes, or negative intrathoracic pressure lung disease.[1] PEf can be used as body fluid to search biomarkers of normal or pathological biological processes[1][2][3]. The atmospheric particulate matter (PM) by penetrate deeply into the lung.The PM has been associated with an increase, in mortality, and increasing the risk of developing lung cancer, due to its metal and metalloid content. Therefore, the presence of metal and metalloids in body fluids can be propose as exposure biomarker[4][5]. The present study; 1) Determine the concentrations of trace elements (Co, Cr, Fe, Mn, Mo, V, Zn, and Se), metals (Ti, Pd, Sr, Al, Pb, Mg, Ni, and As) and metalloids (Sb and Sn) in samples from PEf, patients with different clinical diagnostics, 2) Evaluate the relationship between the elements present in PE and atmospheric contamination by PM.

2. Method

PEf samples were obtained from 136 patients, residents of Zone Metropolitan Valle of México (ZMVM), and collected by thoracentesis in the emergency room service of the National Institute of Respiratory Diseases (INER) Ismael Cosió Villegas. The PEf samples were centrifuged at 1,500 rpm for 5 min and aliquots (1 ml) of the aqueous phase was transferred to 1.5 mL tubes for handling, and freeze at -70°C. To perform multielemental analysis, the samples were digested with HNO_3 in a microwave oven with a temperature ramp up to 140 ºC. The concentrations of sixteen elements were determined by Inductively Coupled Plasma-mass-spectrometry (ICP-MS) and Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) techniques. The Analytical curves prepared using Perkin Elmer multielement calibration standards Perkin Elmer multielement calibration standards.

3. Results

To analyze the results, the Kruskal-Wallis metric test was used, where median and p5-p95 were evaluated, mainly due to the small sample size between the group.

The PEf samples included were 129, of which 49 (37.9%) were men and 80 (62.1%) were women. Between the different comorbidities and sex, we found a significant difference. The average age ranges between 21 and 90 years, between ages and comorbidities we also have a significant difference. Patients with lung cancer 38, non-lung cancer 16, other morbidities 75. In patients diagnosed with lung cancer, see table 1.

.

Table1. Comparison between comorbidities and ages

Variable	Cancer	Lung cancer	Lung disease	Other
Sex*				
Male (n=49)	10	17	4	18
Famale (n=80)	6	21	26	27

[a]Kruskal-Wallis test *p-value <0.050

Eight trace elements (Co, Cr, Fe, Mo, Mn, Se V and Zn) were analysed, the data are shown as mediana (p5-p95), and the most abundant trace elements (TE) were Zn (52.6,860.4), Fe (3.45,12.5) and Cr (16.40, 42.6) as shown in table 2. The only element that shows a significant difference in metals is Mo 0.4 (0.068-2.

Table 2. Trace elements present according to comorbidity

Variable	Trace elements (µg/L,ppb)	Co[b]	Cr[b]	Fe[c]	Mo[b]	Mn[c]	Se[b]	V[b]	Zn[c]
Lung cancer	Mediana	0.2	24.9	1877.7	0.5	2.5	4.2	5.0	381.0
	p5-p95	0.001-1.3	16.4-42.6	485.7-4580	0.005-1.1	1.03-26.6	0.84-8.2	3.4-12.5	52.6-850.4
Cancer	Mediana	0.1	20.3	1488.7	0.4	3.1	3.5	4.6	218.2
	p5-p95	0-1.4	13.7-40.2	177.8-3230	0.098-2.9	1.04-8.5	0.03-12.5	0-12.6	10.4-505
Other desease	Mediana	0.1	22.2	939.0	0.4	2.1	4.7	5.4	423.8
	p5-p95	0.01-0.7	7.16-35.2	179.9-3620	0.07-2.3	1.05-15.4	0.64-10.3	3.72-12.7	57.3-821
Total	Mediana	0.2	23.3	1313.7	0.4	2.7	4.3	5.1	381.0
	p5-p95	0.008-1.3	8.1-36.2	201.5-4087	0.068-2.3	1.04-23.8	0.64-10.3	3.60-12.6	52.6-821
	p-Value	0.55	0.11	0.18	0.01*	0.23	0.96	0.95	0.24

[b]These elements were analyzed by ICP-MS,
[c] These elements were analyzed by ICP-OES
* *p* value < 0.0

Six metals were analyzed (Al, Mg, Pd Pb, Sr and Ti) the most abundant were Mg, Al and Ti, the results are shown in table 3.

Table 3. Metals present according to comorbidity

Variable	Metals (µg/L,ppb)	Al[c]	Mg[c]	Pd[b]	Pb[b]	Sr[c]	Ti[b]
Lung cancer	Mediana	297.99	14473.63	0.065	1.46	21.54	24.38
	p5-p95	212.9-490.9	11052.6-18800	0.017-0.17	0-17	10.4-32.2	11.6-45.1

Cancer	Mediana	269.06	14152.13	0.065	1.76	20.92	29.58
	p5-p95	115.0-480.8	10739.8-18103.5	0.02-0.12	0-16.2	10.4-36.1	14.3-54.6
Other desease	Mediana	322.92	14290.98	0.080	1.41	21.54	25.51
	p5-p95	104.5-505	9089.0-19031.2	0.02-0.2	0-17.9	5.4-43.2	10.8-63.1
Total	Mediana	317.32	14344.52	0.073	1.41	21.54	26.41
	p5-p95	104.5-505	9856.5-18103.5	0.02-0.19	0-17.9	10.3-41.9	11.2-61.9
	p-Value	0.6513	0.6483	0.4404	0.8841	0.7684	0.7498

[b]These elements were analyzed by ICP-MS,
[c] These elements were analyzed by ICP-OES
* *p* value < 0.05

Table 3. Metalloids present according to comorbidity

Variable	Metalloids	Sb[b]	Sn[b]
Lung cancer	Median	0.11	0.16
	p5-p95	0.01-2.8	0.03-2.8
Cancer	Median	0.11	0.18
	p5-p95	0-0.24	0.03-1.3
Other disease	Median	0.14	0.22
	p5-p95	0.02-0.4	0.02-1.1
Total	Median	0.13	0.20
	p5-p95	0.01-0.5	0.02-1.3
	p value	0.66	0.92

[b]These elements were analyzed by ICP-MS,
[c] These elements were analyzed by ICP-OES
* *p* value < 0.05

For the metalloids, only As and Sn were determined, the most abundant was As 2. (2.19, 6.04), we did not find a significant difference between the different elements and co-morbidities.

4. Conclusion

The presence and probably the differences among trace elements, metals and metalloids concentrations in PE could be associated with its essential function in the human body but the presence and high concentrations of someone could associated with anthropogenic activities from urban particles, from different areas of ZMVM that correspond to emissions from industrial processes, burning of fossil fuels and hydrocarbons, and vehicle exhaust emissions.

There are no differences in the pathological status of the patients. The element profile suggests that all patient states are exposed. It would be necessary to carry out multivariate analyzes that define the contribution of these metals to the pathological state.

Acknowledgements

The author gratefully acknowledge to project number 840342 “Bioaccessibility of metals-metalloids from PM2.5 in pleural fluid of patients with lung cancer in Mexico city” number fordecyt-pronaces/840342/2020 and the Red Automática de Monitoreo Atmosférico (RAMA) from Mexico City and the for equipment calibration, and maintenance.

References

[1] L. Guillermo and T. Rend, "Derrame Pleural," no. 88, p. 2011, 2011.

[2] R. W. Light, "Diagnostic principles in pleural disease," *Eur. Respir. J.*, vol. 10, no. 2, pp. 476–481, 1997, doi: 10.1183/09031936.97.10020476.

[3] S. A. Sahn, "The pleura," *Am. Rev. Respir. Dis.*, vol. 138, no. 1, pp. 184–234, 1988, doi: 10.1164/ajrccm/138.1.184.

[4] K. J. Bai, "Alterations by air pollution in inflammation and metals in pleural effusion of pneumonia patients," *Int. J. Environ. Res. Public Health*, vol. 16, no. 5, pp. 1–10, 2019, doi: 10.3390/ijerph16050705.

[5] K. Lee, "Trace Elements in Pleural Effusion Correlates with Smokers with Lung Cancer," 2017, doi: 10.1007/s12011-017-1079-y.