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**Free Communications: Case Presentations**

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# IX International Congress of the Latin American Society of Respiratory Physiology (SOLAFIRE) 2025

## “Respiratory Challenges at High Altitudes: Advances in Physiology and Medicine”

### FREE COMMUNICATIONS: CASE PRESENTATIONS (SOLAFIRE 2025)

#### 1. Measurement of Fractional Exhaled Nitric Oxide (FeNO) in Preschool Children Using an Offline Tidal Breathing Technique

**Authors:** Alejandra Pérez-Villar, Irlanda Alvarado-Amador, Laura Gochicoa-Rangel.

**Country:** City of Mexico, Mexico

**Original research:**

**Introduction:** FeNO is a noninvasive biomarker of type 2 (T2) inflammation in diseases such as asthma. Standard FeNO measurement requires controlled breathing maneuvers that are difficult for preschool children to perform, making the offline technique a viable alternative. However, the lack of reference values for this age group limits its clinical application.

**Objective:** To estimate preliminary FeNO values in healthy children using the offline technique and to analyze their association with anthropometric variables.

**Methods:** A cross-sectional, prospective study was conducted in 51 healthy children aged 2–7 years. Subjects with chronic respiratory diseases or recent infections were excluded. FeNO was measured using an offline tidal breathing technique with a face mask connected to the Sunvou-CA2122 device. Samples were analyzed within the first four hours. Anthropometric variables were recorded. Normality was assessed using the Shapiro–Wilk test. Student’s t-test or the Mann–Whitney U test was applied as appropriate, and Spearman correlation was used.

**Results:** The median FeNO was 8 ppb (IQR 5–10), and the geometric mean was 7.1 ppb. No significant differences were found between sexes, nor were there correlations with age, weight, height, or BMI (Body Mass Index). Only one child (1.9%) had FeNO > 20 ppb. The median FeNO was 8 ppb with a geometric mean of 7.1 ppb. These values are consistent with previous studies in preschoolers. No significant correlations were found between FeNO and anthropometric variables. The Sunvou-CA2122 device proved to be reliable and feasible for measurement in young, minimally cooperative children. This study represents a first step toward the standardization of local reference values.

**Conclusions:** The offline technique using the Sunvou-CA2122 device is feasible and reliable in healthy children under seven years of age. The values obtained are comparable to international reports. Further studies with larger samples are recommended, as well as evaluation of environmental and clinical factors that may influence FeNO levels.

#### 2. Preoperative and Postoperative Functional Evaluation of a Patient Undergoing Pulmonary Bullectomy Using Lung Function Tests

**Authors:** Luis Alberto Tancara Condori, Dr. Mónica Patricia Sea Aramayo.

**Country:** City of La Paz, Bolivia

**Case report:**

**Introduction and initial presentation:** We report the case of a 51-year-old female patient with no history of smoking or prior lung disease. In July 2020, she developed a COVID-19 infection and was treated on an outpatient basis with home isolation. She presented with a three-month history of grade 2 dyspnea, according to the Medical Research Council (MRC) scale.

**Requested studies:** Chest computed tomography (CT) revealed multiple pulmonary blebs and bullae; the largest was located in the left upper lobe, measuring 8.5 × 2.5 cm. Spirometry showed a moderate restrictive ventilatory pattern.

**Outcomes:** Given the diagnosis of pulmonary bullous disease, a bullectomy was performed via video-assisted thoracoscopic surgery without complications, with a favorable outcome. On follow-up, the patient reported improvement in respiratory symptoms and no recurrence or complications. The development of bullae in post-COVID-19 patients is associated with virus-induced diffuse alveolar injury, which predisposes to lung tissue destruction and air cavity formation. The rupture of these bullae may lead to air leaks and complications such as pneumothorax, pneumatocele, or pneumomediastinum, highlighting the importance of surgical bullectomy to prevent these events.

**Conclusions:** One year after the surgical procedure, the patient showed significant postoperative improvement. Pulmonary function testing showed an increase in forced expiratory volume in the first second (FEV1) to 74%, compared to 60% preoperatively (FEV1: 1.81 L vs. 1.50 L). This indicates that surgery helps improve lung volumes by reducing air trapping and promoting better lung expansion. The bullectomy emerges as an effective option for patients with post-COVID-19 bullous disease, as it improves respiratory function and quality of life.

#### 3. Physiological Effects and Therapeutic Potential of Nocturnal Hypoxia in a Murine Model of Asthma.

**Authors:** Andrés Rojas Ruiz, Magali Boucher, Cyndi Henry, François Marcouiller, Vincent Joseph, Jorge Soliz, Ynuk Bossé

**Country:** Québec, Canada

**Original research:**

**Introduction:** Hypoxia exposure is used in mouse models of asthma to investigate potential therapeutic applications. However, its physiological effects vary considerably depending on

the duration and exposure regimen. As a result, no standardized or clinically applicable hypoxia protocol has been established to date. This study represents an initial step in evaluating a novel approach based on nocturnal hypoxia. We hypothesize that this exposure pattern influences the manifestation of experimental asthma.

**Objective:** To evaluate the impact of nocturnal hypoxia in a murine model of asthma.

**Methods:** BALB/c mice were divided into four groups: exposed to normoxia or normobaric hypoxia (12h/day from 6 pm to 6 am at 13% O<sub>2</sub>) with or without experimental asthma induced by daily intranasal house dust mite exposure for 10 days. One day later, anesthetized mice were connected to the flexiVent to measure: 1- lung volumes, such as total lung capacity (TLC) and vital capacity (VC); and 2- basic respiratory mechanics by oscillometry, such as respiratory system elastance (Ers) and lung tissue elastance (H). In addition, mice were nebulized with methacholine at increasing concentrations from 0 to 100 mg/mL to assess changes in respiratory mechanics. Blood samples were then taken to determine hemoglobin and hematocrit levels.

**Results:** Nocturnal hypoxia increased hematocrit and hemoglobin levels. In addition, a two-factor ANOVA shows that nocturnal hypoxia decreased Ers and H ( $p < 0.001$  and  $p < 0.0001$ , respectively) and increased TLC and VC ( $p < 0.001$  and  $p = 0.0002$ , respectively) compared to normoxia. A three-factor ANOVA shows that, compared to normoxia, nocturnal hypoxia did not affect the response to methacholine ( $p = 0.612$ ).

**Conclusions:** Nocturnal hypoxia reduces lung elastance, increases lung volumes such as TLC and VC, and does not exacerbate the response to methacholine in mice with experimental asthma. These results suggest that nocturnal hypoxia has effects that are potentially beneficial, without exacerbating asthma features.

#### 4. Carbon Monoxide Diffusion Test in Adults with Normal Spirometry at High Altitudes

**Author:** Paola A. Añamuro Criales, Nelson Villca Alá, María A. Guzmán Aparicio, Ronald Marín Chuquimia, Nancy Vásquez Siles.

**Country:** City of La Paz, Bolivia

**Original research:**

**Introduction:** When barometric pressure decreases, the percentage of the diffusing capacity of the lung for carbon monoxide (DLCO) over the effective alveolar-capillary area of the lung increases. This phenomenon constitutes a physiological adaptation mechanism that facilitates life under conditions of chronic hypoxia.

**Objective:** To determine the percentage of DLCO in adults living in the city of La Paz, Bolivia (3,600 m above sea level).

**Methods:** A cross-sectional study was conducted in patients who underwent spirometry and DLCO testing during the same visit between February 2022 and July 2025 at the Centro Respira La Paz SR. The tests were performed following the guidelines of the ATS/ERS (American Thoracic Society/European Respiratory Society), using ultrasonic spirometers. Adults ( $\geq 18$  years) with normal spirometry were included, with or without hemoglobin (Hb) measurements. DLCO values were adjusted for altitude using the formula proposed by Vázquez-García et al, and the Student's t-test was used to obtain the p value.

**Results:** A total of 62 adults were included, with a DLCO of  $33.4 \pm 10$  mL/min/mmHg and  $135.7\% \pm 23.6\%$  (71-199%). When comparing the observed value with the predicted value for this population ( $33.4 \pm 10$  vs.  $24.6 \pm 5.8$  mL/min/mmHg), a statistically significant difference was observed ( $p < 0.05$ ). The DLCO adjusted for altitude using the formula was  $27.7 \pm 8.3$  mL/min/mmHg and  $112.5\% \pm 19.5\%$ . Likewise, in the table of altitude-adjusted predicted values by Vázquez-García et al, the DLCO range at 3,600 m above sea level (28.9-30.1 mL/min/mmHg) is close to

that found in our study ( $27.7 \pm 8.3$  mL/min/mmHg). Among the adults included, Hb values were obtained for 10 women (16.1%) with a mean of  $17 \pm 3$  g/dL and 6 men (9.7%) with  $18 \pm 2$  g/dL. When comparing the obtained values with Hb-adjusted reference tables (men:  $33.9 \pm 9.8$  vs.  $32.5$ - $33.6$  mL/min/mmHg [table], and women:  $23 \pm 5.3$  vs.  $21.2$ - $22.36$  mL/min/mmHg), similar results were observed.

**Conclusions:** Adults living in La Paz exhibit a greater alveolar gas diffusion capacity. The values obtained, corrected for altitude and hemoglobin, are similar to those reported by Vázquez-García et al.

#### 5. Fractional Exhaled Nitric Oxide Test in Patients with Obstructive Spirometry in the City of La Paz, Bolivia

**Authors:** Nelson Villca Alá, Paola A. Añamuro Criales, María R. Álvarez Arroyo, María, Guzmán Aparicio, Ronald Marín Chuquimia, Nancy Vásquez Siles

**Country:** City of La Paz, Bolivia

**Original research:**

**Introduction:** Fractional exhaled nitric oxide (FeNO) is a noninvasive marker of eosinophilic airway inflammation and is widely described in diagnostic, treatment, and phenotyping guidelines such as GINA (Global Initiative for Asthma) and GEMA (Spanish Guidelines for Asthma Management).

**Objective:** To estimate the proportion of allergic asthma based on FeNO levels in patients with an established diagnosis of asthma by forced spirometry performed in the city of La Paz, Bolivia (3,600 m above sea level).

**Methods:** A cross-sectional study was conducted in patients who underwent spirometry and FeNO measurement between March 2022 and July 2025 at the Centro Respira La Paz SRL. The tests were performed by technicians certified by the NIOSH (National Institute for Occupational Safety and Health) using ultrasonic spirometers and FeNO devices based on electrochemical techniques. Two groups were analyzed: adults and individuals under 18 years of age. Patients with an obstructive pattern on spirometry were included, with or without a bronchodilator response. Elevated FeNO was defined as  $>25$  ppb in adults and  $>20$  ppb in children. p-values were obtained using the Student's t-test.

**Results:** A total of 69 patients were included: 60 pediatric patients (87%) and 9 adults (13%). Among the 60 children, 34 (56.7%) showed FeNO  $\leq 20$  ppb, whereas 26 (43.3%) had FeNO  $>20$  ppb ( $p < 0.05$ ). Additionally, 24 pediatric patients (40%) exhibited a bronchodilator response, of whom 13 (54.2%) had FeNO  $\leq 20$  ppb and 11 (45.8%) had FeNO  $>20$  ppb ( $p < 0.05$ ). Conversely, 36 children (60%) did not show a bronchodilator response; 21 (58.3%) had FeNO  $\leq 20$  ppb and 15 (41.7%) had FeNO  $>20$  ppb ( $p < 0.05$ ). In adults, 1 patient (11.1%) with a bronchodilator response had FeNO  $\leq 20$  ppb; the remaining patients (6 with a bronchodilator response and 2 without) exhibited FeNO  $>20$  ppb.

**Conclusions:** A total of 45.8% of patients with an obstructive spirometric pattern showed elevated FeNO levels. In previous studies, individuals diagnosed with asthma demonstrated a prevalence of allergic asthma ranging from 52% to 69%. This biomarker serves as a complementary tool in the evaluation of high-altitude populations; however, its prevalence is lower compared with findings from earlier investigations.

#### 6. The Paradox of Asthma Control at High Altitude

**Authors:** Oviden Saavedra, Yesid; Añamuro Criales, Paola.

**Country:** City of La Paz, Bolivia

**Original research:**

**Introduction:** Asthma behavior varies according to the altitude at which the patient lives. In cities located at high altitude, airway inflammation appears to follow a different course than the one observed at sea level, which may influence disease control and the way exacerbations respond.

**Methods:** An observational, descriptive, cross-sectional study was designed in adult patients with a confirmed diagnosis of asthma who received care from pulmonologists and allergists at a secondary-care hospital center. The level of clinical control was assessed using the ACT (asthma control test), along with the presence of exacerbations and spirometry results. Data analysis was performed using frequencies and measures of central tendency.

**Results:** A large proportion of patients (42%) remained in a partially controlled asthma condition during follow-up. During exacerbation episodes, a good response was observed to standard treatment (bronchodilators and corticosteroids), with rapid resolution of symptoms and emergency department stays of less than six hours. Functional evaluation showed moderate obstruction in 35% of cases, mild obstruction in 60%, and severe obstruction in 5%. The findings suggest that although altitude-related inflammation favors patients remaining partially controlled for longer periods, the response to exacerbation management is adequate.

**Conclusions:** Asthma at high altitude is characterized in most patients by predominantly partial control and moderate airway obstruction. Exacerbations, however, respond quickly and effectively to conventional therapy. These results reinforce the importance of considering the particularities of high altitude in the clinical and functional follow-up of asthmatic patients. Nevertheless, patients should be appropriately phenotyped.

#### 7. Impact on the Small Respiratory Airway of Exposure to Brick Kiln Emissions and Volcanic Ash

**Authors:** Javier Palestina Ramírez, Rosaura Esperanza Benítez Pérez, Laura G. Gochicoa Rangel, Irlanda de Jesús Alvarado Amador, Blanca Zamora Mendoza, Rogelio Flores Ramírez, Francisco Javier Pérez Vázquez.

**Country:** San Luis Potosí, Mexico

**Original research:**

**Introduction:** Air pollution is one of the main components of environmental pollution, with deleterious effects primarily on the respiratory system. Mexico is a country with high levels of air pollution due to particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>) and various gases, whose main target is the small airways. Precarious jobs, such as brick manufacturing, and volcanic activity are important sources of pollutant generation. There are more susceptible populations, such as children, who are at risk of developing altered lung function trajectories.

**Objective:** To demonstrate small airway alterations through oscillometry in pediatric patients exposed both acutely and chronically to pollutant emissions.

**Methods:** An observational, cross-sectional, comparative case-control study was conducted including three groups: no exposure, acute exposure to volcanic ash emissions, and chronic exposure to brick kiln emissions. Baseline and post-bronchodilator impulse oscillometry was performed using a Termoflo® C-100 device, evaluated with the Ducharme predicted equation. Statistical analysis was performed using the Kruskal-Wallis test, followed by Dunn's post hoc analysis with Bonferroni correction.

**Results:** The chronic exposure group was the only one showing alterations on impulse oscillometry, mainly in resistance at 5 Hz, which was elevated compared with the no exposed group ( $p = 0.02$ ) and the acute exposure group ( $p = 0.01$ ). Reactance was decreased compared with healthy subjects ( $p = 0.0005$ ).

**Conclusions:** Chronic exposure to pollutant emissions generated by brick kilns is associated with increased resistance and decreased reactance at 5 Hz, with no bronchodilator response. Impulse oscillometry is a useful tool to identify early alterations in respiratory mechanics before the development of symptoms.

#### 8. Measurement of Peak Inspiratory Flow Using the In-Check Dial and Hand Grip Pressure Strength as Tools for the Appropriate Selection of Inhalation Therapy

#### Devices in Patients with Chronic Obstructive Diseases at the Asthma and COPD Clinic of the Instituto Nacional de Enfermedades Respiratorias

**Authors:** Jaqueline Orozco Tellez, Rafael de Jesús Hernández Zenteno, Erika del Carmen López Estrada, Angélica de Jesús Castolo Pérez

**Country:** City of Mexico, Mexico

**Original research:**

**Introduction:** Chronic respiratory diseases such as chronic obstructive pulmonary disease and asthma are among the leading causes of morbidity and mortality. The main treatment consists of inhaled medications; therefore, patients must receive training in the proper administration technique to reduce errors.

**Methods:** A descriptive, analytical, prospective, longitudinal, and comparative study was conducted. The sample consisted of 157 patients diagnosed with asthma and COPD. The educational intervention was carried out using a checklist to identify patients' errors, and with the help of slides the technique was explained and practiced. Inspiratory flow was measured using the In-Check Dial device. Statistical analysis was performed using the Kolmogorov-Smirnov test, Pearson's chi-square test, and Spearman's correlation.

**Results:** 70.7% (111) of the participants were female and 29.29% (46) were male. 72.6% (114) did not perform the inhaler administration technique correctly, and in 72.6% (114) the most frequent error observed was an inadequate inspiratory flow. 56.7% (61) used a metered-dose inhaler, of whom 80.7% generated a supra-optimal flow despite the duration of use. 55.4% (87) used a dry powder inhaler, of whom 40.7% did not achieve an optimal flow, and 22.29% (32) used a soft mist inhaler, in which 90.6% generated a supra-optimal flow. Great dispersion was observed in baseline inspiratory flow for the three types of devices. On average, patients achieved a flow of 40 L/min with the In-Check Dial after the educational intervention, which is considered appropriate for the use of any inhaler.

**Conclusions:** In Mexico, this device is not available, so a substitute was sought, and a greater correlation with maximal expiratory pressure (PE<sub>max</sub>) and maximal inspiratory pressure (PI<sub>max</sub>) was found after the educational intervention. This educational approach is essential for optimizing inspiratory flow.

#### 9. Barometric Pressure as a Determinant of Respiratory Mechanics

**Authors:** Julio Eduardo Morales-Torres, Irlanda Alvarado-Amador, Laura Gochicoa-Rangel, Gustavo I. Centeno-Sáenz, Alejandra García-Velasco, Diana Laura Guzmán-Maldonado, Daniela Astrid López Cázares, Arantxa Mariana Remigio Luna.

**Country:** City of Mexico, Mexico

**Original research:**

**Introduction:** Oscillometry allows the assessment of respiratory impedance (Z) and integrates components of resistance (R) and reactance (X). The latter reflects both elastance, related to the stiffness of the respiratory system, and inductance, which depends on the mass of the moving gas and therefore on air density. Since barometric pressure determines air density, its variation with altitude could modify oscillometry parameters.

**Objective:** To determine the effect of altitude on respiratory impedance in healthy subjects.

**Methods:** An analytical, cross-sectional, and prospective study was conducted in 48 healthy adults residing in Mexico City (CDMX), evaluated by oscillometry at two altitudes: sea level (Acapulco, 30 m above sea level) and moderate altitude (Mexico City, 2,240 m above sea level). The following parameters were analyzed: R<sub>5</sub>, R<sub>20</sub>, R<sub>5</sub>-R<sub>20</sub>, R<sub>5</sub>-R<sub>20</sub>/R<sub>5</sub>, X<sub>5</sub>, X<sub>20</sub>, Fres, and AX. Paired Student's t-tests, correlation coefficients, and Bland-Altman agreement analyses were applied. The study was approved

by the Research and Ethics Committee (approval code C73-23).

**Results:** Resistance parameters were higher in Acapulco (R5:  $0.30 \pm 0.07$  vs.  $0.25 \pm 0.07$  kPa/L/s,  $p = 0.003$ ; R20:  $0.27 \pm 0.06$  vs.  $0.22 \pm 0.06$  kPa/L/s,  $p < 0.001$ ). The (R5-R20)/R5 ratio was higher in Mexico City ( $12.4 \pm 6.9$  vs.  $7.7 \pm 10.4$ ,  $p = 0.01$ ). Regarding reactance, X20 was lower in Mexico City ( $0.025 \pm 0.029$  vs.  $0.056 \pm 0.043$  kPa/L/s,  $p < 0.001$ ), while X5 and AX showed no significant differences. Fres increased in Mexico City ( $16.5 \pm 4.1$  vs.  $14.3 \pm 4.0$  Hz,  $p = 0.009$ ).

**Conclusions:** Barometric pressure appears to primarily modify resistance parameters and, to a lesser extent, reactance; altitude should be taken into account when interpreting oscillometry results.

#### 10. Accelerated Pulmonary Silicosis with a Very Severe Obstructive and Restrictive Pattern, with a normal FEV1/FVC ratio.

Authors: Elizabeth Acha.

Country: Tupiza-Potosí, Bolivia

Case report:

**Introduction and initial presentation:** Silicosis is a chronic and irreversible pneumoconiosis, classified among occupational diffuse interstitial lung diseases. It is caused by prolonged inhalation of crystalline silica particles, which triggers a fibrotic response in the pulmonary parenchyma that severely impairs respiratory function and is manifested on spirometry as a restrictive or mixed pattern. Diagnosis is based on an adequate medical record, radiologic interpretation, and lung function testing.

This case report describes a 43-year-old patient, originally from Tupiza and currently residing there, with an occupational history of having worked in the Chorolque-Atocha mine for approximately 9 years without safety measures. He left work voluntarily due to a sensation of shortness of breath. He was diagnosed with pulmonary silicosis in 2021 and has since been treated with corticosteroids, bronchodilators, and continuous home oxygen therapy, with episodes of exacerbation requiring hospitalization. He has undergone serial spirometry tests from the time of admission to the present, showing very severe obstructive and restrictive patterns, with an FVC of 31%, FEV<sub>1</sub> of 25%, and an FEV<sub>1</sub>/FVC ratio of 79% after a bronchodilator test, with no change at the time of admission to the service. The most recent spirometry, from August 2025, shows a persistent FVC of 31%, FEV1 of 28%, and an FEV1/FVC ratio of 90%. The post-bronchodilator test with salbutamol produced no significant changes. Chest PA X-ray shows extensive pulmonary involvement with fibrotic conglomerates and right-sided pleural thickening.

**Conclusions:** Despite being a country with significant mining activity, there are no up-to-date statistical data on pulmonary silicosis. In addition, there is a lack of adequate care for this population in terms of early diagnosis and timely prevention, as mining centers are often located at great distances and at high altitudes (meters above sea level), which hinders both access for healthcare personnel and the transport of workers to receive occupational medical care.

#### 11. Impact of the Correction of Hemoglobin on Carbon Monoxide Diffusion in Patients with Various Pulmonary Conditions Living at an Altitude of 3,658 m Above Sea Level. La Paz, Bolivia.

Authors: Luis Alberto Tancara Condori, Mónica Patricia Sea Aramayo, Marcel Otto Fernández Peralta.

Country: La Paz, Bolivia

Original research:

**Introduction:** In high-altitude cities such as La Paz, the following question arises: What is the impact of hemoglobin correction on carbon monoxide diffusion in patients with various pulmonary conditions living at high altitude?

**Methods:** An analytical study was conducted from January 2024 to July 2025 at Hospital Luis Uría, located in the city of La Paz, where normal hemoglobin concentrations range from 14 g/dL to 17 g/dL for women and from 15 g/dL to 18 g/dL for men; higher values are considered erythrocytosis. Hemoglobin values obtained within a three-week period were taken into account. The study of DLCO was performed according to the ERS/ATS 2017 technical standards.

**Results:** The study group consisted of 93 patients: 53 patients aged  $59.3 \pm 14.15$  years with normal hemoglobin levels (Group A) and 40 patients aged  $62.3 \pm 10$  years with erythrocytosis (Group B). In Group A, the mean Hb concentration was  $16 \text{ g/dL} \pm 1.33 \text{ g/dL}$ . DLCO values before and after hemoglobin adjustment were  $6.70 \pm 3.08 \text{ mmol/min/kPa}$  and  $92.3\% \pm 37.68\%$ , compared with  $6.40 \pm 3.01 \text{ mmol/min/kPa}$  and  $88.24\% \pm 36.5\%$ , respectively ( $p < 0.001$ ). In Group B, the mean hemoglobin concentration was  $20 \text{ g/dL} \pm 1.53 \text{ g/dL}$ . DLCO values before and after hemoglobin adjustment were:  $7.69 \pm 3.13 \text{ mmol/min/kPa}$  and  $103.4\% \pm 37.50\%$ , compared with  $6.75 \pm 2.73 \text{ mmol/min/kPa}$  and  $90.9\% \pm 32.8\%$ , respectively ( $p < 0.005$ ).

**Conclusions:** This study revealed that correction of DLCO for hemoglobin is crucial for accurate interpretation of results, especially in patients with erythrocytosis. Although the findings are consistent, this study is limited by its small sample size.

#### 12. Arterial Oxygen Concentration Measured by Gasometry Correlates with Stroke Volume Assessed by Transthoracic Echocardiography in Critical Care Medicine at High Altitude.

Authors: Herrera Aguilar, Benjamín; Viruez Soto, José Antonio; Jiménez Torres, Fernando; Viscarra Machaca, Zenón; Ticona Flores, Herry Rudy; Ali Yucra, Noemí; Olivera Rodríguez, Andrea de los Ángeles; De la Cruz Choque, Clara Adriana; Ávila Viruez, María Celeste; Choque Poma, Brígida; Huallpa Condori, Wilson; Tintaya Maquera, Apolinar; Pacheco Arias, Diego Armando; Varela Romero Christian.

Country: La Paz, Bolivia

Original research:

**Introduction:** Stroke volume (SV) is a dynamic marker for monitoring and fluid responsiveness. Its estimation has traditionally relied on invasive and noninvasive methods, which have gradually been replaced by more modern techniques such as transthoracic echocardiography (TTE). Arterial oxygen content (CaO<sub>2</sub>) is a blood gas-derived marker. Current literature lacks studies comparing CaO<sub>2</sub> obtained by gasometry with SV measured by transthoracic echocardiography. This correlation would physiologically explain the Fick method and provide a parameter of fluid responsiveness. The aim of this study was to determine the correlation between CaO<sub>2</sub> and SV.

**Objective:** To determine the correlation between cardiac output (CO) calculated from blood gas analysis using theoretical formulas and CO measured by TTE.

**Methods:** An experimental, descriptive, cross-sectional, single-center study was conducted in the Adult Intensive Care Unit of the Hospital del Norte in the city of El Alto, located at 4,150 m above sea level. Pearson, Spearman, and Bland-Altman correlation tests were performed using SPSS Statistics v29 and XLSTAT. Results: The Pearson correlation coefficient between SV and CaO<sub>2</sub> was the highest in the study, with  $r = 0.9$  (95% CI,  $p = 0.0001$ ). The Bland-Altman test between SV and CaO<sub>2</sub> was 2.8 mL (95% CI: 26 and 37). The Bland-Altman test between velocity-time integral (VTI) and CaO<sub>2</sub> was 1.1 cm (95% CI: -4.6 and -0.05).

**Conclusions:** The correlation between SV and CaO<sub>2</sub> is very high. This supports CaO<sub>2</sub> as a dynamic parameter for fluid resuscitation in critically ill patients. We consider that parameters derived from the Fick method remain useful and are comparable to macrohemodynamic parameters such as SV at the bedside of the critically ill patient.

### 13. Intersectionality and Pulmonary Health in Indigenous Women of the Huasteca Potosina

**Authors:** Blanca Nohemí Zamora Mendoza, Karen Beatriz Méndez Rodríguez, Francisco Javier Pérez Vázquez, Rogelio Flores Ramírez, Rosaura Esperanza Benítez Pérez, Teresa Santiago Marcelino, Berenice Balderas Segura, Stephanie Rangel Ramírez, María del Rocío Mata Hernández.

**Country:** La Paz, Bolivia

**Case report:**

**Introduction and initial presentation:** A 77-year-old retired male patient with a 30-year history of occupational exposure as an arc welder was admitted to the Pulmonology Ward due to a one-month history of productive cough episodes with mucous sputum and grade 1 dyspnea that progressed to grade 2 on the mMRC scale. He denied having fever; however, since 2023 he has experienced intermittently audible wheezing, and non-productive cough. Bilateral rhonchi and wheezing with no changes after coughing. Oxygen saturation ( $\text{SpO}_2$ ): 71%,  $\text{FiO}_2$ : 0.21; HR: 75 bpm; RR: 24 breaths per minute; BP: 100/70 mmHg. Spirometry showed an obstructive pattern with decreased  $\text{FEV}_1$ , reduced  $\text{FEV}_1\%$ , decreased FVC, and severely reduced FEF75. Plethysmography revealed total lung capacity (TLC) below expected values, increased airway resistance, and decreased conductance; residual volume (RV) and RV/TLC ratio above predicted values. Impulse oscillometry showed increased R5, normal R20, elevated R5–R20, markedly negative X5 with reduced lung compliance, very high AX5, indicating severe involvement of the small airways and air trapping. Chest CT showed findings compatible with bronchiolitis. Obliterative bronchiolitis secondary to exposure to metallic fumes was diagnosed. Treatment included inhaled bronchodilators and definitive removal from exposure, which is the cornerstone of management. Annual follow-up with impulse oscillometry was established to assess disease progression.

**Conclusions:** This case highlights the importance of considering obliterative bronchiolitis in workers with prolonged exposure to welding fumes and progressive dyspnea. Early request for lung function tests and highly sensitive impulse oscillometry allows for early diagnosis, monitoring of disease severity, and assessment of disease progression. We understand that early functional testing is essential to determining the possibility of small airway involvement.

### 14. Occupational Obliterative Bronchiolitis in a Retired Arc Welder

**Authors:** María Laura Palaguerra Calizaya, Mónica Patricia Sea Aramayo.

**Country:** San Luis Potosí, Mexico.

**Original research:**

**Introduction:** Approximately 2.1 billion people are exposed to biomass; by 2020, this exposure caused 3.2 million deaths, primarily among women. This problem develops under a complex intersection of multidimensional factors specific to each region, leading to profound inequality that impacts pulmonary health.

**Objective:** To identify the intersectionality of multidimensional factors associated with pulmonary health in Indigenous women from the Huasteca Potosina region.

**Methods:** A mixed-method, cross-sectional, analytical study was conducted in a probabilistic random sample of 44 adult women from two Indigenous communities in the Huasteca Potosina. With informed consent (REC [Research Ethics Committee]: SLP/05/2025), participants completed a multidimensional questionnaire and underwent pre- and post-bronchodilator spirometry according to ATS/ERS standards. In addition, interviews were conducted with women and community leaders for discursive analysis within a dialogue of knowledge regarding pulmonary health.

**Results:** Overall mean values were: age 50.4 years; IEHL 87.8;  $\text{FEV}_1/\text{FVC}$  80.5 (–0.11 Z-score);  $\text{FEV}_1$  91.4% (–0.67 Z-score); FVC 92.3% (–0.63 Z-score); PEF 84.4% (–0.83 Z-score); FEF25–75: 76.5% (–0.85 Z-score). A positive post-bronchodilator response was identified only for FEF25–75: 35.3% (2.34 Z-score). Eighty-nine percent had at least one respiratory symptom. Linear regression analysis revealed a statistical association of FVC (Z-score) with IEHL ( $p = 0.05$ ), age at menarche onset ( $p = 0.00$ ), number of pregnancies ( $p = 0.00$ ), family history of chronic respiratory disease ( $p = 0.04$ ), and having a dirt floor in the home ( $p = 0.05$ ). The intersectional discursive analysis revealed five nodes: normalization of risk, low perception of symptoms, gender, and poverty.

**Conclusions:** The pulmonary health of Indigenous women reflects interaction among gender roles, biological sex, reproductive health, economic conditions, and rural territoriality—factors that reinforce vulnerability amid structural inequalities and inadequate syndemic, integrated, intersectional care.

### 15. Factors Associated with Poor DLCO Quality in Patients with Interstitial Lung Disease

**Authors:** Montserrat Rojas Cevada, Rosaura Esperanza Benítez Pérez, Mario Arturo Flores Valadez.

**Country:** City of Mexico, Mexico.

**Original research:**

**Introduction:** More than 200 interstitial lung diseases are recognized, all characterized by inflammation or fibrosis of the interstitial space—a process that reduces lung compliance and impairs gas exchange. In the management of these diseases, lung function tests play a fundamental role in diagnosis and prognosis. Spirometry is the most widely used and standardized test; therefore, an assessment of gas exchange, such as DLCO, is recommended. Many patients perform poor-quality maneuvers during testing; thus, identifying poor-quality efforts across one or more attempts is essential.

**Methods:** A retrospective, observational, analytical, cross-sectional study was conducted. The sample consisted of 39 patients diagnosed with interstitial lung disease. The statistical analysis was performed using binomial logistic regression.

**Results:** Overall DLCO test technical quality was consistently lower than FVC tests during the same visit: poor-quality DLCO was observed in 63.3% of first visits versus good-quality FVC in 81.6%.

**Conclusions:** In the logistic regression analysis, male sex was associated with a lower probability of achieving a good-quality DLCO test compared with women. Higher FVC values were associated with a greater probability of obtaining a good-quality DLCO test. Spirometry demonstrated high levels of good quality and is consolidated as the most practical and useful tool for evaluation.

### 16. Elevated DLCO and Pulmonary Function Evolution During Treatment in a Patient with Hyperleukocytosis and Leukostasis

**Authors:** Arce SC, Monti PM, Cortés Guerrieri VB.

**Country:** Buenos Aires, Argentina

**Case report:**

**Background:** Pulmonary function tests (PFTs) are essential in the evaluation of respiratory disease. The diffusing capacity of the lung for carbon monoxide (DLCO) is typically reduced in parenchymal or vascular lung disorders, whereas elevated values are uncommon and often attributed to obesity, asthma, polycythemia, or a technical error. Reports in the context of leukemia are scarce.

**Case presentation and follow up:** We describe a 39-year-old man with newly diagnosed chronic myeloid leukemia (CML) and severe hyperleukocytosis ( $640,000/\text{mm}^3$ ). He presented with asthenia, weight loss, hepatosplenomegaly, chloromas, visual

and auditory disturbances, and hypoxaemia. Chest CT showed pulmonary vascular enlargement and increased parenchymal density. PFTs revealed a non-specific spirometric pattern with DLCO and DLCO/AV (alveolar volume) markedly above the upper limit of normal. Serial testing showed progressive normalization of these indices in parallel with leukocyte reduction following leukapheresis, hydroxyurea, and imatinib. Radiological findings also improved, with decreased vascular caliber and parenchymal density.

**Discussion:** Elevated DLCO in this patient could not be explained by haemoglobin concentration, obesity, or technical factors. Instead, pulmonary capillary engorgement and slowed transit time due to blood hyperviscosity likely increased the effective alveolar-capillary surface for gas transfer. Additional CO-binding by leukocyte heme proteins may have contributed. As leukocyte counts fell, DLCO and DLCO/AV returned toward normal, supporting a causal association. To our knowledge, this is the first report of serial PFTs in hyperleukocytosis, providing pathophysiological insights into pulmonary involvement in hyperviscosity syndrome.

**Learning points and conclusions:** Hyperleukocytosis in CML may transiently elevate DLCO and DLCO/AV due to pulmonary vascular engorgement and altered rheology. Recognition of this reversible abnormality is important for correct interpretation of pulmonary function tests in hematological disease. Further studies are needed to determine whether this pattern is consistent across similar patients.

#### 17. Agreement Between Spirometric Quality Reviewers in an Epidemiological Study

**Authors:** Santiago C. Arce, Ricardo Del Olmo, Adrián Ceccato, Juan M. Luchelli, Evelyn Sureda, Mariano Fielli, Sergio J. Arias, Andrés L. Echazarreta.

**Country:** Buenos Aires, Argentina

**Original research:**

**Introduction:** spirometry is the gold standard pulmonary function test, with acceptability criteria established to ensure reliable results. However, variability in spirometry review among trained reviewers remains unexplored. This study examines the agreement among trained reviewers on spirometric acceptability and its components, including number of acceptable maneuvers, predominant defects, and repeatability.

**Methods:** spirometries from 3,982 adults ( $\geq 40$  years) participating in an epidemiological study across six cities in Argentina were reviewed independently by junior reviewers (JRs) and adjudicated by senior reviewers (SRs). Reviewers followed 2005 ATS/ERS guidelines. Agreement was assessed using Cohen's kappa, McNemar's test, and proportions.

**Results:** a total of 7,964 pre- and post-bronchodilator spirometries were analyzed. Agreement on overall acceptability between JRs was 76% and 84% in two independent reviewer teams (RvTa and RvTb). Agreement on specific defects was highest for numerical criteria such as insufficient expiratory time ( $\kappa=0.61$ ) and back extrapolation volume ( $\kappa=0.52$ ), but lower for subjective criteria like weak effort ( $\kappa=0.19$ ) and cough in the first second ( $\kappa=0.36$ ). No agreement was found for glottic closure ( $\kappa=0$ ). SR adjudication increased the number of acceptable tests from 54% to 65%. **Conclusions:** reviewer variability significantly affects spirometric acceptability, with numerical criteria achieving higher agreement than subjective assessments. Discrepancies have implications for large-scale studies, data quality, and automated algorithm development. Cross-checking reviews is recommended to improve reliability. Further standardization of acceptability criteria is warranted.

#### 18. Hypersensitivity Pneumonitis in a Patient with Exposure to Avian Antigen

**Authors:** Claudia Silva Corini, Eva Quispe Fuentes

**Country:** La Paz, Bolivia.

**Case report:**

**Introduction and initial presentation:** Hypersensitivity pneumonitis is an immune-mediated parenchymal lung disease caused by exposure to various allergens. Its diagnosis is challenging, demands a high index of clinical suspicion, and lacks a single definitive test. We present the case of a 53-year-old female patient, a resident of La Paz, who worked as a secretary for 10 years. She reported no allergies, no past medical history, and no toxic habits.

She presented with a two-year clinical course characterized by grade 1 dyspnea, sporadic episodes of nonproductive cough, and fatigue. Initial laboratory findings: secondary erythrocytosis, negative immunological profile; initial lung function tests: spirometry with restrictive pattern, FVC 69% predicted, arterial blood gas with moderate hypoxemia ( $PO_2$  43 mmHg); HRCT: isolated nonspecific nodules in the middle lobe and left lower lobe; transthoracic echocardiogram: right ventricular dilation; follow-up functional tests: spirometry with persistent restriction, DLCO  $<40\%$ , normal plethysmography, impulse oscillometry with very negative X5 consistent with restriction. Image: expiratory HRCT demonstrated mosaic air trapping with three densities; airway allergen profile was negative; follow-up echocardiography showed moderate right ventricular dilation with no evidence of pulmonary arterial hypertension. On further history taking, the patient reported frequent exposure to pigeon droppings in her home. Physical examination revealed oxygen saturation of 81% and bilateral subscapular "sail-type" crackles.

**Diagnosis:** Moderate diagnostic confidence for chronic hypersensitivity pneumonitis based on exposure to avian allergen, dyspnea, hypoxemia, imaging findings of air trapping with a three-density mosaic pattern, small airway involvement, and lung function tests consistent with diffuse interstitial lung disease (chronic hypersensitivity pneumonitis).

**Treatment and course:** removal from exposure and corticosteroid therapy were initiated. Fiberoptic bronchoscopy with bronchoalveolar lavage (BAL) was requested.

**Discussion:** Evaluating the patient's progress requires applying a questionnaire to assess allergen exposure, as it enables ordering the necessary tests to reach a diagnosis. The condition is associated with erythrocytosis, likely due to hypoxemia secondary to interstitial lung disease or residence at higher geographic altitude.

**Conclusions:** A thorough medical record, use of allergen exposure questionnaires, and HRCT allow for early diagnosis and improved prognosis. The mainstay of management consists of removal from allergen exposure, use of corticosteroids, and close follow-up to assess response and disease progression, to complete the protocol. Fiberoptic bronchoscopy with bronchoalveolar lavage was requested to complete the diagnostic protocol.

#### 19. Is obesity a protective factor in COPD?: Evaluation of Comorbidities and Exacerbations in a Group of Patients with COPD in the City of La Paz, Bolivia

**Authors:** Luis Alberto Tancara Condori, Mónica Patricia Sea Aramayo, Marcel Otto Fernández Peralta.

**Country:** La Paz, Bolivia.

**Original research:**

**Introduction:** Overweight and obesity have been associated with lower mortality in patients with COPD (chronic obstructive

tive pulmonary disease), which gave rise to the idea of obesity as a protective factor in COPD, a phenomenon known as the "obesity paradox". This refers to the notion that obese patients with COPD may have lower hospitalization rates than patients with normal weight.

**Objective:** To provide an evaluation of comorbidities and exacerbations in patients with COPD according to their BMI (Body Mass Index).

**Methods:** A descriptive study conducted from January to December 2024 at Hospital Luis Uría, located in the city of La Paz, which included patients diagnosed with COPD with a post-bronchodilator FEV<sub>1</sub>/FVC < 0.7; other pulmonary diseases were excluded.

**Results:** 26 patients were included: 62% men and 38% women, with a mean age of 70 years. COPD severity was distributed according to the guidelines of the Global Initiative for Chronic

Obstructive Lung Disease (GOLD) as follows: 50% GOLD 2, 31% GOLD 3, and 19% GOLD 1. 46% of patients had normal weight (Group A); the remaining 53.7% were overweight or obese (Group B). In Group A, 58% had erythrocytosis, 41% had systemic arterial hypertension, and 66% experienced two exacerbations per year requiring hospitalization. In contrast, in Group B, 78% had erythrocytosis and systemic arterial hypertension, and 21% had type 2 diabetes mellitus; 85% experienced two exacerbations per year requiring hospitalization.

**Conclusions:** This study suggests that patients with COPD and obesity were more frequently associated with comorbidities and a higher percentage of exacerbations requiring hospitalization, contrary to the concept of obesity as a protective factor in COPD. This study has several limitations: it was conducted at a single center, limiting the generalizability of the findings, and included a small number of patients.