Case Studies in Pulmonary Function Testing

Al Heuer, PhD, MBA, RRT-ACCS, RPFT, FAARC

Professor—Rutgers School of Health Professions

Co-Owner—A & T Lectures

Case 1

- **Overview:** A 70-year-old man has a chief complaint of severe dyspnea on exertion. The dyspnea has increased gradually over the past several years. He has had severe kyphoscoliosis from his teenage years. He denies a history of cough, sputum production, smoking, working in a polluted environment, or respiratory disease. Physical examination reveals tachypnea, tachycardia, jugular venous distention, ankle edema, and kyphoscoliosis.
- **Personal Data**
- Age: 70 years
- Height: 66 inches
- Weight: 155 lb
- Gender: male

Case 1 (Cont.) -Spirometry

Report	Predicted	Observed	Predicted %
FVC (L)	3.78	1.46	39
FEV_1 (L)	2.57	1.40	54
FEV_1/FVC	75%	96%	—
FEF25%-75%	2.46	2.01	82

Case 1 (Cont.) - Lung Volumes

	Predicted	Observed	Predicted %
VC (L)	3.78	1.79	47.4
FRC (L)	2.42	2.01	83.0
RV (L)	1.75	1.86	106
TLC (L)	5.78	3.65	63.2
RV/TLC	30%	51%	—

Case Study I -- Interpretation

- Spirometry reveals a small FVC and FEV1 with a normal FEV1/FVC ratio and FEF25%-75%. This suggests that the small FEV1 is caused by restrictive lung disease and small lung volumes rather than by an obstructive impairment with low flows. The lung volume studies demonstrate a small VC and TLC. These findings confirm restrictive lung disease.
- The lung function studies are typical for a patient with kyphoscoliosis. Kyphoscoliosis causes a reduction in the size of the thoracic cage and can severely compromise lung expansion and eventually result in pulmonary hypertension (cor pulmonale), which can cause right-sided heart failure, resulting in elevated jugular venous distention and pedal edema.

Case 2

- **Overview:** A 38-year-old man complains of long-standing dyspnea on exertion. His dyspnea has increased over the past year and now occurs with minimal exertion. He denies cough, chest pain, and sputum production. He has a 40 pack-year smoking history. There is no history of exposure to environmental pollutants. Physical examination shows large anteroposterior chest diameter and diminished breath sounds bilaterally.
- **Personal Data**
- Age: 38 years
- Height: 76 inches
- Weight: 188 lb
- Sex: male

Case 2 (Cont.) -Spirometry

Report	**Predicted**	**Observed**	**Predicted %**
FVC (L)	6.06	5.10	79
FEV_1 (L)	4.52	1.53	34
FEV_1/FVC	75%	28%	—

Case 2 (Cont.)- Interpretation and Discussion

- **Interpretation**
- Spirometry reveals a markedly low FEV1 and FEV1/FVC, indicating a severe obstructive ventilatory impairment.
- **Discussion**
- FVC measurement prebronchodilator and postbronchodilator and static lung volume and Dlco measurements would help further evaluate this patient's status. There should be a high index of suspicion for a1-antitrypsin deficiency in this patient given the severity of his lung disease at such a young age.

Case 3

- **Overview:** A 72-year-old woman was admitted to the medical service complaining of weakness and shortness of breath. She recently had been diagnosed with asthma but previously was in good health. Physical examination of the chest revealed markedly diminished breath sounds. There was no wheezing, but crackles were noted at both bases. The admitting chest radiograph revealed the presence of bibasilar atelectasis but was otherwise clear. Her admitting laboratory work was normal.
- Her blood gas results indicated that her pH was normal, but the Paco2 was 54 mm Hg, with a Pao2 of 58 mm Hg while breathing room air. After 3 days of standard therapy for asthma that included inhaled bronchodilators and steroids, her respiratory symptoms did not improve. Her Paco2 had increased to 62 mm Hg, and her chest radiograph was unchanged. Her weakness was a little better. Pulmonary consultation was requested.
- The consultant requested bedside spirometry. More blood testing was also ordered, including a sedimentation rate and anti–acetylcholine receptor (AChR) antibody.
- **Personal Data:**
- Age: 72 years
- Height: 63.5 inches
- Weight: 166 lb
- Sex: female

Case 3 (Cont.) - Spirometry

	Predicted	Observed	Predicted %
FVC (L)	2.80	1.45	52
FEV_1 (L)	2.13	1.19	56
FEV_1/FVC	75%	82%	—

Case 3- Interpretation and Discussion

- **Interpretation**
- Results indicate low lung volumes with a normal FEV1/FVC. This indicates restrictive lung disease rather than obstructive lung disease such as asthma.
- **Discussion**
- Restrictive lung disease may be caused by diseases that decrease lung compliance, such as pulmonary fibrosis; by diseases that "stiffen" the chest wall, such as kyphoscoliosis; by diseases associated with muscle weakness, such as muscular dystrophy; or by neurologic disorders affecting nerve transmission, such as amyotrophic lateral sclerosis or myasthenia gravis. Results in this case confirm a restrictive impairment. Blood testing for antibodies against the neurotransmitter acetylcholine makes the specific diagnosis of myasthenia gravis. As myasthenia gravis worsens, respiratory muscles weaken, and the patient develops hypercapnic respiratory failure ("myasthenia crisis"). This is the reason for the patient's rising Paco2. The patient's chest radiograph findings of small volumes and bibasilar atelectasis are also explained by weakening respiratory muscle , causing an inability to take a deep breath.

Take Home Points

- Chest-wall restrictive disorders such a kyphoscoliosis tend to reveal themselves in PFTs with lowers volumes and normal or higher flows.
- Neuromuscular disorders such as myasthenia gravis are restrictive disorders which tend to result in lower volumes ***and flows*** owing weakness of respiratory muscles inhibiting the ability to inhale normal volumes and exhale normal flows.
- Obstructive disorders such as asthma and COPD tend to be associated with lower flows, especially FVC/FEV1, which is less effort dependent than PEFR.
- Disorders which can cause a lower DL_{CO} are emphysema and pulmonary fibrosis.
- Asthma is an obstructive disorder which tends to be more responsive to bronchodilators (e.g., greater than 15% change, pre vs post bronchodilators), than chronic ones such as COPD.

References

- Haynes, JM, Debunking myths in pulmonary function testing Can J Respir Ther 2018;53(1):7–11.
- Heuer & Scanlan, Clinical Assessment in Respiratory Care, ed. 8, 2019.
- Kacmarek, Stoller, Heuer, Egan's Fundamentals of Respiratory Care, ed 12, 2021.