**X-Y-T Recorder with Body Plethysmograph for Determining Functional Residual Capacity from Thoracic Gas Volume**

To the Editor:

The advantages of determining thoracic gas volume and functional residual capacity (FRC) via the body plethysmograph have long been recognized. In our laboratory, we have found that employing a standard X-Y-T recorder in conjunction with the plethysmograph enables us to determine a more precise measurement of FRC from our measurement of thoracic gas volume.

During plethysmographic study, the technician has the responsibility of determining when the subject is at an end resting tidal volume (TV) or FRC so that the mouth shutter can be closed and the panting maneuver initiated if the technician is to assume that the measured thoracic gas volume represents the subject's FRC. In our laboratory, we have often had difficulty determining when the patient was at true FRC. The operating manual for our plethysmograph (Cardio-Pulmonary Instruments 2000TB) suggests observing the oscilloscopic tracing that occurs during tidal breathing. When the tracing has stabilized and is consistently retracing itself, the shutter can be closed at end of expiration; however, this technique does not allow the technician to know at exactly what pulmonary volume the subject is when the shutter closes. Great variations in the measurement of FRC and thoracic gas volume will occur if the shutter closes at pulmonary volumes above or below FRC.

By employing an X-Y-T recorder and by plotting volume on the Y axis and time on the X axis (in order to monitor tidal breathing), it is possible to more accurately assess when the patient has reached a stable TV. Since there is no volume displacement when the shutter is closed and the panting maneuver is initiated, only time is plotted on the recorder. After the panting maneuver, the shutter is released, and the patient is instructed to perform a maneuver for determining vital capacity (VC) (Fig 1).

From the tracing on the oscilloscope, thoracic gas volume can be calculated. From the tracing on the recorder, it is possible to determine where this thoracic gas volume is in relationship to TV. If it is at end resting TV, then this thoracic gas volume represents FRC. If the shutter closed above or below end resting TV, then the thoracic gas volume can be corrected to FRC by knowing the sensitivity and calibrating factors for the recorder (Fig 2).

From Figure 2, it is apparent that the thoracic gas volume included a portion of the subject's inspiratory capacity (IC). By subtracting this portion of the IC from the calculated thoracic gas volume, a more accurate FRC is reported. This technique can easily be checked by closing the mouth shutter at various pulmonary volumes, initiating the panting maneuver, calculating thoracic gas volume, and correcting this value to FRC.

Our plethysmographic assembly included the plethysmograph, an X-Y-T recorder (Cardio-Pulmonary Instruments 750), a mouth shutter (Hans Rudolph model 4100), and a heated pneumotachygraph (Hans Rudolph model 3800). We believe that the X-Y-T recorder is a valid tool for increasing the accuracy and reproducibility of FRC from measurements of thoracic gas volume, when determined by the body plethysmograph.

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Massive Pulmonary Hemorrhage Complicating Thoracocentesis in Chronic Renal Failure

To the Editor:

Pulmonary hemorrhage is an unusual complication of thoracocentesis. Even with deliberate puncture of the lung, the incidence of bleeding is extremely low. In this report a diagnostic thoracocentesis in a patient with chronic renal failure resulted in massive pulmonary hemorrhage and opacification of an entire hemithorax.

CASE REPORT

A 41-year-old black man who was receiving long-term therapy with hemodialysis was hospitalized with left lower lobar pneumonia. Despite oral therapy with erythromycin (500 mg four times daily), a low-grade fever persisted for five days, and roentgenograms of the chest showed an increasing density in the left lower lobe. When chest x-ray films in the decubitus position failed to demonstrate free pleural fluid, an ultrasonic examination was performed, which showed a collection of fluid in the posterior portion of the left hemithorax. A routine hemodialysis reduced the blood urea nitrogen concentration to 45 mg/100 ml. The platelet count was 225,000/cu mm, and the prothrombin time and the partial thromboplastin time were normal.

On the next day a thoracocentesis was attempted, using markers placed on the wall of the chest during the ultrasonic examination. Initial passes with needles of No. 20 and 22 gauge to a depth of 1½ inches were unrewarding. During another attempt with a spinal needle of No. 20 gauge to a depth of approximately 1½ inches, the patient suddenly coughed, complained of pain in the chest, and began to expectorate blood. Four units of fresh frozen plasma and four units of packed red blood cells were administered. Following transfusion with six units of platelet concentrates, the massive hemoptysis (approximately 1,400 ml) stopped.

On that evening, the chest roentgenogram (Fig 1) showed nearly complete opacification of the left hemithorax. A rigid bronchoscopic procedure removed multiple clots of blood from the left side of the endobronchial tree. Clinical and roentgenographic improvement followed, and the patient was discharged on the 21st day of hospitalization.

DISCUSSION

Although azotemia is considered to be a risk factor in invasive pulmonary procedures (such as biopsy via aspiration and transbronchial biopsy), to our knowledge, no case of massive pulmonary hemorrhage complicating an attempted thoracocentesis has been reported within the last ten years. The abnormal bleeding which may complicate chronic renal failure has been attributed to a qualitative defect of the platelets and is usually corrected by dialysis. A prolonged bleeding time is a sensitive indicator of this dysfunction of the platelets.

Despite normal routine measurements of blood coagulation and the recent hemodialysis, our patient had life-threatening hemoptysis following a relatively superficial puncture of the lung. Since such serious bleeding rarely results from either inadvertent or deliberate pulmonary puncture, a qualitative defect of the platelets may have contributed to the hemorrhage. Invasive procedures in azotemic patients should be preceded by routine tests of blood coagulation, with the addition of a determination of the bleeding time. If the bleeding time is prolonged, platelet concentrates should be infused immediately before the procedure.

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REFERENCES