UNIT SEVEN: COMPARING CHANGES FOLLOW-UP SPIROGRAMS

A. Rationale for Comparing Changes

Medical surveillance is an important use of spirometry in occupational health. In this context, it is essential to compare an employee's present results with his or her past results. When no other data are available, comparison with predicted normal values is useful. However, predicted values are not a baseline; therefore a subject's previous test results should be used as a baseline whenever possible. (See **Unit Six: Comparing Observed to Predicted Normal Values** for information on using predicted values.) A healthy individual's performance relative to predicted values remains remarkably consistent in adulthood. For example, a person who achieves 106% of the predicted FVC in one year tends to perform between 102-110% in subsequent years, assuming that the testing is satisfactory. Repeat testing of the same subject over a period of time may be more sensitive than comparing his/her values to a set of "predicted" normals. Hankinson and Wagner (42) concluded that approximately half of a worker population may benefit from the addition of a longitudinal comparison of their spirometry results, over using only comparison with predicted normal values. They suggest a greater than 15% decrease in FEV_1 is significant. This is illustrated by the following example:

> During his first year on the job, the FVC of a healthy young worker was 110% of a predicted normal value. The following year it was 90%. If his second year FVC is compared to the value of the first year, the difference could indicate the rapid development of serious restrictive pathology. This should alert the physician to conduct additional tests to identify the problem. However, if his FVC is only compared to a predicted value, it would be considered normal. Therefore, it is likely that no follow-up action would have been taken. As a result, his health could be seriously jeopardized. Although the comparisons with the LLN are preferred, results that are at least 80% of the predicted normal value, are often considered within the normal range if no other data are available for comparison. Interpreting follow-up spirograms will be discussed in more detail later in this unit. (See **Appendix M. Tables of Obstructive/Restrictive Patterns**.)

B. Interpreting Changes in Follow-up Spirograms.

Spirometric testing is usually used in two ways for respiratory surveillance programs:

a. To compare <u>pre- and post-shift values</u> for acute changes (example: FEV_1 in cotton dust exposure).

b. To compare <u>longitudinal</u> test results (e.g., those taken over an extended period of time, such as annually) for signs of chronic disease (example: FVC in asbestos exposure).

HOW TO CALCULATE:

When comparing a current spirometric value to a previous one, the difference can be expressed in two ways:

1. As an absolute difference (+ gain, - loss) in liters or ml:
   Value at $time_1$ - Value at $time_2$ = + or - liters.

2. As a percent change from the previous value (+ gain, - loss):

$$\frac{\text{Value at time}_1 - \text{Value at time}_2}{\text{Value at time}_1} \times 100$$

   a. Calculate the absolute difference.
   b. Divide the answer by the value at $time_1$.
   c. Multiply by 100 for the percent change and indicate whether it is a gain or a loss.

3. A third method involves a least squares linear fit to the FVC and FEV_1 values as a function of time. However, this approach generally requires the use of a computer and is not described in this manual.

EXAMPLE A: In an ongoing annual surveillance of asbestos workers, a 24 year old woman is found to have an FVC of 3.59 liters. Her previous FVC was 4.17 liters. What is the absolute and percent change in her FVC from the previous value?

Absolute change: 4.17-3.59 = .58 liters
She showed a loss of .58 liters.

Percent change: ((4.17-3.59)/4.17) x 100 = 13.9%
She showed a loss of 13.9% in her FVC.

EXAMPLE B: A 23 year old cotton dust worker has a pre-shift (7AM) FEV_1 of 4.00 liters, and a post-shift (3PM) FEV_1 of 3.85 liters.

Absolute change: 4 - 3.85 = .15 liters
He showed a loss of .15 liters.

Percent change: ((4.00-3.85)/4.00) x 100 = 3.8%
He showed a loss of 3.8%.

EXERCISE: A 71-inch, 62-year-old Caucasian male maintenance worker is intermittently exposed to asbestos. In ongoing medical surveillance testing, the following results were obtained:

1989: FVC = 4.48 L. ATPS (24°C)

1990: FVC = 4.38 L. ATPS (26°C)

Calculate the absolute change in the FVC and the change as a percent.

FEEDBACK: 1989 FVC: 4.84 L. (BTPS)

1990 FVC: 4.68 L. (BTPS)

FVC absolute change: - 0.16 liters

FVC change as a %: 3.3% decline

POINTS TO REMEMBER:

1. Percent change: Percent changes in follow-up studies always refer to a percent change from a PREVIOUS value, so the PREVIOUS value always appears in the denominator. Percentages are rounded to one decimal point (e.g., 85.3%).

2. Expected decline in pulmonary function in longitudinal studies: In annual follow-up studies, the comparison of current results can be made to:
    a. The previous year's value.
    b. The previously recorded best value for each test, regardless of the year in which it occurred.

In either case, the **expected annual decline** (simply due to normal aging) in spirometry values must be taken into account. The numbers below are "averages" derived from cross-sectional studies; considerable variation may occur among individuals.

a. For males FEV_1: 30 ml/year
   FVC: 25 ml/year

b. For females: FEV_1: 25 ml/year
   FVC: 25 ml/year

3. Other changes: One of the purposes of respiratory surveillance programs is to detect changes in lung functioning that may be job-related. However, there may be other changes that could influence spirometric results. Some of the more common ones are given below. Be sure to note any of these changes for the physician to aid in interpretation.
   a. Height: Some individuals tend to become shorter as they age.
   b. Weight: A large weight gain or loss over the period of examination.
   c. Smoking: The FEV_1 declines more quickly from year to year in smokers than in nonsmokers.
   d. Seasonal Allergies: Someone with hayfever may not perform as well during allergy season.
   e. Medications: May influence motivation or may directly affect air flow.
   f. Illness: May reduce performance. (See **Unit Four: Spirometric Technique** for guidelines for postponing the test.)

4. Further investigation is usually recommended for follow-up results when:
   a. There is a decline in FEV_1 or FVC that is greater than 15% in longitudinal screening. However, if the period of follow-up is long (greater than 5 years), it may be necessary to adjust for the expected decline due to aging.
   B. The FVC, FEV1, or FEV_1/FVC% is less than the LLN at any time.
   c. There is a 10% or greater decline in the FEV_1 between pre- and post-shift screening, when a single exam is conducted or a 5% or greater decline (more than 150 ml for FEV_1s less than 3 liters) if a follow-up exam confirms this decline (Cotton Dust recommendation).

NOTE: The interpretation of longitudinal changes in FVC and FEV_1 are limited due to the relative considerable variability of these parameters with respect to the expected annual decline (25 to 30 ml/year). This means that either a large change must occur in a short period of time, or the length of follow-up must be longer than 5 years. In addition, a good quality control program is essential if these relatively small changes are to be detected. For this reason, the ATS has recommended that a greater than 15% year-to-year change is needed to be considered significant.