



Portable Spirometer for Occupational Respiratory Epidemiology



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Rationale

Workplace challenge tests are a gold standard for diagnosis of work-related asthma. A highly accurate portable electronic spirometer is needed to facilitate research and clinical diagnosis. The spirometer should be user friendly, date- and time-stamped, capture flow volume loop as well as derived parameters, and enable questionnaires and pre- and post-bronchodilator testing. Coaching messages during the course of data collection and a modem to download data for review are desirable.

Method

Detailed specifications were developed, including adherence to ATS spirometry recommendations, an algorithm to collect basic data on workers' activities regardless of shift, and incorporation of an investigator-defined questionnaire.

The instrument was tested three times at NIOSH with each of the 24 volume and 26 flow ATS waveforms. It was field tested on 12 subjects by placing the EasyOne in line ahead of a digital dry rolling seal spirometer.

Features include:

- ✓ User feedback on maneuver quality;
- ✓ Storage of parameters for the 3 best blows / session
- ✓ Storage of flow-volume curves from 3 best blows
- ✓ Pre- and post-bronchodilator test capability
- ✓ Award of incentive points
- ✓ Data can be downloaded via modem.

The algorithm (Figure 1) collects activity information necessary for analysis in the OASYS Utilities software

The algorithms were tested with simulated work schedules and by workers with asthma. Data is stored in Microsoft Access format.

The session timing and desired testing window can be customized for each individual study. Additionally up to 10 study specific questions may be entered. The response categories may be yes/no, number, or multiple selection. See Figure 2.

Subject data is entered into a screen as shown in Figure 3.

An additional screen allows entering target FEV₁ and PEF from initial coached session for use in automated coaching by the instrument.

Figure 1: Algorithm for Collection of Activity Information

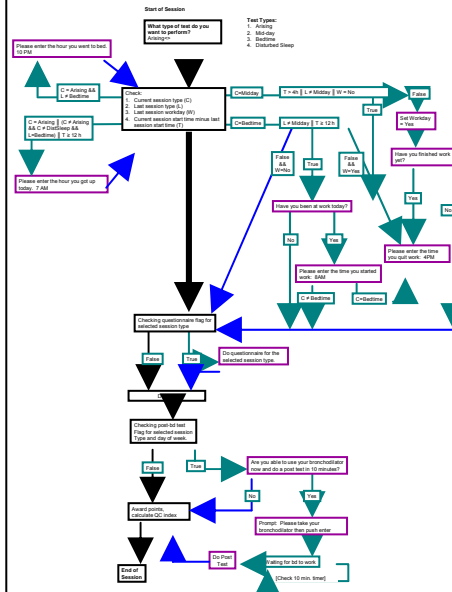


Figure 2: Customization for Each Study

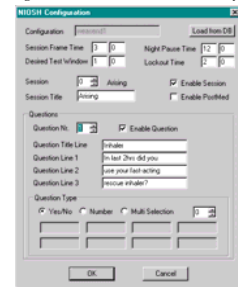
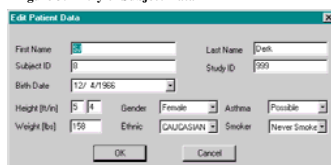


Figure 3: Entry of Subject Data



Results

Standard diagnostic software was successfully modified to adapt a lightweight highly accurate portable spirometer for use in occupational respiratory epidemiology. The final software is accurate, user-friendly, and customizable to various research settings.

The instrument passed all ATS waveforms when tested at NIOSH. Results of in-line field tests are shown in Table 1.

Table 1: Results for 12 Subjects Tested with EasyOne (EZ1) In Line with a Dry Rolling Seal Spirometer (DRS)

Parameter	Mean		Difference (95% Confidence)	
	DRS	EZ1	Mean	Upper
FVC	4.29	4.32	-0.04%	-3.16%
FEV ₁	3.43	3.38	1.86%	3.32%
PEF	8.19	8.44	-3.66%	-7.60%

Data uploaded nightly by subjects can be reviewed on screen and used to give telephone support and encourage improved performance.

Figure 4: On Screen Quality Monitoring of Downloaded Data

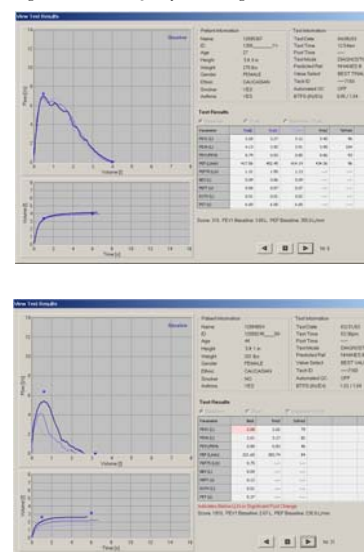


Figure 5: Customizable Questionnaire / Diary

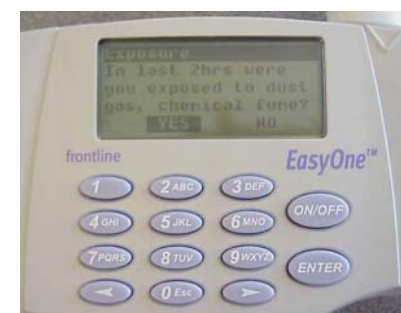


Figure 6: EasyOne in Cradle Attached to Modem and Phone



Conclusion

Use of the small lightweight portable hand-held spirometer enables researchers and health care professionals to observe workers, in their workplace and home environments over a period of weeks, to establish work-related asthma status.

References

1. Townsend MC. ACOEM position statement. Spirometry in the occupational setting. American College of Occupational and Environmental Medicine. J Occup Environ Med 2000; 42:228-45.
2. Hankinson JL. Beyond the peak flow meter: newer technologies for determining and documenting changes in lung function in the workplace. Occup Med 2000; 15:411-20.
3. Gannon PF, Newton DT, Belcher J, Pantin CF, Burge PS. Development of OASYS-2: a system for the analysis of serial measurement of peak expiratory flow in workers with suspected occupational asthma. Thorax 1996; 51:484-9.