

Modification of a Commercial Portable Spirometer for Use in Studies of Work-Related Respiratory Disease

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Aims

Serial spirometry is one of the methods that can be used to confirm suspected work-related respiratory disease, especially asthma. We sought an accurate, user-friendly portable spirometer that was flexible enough to be used in different studies, and would have the following features: a) Remind users when to blow; b) Provide real-time coaching after each blow, consistent with American Thoracic Society (ATS) standards; c) Record flow-volume curves for quality reviews; d) Automatically date- and time-stamp recorded data; e) Allow the investigator to specify questions which are communicated to the user via the spirometer's small LCD screen, with answers indicated via a keypad; f) Allow remote telephone uploading of data.

Methods

The EasyOne™ Frontline portable spirometer was tested three times at the National Institute for Occupational Safety and Health (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 uploaded via modem

An algorithm was developed to collect activity information needed to evaluate the work-relatedness of serial measurements. Questions are presented on the spirometer's screen to determine:

- Type of test session (arising, midday, bedtime).
- Time of arising and going to bed.
- Time started and finished work.

The algorithm was tested with simulated work schedules and by workers with asthma.

The session timing and desired testing window can be customized for each study. Up to 10 study-specific questions may be entered via desktop computer (see Figure 1). The response categories may be yes/no, number, or multiple selection.

Subject data is entered via desktop computer using the software as shown in Figure 2. The software also allows entering target FEV1 and PEF from a coached session for use in automated coaching by the instrument.

Figure 1: Customization for Each Study via Desktop Computer

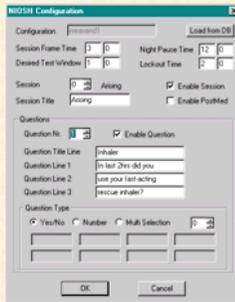
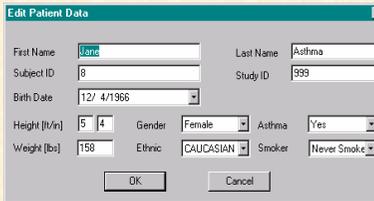


Figure 2: Entry of Participant Data via Desktop Computer



Results

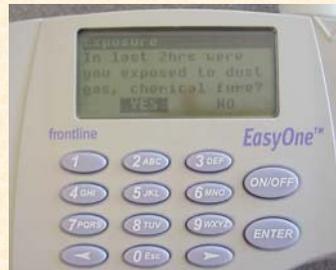
In a collaborative effort between NIOSH, Fallon Clinic Research Department, and nnd Medical Technologies, standard diagnostic software was successfully modified to adapt a lightweight, highly accurate, portable spirometer for use in occupational respiratory epidemiology. The final software is accurate, 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.

Parameter	Mean (L or L/s)		Difference (95% Confidence)		
	DRS	EZ1	Mean	Lower	Upper
FVC	4.29	4.32	-0.04%	-3.16%	3.09%
FEV ₁	3.43	3.38	1.86%	0.40%	3.32%
PEF	8.19	8.44	-3.66%	-7.60%	0.27%

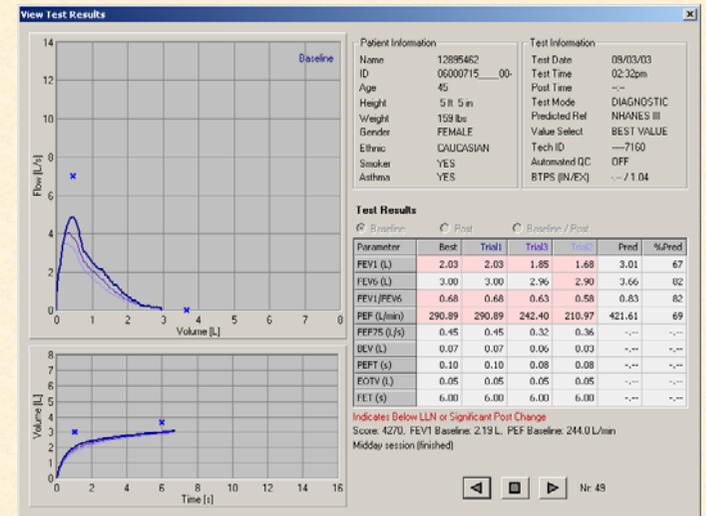
Questions appear in sequence on the instrument's screen and subjects record their answers using the keypad (Figure 3).

Figure 3: Customizable Questionnaire / Diary Screen



Data can be uploaded by subjects via telephone and reviewed by study staff using a desktop computer (Figure 4). Information from the review can be used to generate individualized recommendations to improve performance.

Figure 4: Quality Monitoring of Participant Data via Desktop Computer



Data Management and Analysis

- All data collected are stored in Microsoft Access format.
- Data can be used with the OASYS Utilities software (Gannon et al., 1996) to determine work-related pattern.

Field Testing

- We are using the EasyOne in a study of workplace exacerbation of asthma.
- To date, 15 adults with asthma have completed three weeks of self-testing.
- The field testing identified additional problems with the software, which resulted in further changes.
- Telephone uploading worked well.
- We will continue field testing with eligible participants.

Conclusions

Use of the lightweight, highly accurate, 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. We plan to use this equipment in other studies and to make additional software refinements as needed.

