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Emerging research article

The impact of severe lung disease on evidential breath analysis collection

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ABSTRACT

Background: It is a legal requirement to supply a breath analysis sample when requested by Police at roadside checkpoints. The current device requires a 1 L sample at 8 $L \cdot min^{-1}$. Court disputes commonly attribute respiratory disease for failure to produce a sample.
Objective: To determine whether respiratory disease aetiology and/or severity precludes an adequate breath sample using a modern evidential breath analyser.
Methods: Subjects performed breath analysis following standard Police procedure. Three efforts within 15 min were allowed and any reasons for failure recorded.
Results: 24 subjects with interstitial lung disease (ILD) and 26 subjects with chronic obstructive pulmonary disease (COPD) were studied and met minimum respiratory function criteria as per device specifications. 18 ILD subjects (75%) and 24 COPD subjects (92%) were able to provide a sample. All subjects with a vital capacity below 1.5 L were unable to provide a sample.
Discussion: In the balance of probabilities most patients with lung disease are able to supply an evidential breath sample. The exception is a very severe disease, particularly in volume limited patients.

1. Introduction

Law enforcement sobriety checkpoints have been shown to effectively reduce driving fatalities by 18–24% [1,2]. When preliminary screening at the roadside suggests an unacceptable level of intoxication, a driver is obliged to provide an evidential breath sample on an immobile breath analyser [3]. A failure to provide an adequate sample is a criminal offence. Periodically there are disputes in the law court by those criminally charged with a "failure to supply sample" offence claiming they have an inability to do so due to their respiratory disease. As there has been no direct quantification of the ability of those with lung disease to meet the specific requirements of the currently operating breath analysis device, these legal disputes are difficult to adjudicate.

The New South Wales (NSW) Police Force in Australia has introduced the Lion Intoxilyser 8000 breath analysis system [3]. The system calculates alcohol concentration in the exhaled breath using infrared absorption. It requires a minimum 1 L exhaled sample, delivered through a purpose built heated tube, fitted with a one-way, low volume single use plastic mouth piece. The system is designed to disallow variations in sampling procedure. The sample circuit employs a resistor which flow limits the exhalation to 8 $L \cdot min^{-1}$ thus requiring ≈7.5 s for collection. Any cessation in flow prior to the end of the test will terminate the sample collection. The standard operating procedure allows three attempts within 15 min, otherwise the individual is criminally charged with a "failure to produce sample".

Studies on previous comparative models have shown brand specific compliance when tested on those with known lung disease, predominantly chronic obstructive pulmonary disease (COPD). This variation appears to relate to equipment specifications; The Drager Alcotest 7110 (requiring a 775–925 mL sample at 4 $L \cdot min^{-1}$) had an extremely high 92% success rate [4,5] compared to the Lion Intoximeter 6000 (requiring a 1.2 mL sample at 12 $L \cdot min^{-1}$) showing a reduced success rate of 60% [6].

Intuitively, lung function would correlate with the ability to provide a sample. Gomm and colleagues suggested that those with a forced expiratory volume in one second (FEV_1) less than 2.0 L and forced vital capacity (FVC) less than 2.6 L were generally unable to use evidential breath analysis devices, and this includes healthy normals with small lungs [7,8]. In contrast Odell and colleagues, while assessing a more favourable device, successfully obtained samples from subjects with much poorer lung function (FEV_1 from 0.54 L and FVC from 800 mL) [4].

The "suitability for driving" guidelines in Australia are extremely tolerant. There is an allowance for those with supplemental oxygen to drive a motor vehicle, which thus includes those with severe respiratory disease [9]. Considering the previous broad range in compliance rates, and the introduction of a new evidential breath analysis device with altered specimen requirements, a quantification of the physiological

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limits of complying with an evidential breath testing is required, particularly in those with volume impairment, such as interstitial lung disease (ILD). A critical assessment of the collection process and the establishment of contingency tables may help to clarify the legal situation in future court disputes.

1.1. Aim

We sought to determine whether lung disease aetiology and/or severity precludes a motorist from supplying an adequate sample for analysis using the current evidential roadside breath analysis system currently used by NSW law enforcement officers. Those that are affected by expiratory volume limitation (ILD) and flow limitation (COPD) were compared.

2. Methods

2.1. Subjects

Patients with a diagnosis of ILD or COPD were recruited from a tertiary hospital outpatient's clinic. Patients had been clinically assessed as having moderate to severe disease, confirmed by their treating physician as per clinical guidelines, and recorded in their medical file [10,11]. Patients were excluded if they had any structural abnormalities of the chest wall, neurological disease or recent upper respiratory tract infections.

2.2. Questionnaire

Subjects were asked to complete a short questionnaire, as used by the NSW Police Force procedure during all random roadside breath analysis tests [3]. This includes asking subjects whether they have any injuries or illnesses, what current medications they are on and whether they may have any reason that would prevent supplying a breath sample.

2.3. Breath analysis

Subjects performed routine breath analysis following the NSW Police Force procedure that is pre-programmed into the Lion Intoxilyser 8000 evidential breath analyser (Lion Laboratories Pty Ltd., Barry, Vale of Glamorgan, UK). Instruction was strictly kept to the provided script;

"*You are now required to provide a sample of your breath that is sufficient for analysis...I now require you to submit to a breath analysis by exhaling air from your lungs, calmly and continuously, directly into this approved breath analysing instrument until I direct you to stop by saying the words "stop now*"".

If the subject was unable to supply a successful breath sample within 15 min or after three attempts, a formal classification of "failure to supply sample" was documented. On each failed attempt the device printed a report of "insufficient sample" with the sample volume collected. The documented reasons for failure were attributed by the tester as either; "Inadequate sample with good effort", "Inadequate sample with poor technique", "Lack of comprehension" or "Other".

2.4. Respiratory function

Following the breath analysis, spirometry, transfer factor and lung volumes (via plethysmography) were measured according to American Thoracic Society/European Respiratory Society criteria [12–14]. Predicted values were derived from the recommendations of the Global Lung Initiative [15] and the European Community for Coal and Steel [16].

2.5. Statistical analysis

Results are expressed as mean (SD) unless otherwise stated. Group demographics and respiratory function were compared using unpaired, two-tailed, t-tests. A P value < 0.05 was considered significant. Positive (failure to supply) and negative (ability to supply) results were formulated in contingency tables.

The study was reviewed and approved by the Human Ethics Review Board of Sydney Local Area Health (New South Wales, Australia). Each subject gave written informed consent.

3. Results

3.1. Subjects

24 subjects with ILD [age 67 (15) years] and 26 subjects with COPD [age 66 (13) years] were studied. Group mean (SD) subject demographics and respiratory function are presented in Table 1.

3.2. Questionnaire

Seven of the subjects with ILD were currently taking prednisone and inhaled corticosteriods. All subjects with COPD were taking an anticholinergic, combination long-acting bronchodilator and corticosteroid and/or a leukotriene-receptor antagonist. None of the subjects disclosed a reason for being unable to provide a sample.

3.3. Breath analysis and respiratory function

Individual subject data for forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) are presented in Fig. 1. 42/50 (84%) of all subjects successfully provided a sample. Of those unable to provide a sample, six were classified with severe ILD and two with severe COPD. All subjects with an FVC less than 1.5 L could not supply a sample.

18 ILD subjects (75%) were able to provide a sample, with 11 successful on the first attempt. All six ILD subjects who failed to provide a sample were documented as providing an "insufficient sample with good effort" and were classified as having a severe disease. One ILD subject with scleroderma (with facial involvement) could not achieve an adequate mouth seal and the remaining five subjects could not provide sufficient sample volume.

24 COPD subjects (92%) were able to provide a sample, with 17 successful on the first attempt. The two COPD subjects who failed to provide a sample were documented as providing an "insufficient sample with good effort" and were classified as having a severe disease.

The demographic and respiratory function data of the subjects who failed to supply a sample are presented in Table 2. Contingency tables are presented in Table 3.

Table 1
Subject demographics and respiratory function.

	ILD	COPD	P value
Age (years)	67 (15)	66 (13)	0.8
Gender (male:female)	17:7	13:13	–
Severity (moderate:severe)	15:9	13:13	–
FEV_1 (L)	1.68 (0.48)	1.13 (0.39)	0.01
FEV_1 (%predicted)	64 (16)	43 (12)	0.01
FVC (L)	2.08 (0.57)	2.49 (0.62)	0.02
FVC (%predicted)	61 (15)	73 (15)	0.01
TLC (L)	3.26 (0.76)	5.64 (1.0)	0.01
TLC (%predicted)	55 (10)	101 (14)	0.01
DL_{CO}	10.9 (3.6)	11.9 (3.6)	0.2
DL_{CO} (%predicted)	46 (14)	53 (19)	0.4

Data are mean (SD). ILD; interstitial lung disease, COPD; chronic obstructive lung disease, FEV_1; forced expiratory volume in one second, FVC; forced vital capacity, TLC; total lung capacity, DL_{CO}; transfer factor.