Fast Pulmonary Function Test Using Onboard Smartphone Equipment

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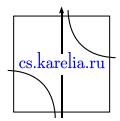

Respiratory diseases

Facts by WHO

- Approx. 64 million people suffered from COPD (and 235 million from asthma) worldwide in 2004
- Approx. 5% of deaths every year
- Not curable but treatment can slow the progress of the disease

Risk factors

- Air pollution
- Occupational dusts and chemicals
- Tobacco use
- Unhealthy diet
- Physical inactivity

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Pulmonary Function Tests

- Spirometry
- Peak flowmetry
- Body plethysmography
- Nitrogen washout
- Ergospirometry

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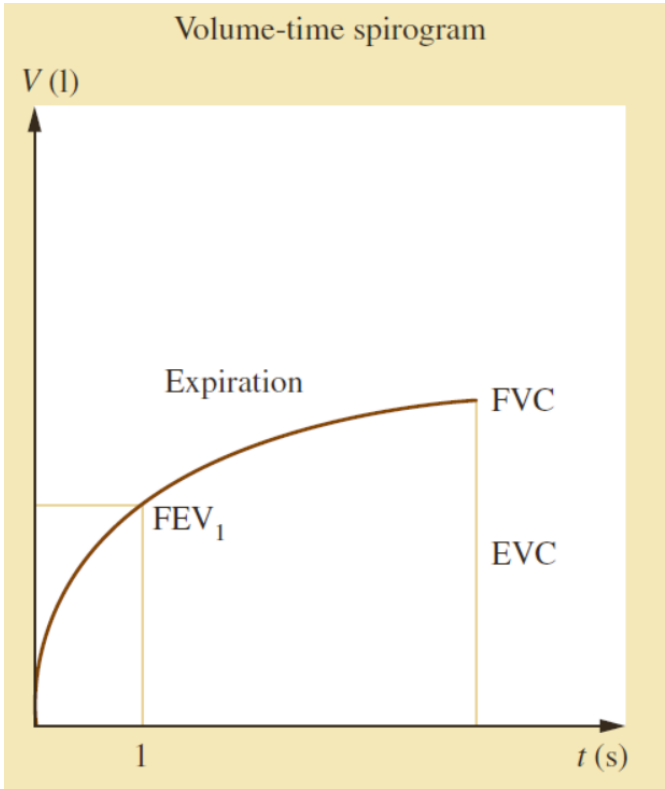
Spirometry Test

Noninvasive diagnostic for screening of pulmonary function

- What is the size of lung volume which can be inspired or expired
- What is the time it takes to exhale the volume and what is the flow rate?



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Testing: VF ECG record

Algorithm 1 Diagnosing obstruction or restrictive/mixed abnormalities

```
if FVC ≥ LLN then
    if FEV1 / FVC ≤ LLN &  then
        diagnose normal case
    else
        diagnose obstruction
    end if
    if FEV1 / FVC ≥ 0.55 & FVC < 85% then
        diagnose restrictive or mixed abnormalities
    else
        diagnose obstruction
    end if
end if
```

[1] from "Diagnostic Spirometry in Primary Care. Proposed standards for general practice...-by M. L. Levy et. al.

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Lung Capacity

Forced volume capacity[2]

$$FVC_m = 0.1524 \times height - 0.0214 \times age - 4.6500$$

$$FVC_f = 0.1247 \times height - 0.0216 \times age - 3.5900$$

Forced expiratory volume after one second

$$FEV1_m = 0.1052 \times height - 0.0244 \times a - 2.1900$$

$$FEV1_f = 0.0869 \times height - 0.0255 \times a - 1.5780$$

[2] from "Lung Capacity Estimation Through Acoustic Signal of Breath" by Ahmad Abushakra and Miad Faezipour

Estimated Lung Capacity

Forced volume capacity assessment based on breath sound analysis[3]

$$FVC_m = \frac{15e}{100}(0.1524 \times height - 0.0214 \times age - 4.65) \times t$$

$$FVC_f = \frac{15e}{100}(0.1247 \times height - 0.0216 \times age - 3.5900) \times t$$

Here t is the average time duration of exhale and inhale and e is the signal energy.

[3] from "Lung Capacity Estimation Through Acoustic Signal of Breath" by Ahmad Abushakra and Miad Faezipour

Current Results and Future Plans

- Experiments with breath sound analysis acquired from laptop microphones have been done.
- UI for mobile was designed to help a patient to articulate for better sound produce.
- Wide experiments with colleagues from department of pulmonary deseases
- Android app is planned to be developed.