

Slope indices from ultrasonic measurement of tidal molecular mass volume curves

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Background

- Simple, yet sensitive tools for assessment of peripheral airways disease are urgently needed
 - Ideally, assessment should be performed during tidal breathing, facilitating measurements in all age groups
- Airway obstruction may result in impaired ventilation-perfusion matching
 - Assessment by volumetric capnography
- The slope of the alveolar phase III from capnography has been shown to reflect changes in ventilation not detected by conventional spirometry

Background (2)

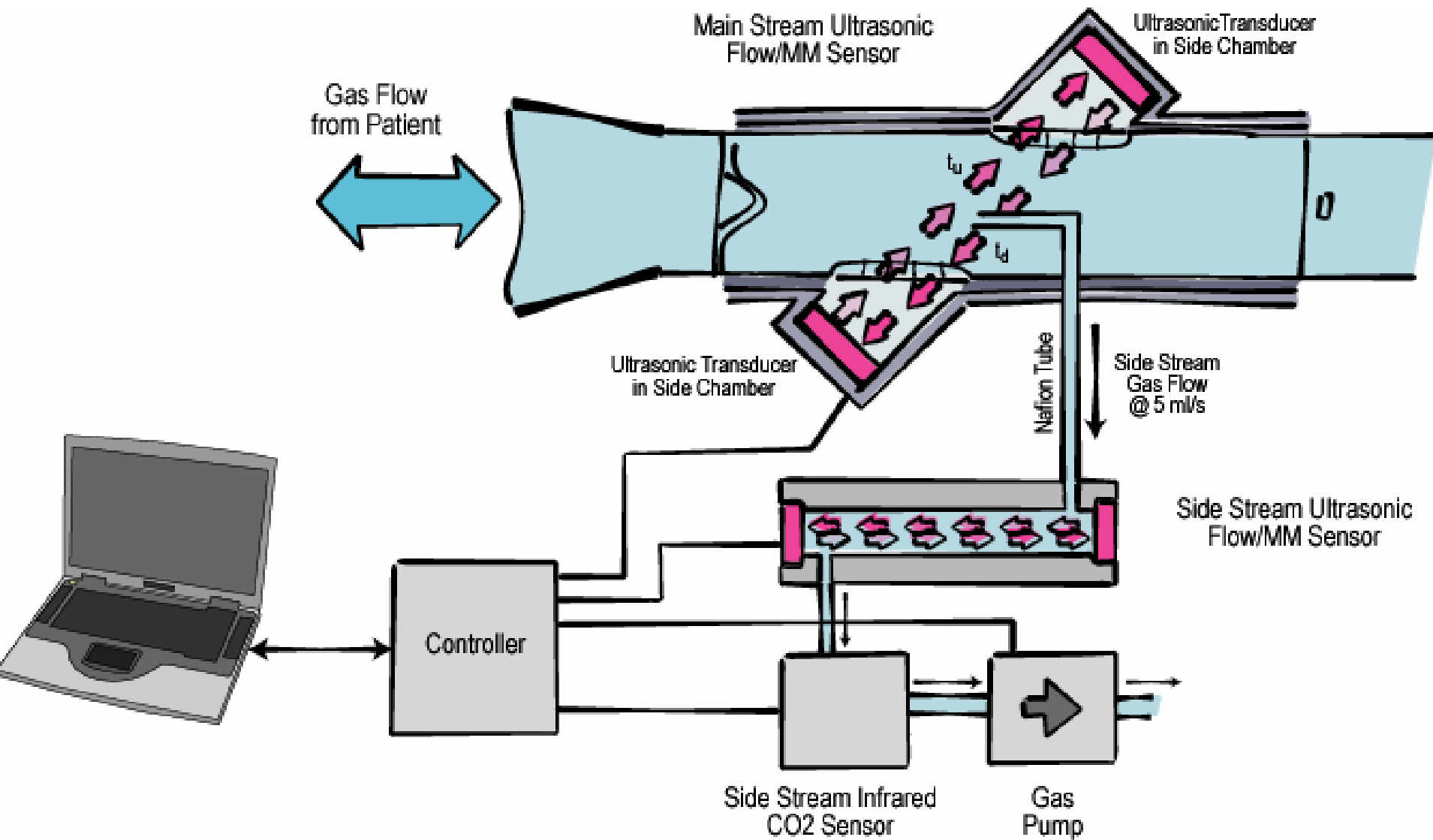
- An ultrasonic flowsensor (Spiroson) allows simultaneous measurement of molecular mass (MM), flow and volume
- Problem: influence of temperature and humidity
 - Negligible if sidestream device is used
- MMss can be used analogous to volumetric capnography (Buess, ATS 2005)

Aims

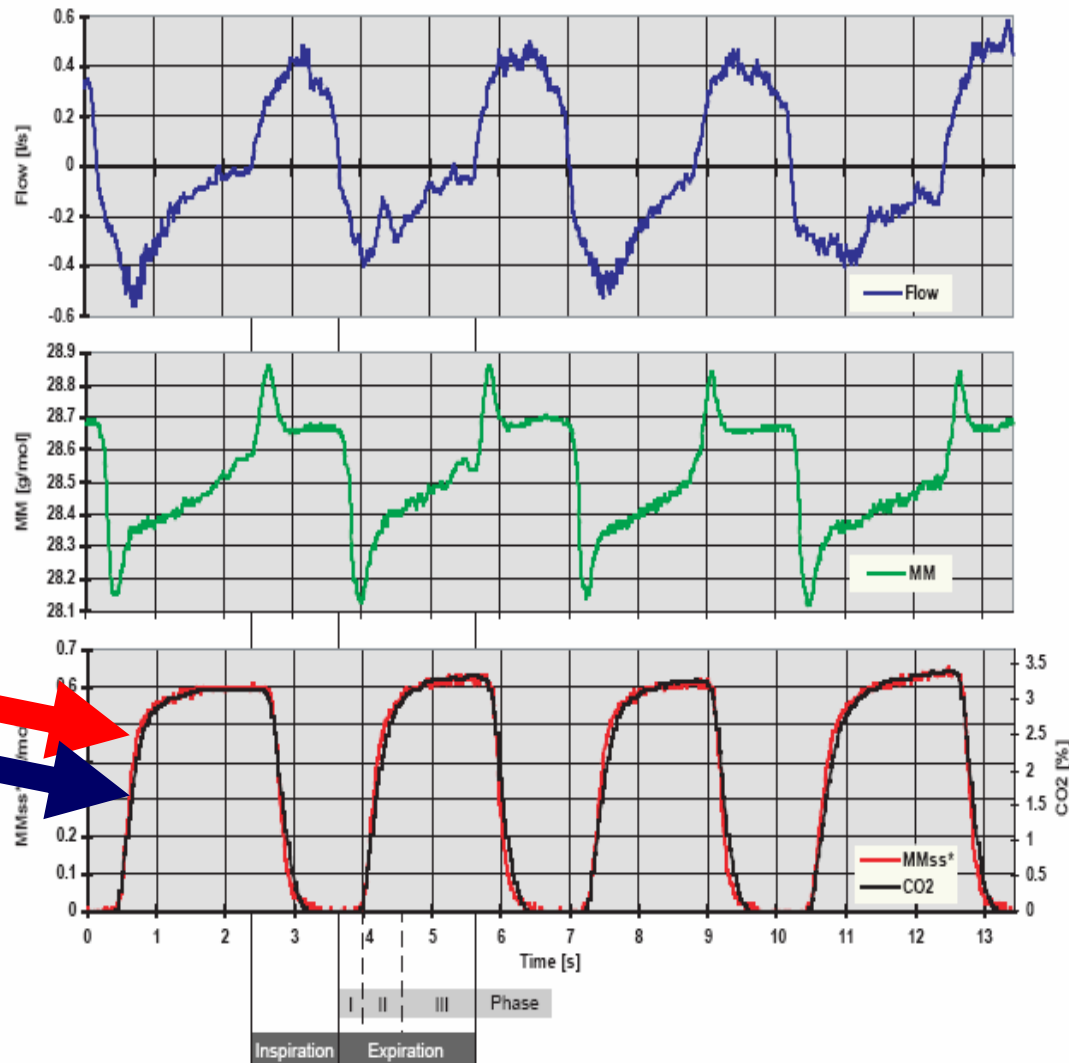
- to assess the feasibility of using mainstream molar mass-volume curves for assessing changes in ventilation-perfusion mismatch as in volumetric capnography
- and to assess the potential diagnostic value of molar mass-volume curves for identifying patients with lung disease

Subjects and protocol

- n=52 children with CF
 - Age 10.4 (2.8-18.3) years
 - FEV₁/FVC 81%
- N=99 healthy control children
 - Age 9.8 (2.8-17.9)
 - FEV₁/FVC 89.8%
- 2 minutes quiet tidal breathing prior to MBW
 - 49/99 „filed study“, no MBW
 - Sitting, mouth piece, nose clip



Comparison MMss/ capnography



Sidestream-MM

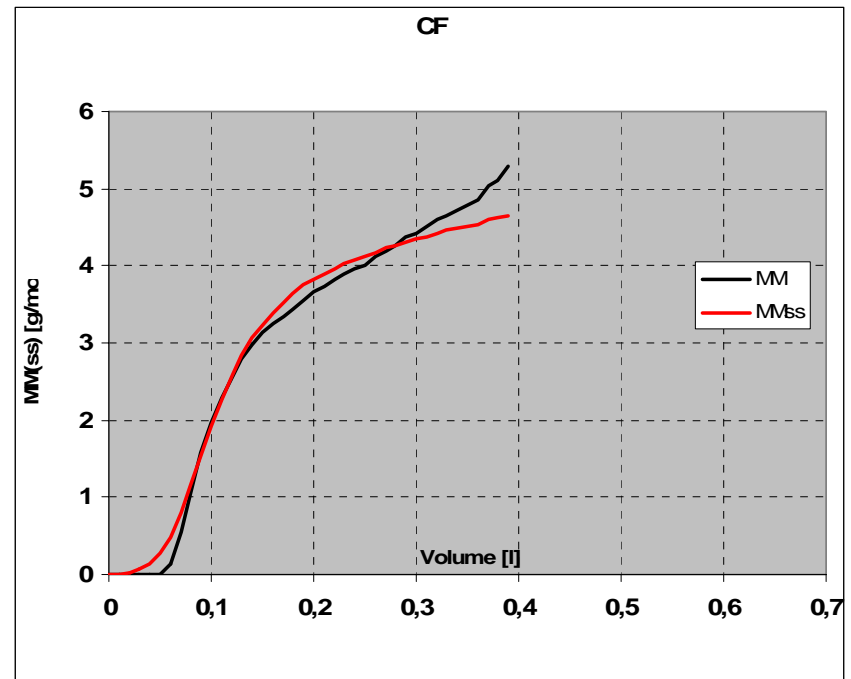
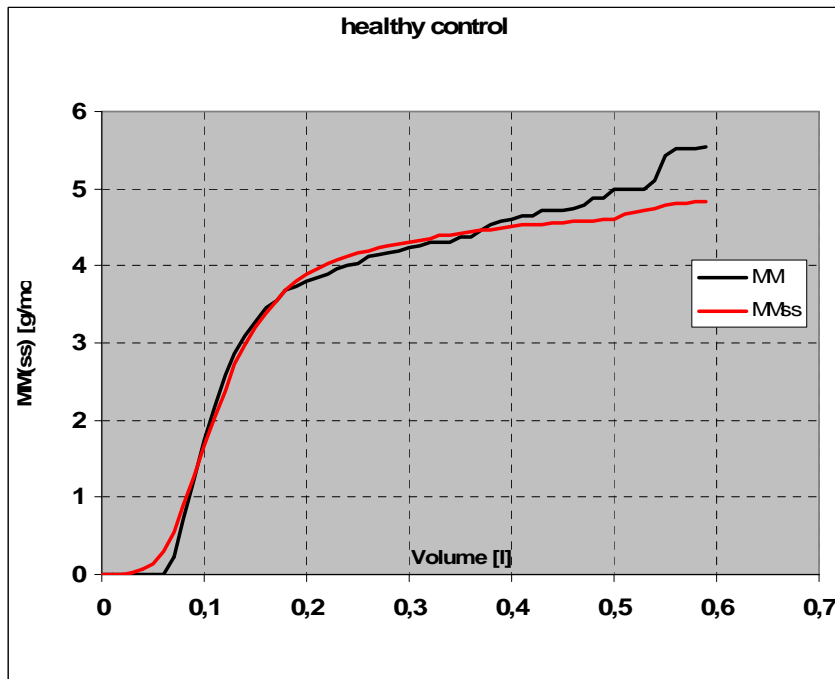
CO₂



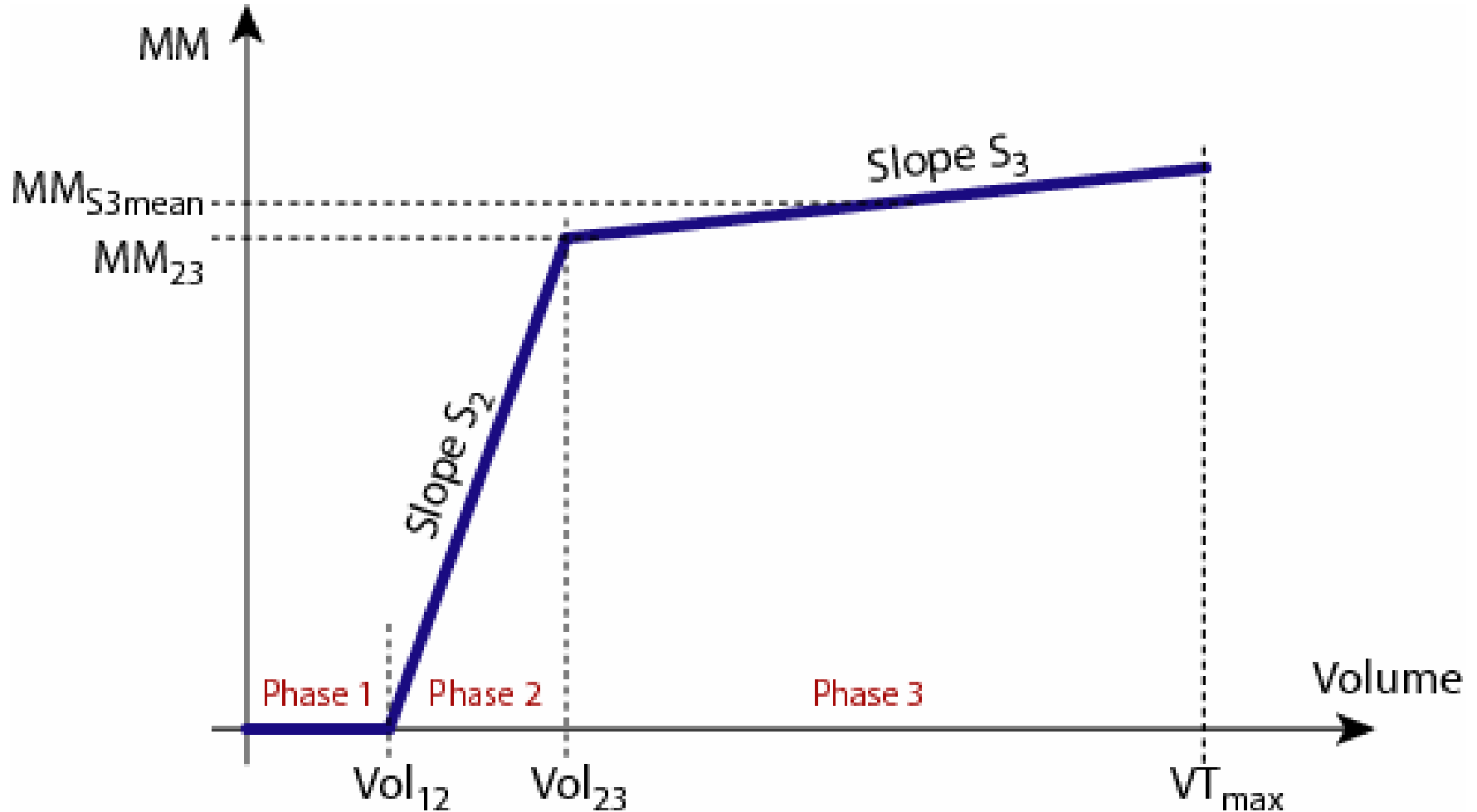
Molar mass-volume curves

Analysis: averaged curve

- from all breaths +/-40 % of mean tidal volume AND
- $t_{PEF}/t_E < 0.5$



Slope analysis of tidal breaths



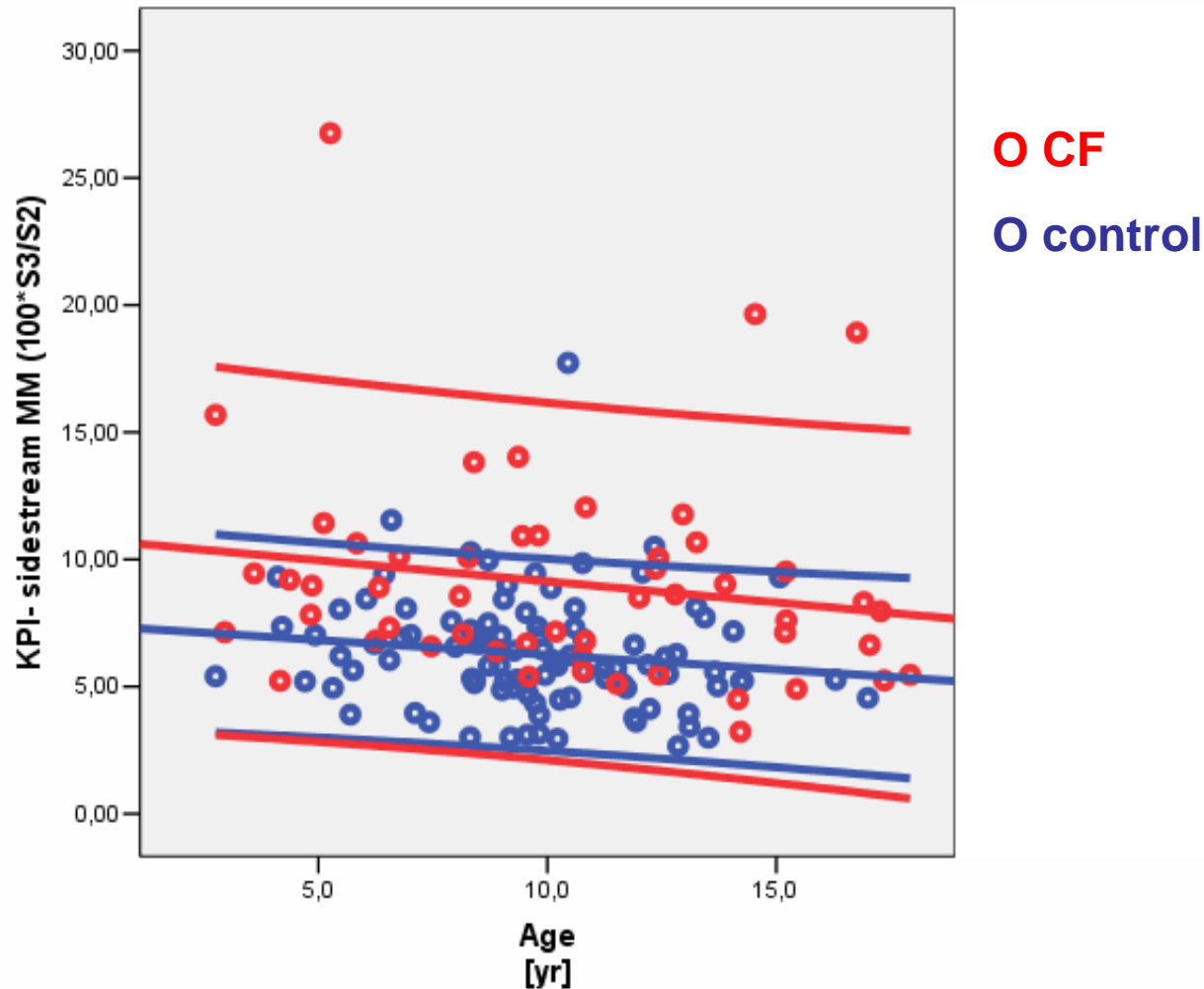
$$\text{Slope index} = 100 * \text{Slope } S_3 / \text{Slope } S_2$$

Results

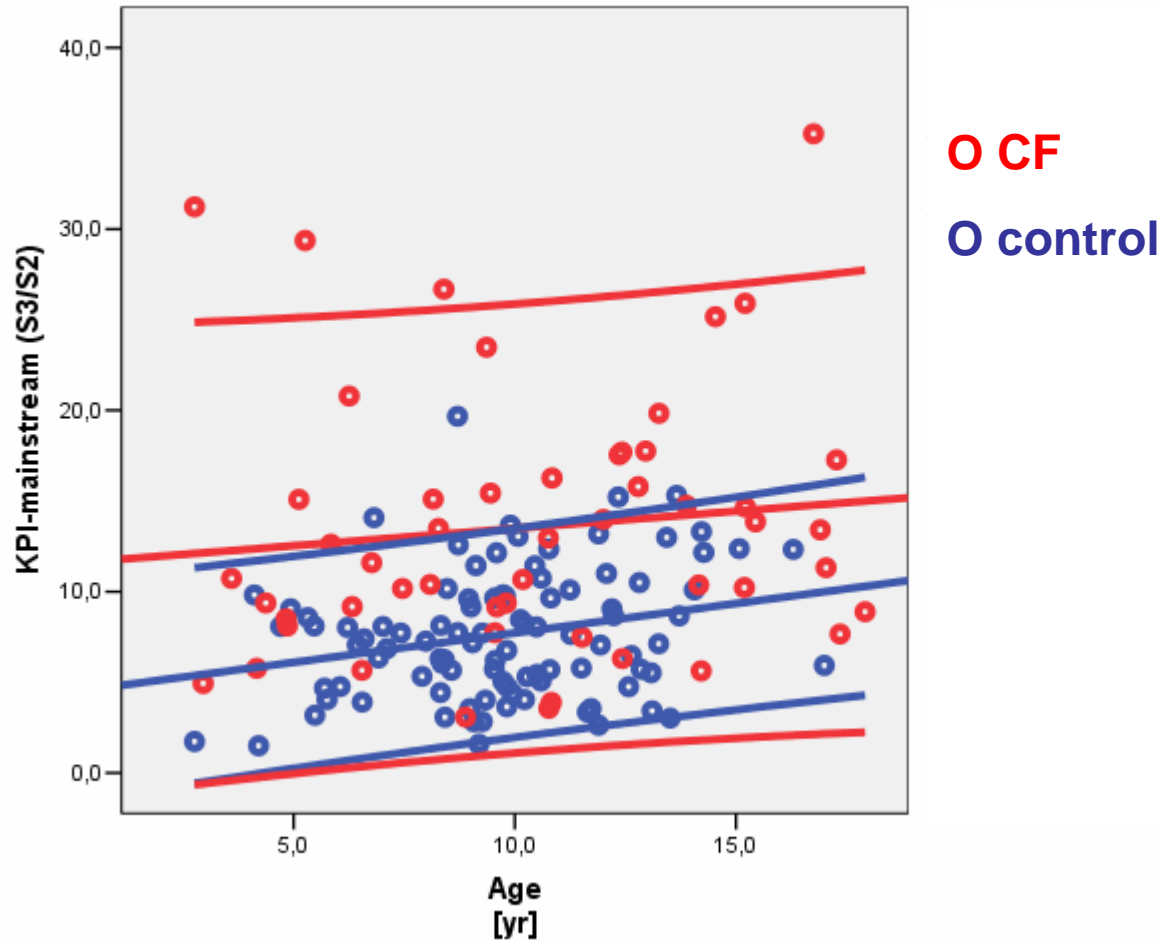
	healthy	CF
Vt* [mL]	418 (157)	392 (147)
RR [min ⁻¹]	26.2 (9.0)	24.6 (6.5)
Slope index ss**	6.3 (2.3)	9.1 (4.2)
Slope index ms**	7.7 (3.6)	13.6 (7.3)

*mean (SD), **p<0.01

„KPI“ Slope Index ($100 \cdot \text{slope S3} / \text{slope S2}$) from side stream MM

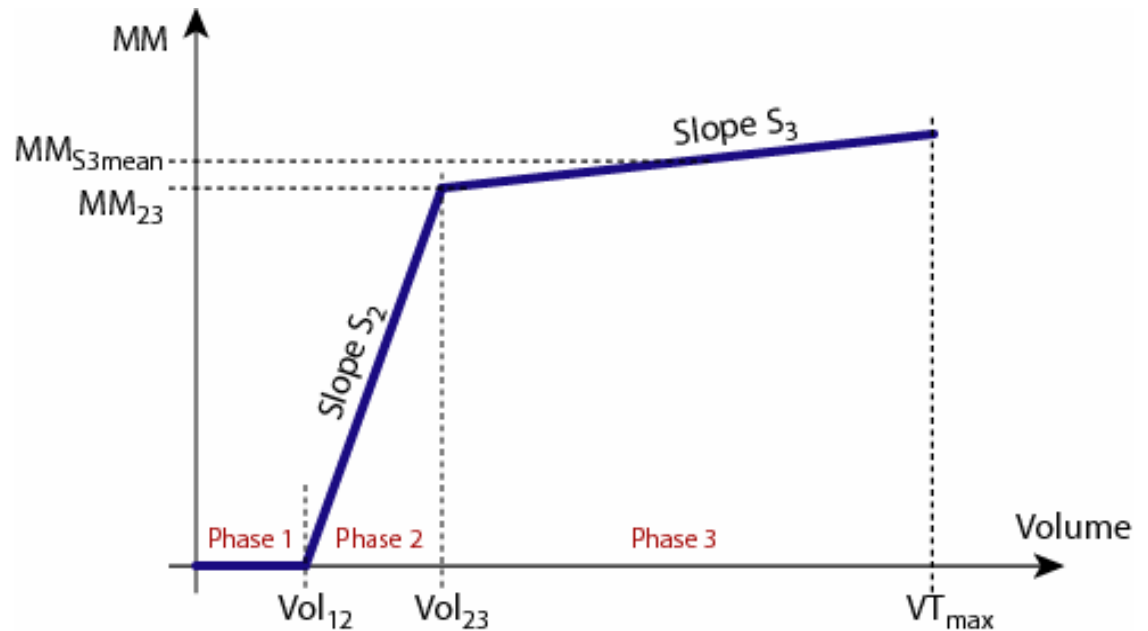


„KPI“ Slope Index ($100 \cdot \text{slope S3} / \text{slope S2}$) from **main** stream MM



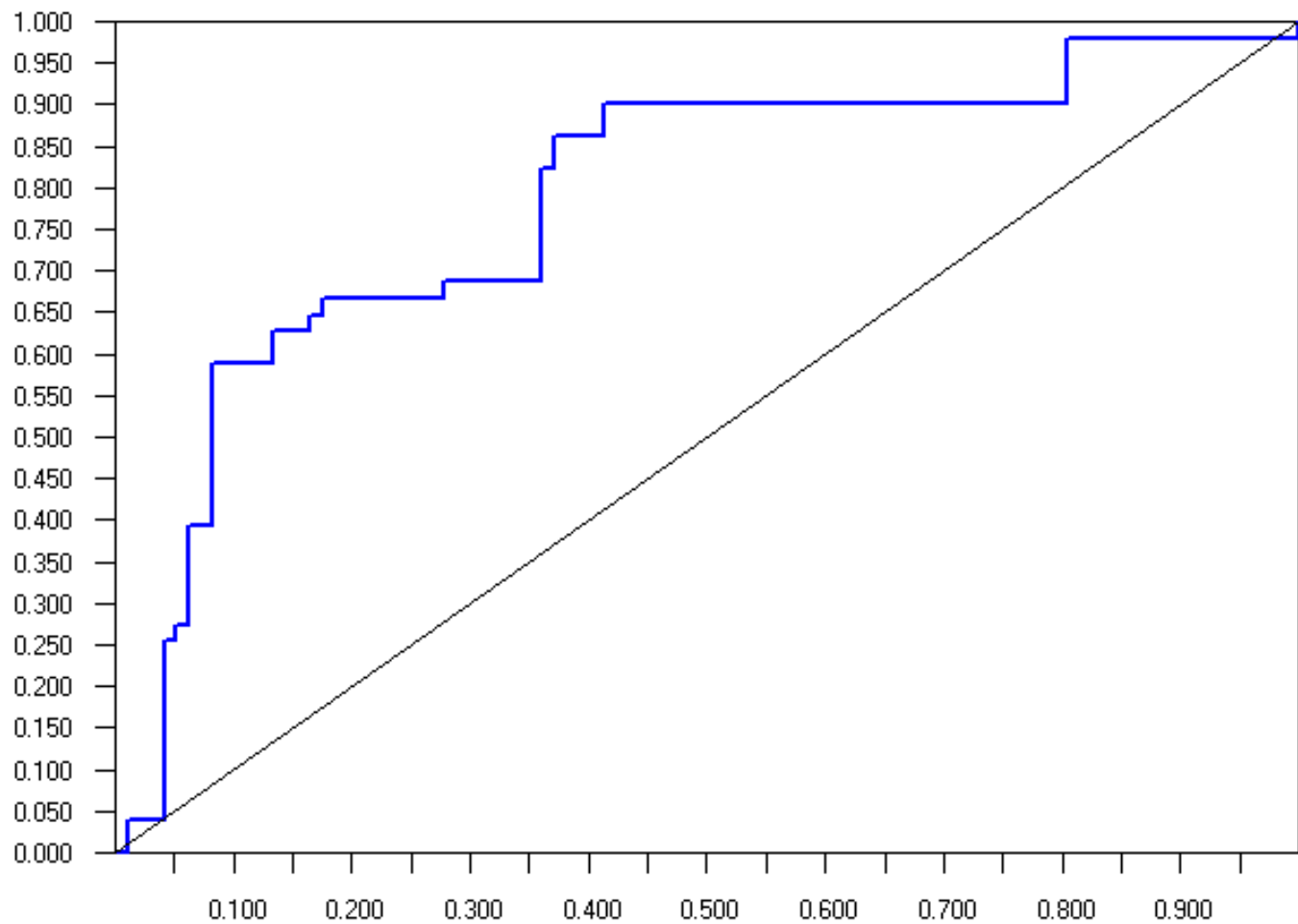
Fuzzy Membership analysis

- Age
- Slope3
- V23
- Vol12
- MM23
- S3/ MM23



Receiver Operating Characteristic for Method 2

Sensitivity



Number of Selected Variables: 6
Number of Data Sets: 148

• Fuzzy Class Prediction ROC 0.786

Variables

- Age
- Diagnosis
- S3
- VolS1S3
- Vol12
- MM23
- S3/MM23

Discussion

- tidal breathing measurements with ultrasonic flowmeter over wide age range
- Slope analysis feasible from sidestream and mainstream data
- High inter-subject variability limits usefulness in individual subjects
- Complex statistical models differentiate patients and controls

Outlook

- with this approach simple tidal molar mass-volume curves may become a useful screening tool to identify subjects with lung disease

Acknowledgements

This study was supported by Mukoviszidose
e.V., Germany

We thank O. Tietje for statistical assistance

MMss vs. MMms for „KPI“

