Solunum Fonksiyon Testlerinin Yorumlanması
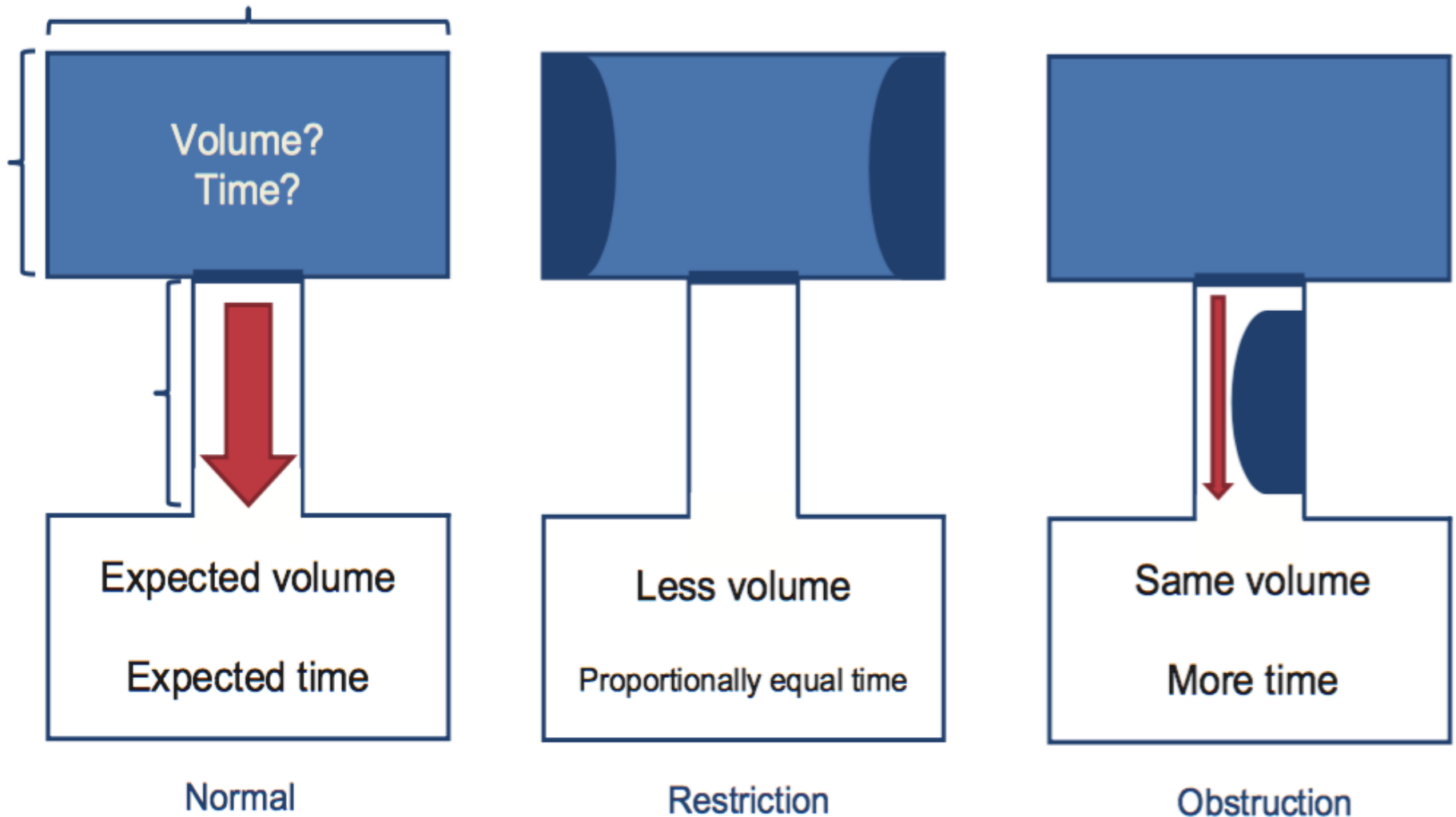
Doç. Dr. Funda Coşkun

Bursa Uludağ Üniversitesi

Göğüs Hastalıkları
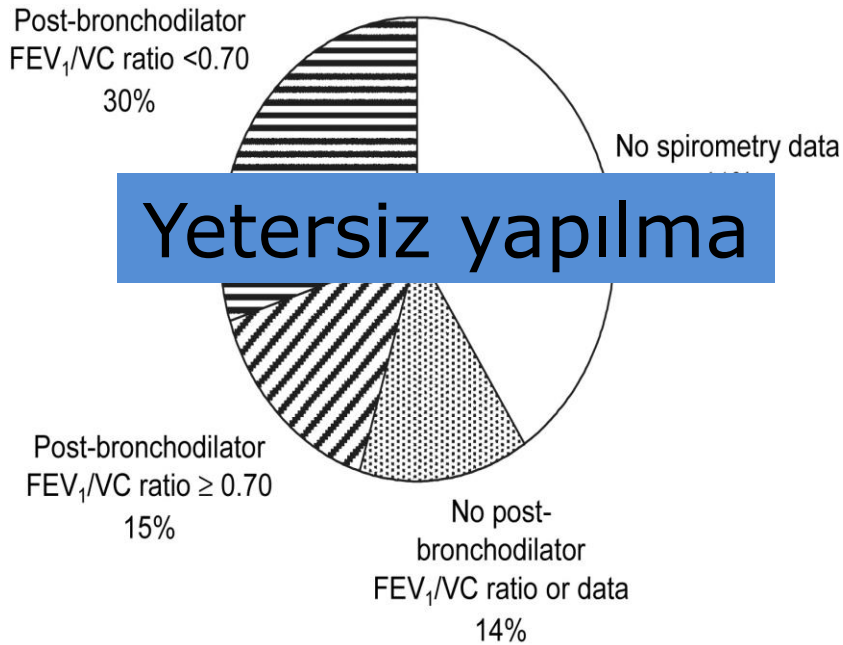
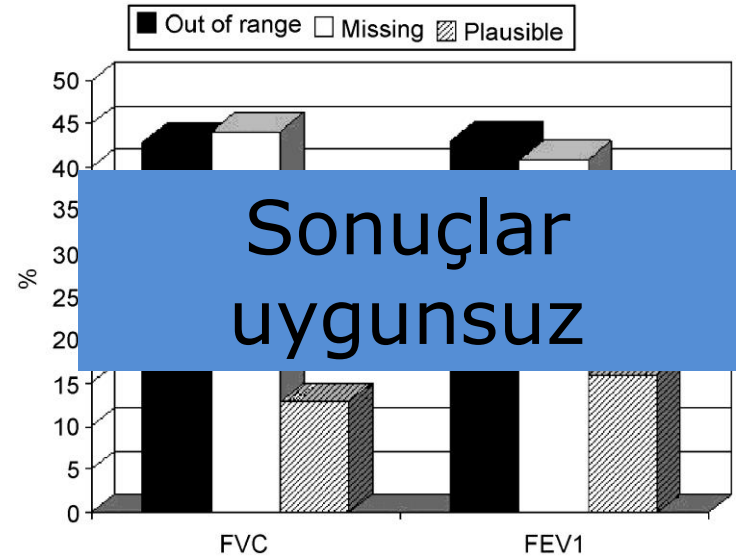# Hız ve Volüm Ölçümü

Spirometri: Gerçek Yaşam

Post-bronchodilator FEV$_1$/VC ratio <0.70 30%

No spirometry data

Post-bronchodilator FEV$_1$/VC ratio ≥ 0.70 15%

No post-bronchodilator FEV$_1$/VC ratio or data 14%

Yetersiz yapılma

Out of range ☐ Missing ▨ Plausible

Sonuçlar uygunsuz

FVC   FEV1

Arne Resp Med, 2010

Miravitlles Resp Med, 2007

Türkiye Verisi

- Türkiye Kronik Hastalıklar ve Risk Faktörleri Sıklığı Çalışması

    - Uygun spirometri %22.6

- ERS KOAH Denetim Çalışması
    - Alevlenme ile yatan hastaların %37.4'ünde yatış öncesi spirometre saptanmamış

Türkiye Kronik Hastalıklar ve Risk Faktörleri Sıklığı Çalışması. Sağlık Bakanlığı Yayın No: 909, Ankara, 2013

Roberts CM, Lopez-Campos JL, Pozo-Rodriguez F, Hartl S; on behalf of the European COPD Audit team. European hospital adherence to GOLD recommendations for chronic obstructive pulmonary disease (COPD) exacerbation admissions. Thorax 2013;68:1169-71

KOAH taramasında spirometri kullanılmalı mı?

Rutin Tarama

- USPSTF asemptomatik hastalarda spirometri ile tarama önermemektedir
  - Taramanın herhangi bir faydası görülmemiştir
  - Yüksek maliyet ile ilişkilidir
- ACP/ATS/ERS ve NICE aynı öneriyi getirmiştir

USPSTF, 2016; Wilt, 2011; NICE 2015

Aktif Vaka Bulma

Anket
- Risk faktörleri
- Sigara geçmişi
- Demografik veriler
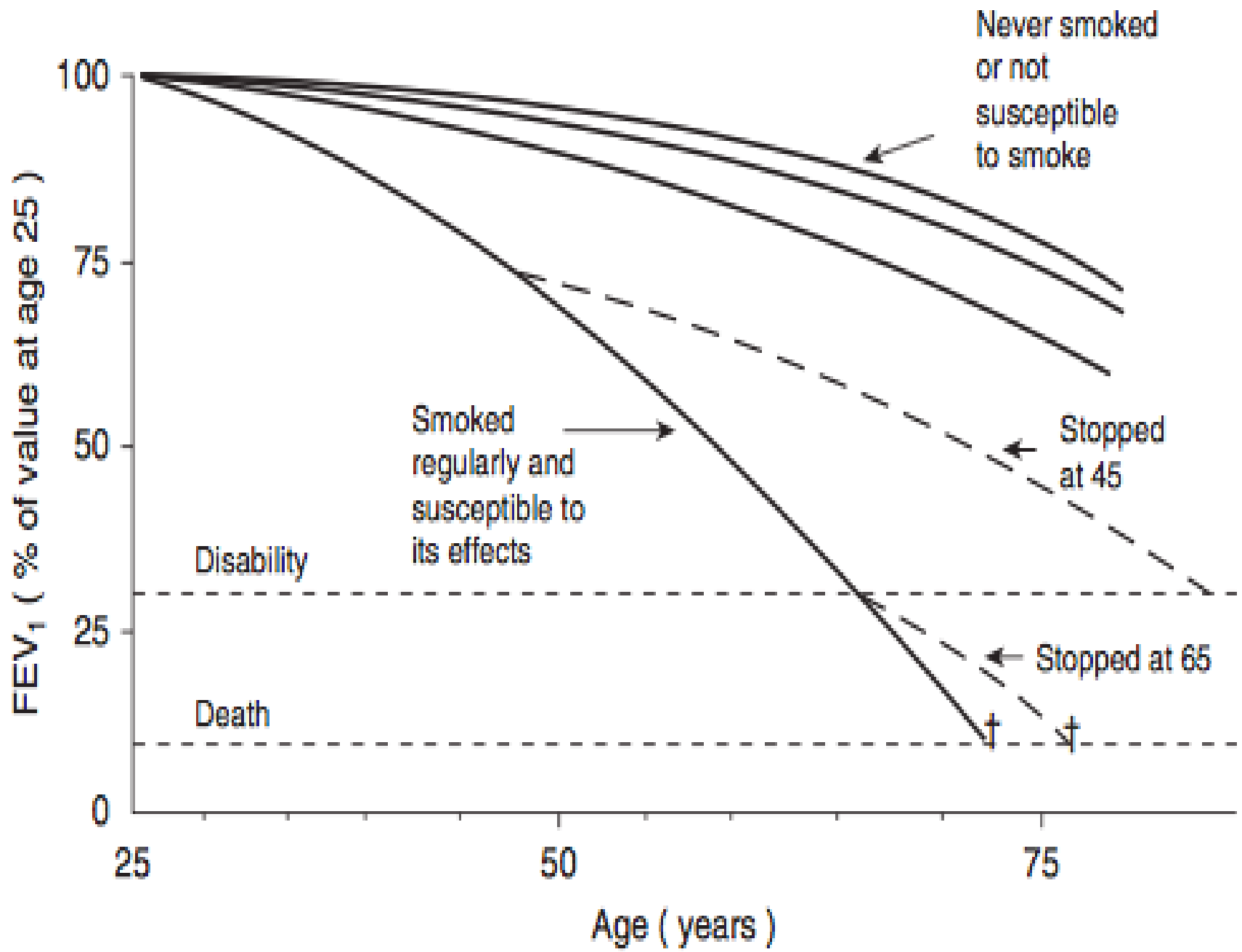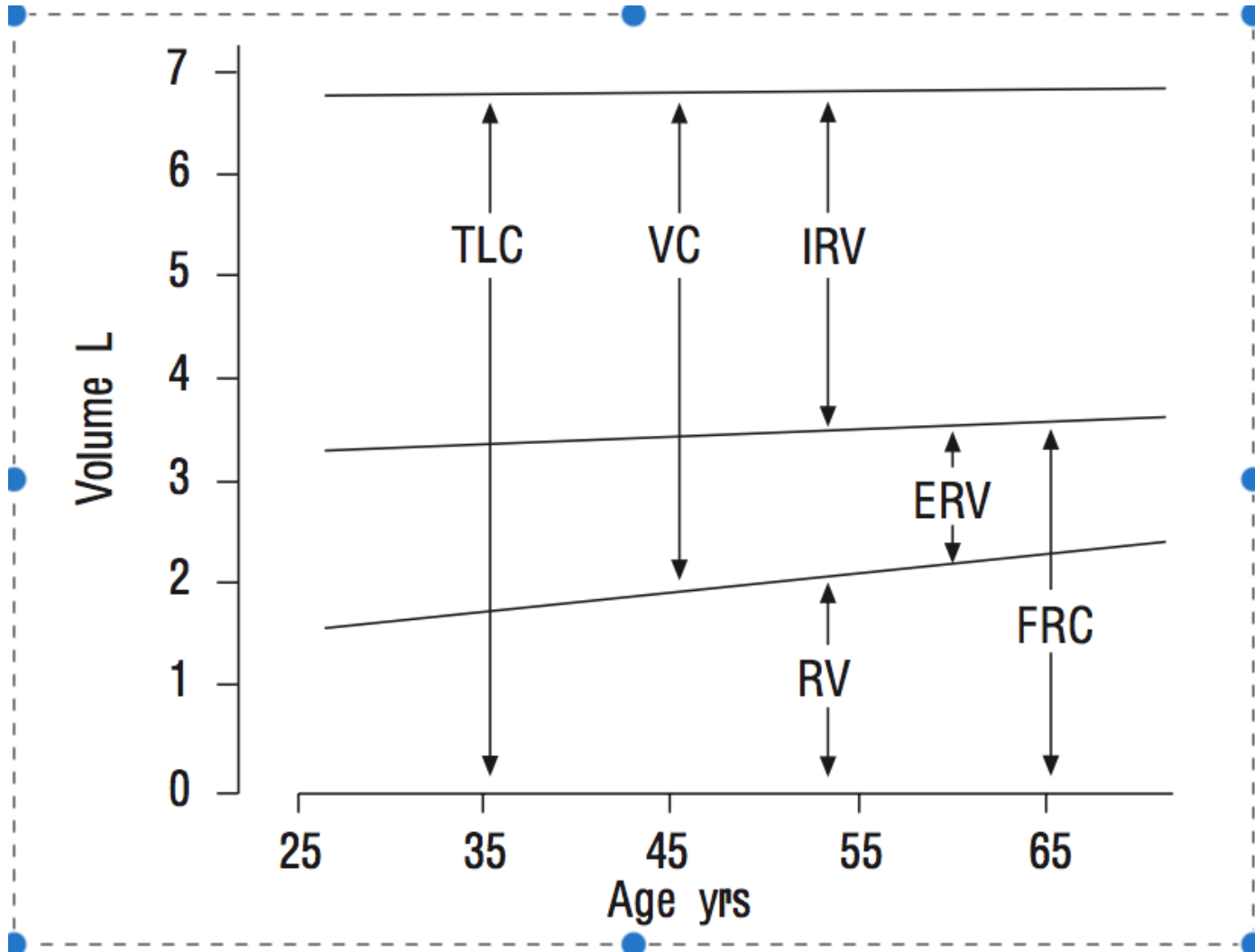- Solunum semptomları

Orta- Ağır Yük
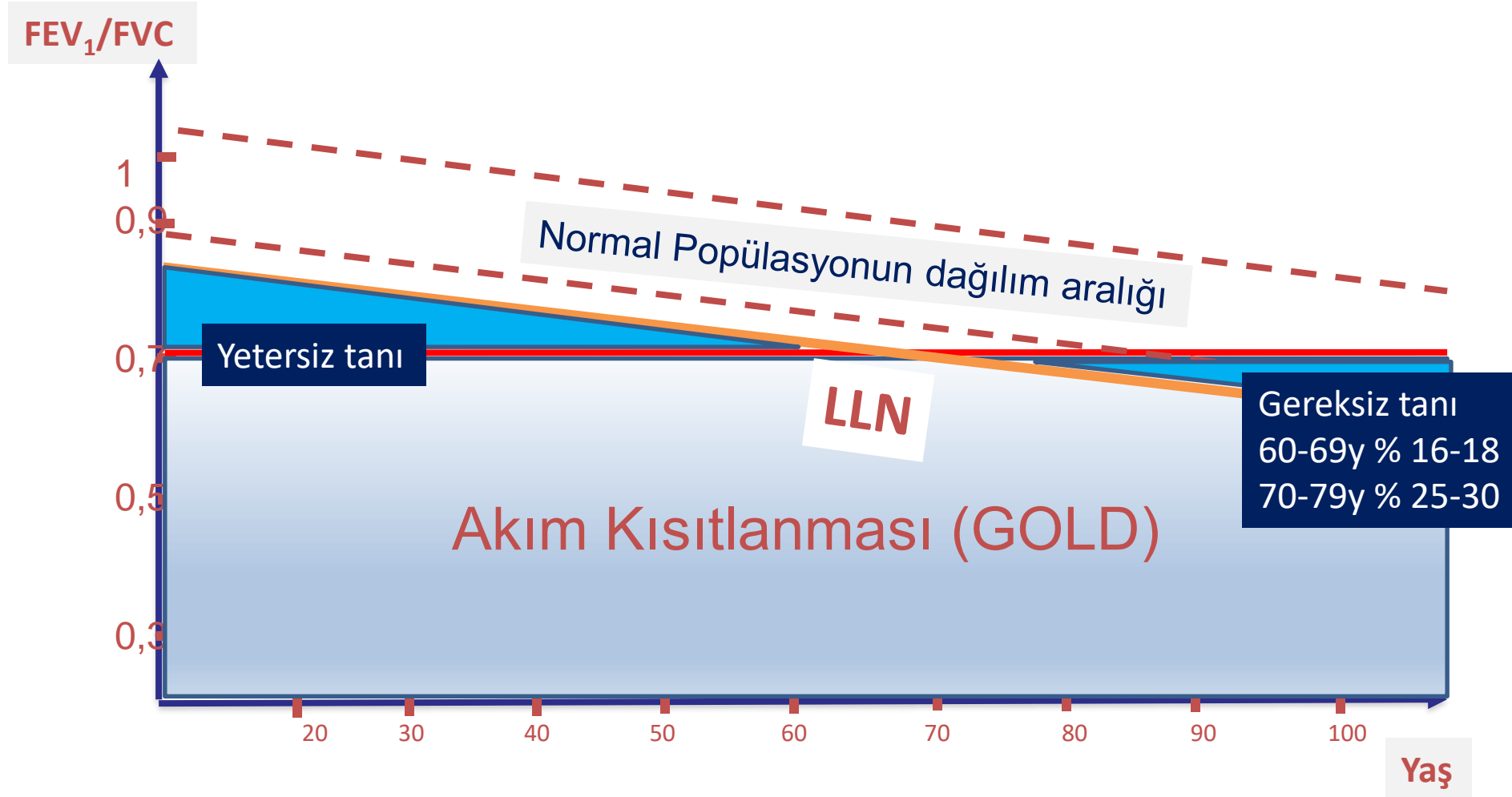
$FEV_1/FVC<0.70$

Tedavi değerlendirme

Hill, 2010; Dirven, 2013

Never smoked
or not
susceptible
to smoke

Smoked
regularly and
susceptible to
its effects

Stopped
at 45

Disability

Stopped at 65

Death

Yaşlanma

Gazi Gülbaş'ın İzniyle

AMERICAN THORACIC SOCIETY DOCUMENTS

Standardization of Spirometry 2019 Update
An Official American Thoracic Society and European Respiratory Society Technical Statement

Brian L. Graham, Irene Steenbruggen, Martin R. Miller, Igor Z. Barjaktarevic, Brendan G. Cooper, Graham L. Hall, Teal S. Hallstrand, David A. Kaminsky, Kevin McCarthy, Meredith C. McCormack, Cristine E. Oropez, Margaret Rosenfeld, Sanja Stanojevic, Maureen P. Swanney[†], and Bruce R. Thompson; on behalf of the American Thoracic Society and the European Respiratory Society

Endikasyonları

Table 1. Indications for Spirometry

Diagnosis
    To evaluate symptoms, signs, or abnormal laboratory test results
    To measure the physiologic effect of disease or disorder
    To screen individuals at risk of having pulmonary disease
    To assess preoperative risk
    To assess prognosis

Monitoring
    To assess response to therapeutic intervention
    To monitor disease progression
    To monitor patients for exacerbations of disease and recovery from exacerbations
    To monitor people for adverse effects of exposure to injurious agents
    To watch for adverse reactions to drugs with known pulmonary toxicity

Disability/impairment evaluations
    To assess patients as part of a rehabilitation program
    To assess risks as part of an insurance evaluation
    To assess individuals for legal reasons

Other
    Research and clinical trials
    Epidemiological surveys
    Derivation of reference equations
    Preemployment and lung health monitoring for at-risk occupations
    To assess health status before beginning at-risk physical activities

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Olguya Bakış

- Yaş
- Boy
- Kilo
- İlaçlar
- Sigara içim durumu

- Testin suboptimal olma nedenleri?
  - Göğüs ya da karın ağrısı
  - Oral ya da facial ağrı
  - Stres inkontinansı
  - Demans veya konfüzyon

Ölçülen, beklenen ve beklenenin yüzdesi

60 Yaşında Erkek, 1.50 boy, FEV1 1.75

	Beklenen FEV1	%beklenen FEV1
Morris	2.25	78
Crapo	2.56	68
Knudson	1.71	102
Quanjer	2.23	78
Dockery	2.42	72
Glindmeyer	2.12	83
Brandli	2.68	65

Kerstjens et al, Thorax 1997

Tiffeneau oranı: FEV_1/ FVC oranı: FEV_1 %

- Solunumsal bozukluğun tipini (obstrüktif veya restriktif) belirlemede önemlidir.
- Genç, sağlıklı kişilerde bu oran % 75' in üzerindedir. Akciğerin elastik yapısındaki değişikliklere bağlı olarak yaşlılarda bu oran
  % 65-70' e kadar düşebilir.

	Obstrüksiyon	Restriksiyon
FVC	normal veya artar	azalır
FEV_1	azalır	azalır
FEV_1/FVC (%)	azalır	normal veya artar

Spirometri Öncesi

Table 5. Activities That Should Be Avoided before Lung Function Testing

- Smoking and/or vaping and/or water pipe use within 1 h before testing (to avoid acute bronchoconstriction due to smoke inhalation)
- Consuming intoxicants within 8 h before testing (to avoid problems in coordination, comprehension, and physical ability)
- Performing vigorous exercise within 1 h before testing (to avoid potential exercise-induced bronchoconstriction)
- Wearing clothing that substantially restricts full chest and abdominal expansion (to avoid external restrictions on lung function)

Table 6. Procedures for FVC Maneuvers

Wash hands* (or use an approved hand sanitizer)

Prepare the patient
    Dispense hand sanitizer for the patient
    Confirm patient identification, age, birth sex, ethnicity, etc.
    Measure weight and height without shoes
    Ask about activities listed in Table 5, medication use, and any relative contraindications
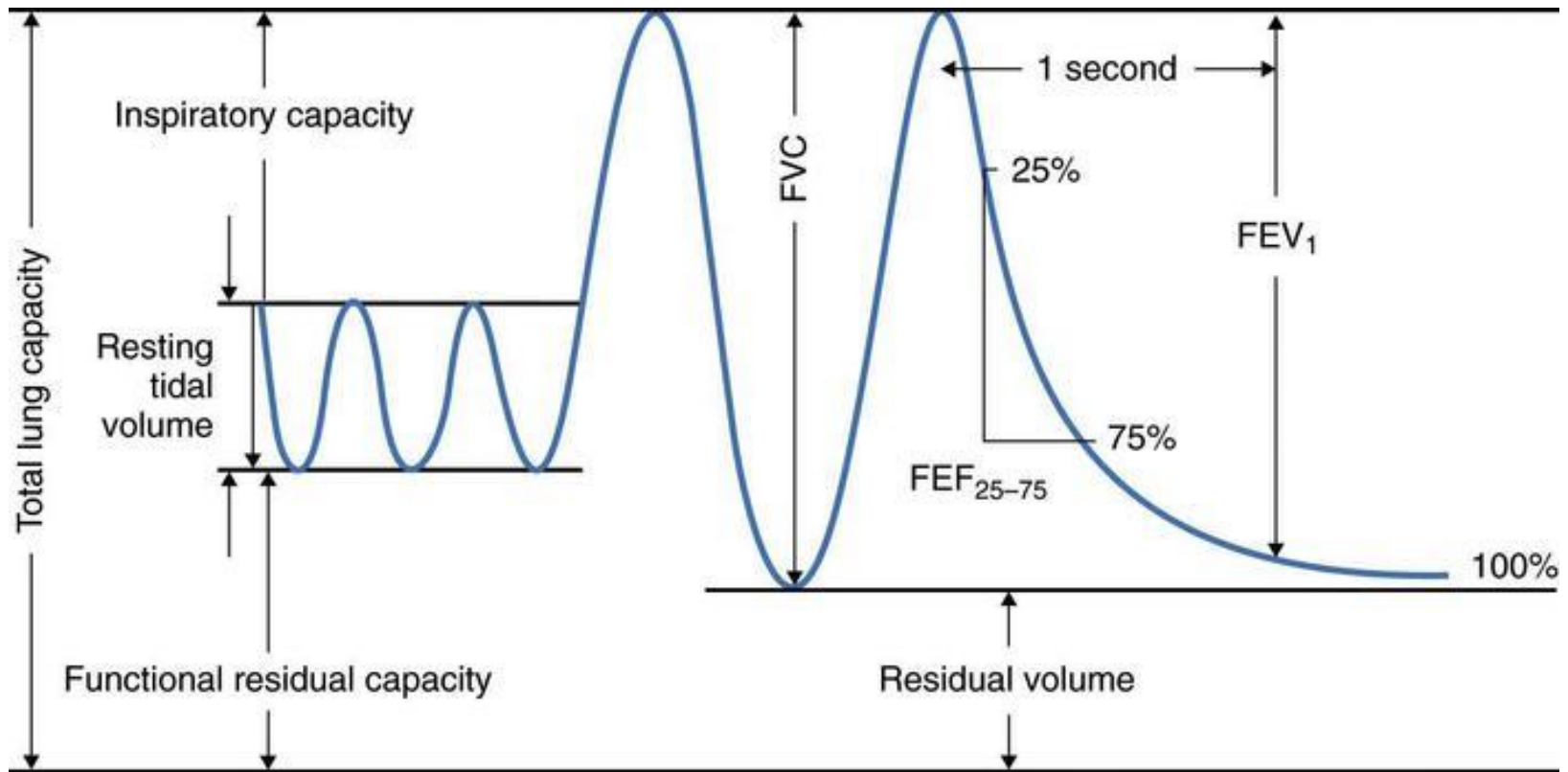   flagged on the requisition; note respiratory symptoms

Instruct and demonstrate the test
    Position of the mouthpiece and noseclip
    Correct posture with head slightly elevated
    Inspire rapidly until completely full
    Expire with maximal effort until completely empty
    Inspire with maximal effort until completely full
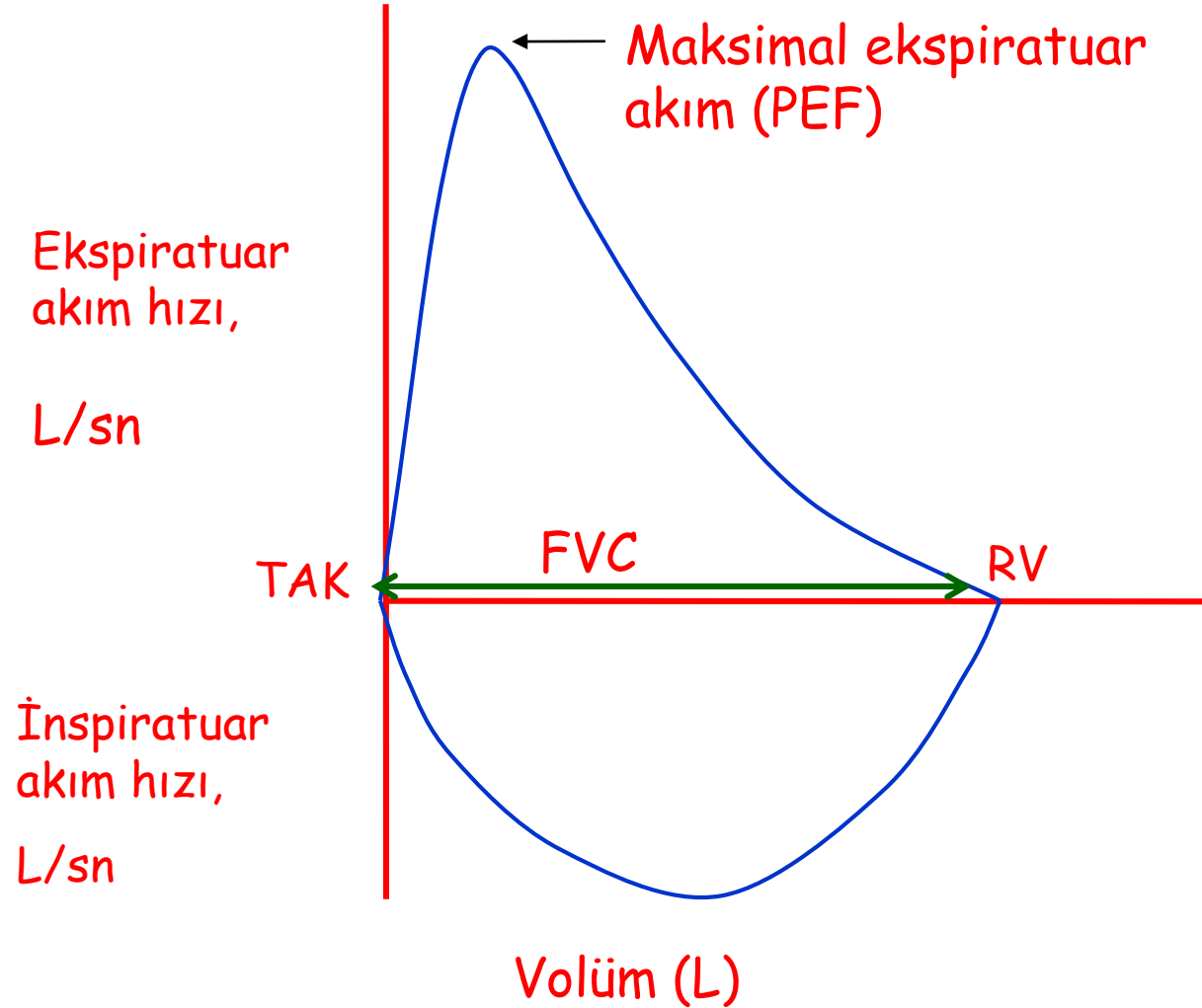   Confirm that patient understands the instructions and is willing to comply

Perform maneuver
    Have patient assume the correct posture
    Attach noseclip, place mouthpiece in mouth, and close lips around the mouthpiece
    Breathe normally
    Inspire completely and rapidly with a pause of ≤ 2 s at TLC
    Expire with maximal effort until no more air can be expelled while maintaining an
        upright posture
    Inspire with maximal effort until completely full
    Repeat instructions as necessary, coaching vigorously
    Repeat for a minimum of three maneuvers, usually no more than eight for adults
    Check FEV_1 and FVC repeatability and perform more maneuvers as necessary

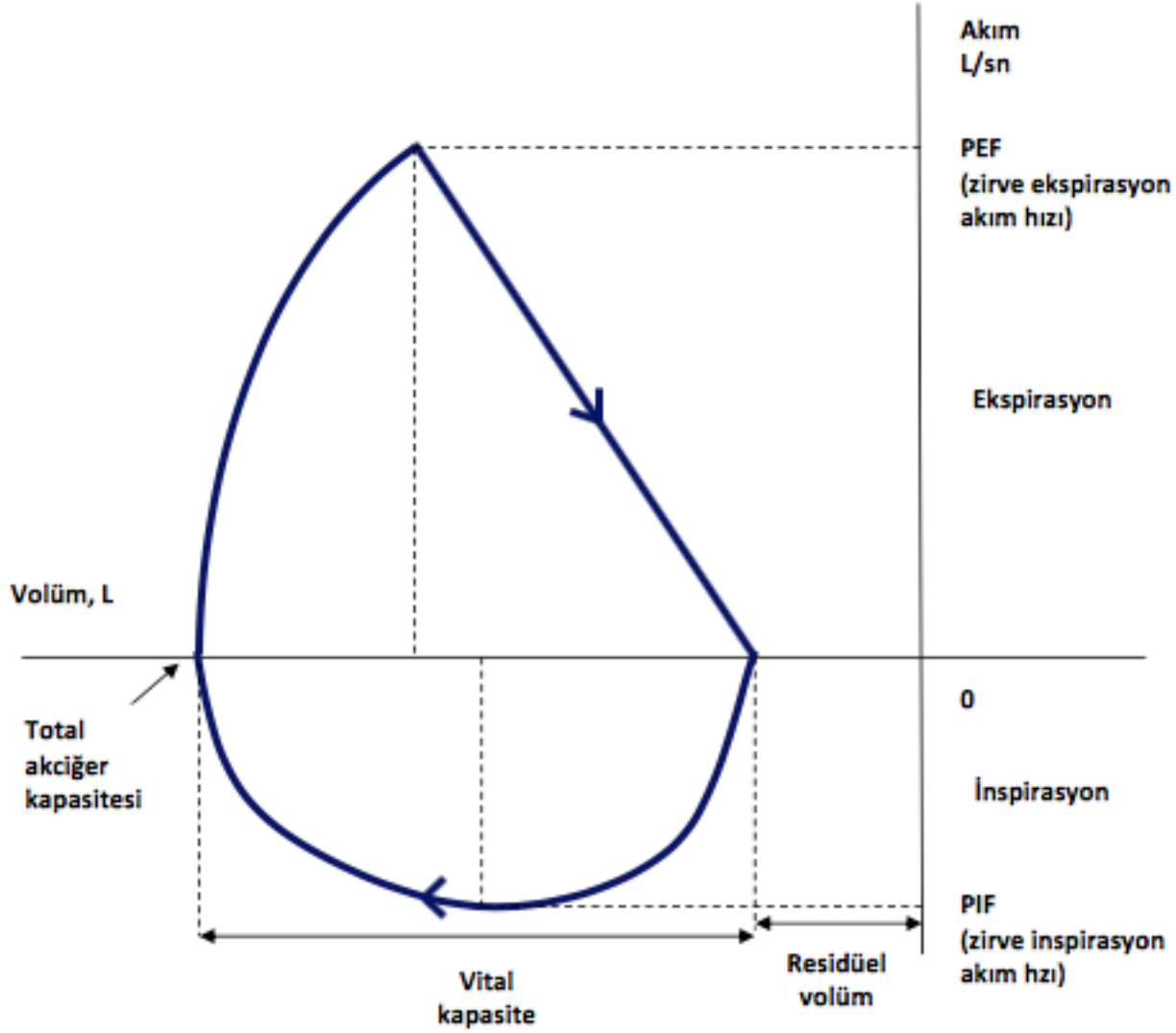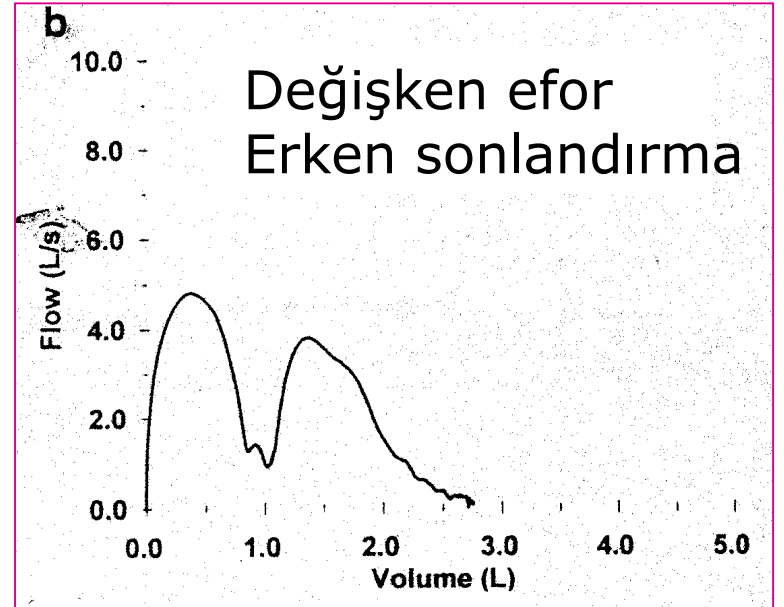**Perform maneuver (expiration-only devices)**
    Have patient assume the correct posture
    Attach noseclip
    Inspire completely and rapidly with a pause of ≤ 2 s at TLC
    Place mouthpiece in mouth and close lips around the mouthpiece
    Expire with maximal effort until no more air can be expelled while maintaining an
        upright posture
    Repeat instructions as necessary, coaching vigorously
    Repeat for a minimum of three maneuvers, usually no more than eight for adults
    Check FEV_1 and FVC repeatability and perform more maneuvers as necessary

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Inspiratory capacity

Total lung capacity

Resting tidal volume

Functional residual capacity

FVC

1 second

25%

75%

FEF$_{25-75}$

FEV$_1$

100%

Residual volume

Akım Volüm Halkası

Maksimal ekspiratuar akım (PEF)

Ekspiratuar akım hızı, L/sn

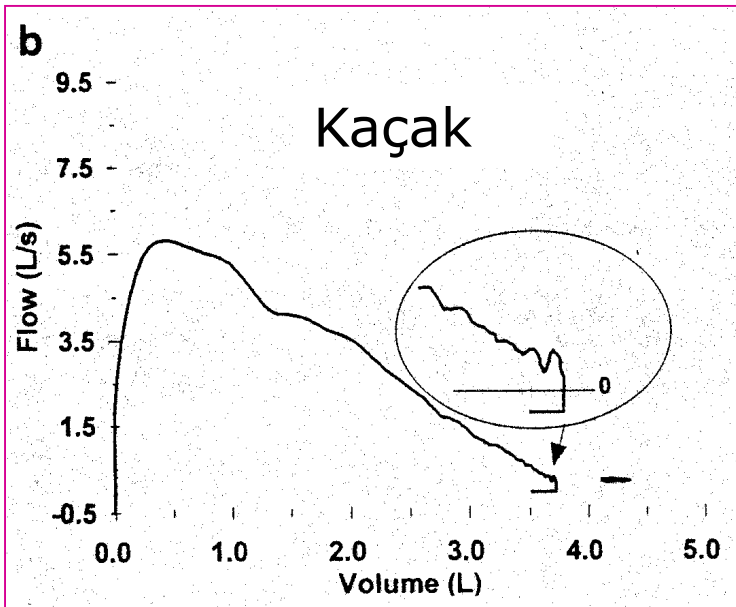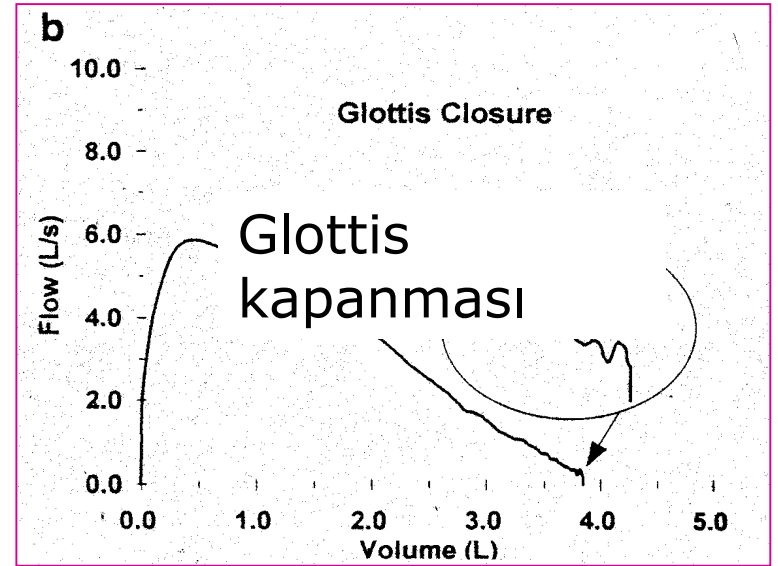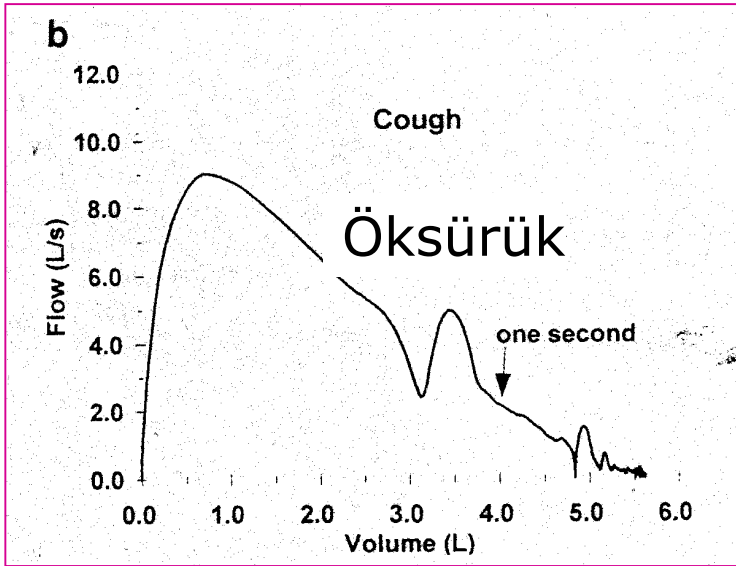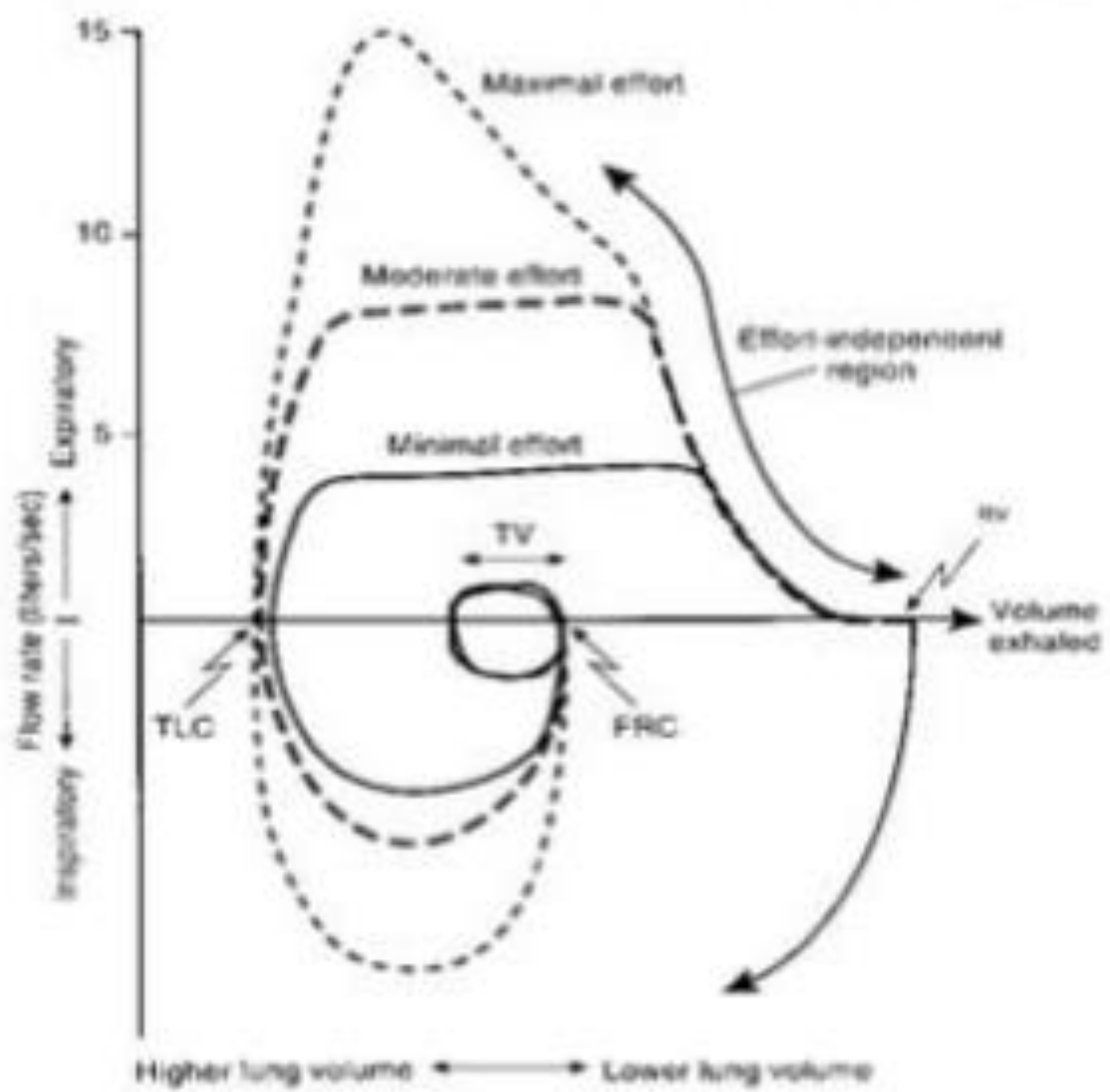İnspiratuar akım hızı, L/sn

TAK   FVC   RV

Volüm (L)

NORMAL AKIM-VOLÜM HALKASI

Kabul edilebilirlik

- **Spirogramda artefakt bulunmamalıdır:**
  - öksürmemeli
  - erken bitirilmemeli
  - efor değişkenliği olmamalı
  - ağızlıktan kaçak olmamalı veya kapatılmamalı
- **Test başlangıcı iyi olmalı:**
  - ekstrapolasyon volümü FVC'nin % 5'i veya 0.15 lt'den az,
 - tepe akıma ulaşma süresi 120 msn'den kısa olmalı

b

Cough

Öksürük

one second

Flow (L/s) — Volume (L)

b

Glottis Closure

Glottis kapanması

Flow (L/s) — Volume (L)

b

Kaçak

0

Flow (L/s) — Volume (L)

b

Değişken efor
Erken sonlandırma

Flow (L/s) — Volume (L)
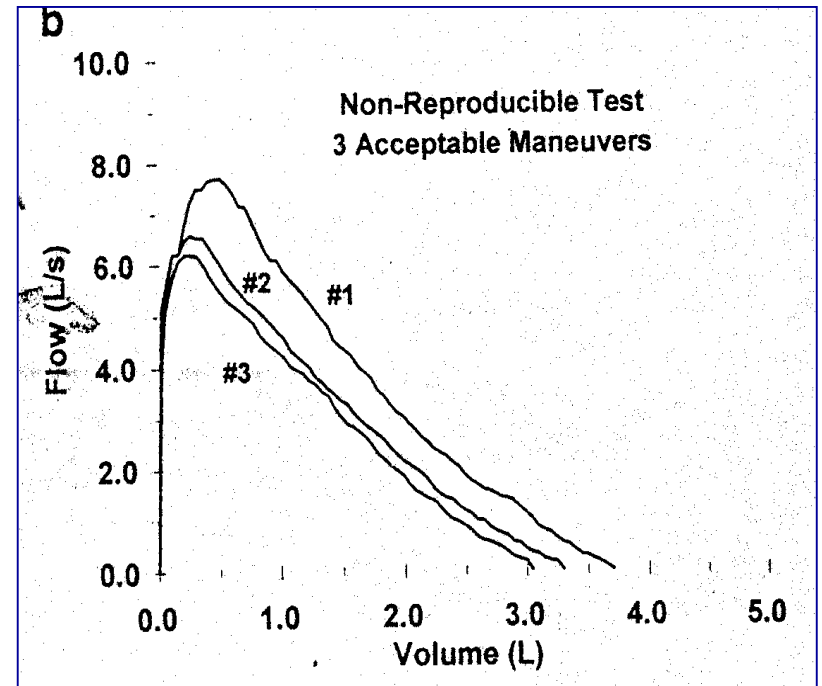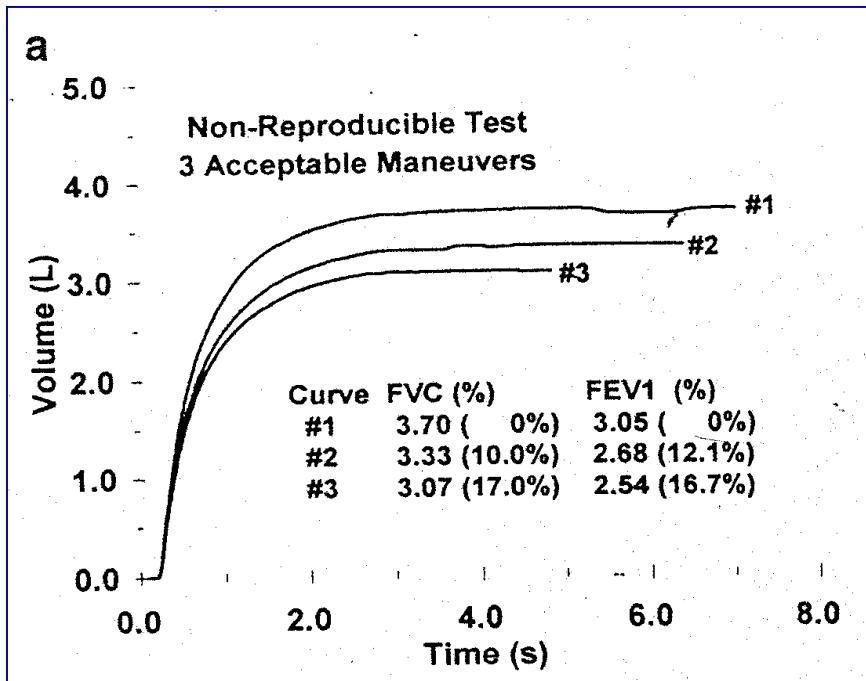
Tekrarlanabilirlik

- **3 kabul edilebilir spirogramda:**
  - En yüksek iki FVC arasındaki fark < 0.15 lt
  - En yüksek iki FEV_1 arasındaki fark <0.15 lt

- **Bu kriterler yoksa:**
  - Yeni testlerde uygunluk saptanana
  - Toplam 8 test yapılana
  - Testleri sürdüremeyene kadar
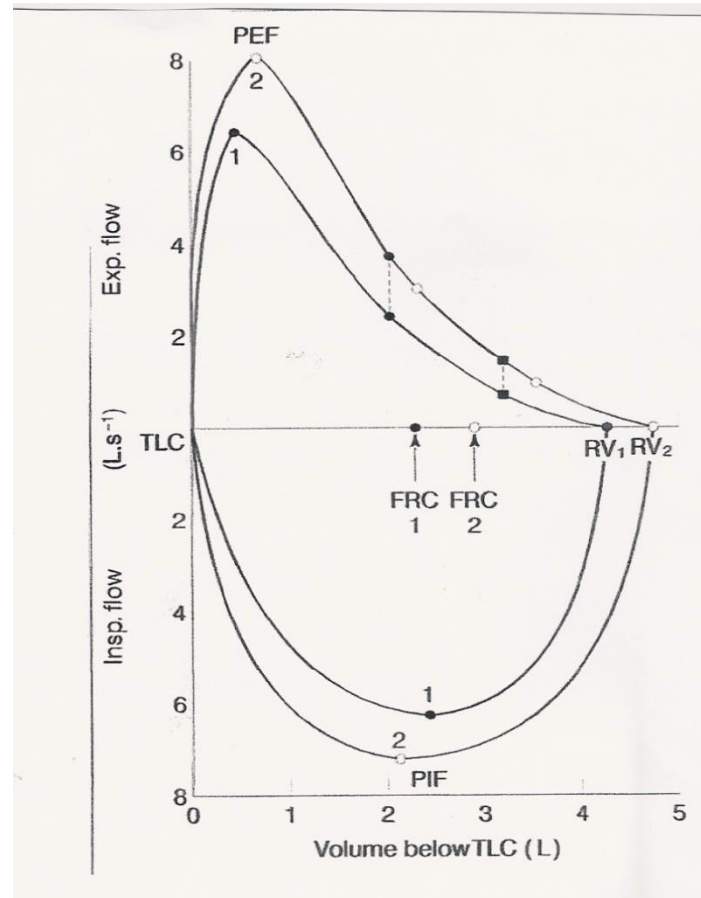   **En iyi üç test kayda alınır.**

Tekrarlanabilirlik
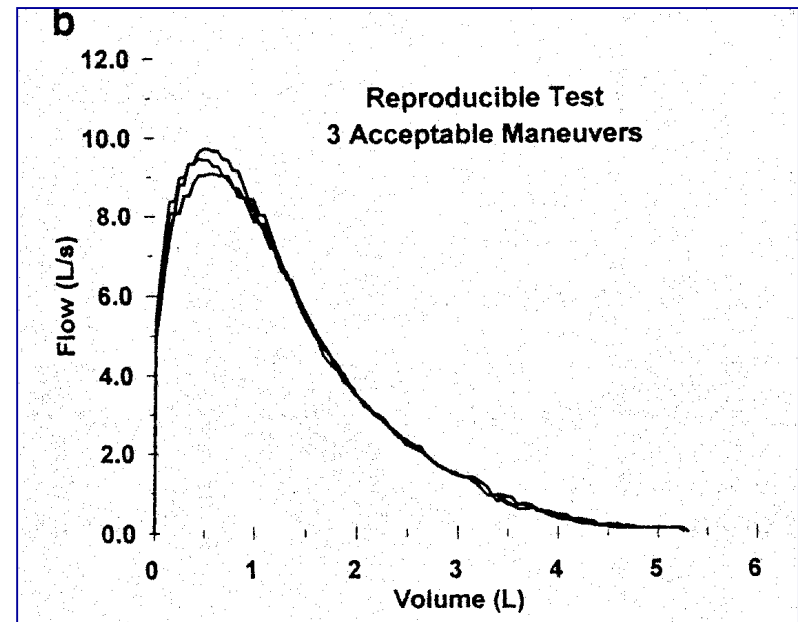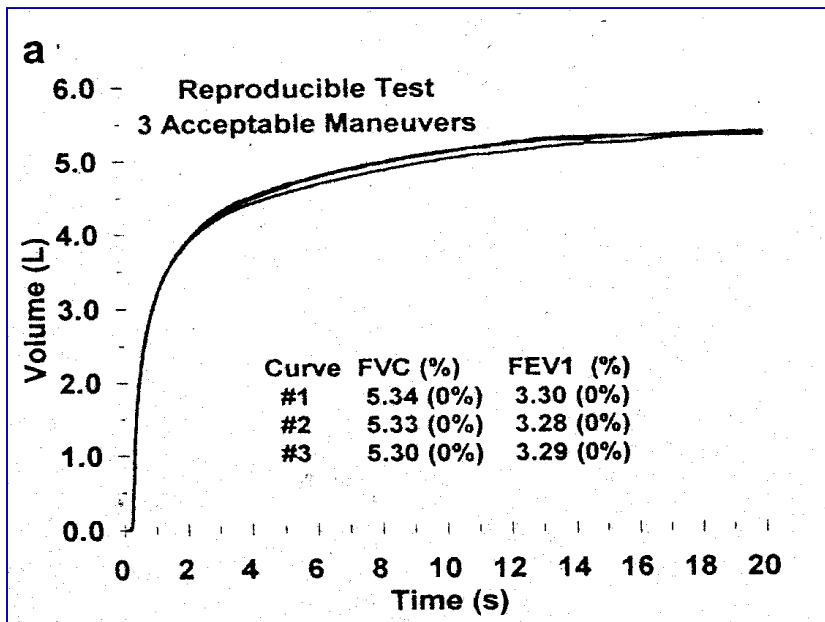
Tekrarlanabilirlik

İyi Performans Göstergeleri

- Yeterli efor
- Y ekseni boyunca hızla yükselme
- Belirgin zirve
- X eksenine ani düşüş yok
- 0 noktasına ulaşım
- Tekrar edilebilir

İnspirasyonda yetersiz efor

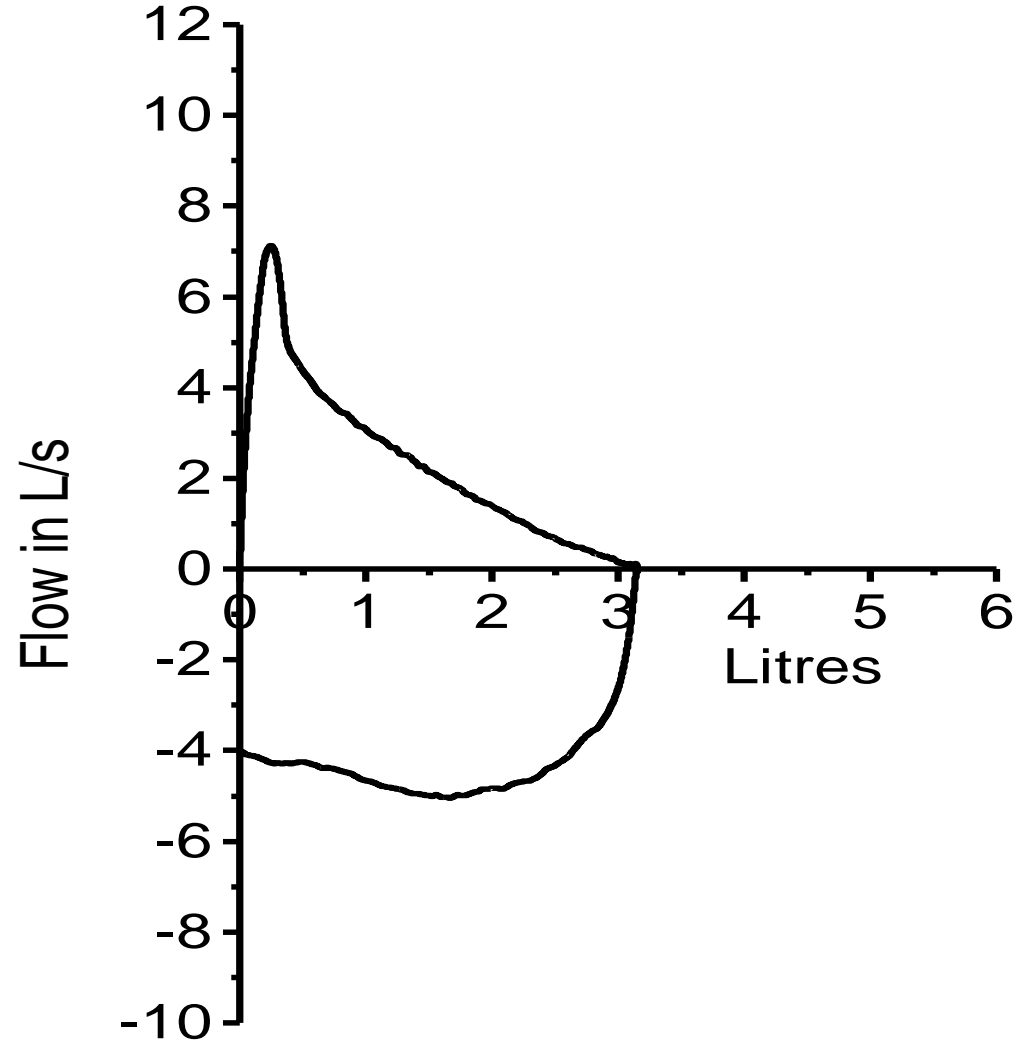# Total akciğer kapasitesinden başlamamış

Table 7. Summary of Acceptability, Usability, and Repeatability Criteria for FEV_1 and FVC

Acceptability and Usability Criterion	Required for Acceptability		Required for Usability	
	FEV_1	FVC	FEV_1	FVC
Must have BEV ≤5% of FVC or 0.100 L, whichever is greater	Yes	Yes	Yes	Yes
Must have no evidence of a faulty zero-flow setting	Yes	Yes	Yes	Yes
Must have no cough in the first second of expiration*	Yes	No	Yes	No
Must have no glottic closure in the first second of expiration*	Yes	Yes	Yes	Yes
Must have no glottic closure after 1 s of expiration	No	Yes	No	No
Must achieve one of these three EOFE indicators:	No	Yes	No	No
1. Expiratory plateau (≤0.025 L in the last 1 s of expiration)				
2. Expiratory time ≥15 s				
3. FVC is within the repeatability tolerance of or is greater than the largest prior observed FVC[†]				
Must have no evidence of obstructed mouthpiece or spirometer	Yes	Yes	No	No
Must have no evidence of a leak	Yes	Yes	No	No
If the maximal inspiration after EOFE is greater than FVC, then FIVC − FVC must be ≤0.100 L or 5% of FVC, whichever is greater[‡]	Yes	Yes	No	No

Repeatability criteria (applied to acceptable FVC and FEV_1 values)

  Age >6 yr: The difference between the two largest FVC values must be ≤0.150 L, and the difference between the two largest FEV_1 values must be ≤0.150 L

  Age ≤6 yr: The difference between the two largest FVC values must be ≤0.100 L or 10% of the highest value, whichever is greater, and the difference between the two largest FEV_1 values must be ≤0.100 L or 10% of the highest value, whichever is greater
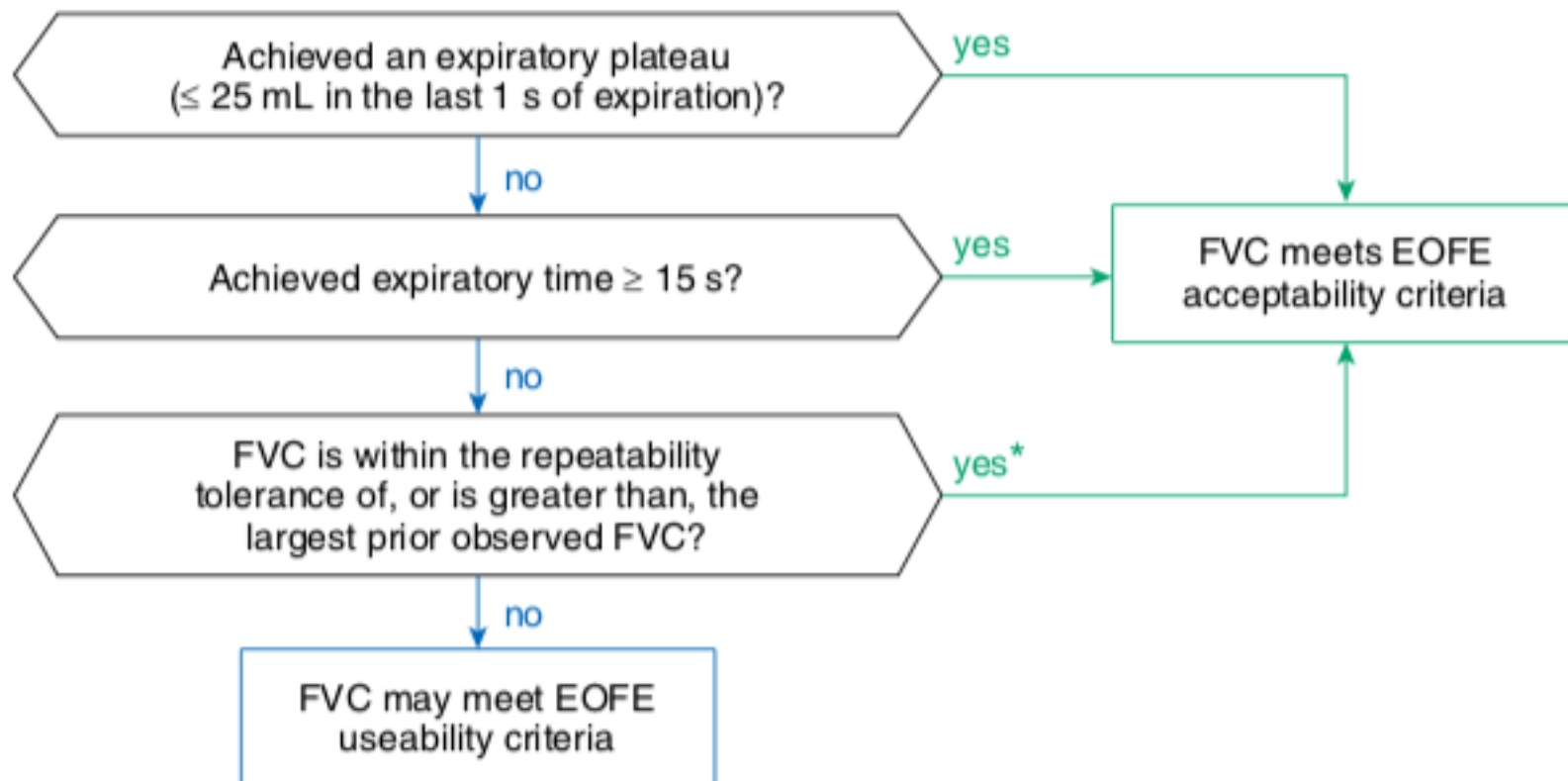
Figure 2. Flowchart outlining the end of forced expiration (EOFE) acceptability criteria for FVC. *If there are no prior observed FVC values in the current pre- or post-bronchodilator testing set, then the FVC provisionally meets EOFE acceptability criteria.
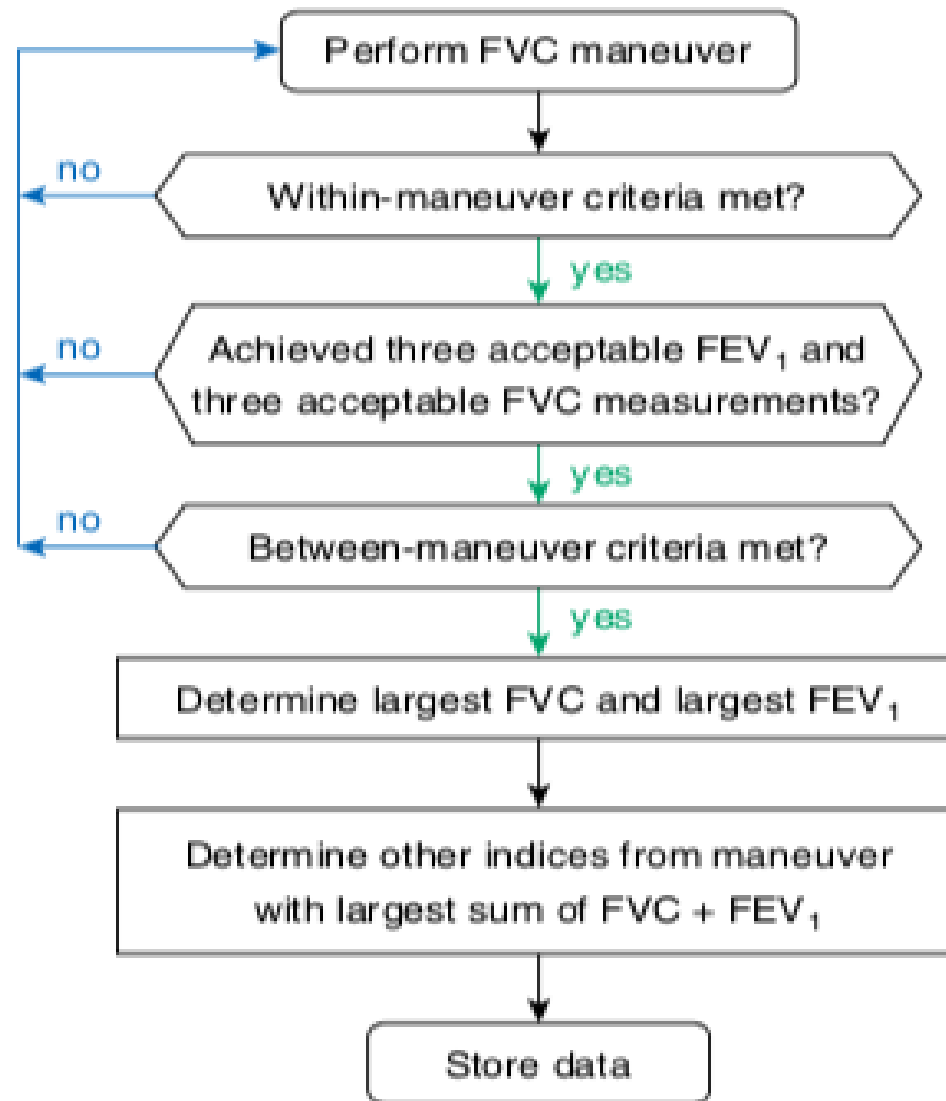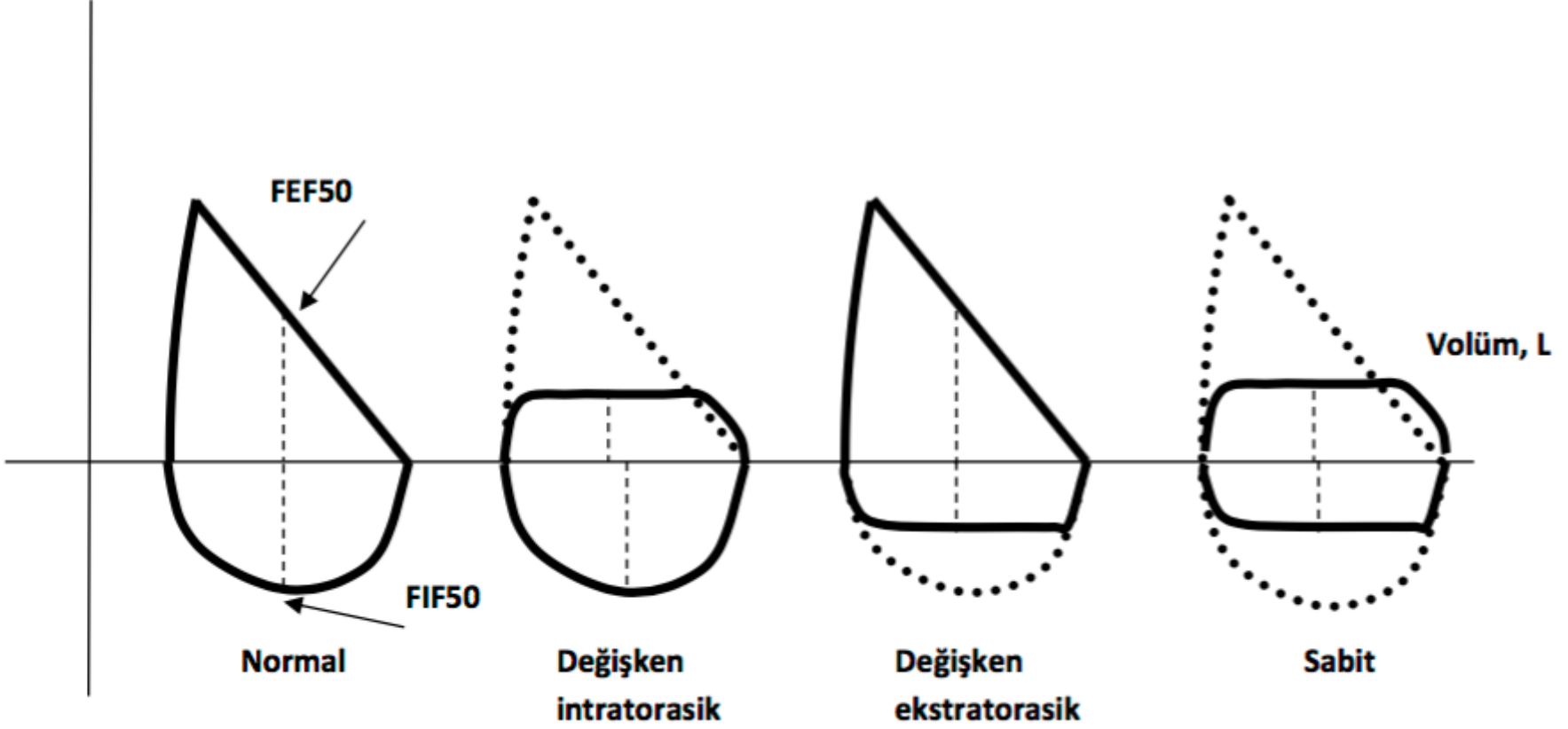
Figure 3. Flowchart outlining application of acceptability and repeatability criteria.

Örnekler

Akım L/sn

FEF50

Volüm, L

FIF50

Normal

Değişken intratorasik

Değişken ekstratorasik
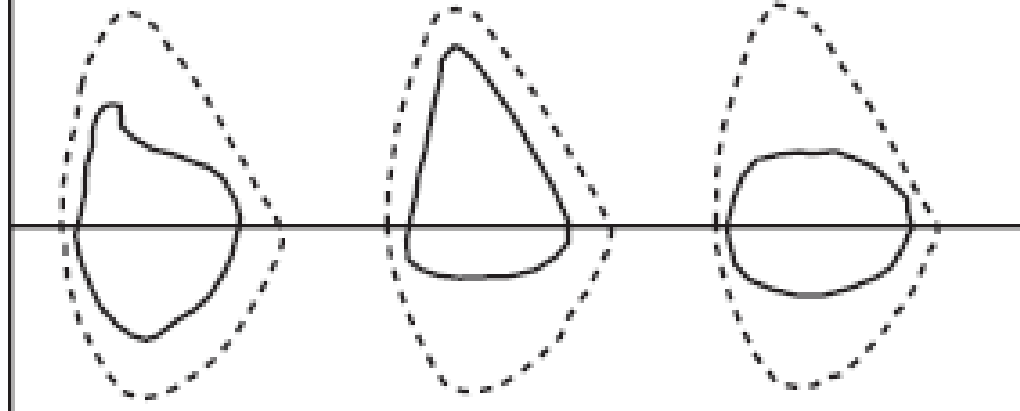
Sabit
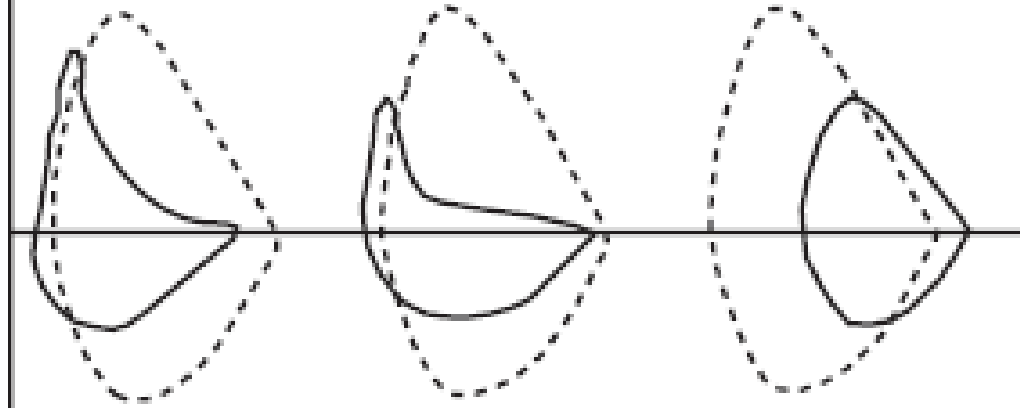
Trakeomalasi, Tümör

Trakeomalasi Vokal kord paralizisi Farenks problemleri

Trakeal stenoz Guatr

Astım   Amfizem   Restriksiyon

Değişken
intratorasik
obstrüksiyon
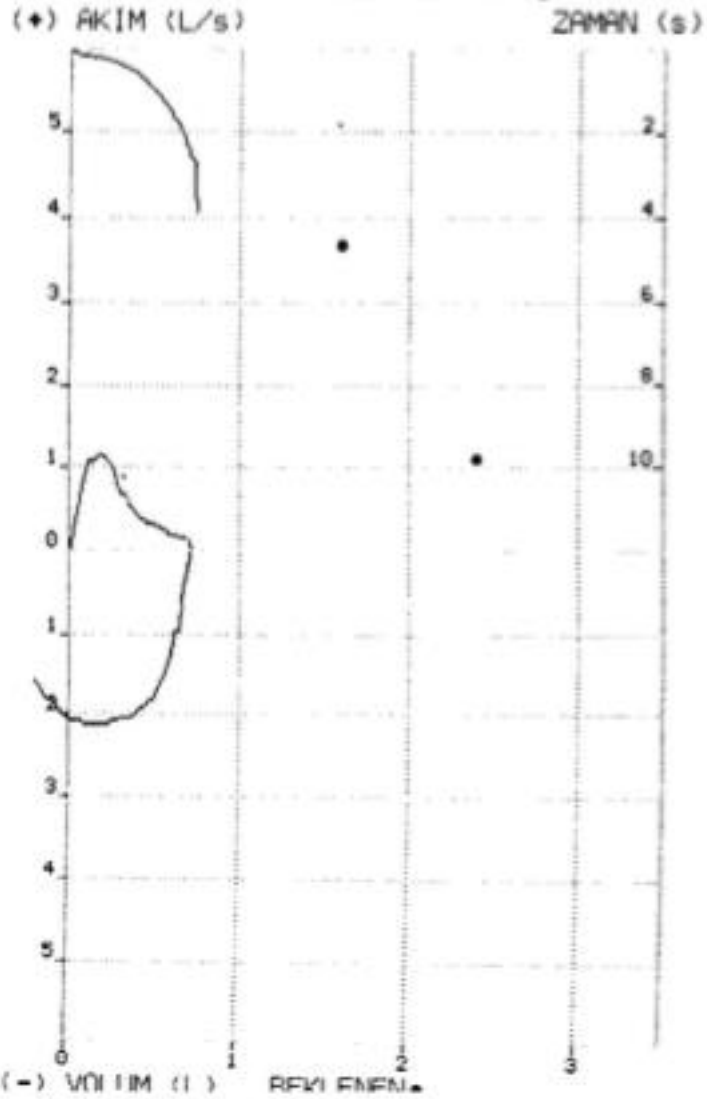
Değişken
ekstratorasik
obstrüksiyon

Sabit
obstrüksiyon

Ekspirasyon

İnspirasyon

Fiks
Obstrüksiyon

Değişken
Obstrüksiyon
(İntratorasik)

Değişken
Obstrüksiyon
(Ekstratorasik)
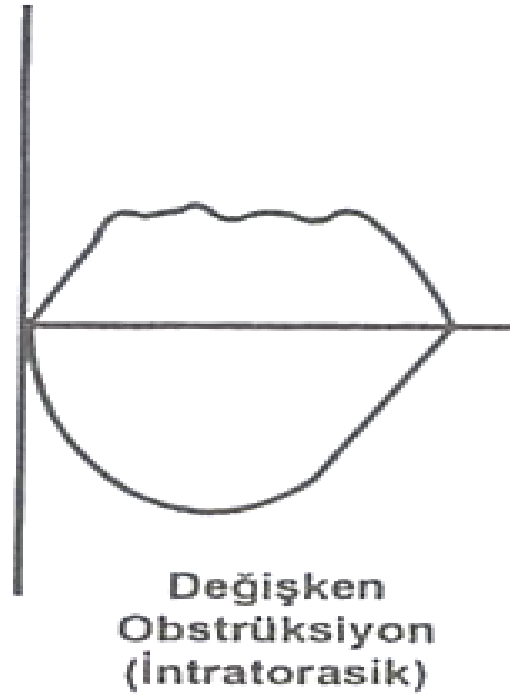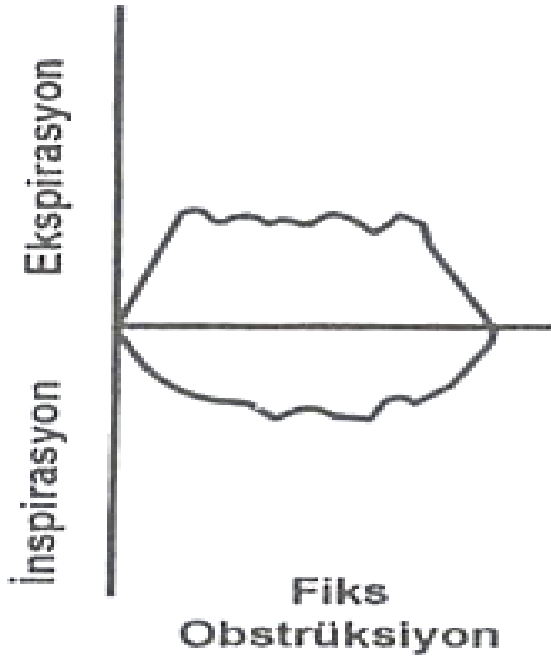
SPIROMETRE RAPOR EN IYI TEST

AKIM-VOLUM & VOLUM-ZAMAN egrileri
(+) AKIM (L/s)   ZAMAN (s)

FVC: 0,72   L   % 22

FEV1:   0,49   L/sn   % 19

FEV1/FVC: % 68

(-) VOLUM (l)   REKLENEN

ULUDAG UNI TIP FAK GOGUS HASTALIKLARI

TARIH 03/05/16 SAAT 08:24 BTPS 1.111 Ver 3.4

DOGUM TARIHI 01/01/48   #NO 1736
YAS 68 BOY cm 165   CINS. ♂ KILO Kg 71

BEKLENEN ERS (ECCS)   NORMAL 0. CEVRIMI 14%
PRE DOSYA NO 1732

SPIROMETRE RAPOR EN IYI TEST

AKIM-VOLUM & VOLUM-ZAMAN egrileri
(•) AKIM (L/s)   ZAMAN (s)

(-) VOLUM (L)   BEKLENEN•

FVC: 2,76 L   % 81

FEV1:   2,29   L/sn   % 87

FEV1/FVC: % 83

TARIH 04/05/16 SAAT 09:48 BTPS 1.097 Ver 3.4

DOGUM TARIHI 01/01/50 #NO 1982
YAS 66 BOY cm 155 CINS.♀ KILO Kg 86

BEKLENEN ERS (ECCS) NORMAL D. DEVRIMI 1985
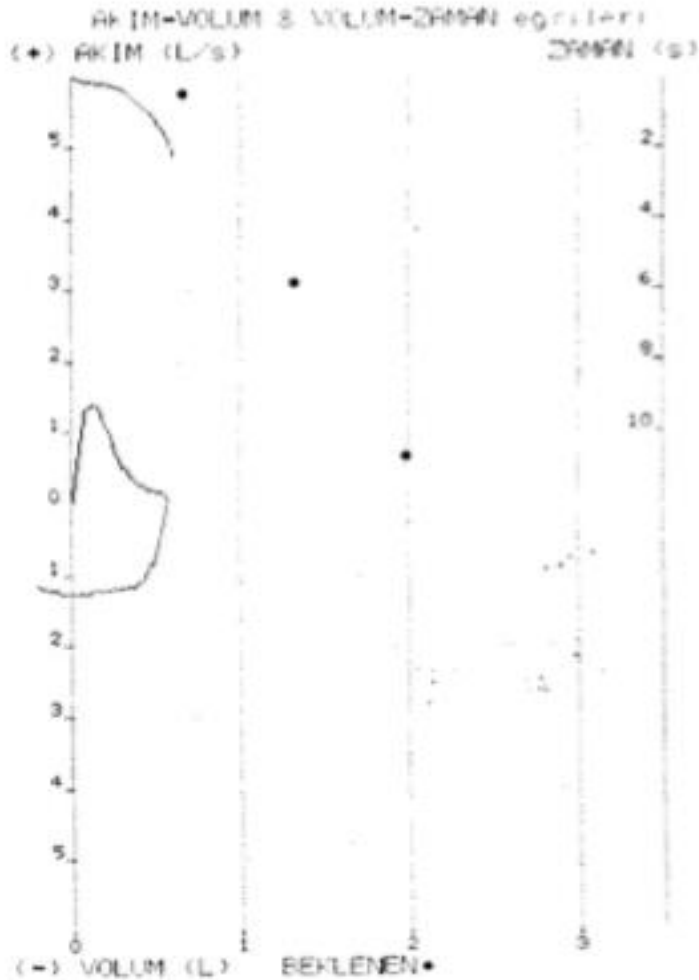PRE DOSYA NO 1904 POST DOSYA NO 1911
DOZ 4

SPIROMETRE RAPOR EN IYI TEST

AKIM-VOLUM & VOLUM-ZAMAN egrileri
(•) AKIM (L/s) ZAMAN (s)

(-) VOLUM (L) BEKLENEN• PRE — POST —
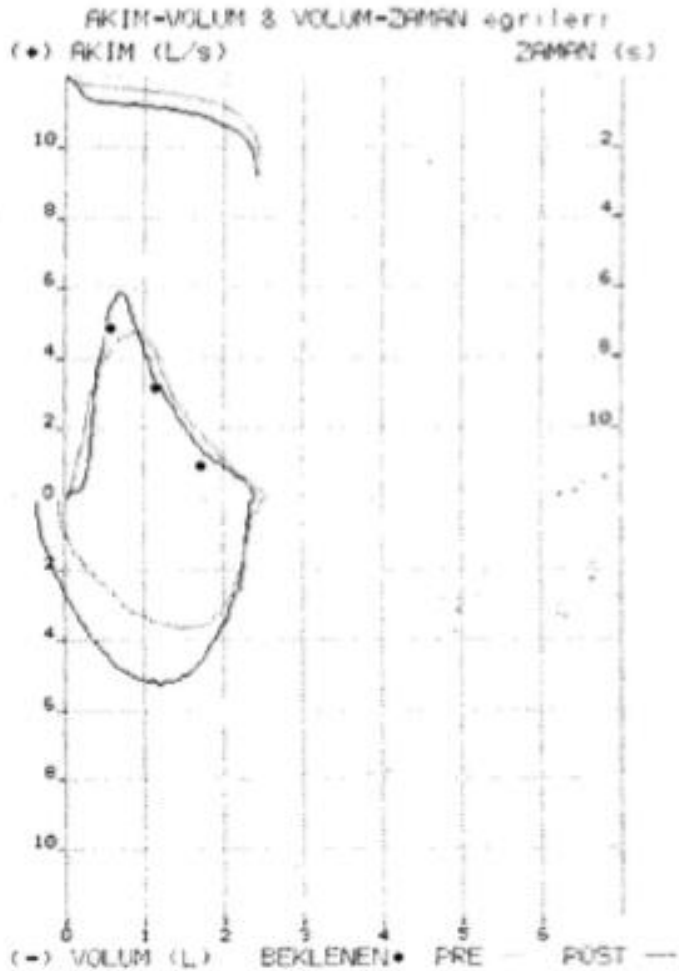
FVC: 2,44 L %108

FEV1: 2,20 L/sn % 118

FEV1/FVC: % 90

REV: FEV1: 2,18 % -1

FVC: 0,57 L   % 22

FEV1: 0,42   L/sn   % 21

FEV1/FVC: % 73

FVC: 2,94   L   % 120

FEV1: 2,61   L/sn   % 127

FEV1/FVC: % 88

ULUDAG UNI TIP FAK GOGUS HASTALIKLARI

TARIH 04/05/16 SAAT 13:02 BTPS 1.092 Ver 3.4

DOGUM TARIHI 01/01/60   #NO 1941
YAS 56 BOY cm 168   CINS.♀ KILO Kg 86

BEKLENEN ERS (ECCS)   NORMAL D. CEVRIMI 100%
PRE DOSYA NO 1940   POST DOSYA NO 1951
DOZ   4

SPIROMETRE RAPOR EN IYI TEST

AKIM-VOLUM & VOLUM-ZAMAN egrileri
(+) AKIM (L/s)   ZAMAN (s)

(-) VOLUM (L)   BEKLENEN•   PRE —   POST —
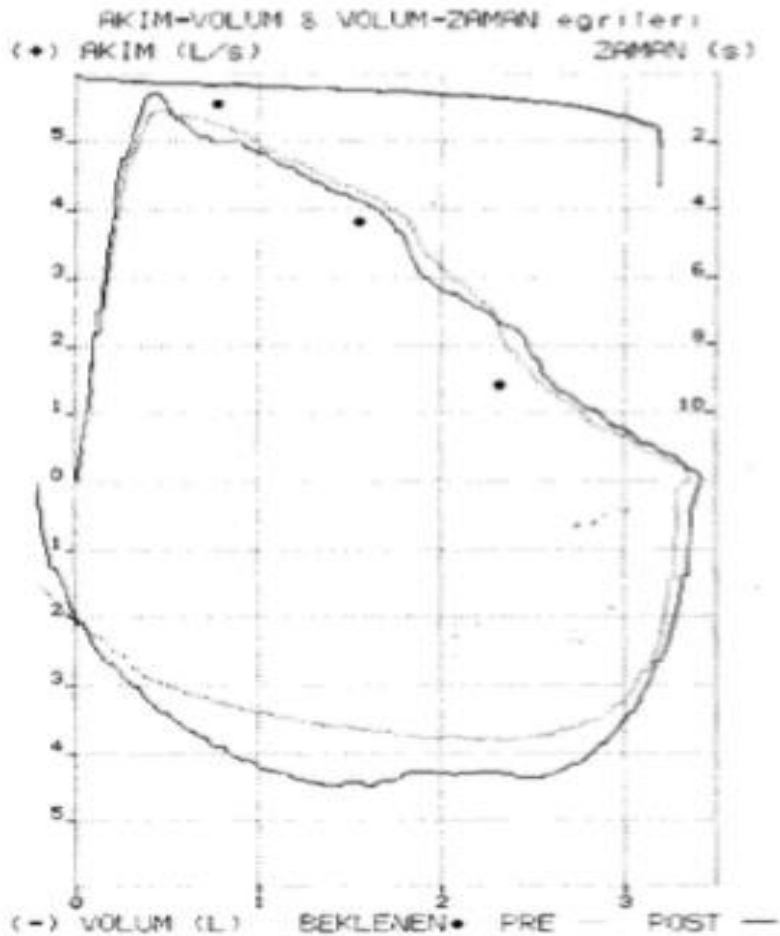
FVC: 3,35   L   % 108

FEV1: 2,86   L/sn   % 109

FEV1/FVC: % 85

REV

FEV1: 2,92 %2

DOĞUM TARIH: 01/01/66   #NO 1666
YAŞ 50   BOY cm 156   CINS. ?   KILO Kg 85

HESAPLANAN FKS (E/S)   NORMAL D.   % VERIM) 100%
PRE DOSYA NO 1667

SPIROMETRE RAPOR EN IYI TEST

AKIM-VOLUM & VOLUM-ZAMAN eğrileri
(+) AKIM (L/s)   ZAMAN (s)
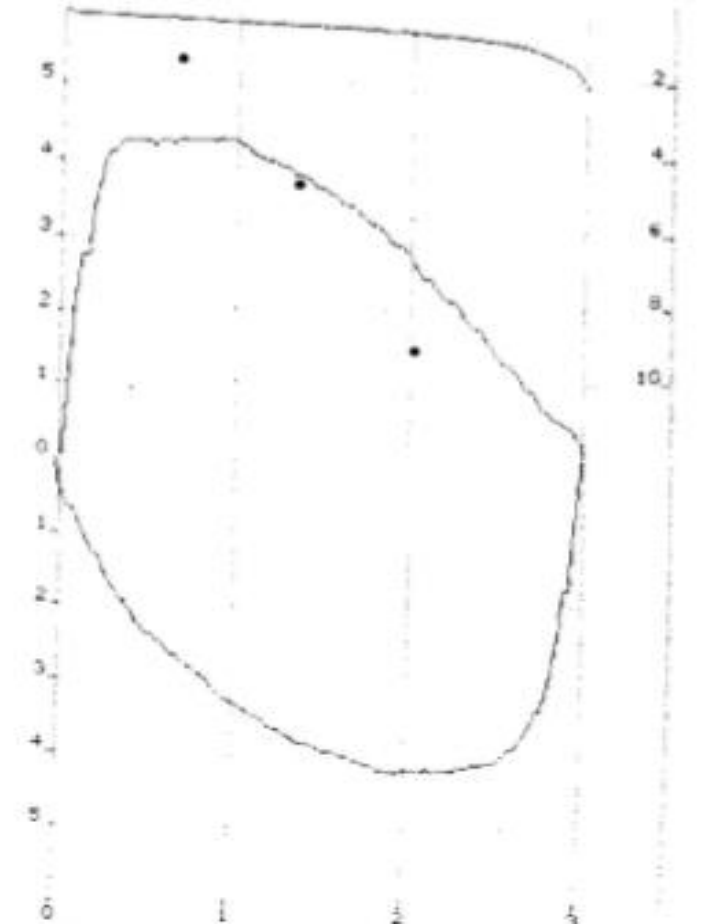
FVC: 3,0   L   % 110

FEV1: 2,70   L/sn   % 117

FEV1/FVC: % 90
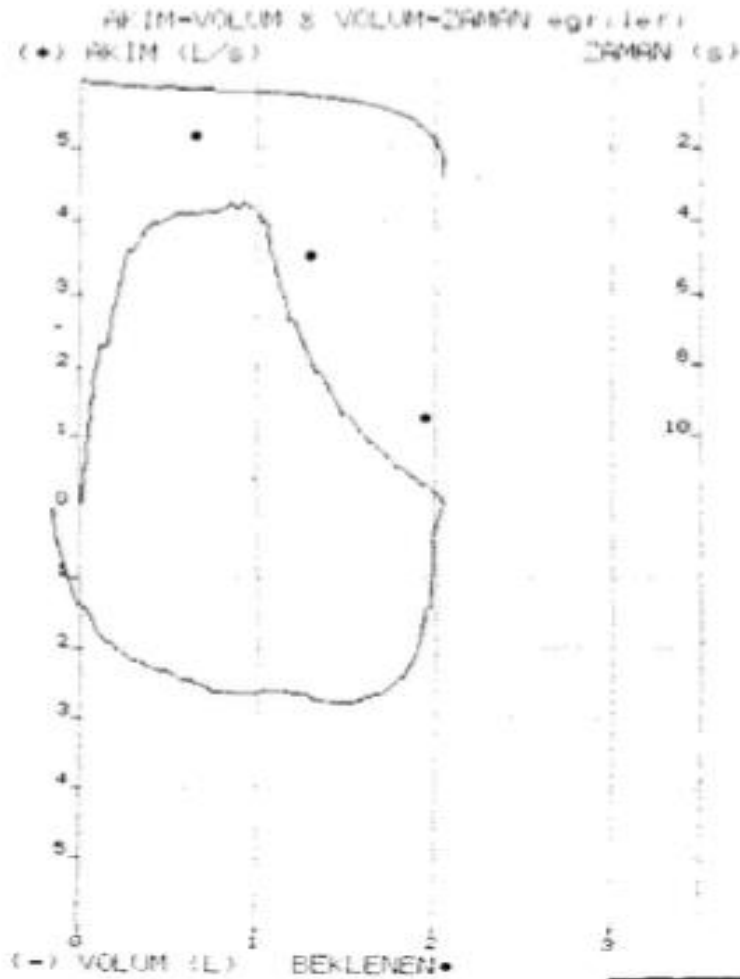
FVC: 2,05   L   % 78

FEV1: 1,83   L/sn   % 83

FEV1/FVC: % 89
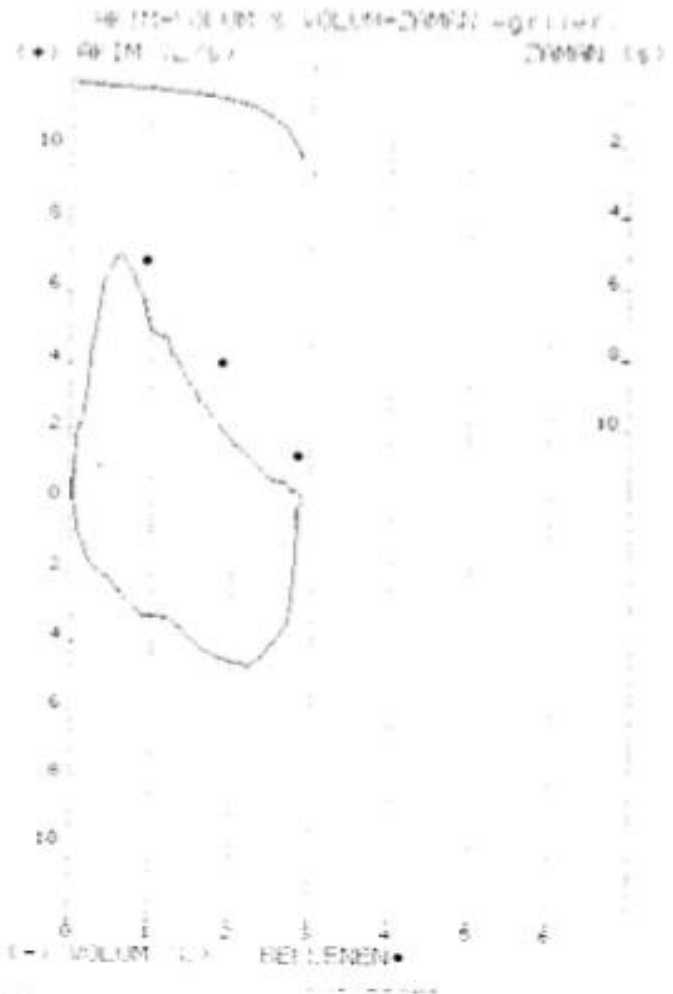
FVC: 2,89 L   % 76

FEV1: 2,51   L/sn   % 85

FEV1/FVC: % 86
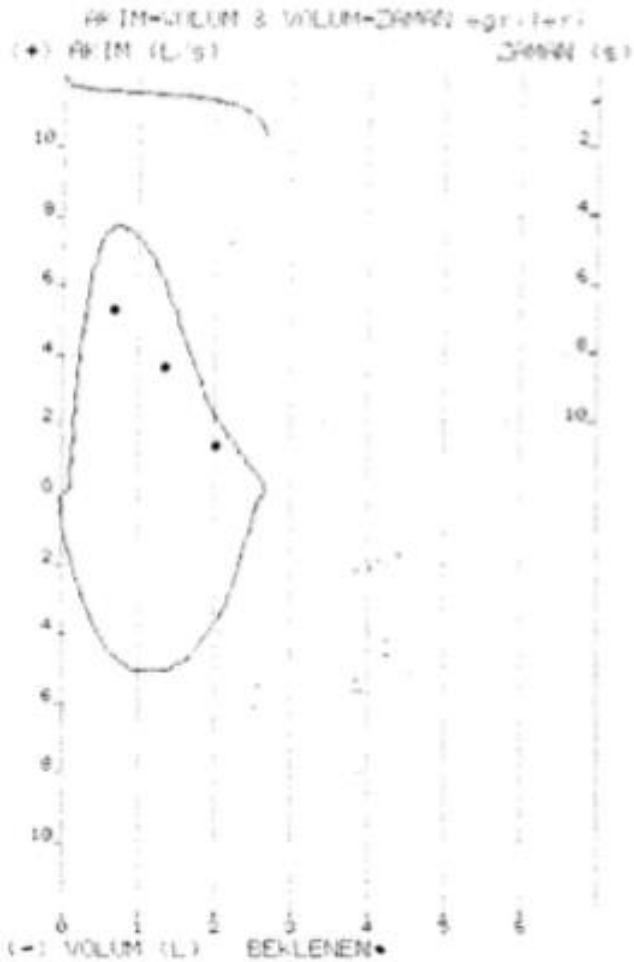
FVC: 2,67   L   % 97

FEV1: 2,58   L/sn   % 111
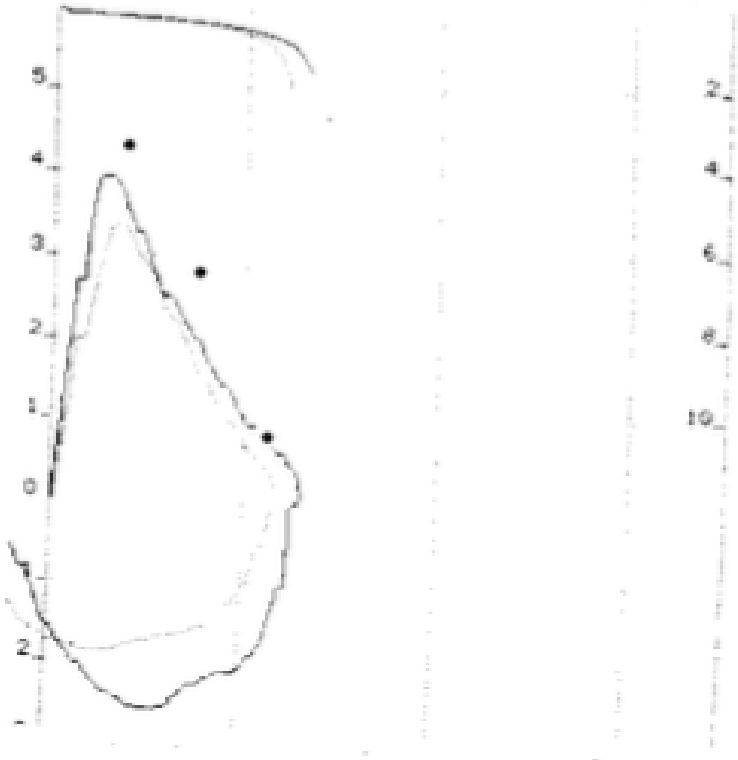
FEV1/FVC: % 96

FVC: 1,18   L   % 79

FEV1:   1,11   L/sn   % 94

FEV1/FVC: % 94

REV

FEV1: 1,24 % 105

%12 REV

JDRG UNI TIP FAK GOGUS HASTALIKLARI

RIH 04/05/16 SAAT 13:22 BTPS 1.092 Ver 3.4

GUM TARIHI 01/01/69   #NO 1953
3 47 BOY cm 175   CINS. ♂   KILO Kg 73

<LENEN ERS (ECCS)   NORMAL D. CEVRIMI 100%
E DOSYA NO 1954

SPIROMETRE RAPOR EN IYI TEST

AKIM-VOLUM & VOLUM-ZAMAN egrileri
(*) AKIM (L/s)   ZAMAN (s)

) VOLUM (L)   BEKLENEN•
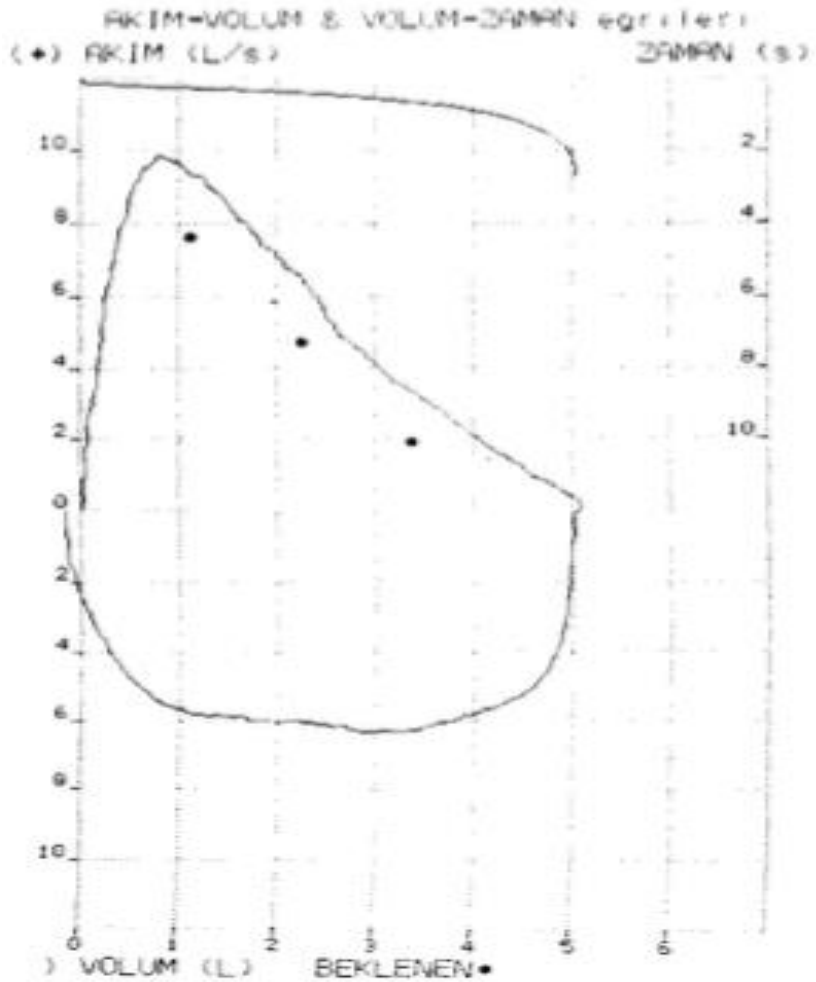
FVC: 5,10   L   % 113

FEV1: 4,43   L/sn   % 121

FEV1/FVC: % 86

FVC: 1,24 L   % 41

FEV1:   0,66 L/sn   % 28

FEV1/FVC: % 53

2017 ERS/ATS standards for single-breath carbon monoxide uptake in the lung

Brian L. Graham[1], Vito Brusasco[2], Felip Burgos[3], Brendan G. Cooper[4], Robert Jensen[5], Adrian Kendrick[6], Neil R. MacIntyre[7], Bruce R. Thompson[8] and Jack Wanger[9]
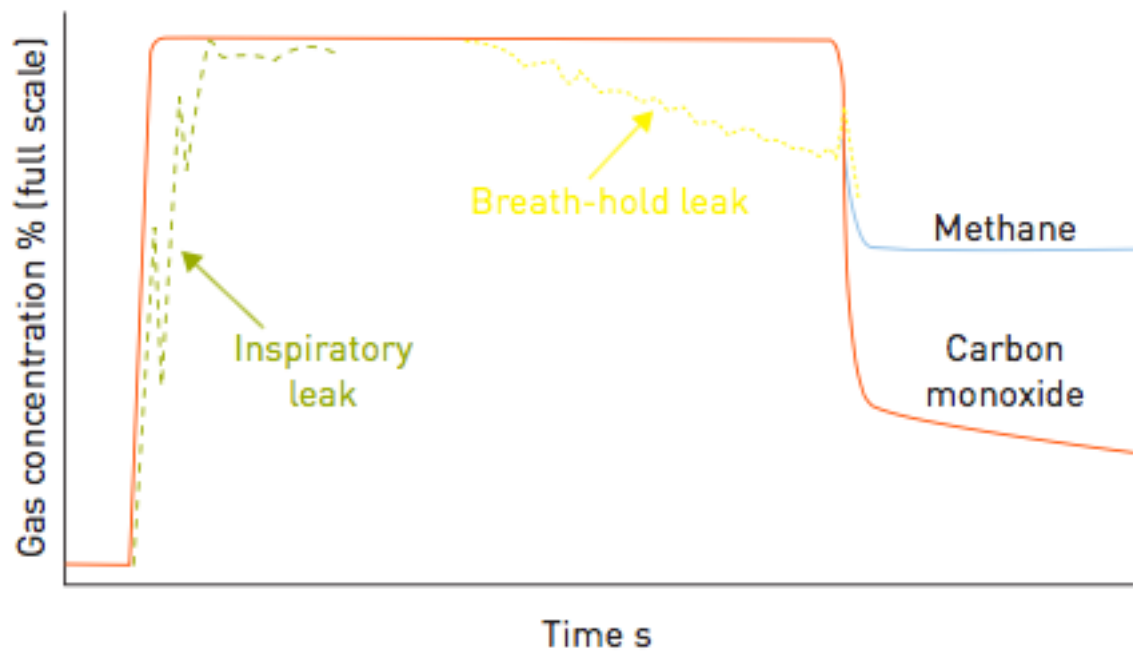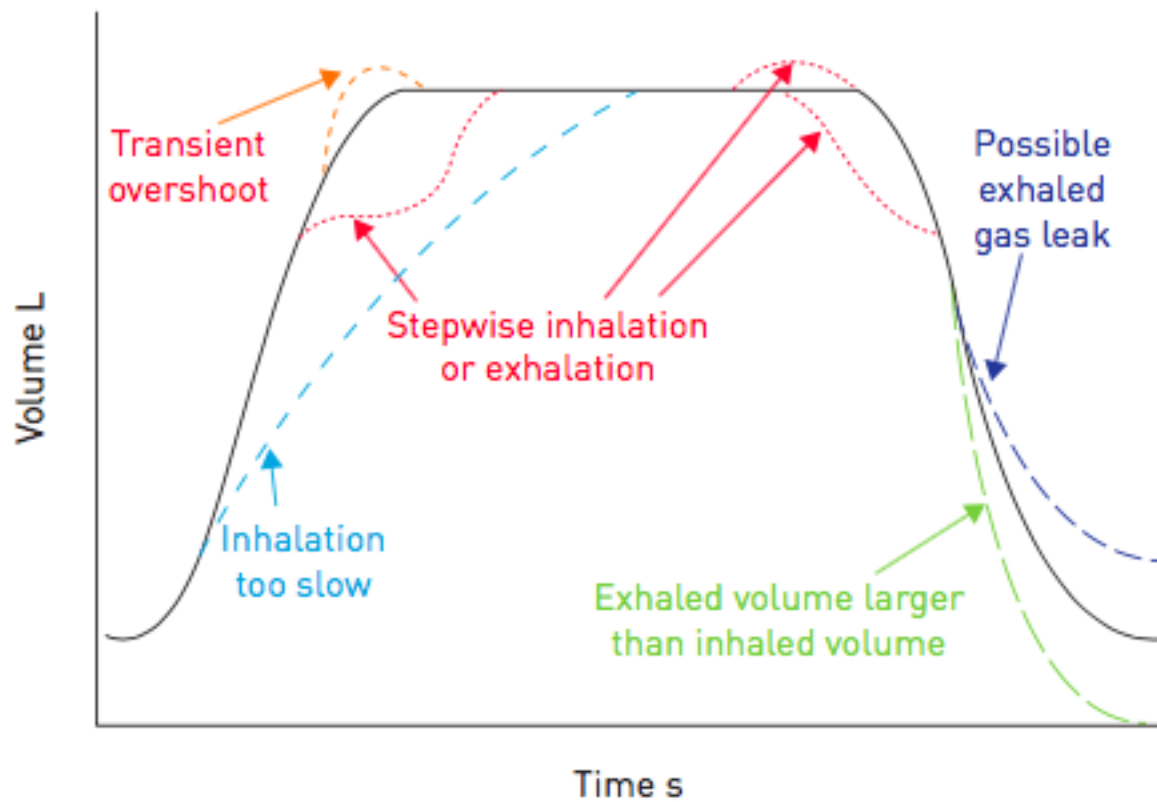
TABLE 3 Acceptability, repeatability and quality control in D_{LCO} testing

Criteria for acceptability

A V_I ⩾90% of the largest VC in the same test session; alternatively a V_I ⩾85% of the largest VC in the same test session and V_A within 200 mL or 5% (whichever is greater) of the largest V_A from other acceptable manoeuvres

85% of test gas V_I inhaled in <4 s

A stable calculated breath-hold for 10±2 s with no evidence of leaks or Valsalva/Müller manoeuvres during this time

Sample collection completed within 4 s of the start of exhalation. For RGA systems, virtual sample collection should be initiated after dead-space washout is complete

Criteria for repeatability

At least two acceptable D_{LCO} measurements within 2 mL·min^{-1}·mmHg^{-1} (0.67 mmol·min^{-1}·kPa^{-1}) of each other

Score	Quality control grading[#]		
	V_I/VC	t_{BH}	Sample collection
A	$\geqslant 90\%$[¶]	8–12 s	$\leqslant 4$ s
B	$\geqslant 85\%$	8–12 s	$\leqslant 4$ s
C	$\geqslant 80\%$	8–12 s	$\leqslant 5$ s
D	$\leqslant 80\%$	<8 or >12 s	$\leqslant 5$ s
F	$\leqslant 80\%$	<8 or >12 s	>5 s

V_I: inspired volume; VC: vital capacity; V_A: alveolar volume; t_{BH}: breath-hold time; D_{LCO}: diffusing capacity of the lung for carbon monoxide. [#]: only grade A manoeuvres meet all acceptability criteria. The average D_{LCO} values from two or more grade A manoeuvres that meet the repeatability criterion should be reported. If only one grade A manoeuvre is attained, the D_{LCO} value from that manoeuvre should be reported. If no grade A manoeuvre is obtained, manoeuvres of grades B to D might still have clinical utility. The average of such manoeuvres should be reported but these deviations from the acceptability criteria must be noted to caution the interpreter of the test results. Manoeuvres of grade F are not useable. [¶]: or $V_I/VC \geqslant 85\%$ and V_A within 200 mL or 5% (whichever is greater) of the largest V_A from another acceptable manoeuvre.

Difüzyon Kapasitesi Değerlendirme

Difüzyon bozukluğu düzeyi	DLCO % beklenen
Normal	%81-140
Hafif	% 61–80
Orta	% 41-60
Ağır	<40 %

Pulmonary Function Analysis

Id: 1805075

Date: 23/09/19

Diagnosis:

Physician:

Age: 68   Height(cm): 160   Weight(kg): 58.0   Gender: Male   Race: Caucasian

Spirometry

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	3.11	2.37	76			
FEV1	Liters	2.42	1.94	80			
FEV1/FVC	%	75	82				
FEF25-75%	L/sec	2.88	2.39	83			
FEF50%	L/sec	3.61	4.21	117			
PEF	L/sec	7.05	7.68	109			
MVV	L/min						

Lung Volumes

		Ref		
TLC	Liters	5.70		
RV	Liters	2.36		
RV/TLC	%	40		
FRC N2	Liters	3.27		

Diffusion

		Ref	Pre Meas	Pre % Ref
DLCO	mL/mmHg/min	21.7	7.8	36
DL Adj	mL/mmHg/min	21.7	7.8	36
DLCO/VA	mL/mHg/min/L	3.80	2.10	55
DL/VA Adj	mL/mHg/min/L	3.80	2.09	55
VA	Liters	5.70	3.72	65

Maximal Respiratory Pressures
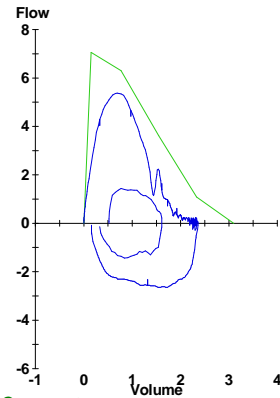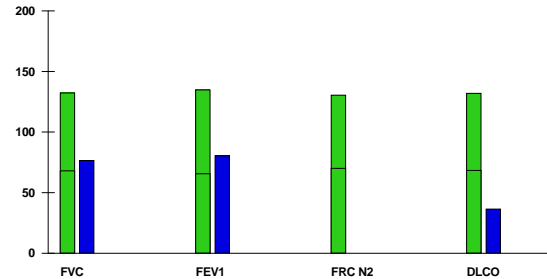
PI max	cmH2O
PI Volume	Liters

Comments:

Interpretation:

 There is no obstructive lung defect indicated by the FEV1/FVC ratio. Since VC is 76% of predicted, an additional restrictive lung defect cannot be excluded by spirometry alone. On the basis of this study, more detailed pulmonary function testing may be useful if clinically indicated. There is a severe decrease in diffusing capacity.

By signing this interpretation the physician is acknowledging that he/she has reviewed the computer interpretation and, in his/her professional opinion, this is a true and accurate reflection of the patient's current clinical condition.

Pulmonary Function Analysis

Id: 1141040
Date: 01/04/19
Physician:

Diagnosis:

Age: 80   Height(cm): 156   Weight(kg): 77.0   Gender: Male   Race: Caucasian

Spirometry

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	2.57	1.82	71			
FEV1	Liters	1.90	1.53	81			
FEV1/FVC	%	73	84				
FEF25-75%	L/sec	2.29	2.19	96			
FEF50%	L/sec	3.08	2.75	89			
PEF	L/sec	6.29	3.50	56			
MVV	L/min						

Lung Volumes

		Ref
TLC	Liters	5.38
RV	Liters	2.57
RV/TLC	%	45
FRC N2	Liters	3.28

Diffusion

		Ref	Pre Meas	Pre % Ref
DLCO	mL/mmHg/min	18.0	6.1	34
DL Adj	mL/mmHg/min	18.0	6.0	34
DLCO/VA	mL/mHg/min/L	3.34	2.44	73
DL/VA Adj	mL/mHg/min/L	3.34	2.42	73
VA	Liters	5.38	2.50	46

Maximal Respiratory Pressures
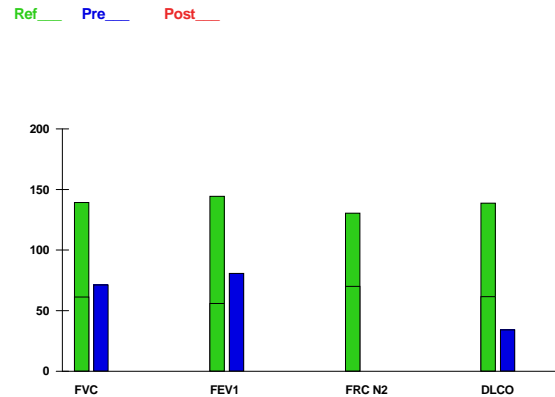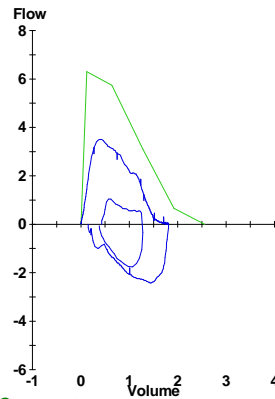
PI max	cmH2O
PI Volume	Liters

Comments:

Interpretation:

There is no obstructive lung defect indicated by the FEV1/FVC ratio. Since VC is 71% of predicted, an additional restrictive lung defect cannot be excluded by spirometry alone. On the basis of this study, more detailed pulmonary function testing may be useful if clinically indicated. There is a severe decrease in diffusing capacity.

By signing this interpretation the physician is acknowledging that he/she has reviewed the computer interpretation and, in his/her professional opinion, this is a true and accurate reflection of the patient's current clinical condition.

Pulmonary Function Analysis

Id: 1489949
Date: 22/10/19

Diagnosis:

Physician:

Age: 62   Height(cm): 153   Weight(kg): 44.0   Gender: Female   Race: Caucasian

Spirometry

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	2.28	1.91	84			
FEV1	Liters	1.89	1.74	92			
FEV1/FVC	%	77	91				
FEF25-75%	L/sec	2.72	3.16	116			
FEF50%	L/sec	3.36	3.68	110			
PEF	L/sec	5.44	5.00	92			
MVV	L/min						

Lung Volumes

		Ref					
TLC	Liters	4.31					
RV	Liters	1.76					
RV/TLC	%	40					
FRC N2	Liters	2.49					

Diffusion

		Ref	Pre Meas	Pre % Ref			
DLCO	mL/mmHg/min	20.1	10.7	53			
DL Adj	mL/mmHg/min	20.1	10.7	53			
DLCO/VA	mL/mHg/min/L	4.67	4.00	86			
DL/VA Adj	mL/mHg/min/L	4.67	3.99	85			
VA	Liters	4.31	2.67	62			

Maximal Respiratory Pressures

PI max	cmH2O						
PI Volume	Liters						

Ref___   Pre___   Post___
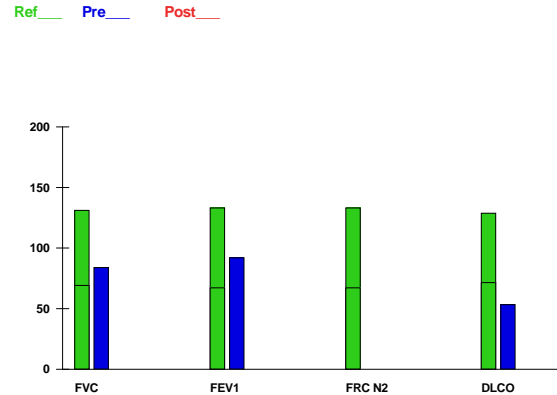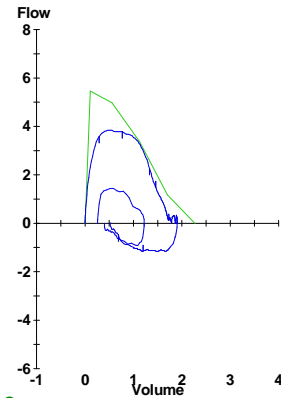
Comments:

Interpretation:

Spirometry is within normal limits. There is a moderate decrease in diffusing capacity.

By signing this interpretation the physician is acknowledging that he/she has reviewed the computer interpretation and, in his/her professional opinion, this is a true and accurate reflection of the patient's current clinical condition.