

Interpretatie Cardiopulmonale Inspanningstests



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**Vereniging voor Hart-, Vaat-
en Longfysiotherapie**

Aangesloten bij KNGF

Cardiopulmonale inspanningstest (CPET)

- Integrale fysiologische respons tijdens inspanning
- Progressieve (intensiteit) inspanning waarbij grote spiergroepen worden gebruikt
 - *Rust* ⇨ *Submaximaal* ⇨ *Maximaal* ⇨ *Herstel*
 - *Non-invasive and dynamic*
- Capaciteit to fulfil incremental metabolic demands
- Gouden standaard (traditioneel) : $VO_{2\text{-piek}}$
 - *Belangrijke gezondheidsuitkomst*
- Ondersteunend om pathologie te identificeren bij personen met inspanningsintolerantie:
 - *Diagnostiek*
 - *Prognostiek*
 - *Evaluatief*



Vraag 1: Welke indicaties zijn er voor een CPET?

- A. Bepalen van het fitheidsniveau?
- A. Bepalen/kwantificeren (inspanning)beperking?
- A. Bepalen/inschatten (pre)operatieve risico?
- A. Combinatie van bovengenoemde?

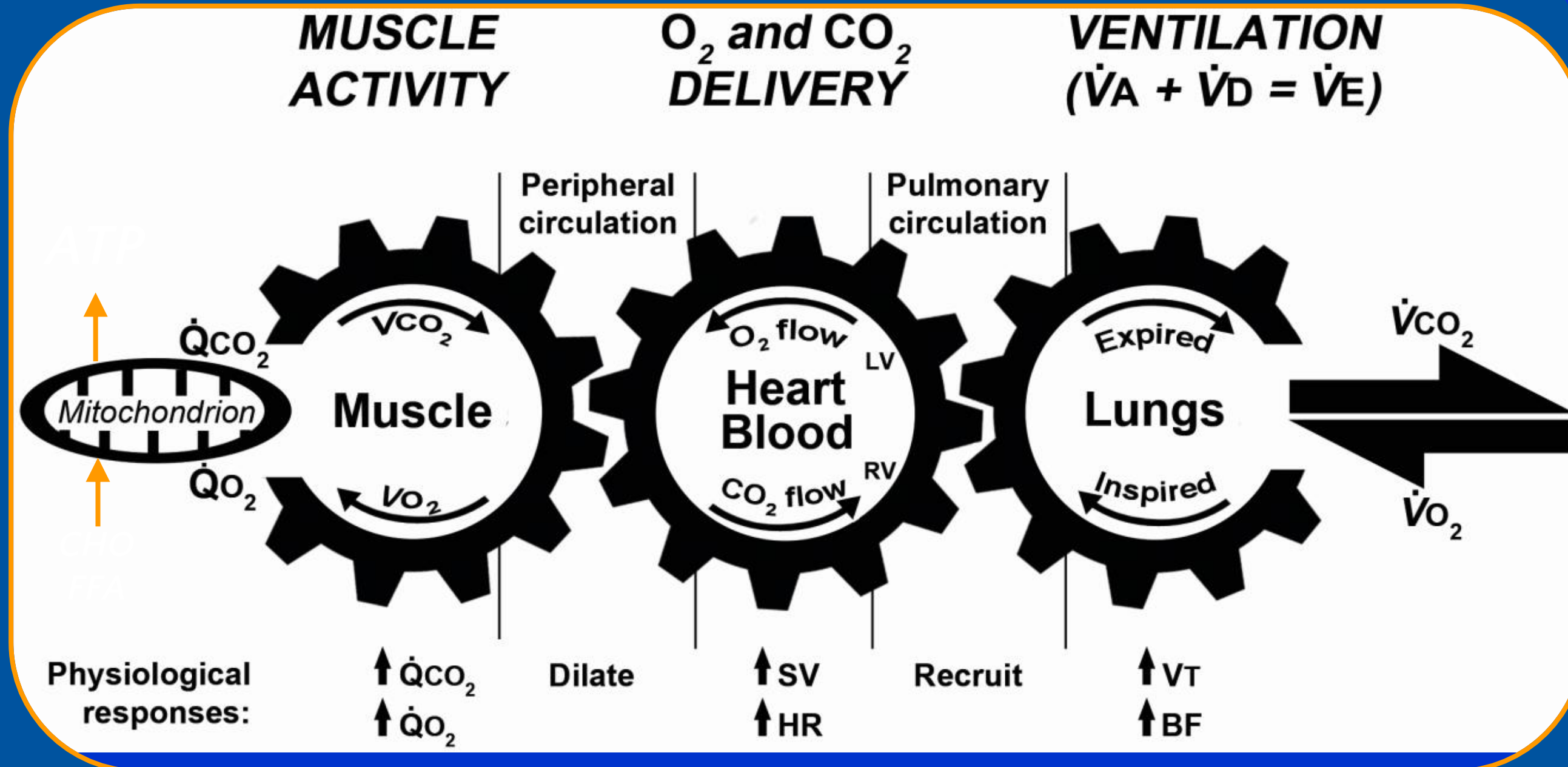


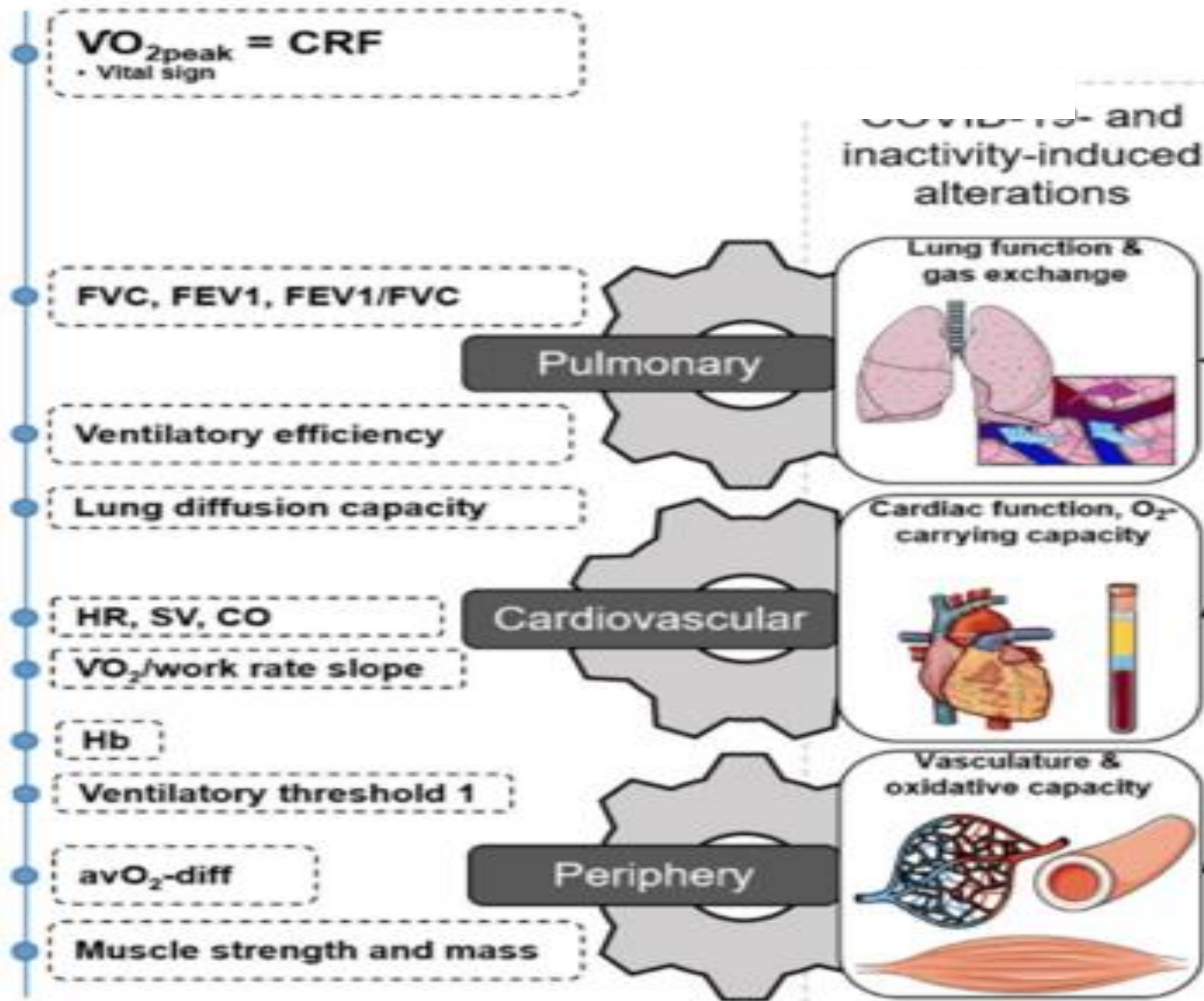
Waarom een CPET?

- Diagnostiek bij patiënten met kortademigheidsklachten
- Beoordelen welke bijdrage cardiorespiratoire pathologie heeft bij inspanningsintolerantie
- Mate van (inspannings)beperking kwantificeren
- Beoordeling operatie risico (Fit-For-Surgery)
- Evalueren respons op een interventie (operatie; training; medicamenteus)

Fysiologische respons

(koppeling cellulaire (interne) respiratie en pulmonale (externe) respiratie)





Vraag 2: Welk fysiologische systeem is bij een "gezond" persoon de meest limiterende factor bij inspanning?

A. Het respiratoire systeem

A. Het cardiovasculaire systeem

A. Het musculo-skeletale (perifere) systeem

A. Combinatie van bovengenoemde



Equipment for CPET



Lung function

FEV_1
 FVC
 TLC

Ventilatory reserve

Saturation

SpO_2

Tidal volume
Breathing frequency

Volume
Respiratory gas
analyzer

VE
 VO_2
 VCO_2

RER
Ventilatory threshold
 EqO_2
 $EqCO_2$
 VE/VO_2 -slope
 VE/VCO_2 -slope
OUES
 $P_{ET}O_2$
 $P_{ET}CO_2$

ECG

Rhythm
Rate
Depolarisatie
Repolarisatie

Blood pressure

O_2 -pulse

Work load

WR_{pick}

$\Delta VO_2/\Delta WR$

Goed geventileerde ruimte!

Stappenplan Interpretatie CPET

1. REASON FOR TESTING

2. SYSTEMATIC ERRORS

3. QUALITY of CPET

4. AEROBIC
PERFORMANCE

5. PHYSIOLOGICAL RESPONSE

6. SYMPTOM PERCEPTION

7. CONCLUSIONS

Cardiovascular
response

Ventilatory response

Gas exchange

Peripheral response

SYSTEMATIC INTERPRETATION CPET DATA

THE PHYSIOLOGY ACADEMY

Reasons for Testing

Systematic Errors

Quality of CPET
(HR>95% pred, RER>1.1, VR>15%)

Aerobic Performance
(VO_{2peak} > 80% predicted)

Physiological Response
- Cardiovascular
- Ventilatory
- Gas exchange
- Muscle metabolism

Symptom Perception
(BORG/RPE)

Conclusion

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Oorzaak van inspanningsbeperking

Abnormal exercise response

At least one of:

$\dot{V}_{O_2\text{peak}}$ <85% predicted

Peak HR <90% predicted

$\dot{V}_{E\text{peak}}$ >85% MVV

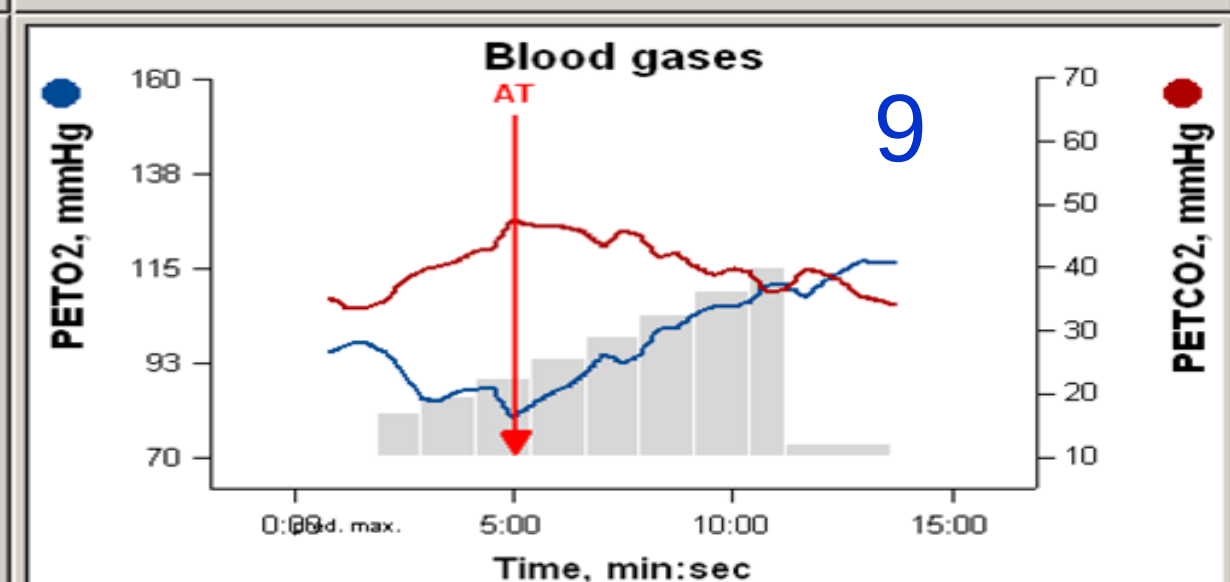
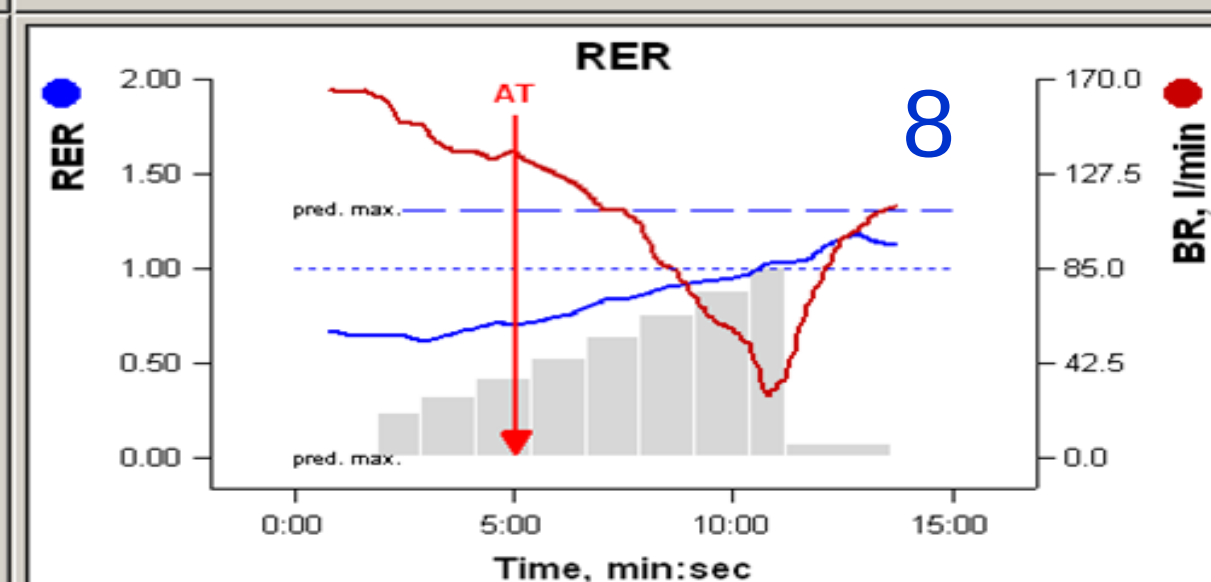
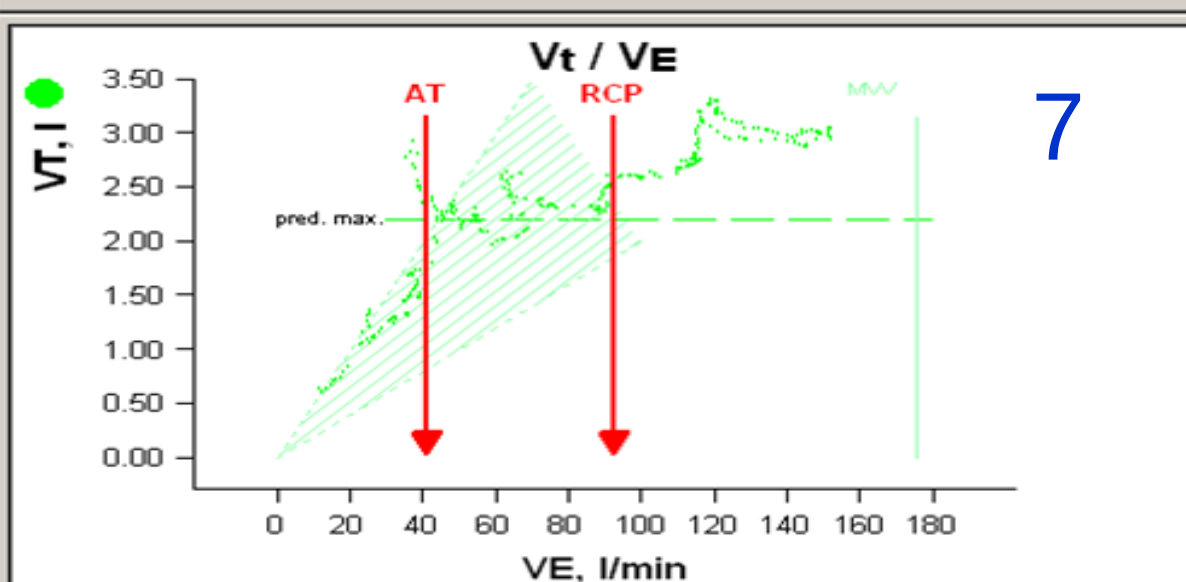
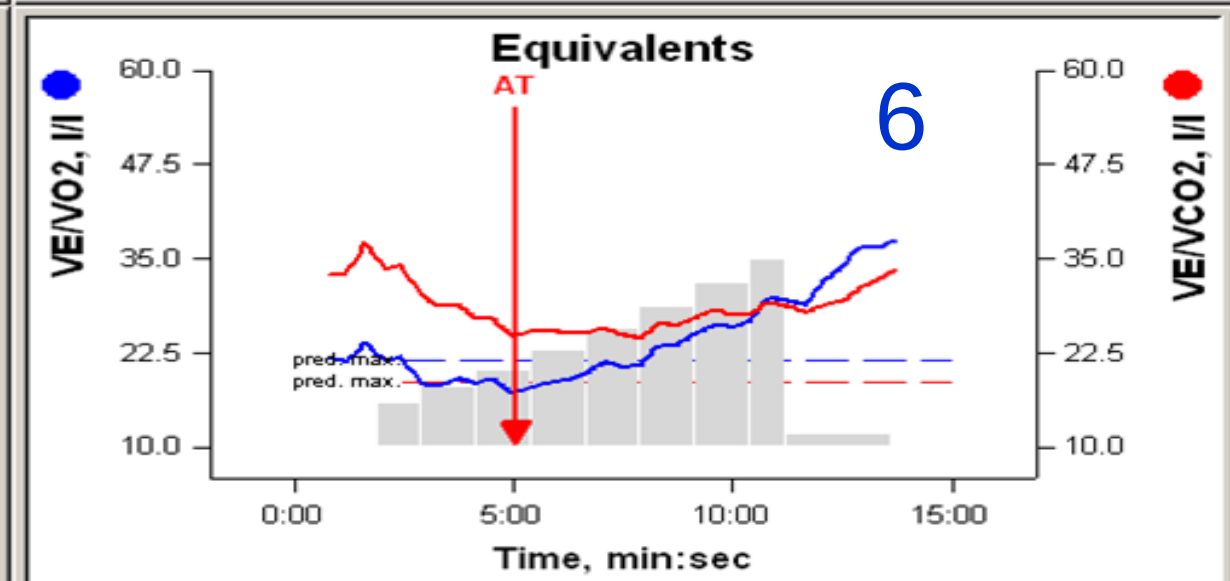
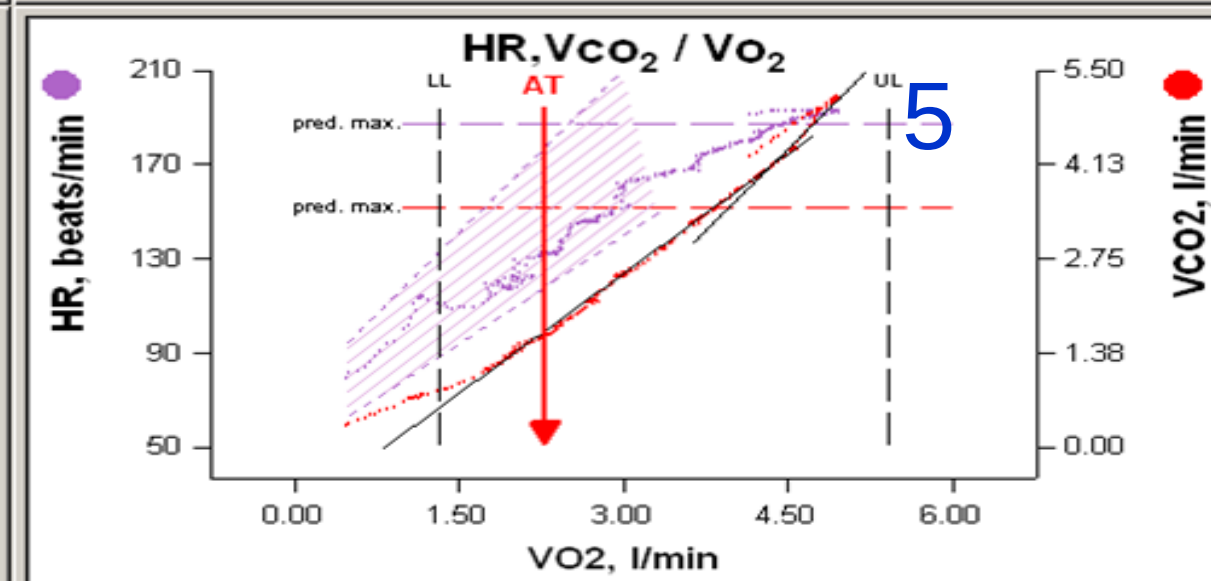
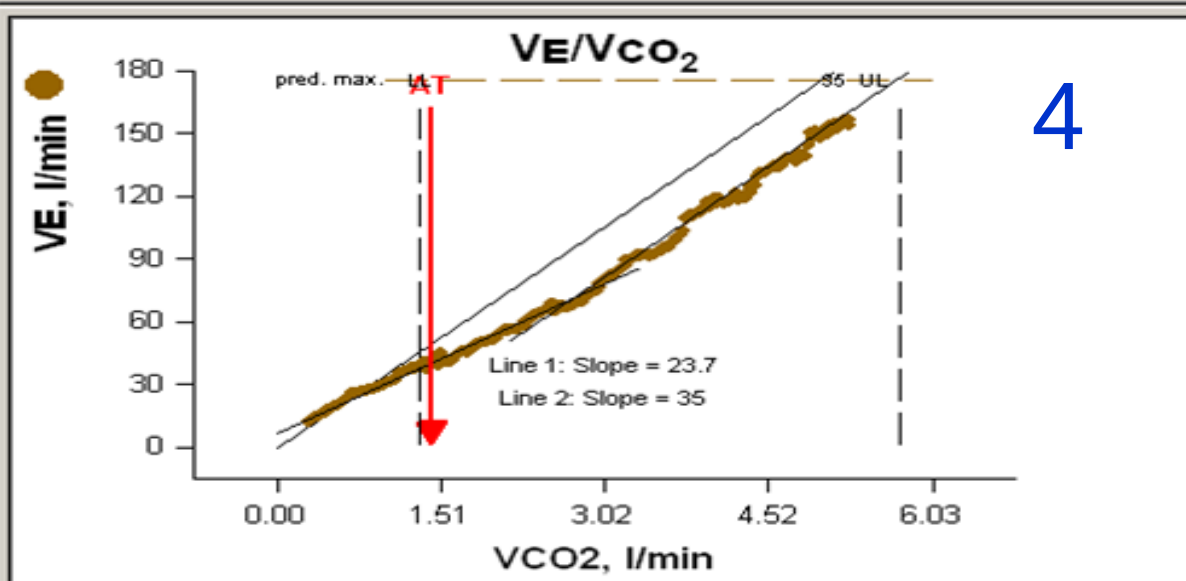
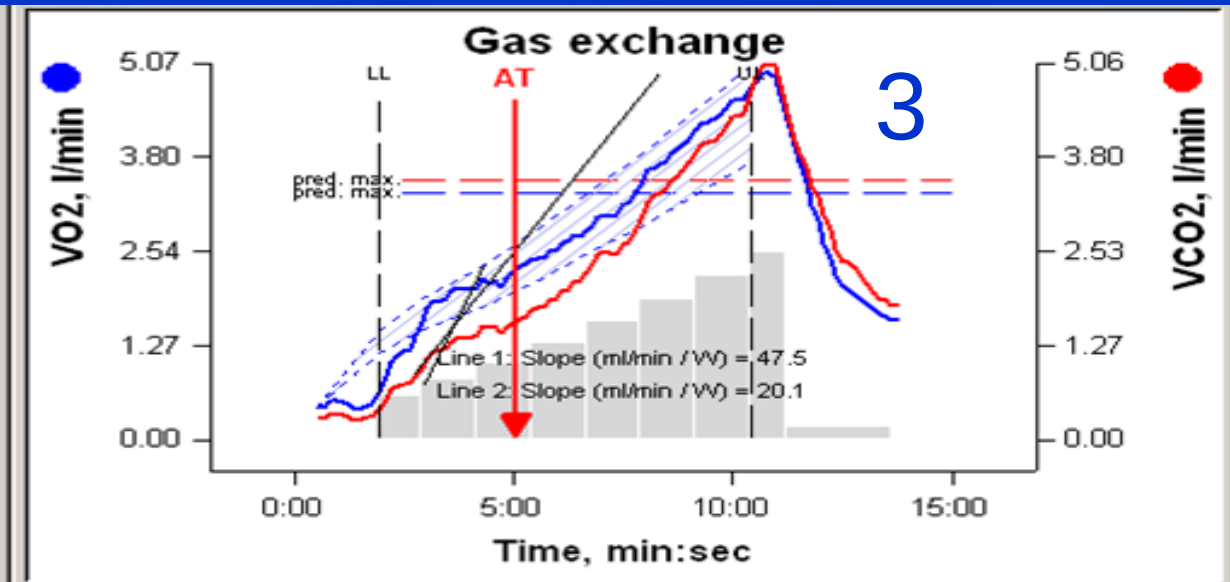
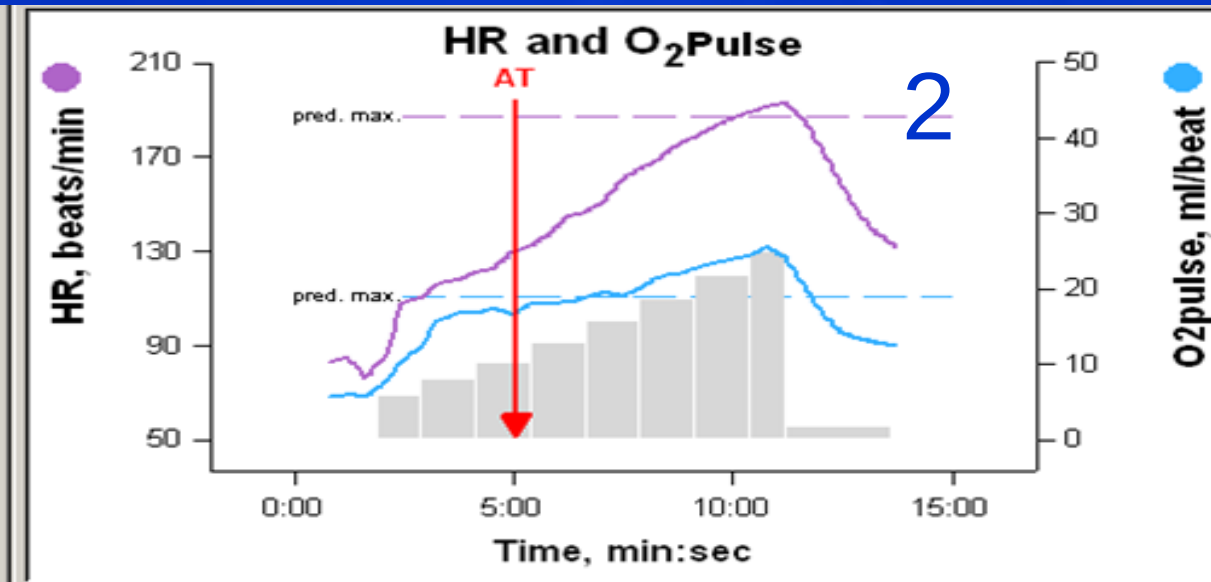
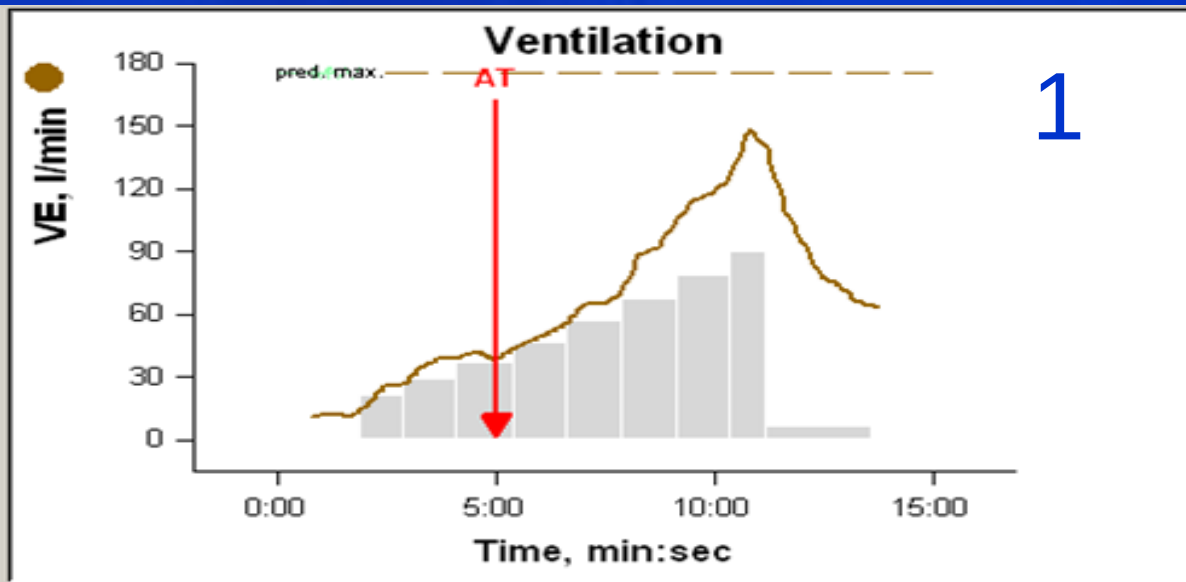
$\dot{V}_{O_2}$ at AT <50% predicted $\dot{V}_{O_2\text{peak}}$

Desaturation $\geq 5\%$ from baseline

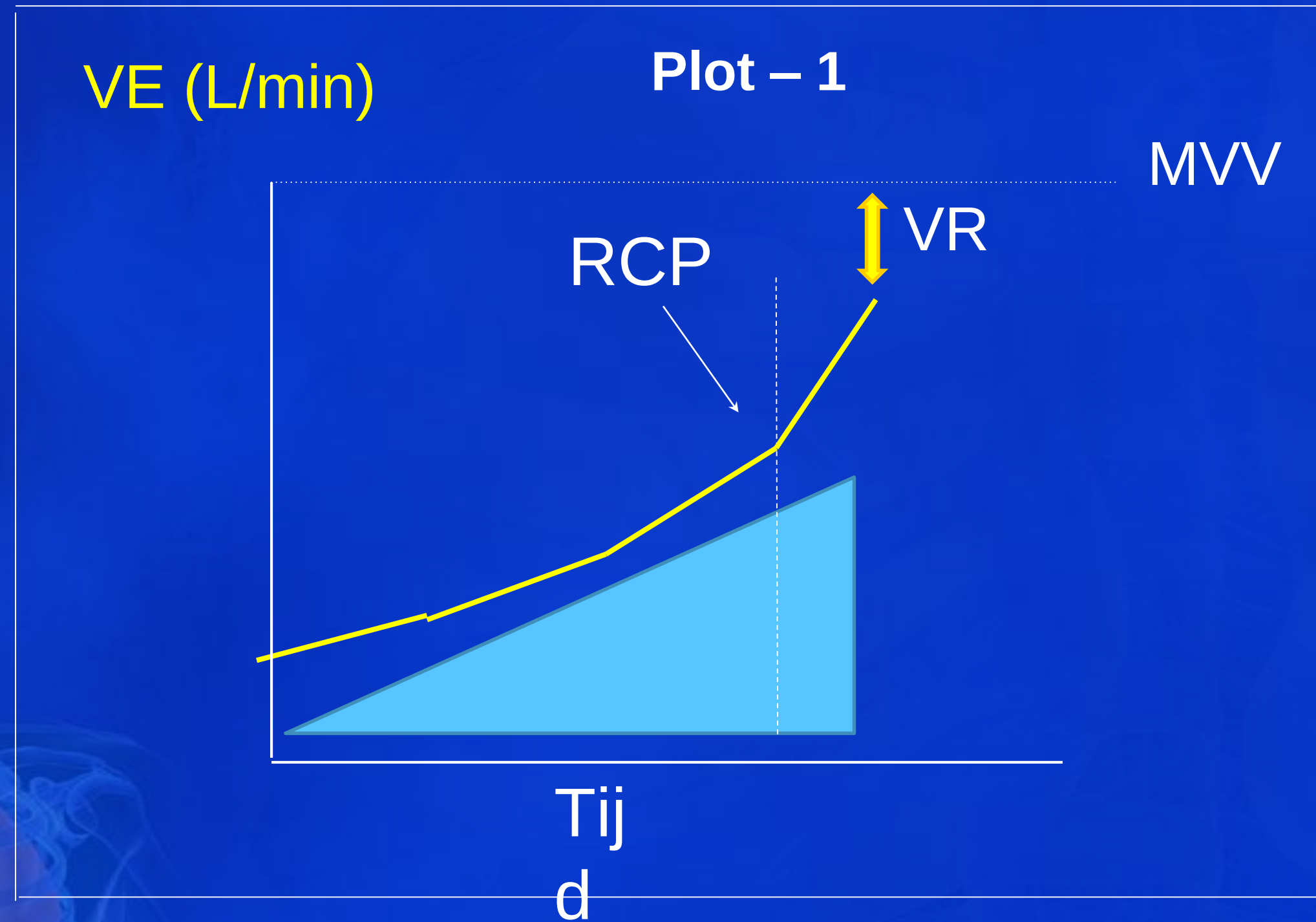
Decrease in IC >150 mL

Determine cause of exercise limitation

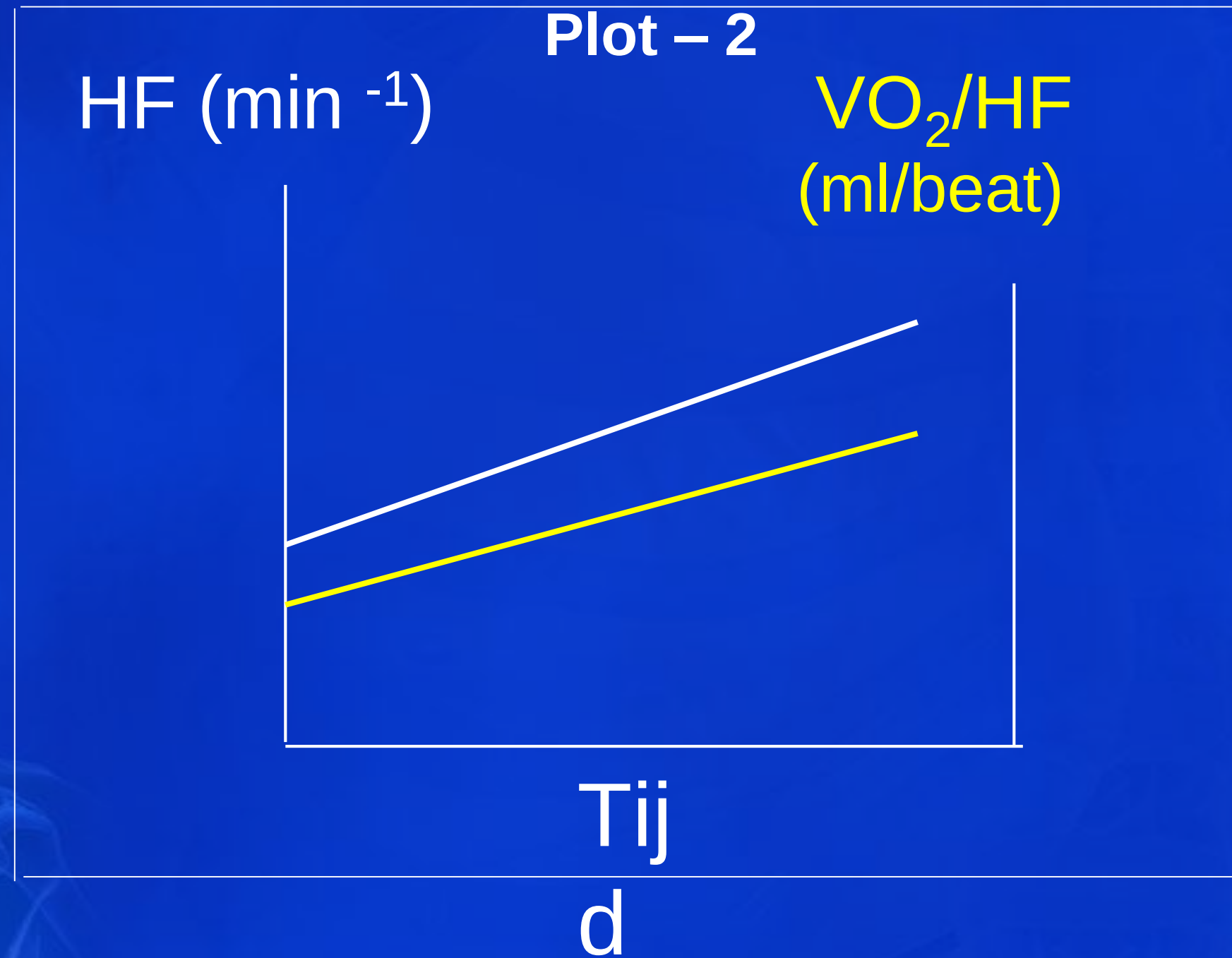
	Respiratory limitation	Cardiovascular limitation	Peripheral muscle limitation	Peripheral deconditioning
$\dot{V}_{O_2\text{peak}}$	Reduced	Reduced	Reduced	Reduced
$\dot{V}_{O_2}$ at AT	Normal	Normal/reduced	Likely reduced	Reduced
Peak HR	Reduced	Likely normal	Reduced	Normal
$\dot{V}_E/\text{MVV}$	>85%	<85%	<85%	<85%
S_{pO_2}	Normal/reduced	Normal	Normal	Normal



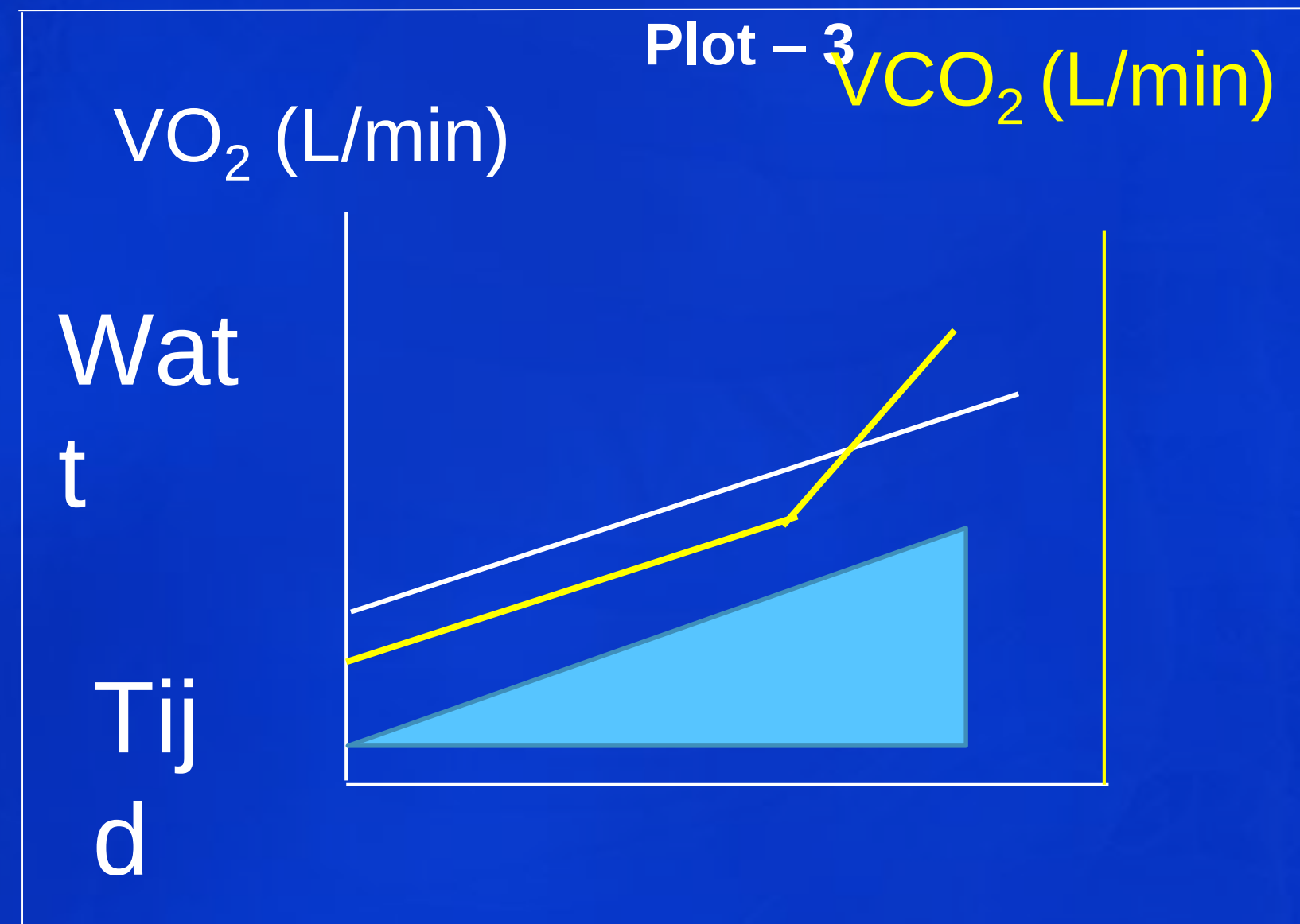
PLOT 1 – Ventilatie



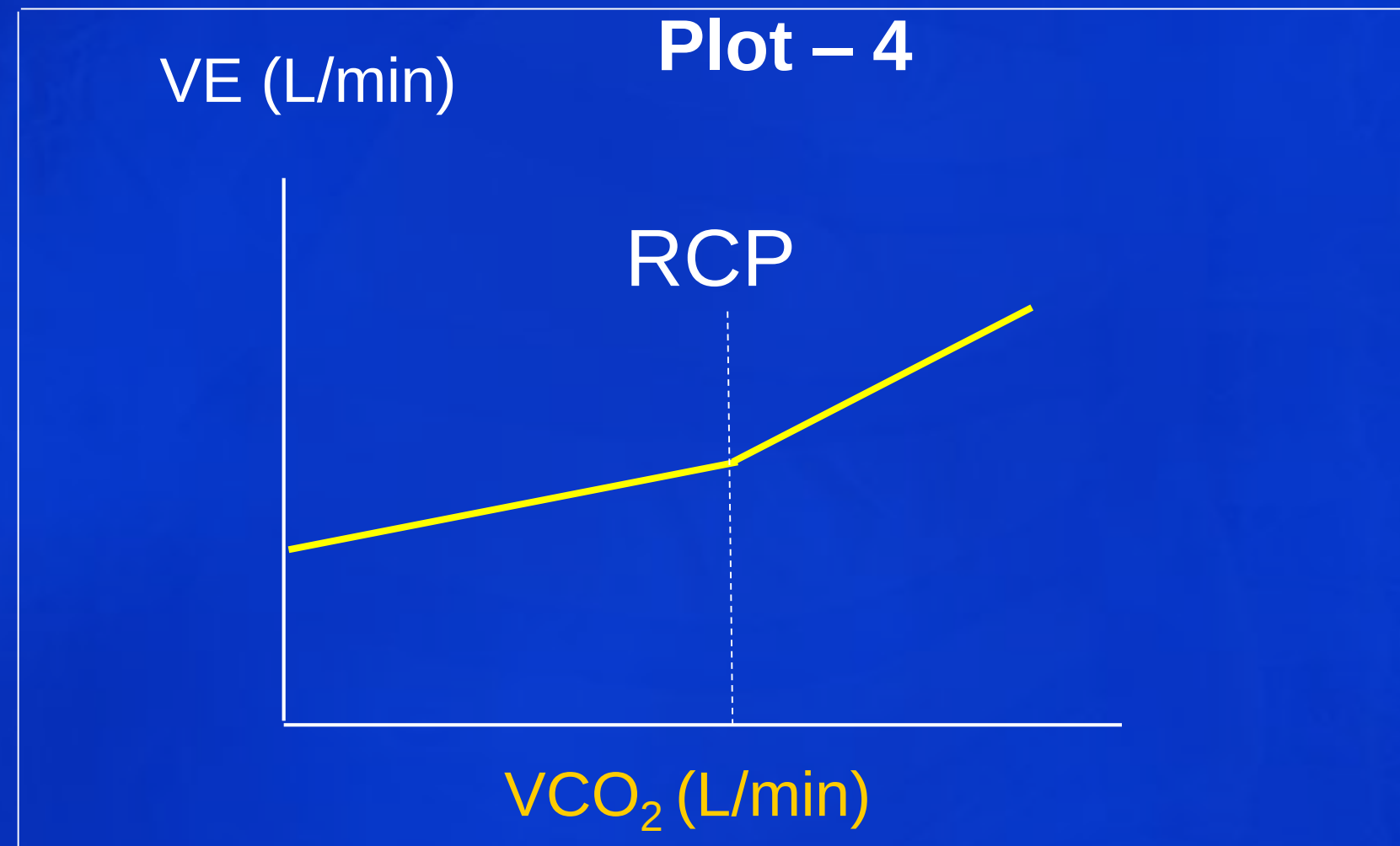
PLOT 2 – Hartslag (HF) en VO_2/HF (Zuurstofpols)



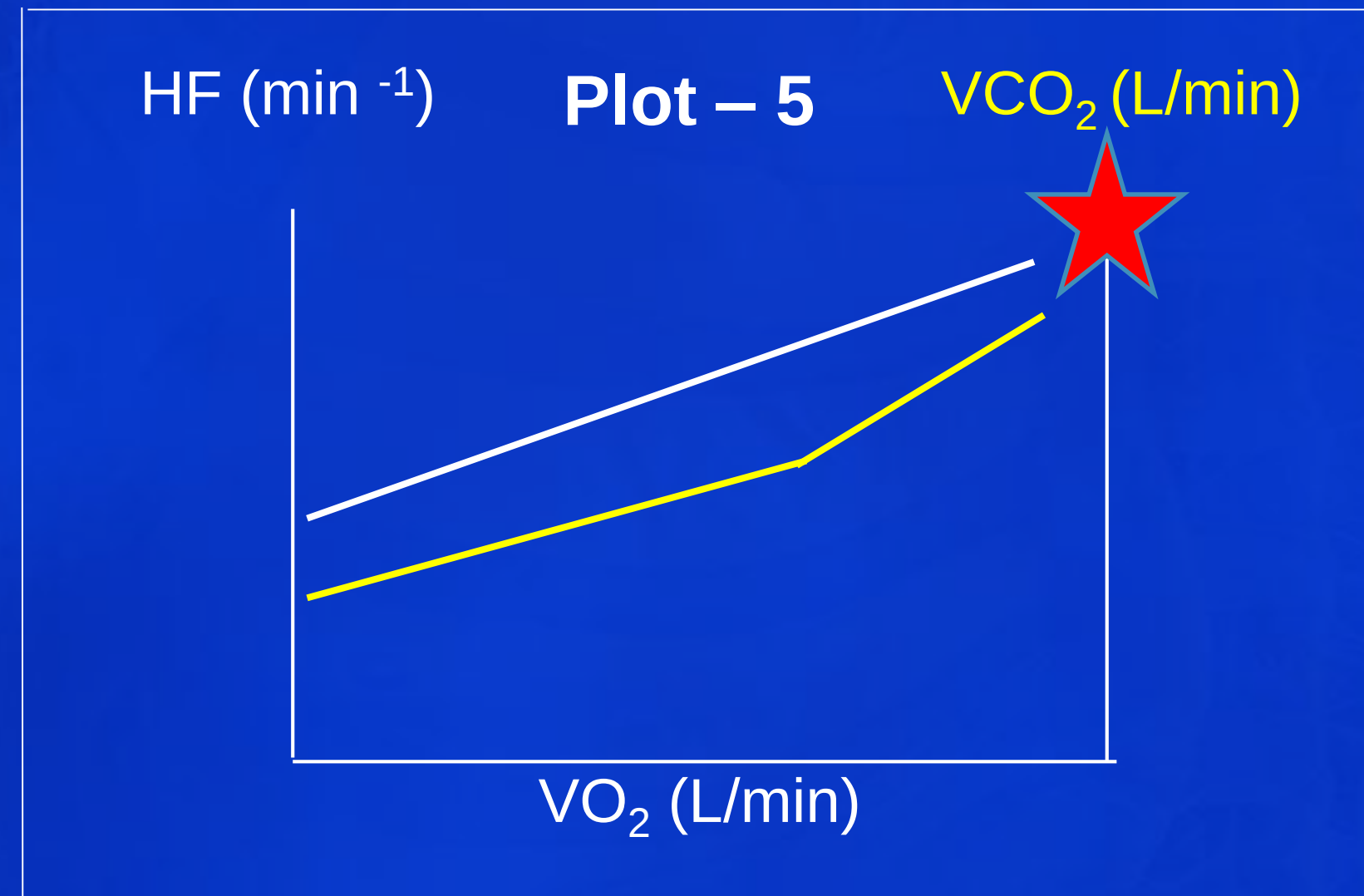
PLOT 3 – VO_2 en VCO_2



PLOT 4 – VE vs $\dot{V}CO_2$

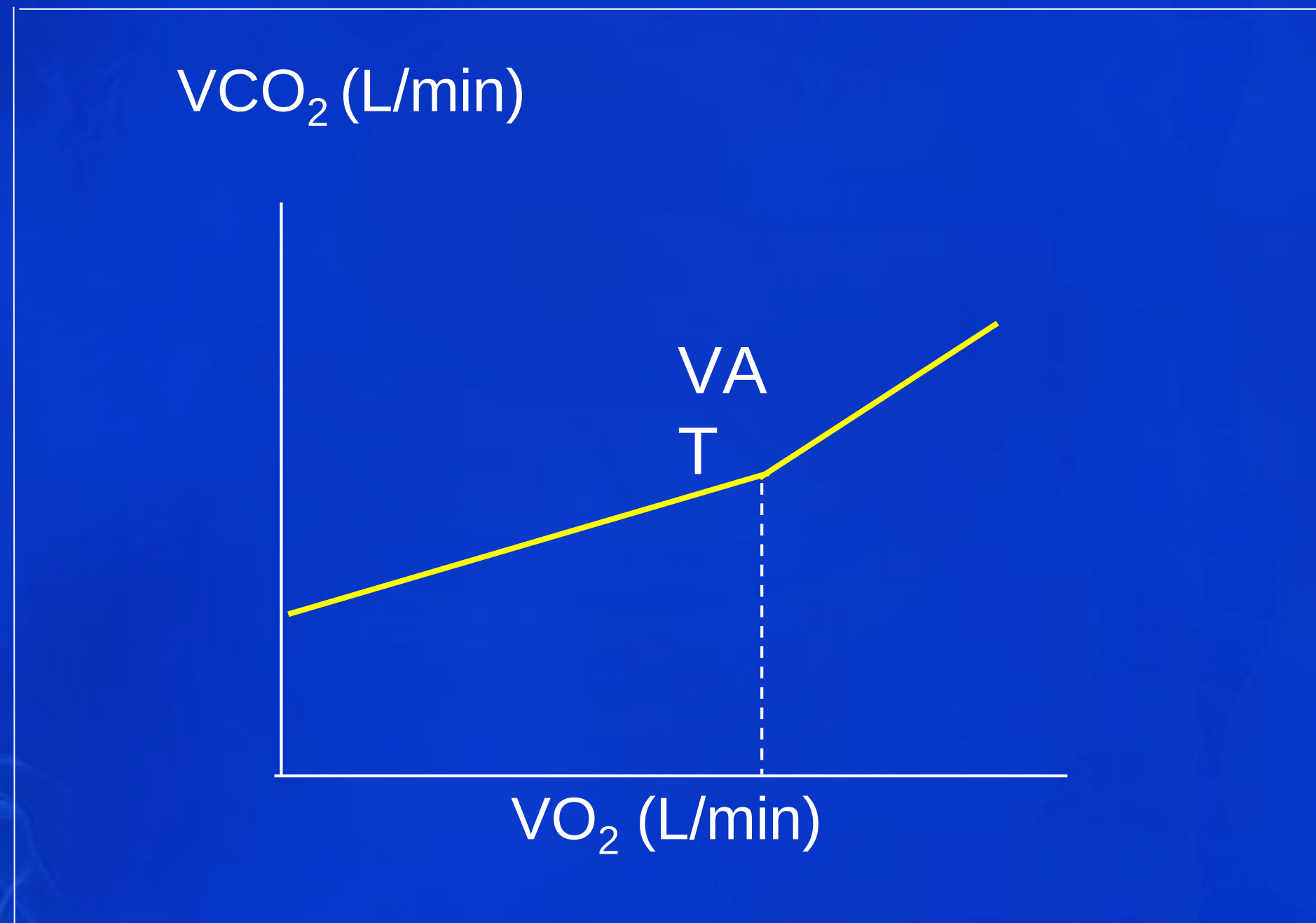


PLOT 5 – HF vs VO_2 en VCO_2 vs VO_2

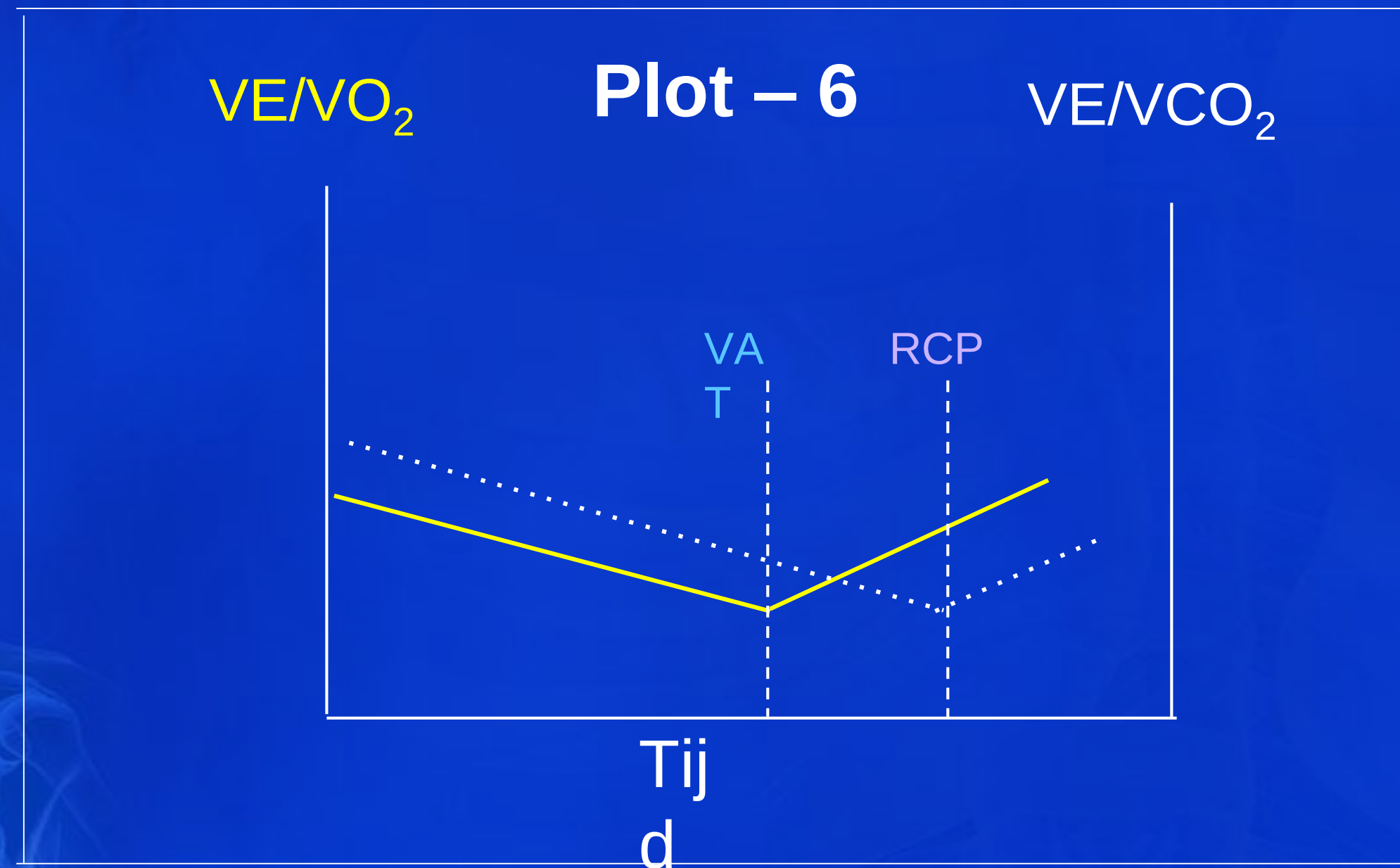


★ : Hansen point

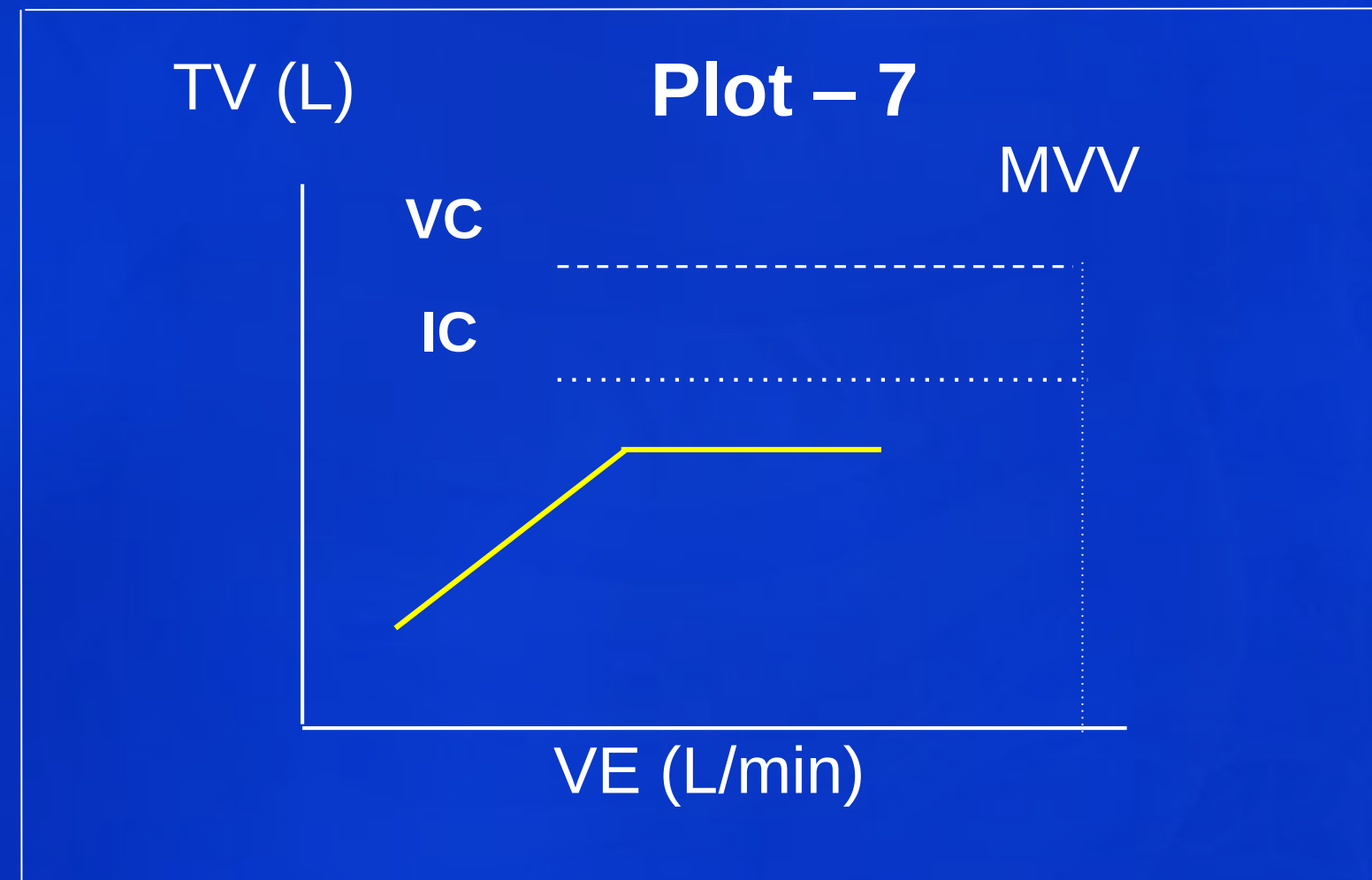
VAT dmv V-Slope Methode



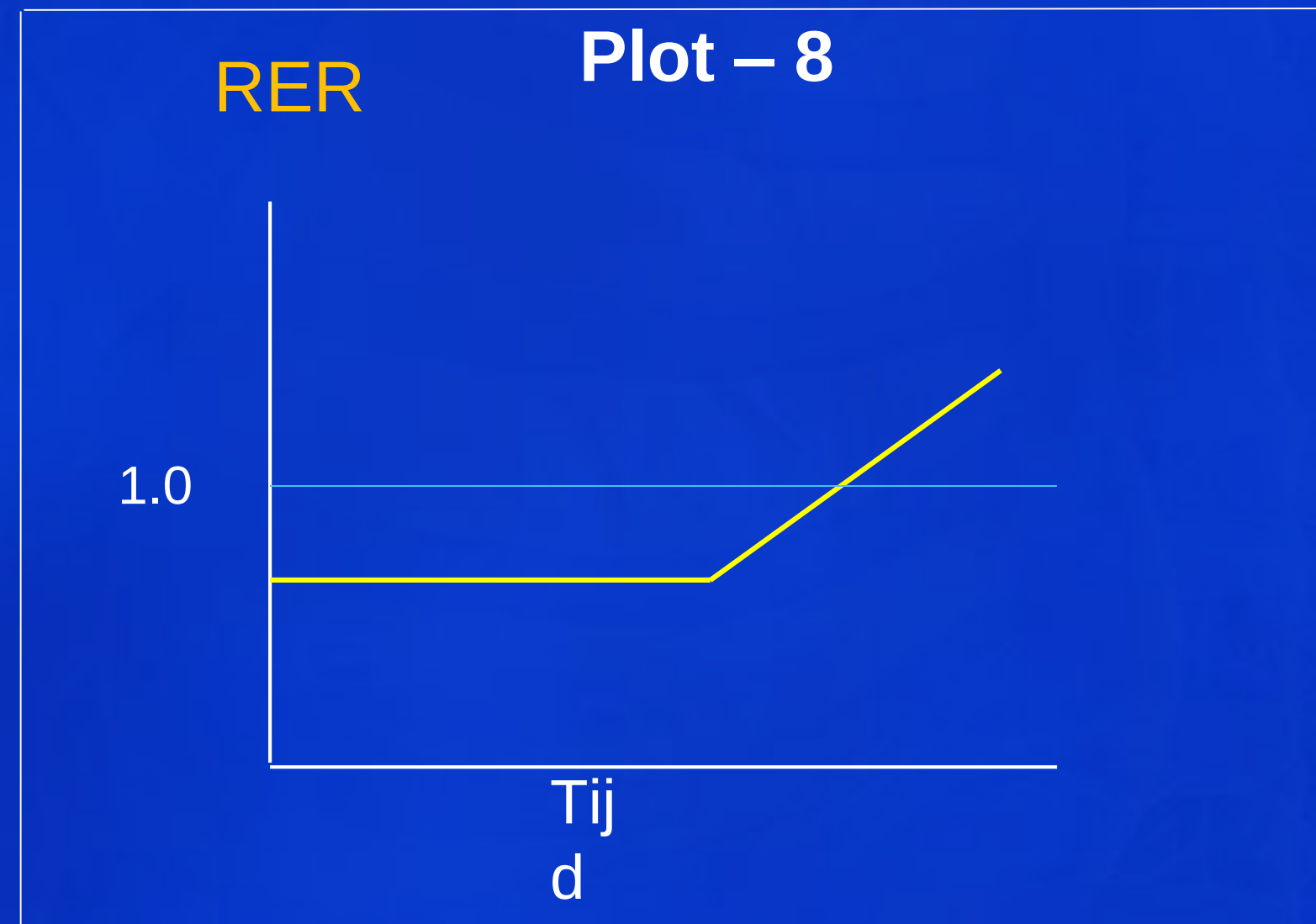
PLOT 6 – Ventilatore equivalent voor O₂ en CO₂ (VE/VO_2 & VE/VCO_2) vs. Tijd



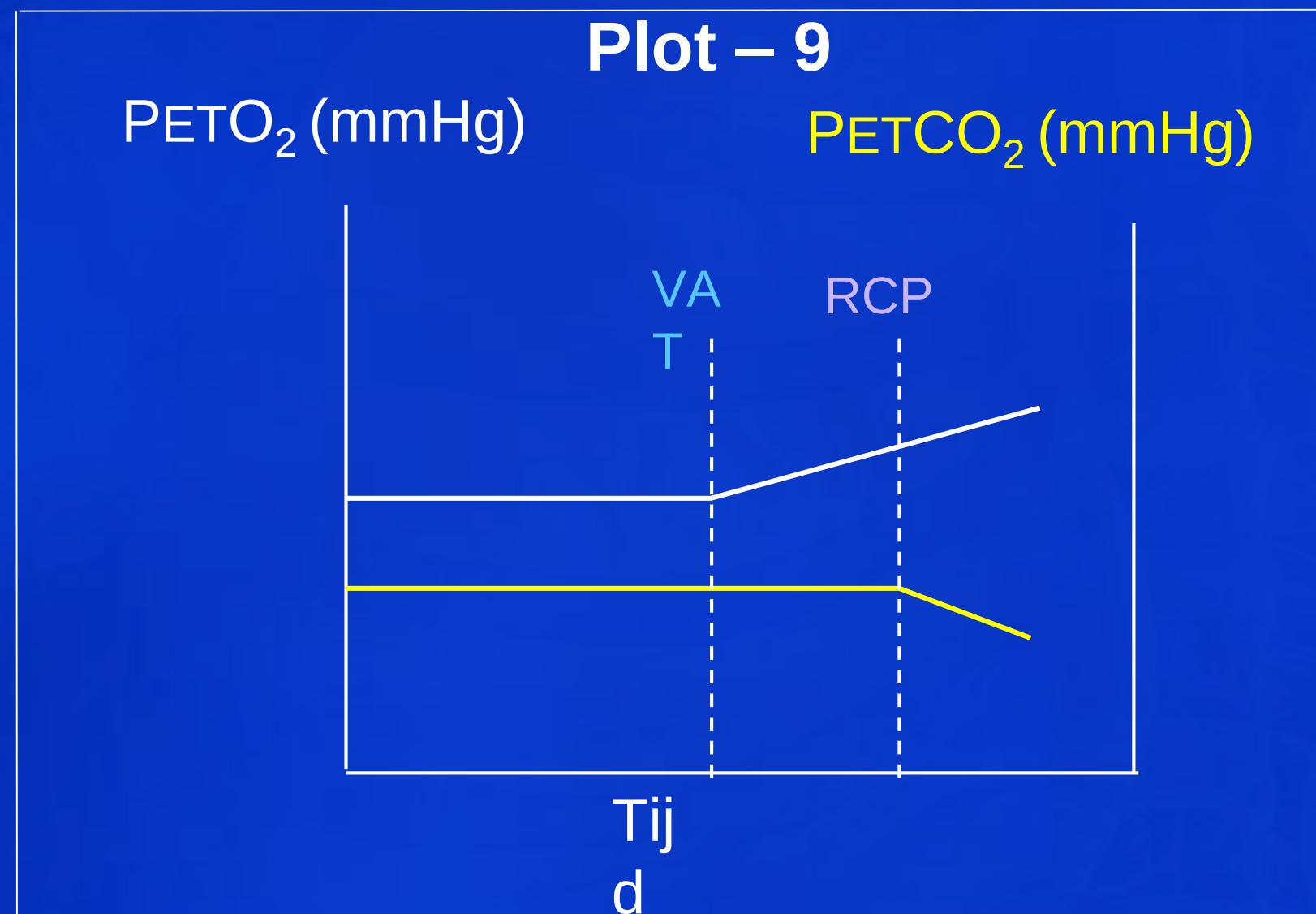
PLOT 7 – Teugvolume vs. VE



PLOT 8 – RER ($V\text{CO}_2/V\text{O}_2$)



PLOT 9- PETCO₂ and PETO₂



TAKE-HOME MESSAGES

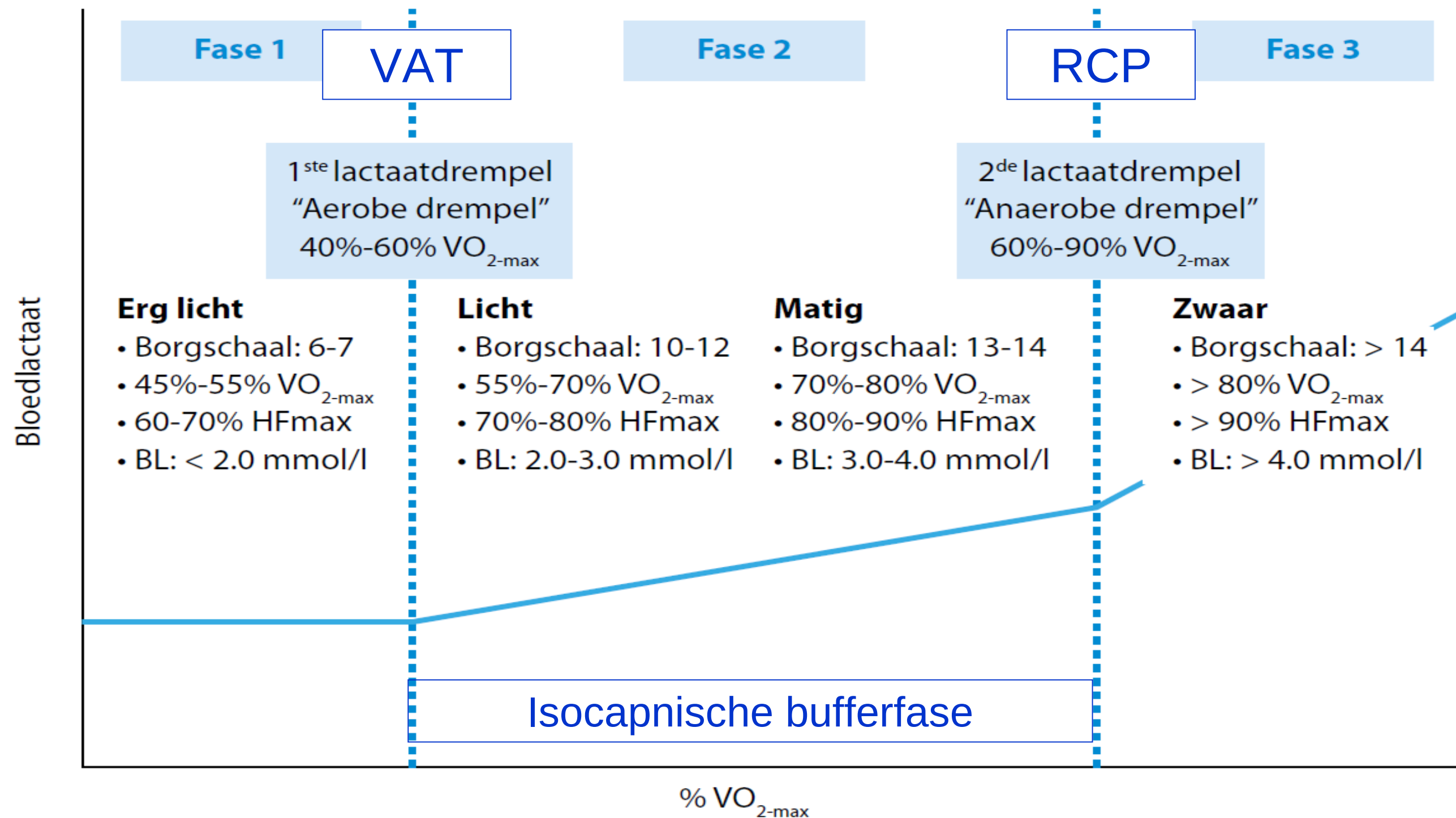
- Veel (CPET) parameters om naar te kijken
- Patroon herkenning
- Eerst beschrijven daarna concluderen
- 9 panel grafiek geeft overzicht
- Soms combinatie van parameters
- Systematische aanpak – 9 stappen



Training & CPET



Training : Drie Fasen Model



Figuur 2. Driefasenmodel van training gericht op het uithoudingsvermogen volgens Skinner en McLellan (1980).¹²

Het inspanningsniveau is gerelateerd aan het bloedlactaat (BL), het percentage van de maximale zuurstofopname (VO_{2max}), het percentage van de maximale hartfrequentie (HF_{max}) en de borgschaal als maat voor de ervaren inspanning.

Vraag 3: Welke trainingszone is hoofdzakelijk aeroob van aard?

A. Trainingszone 1?

A. Trainingszone 2?

A. Trainingszone 3?

A. Combinatie van bovengenoemde?



Trainingzones

Note about Recalculation of Training Zones for other Sports

Type of workload device: Bicycle Ergometer

Please make the following changes to get the specific HR for the according sports:

- +10 for running.
- + 5 for walking.
- 10 for swimming.



Intensity Zone	VO ₂ (%max)	Heart Rate (%max)	Lactate (mmol·L ⁻¹)	Duration	
1	45-65	55-75	0.8-1.5	1-6 h	} 'Zone 1'
2	66-80	75-85	1.5-2.5	1-3 h	
3	81-87	85-90	2.5-4	50-90 min	} 'Zone 2'
4	88-93	90-95	4-6	30-60 min	
5	94-100	95-100	6-10	15-30 min	} 'Zone 3'

Progressed Training:

- 30 min/day
- 5 dgn/week
- 12 wkn

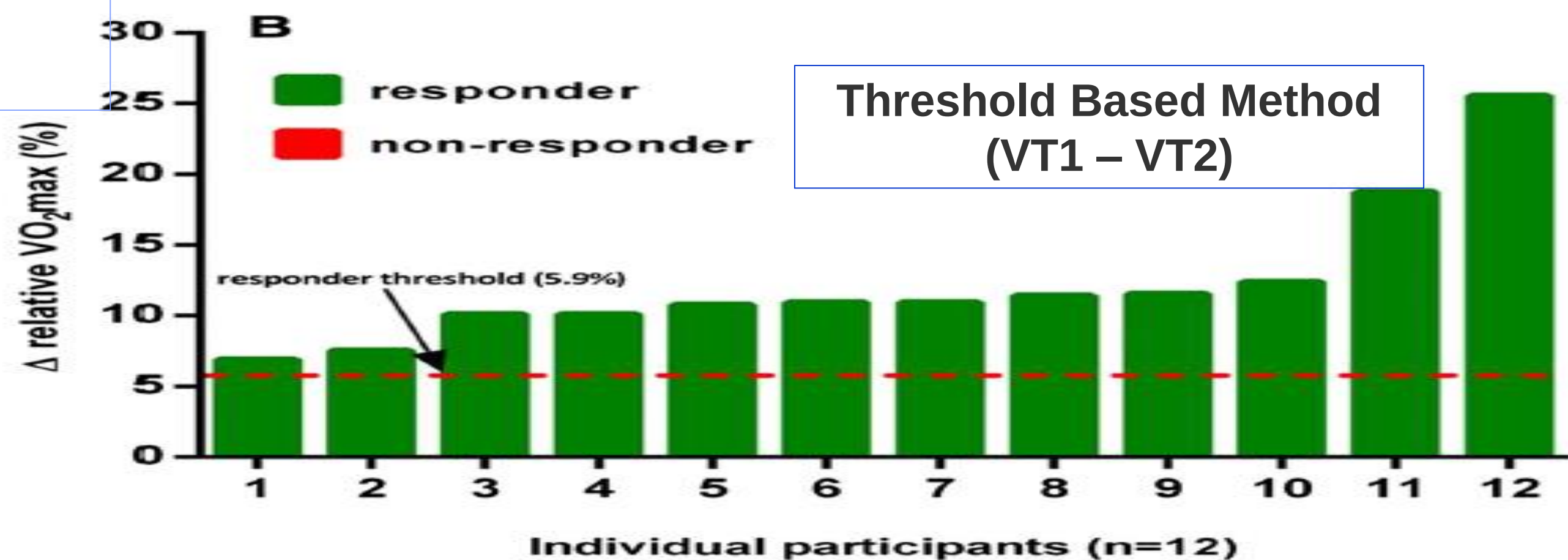
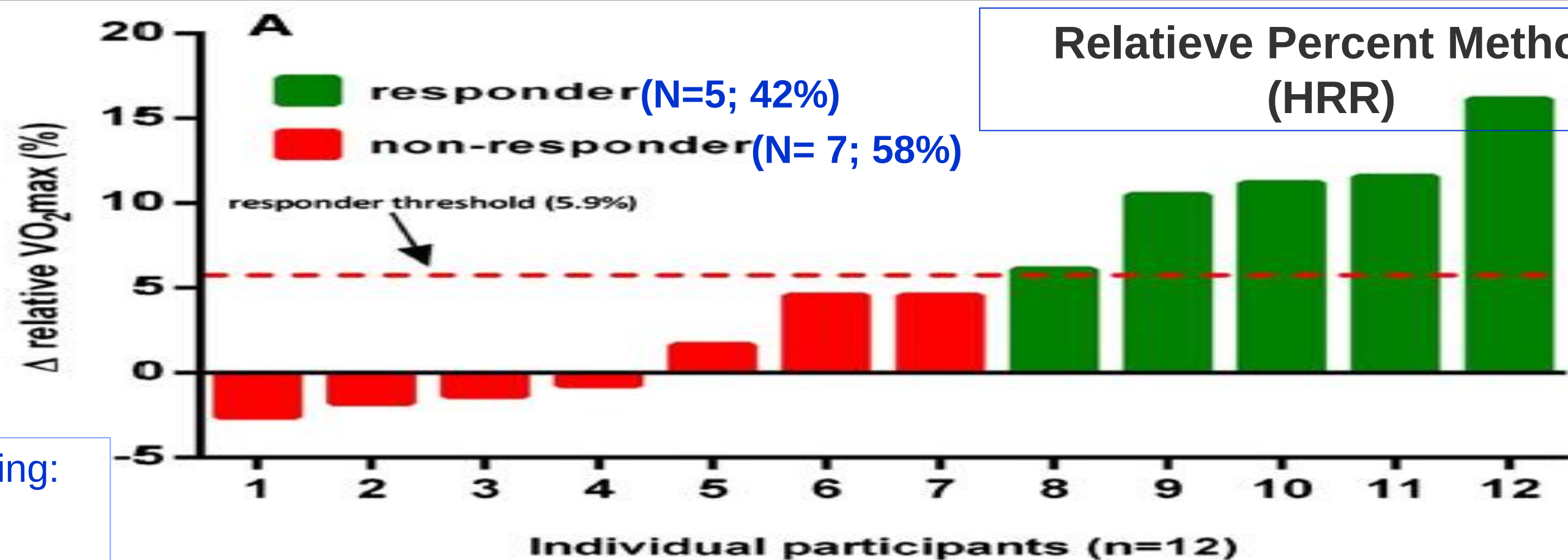
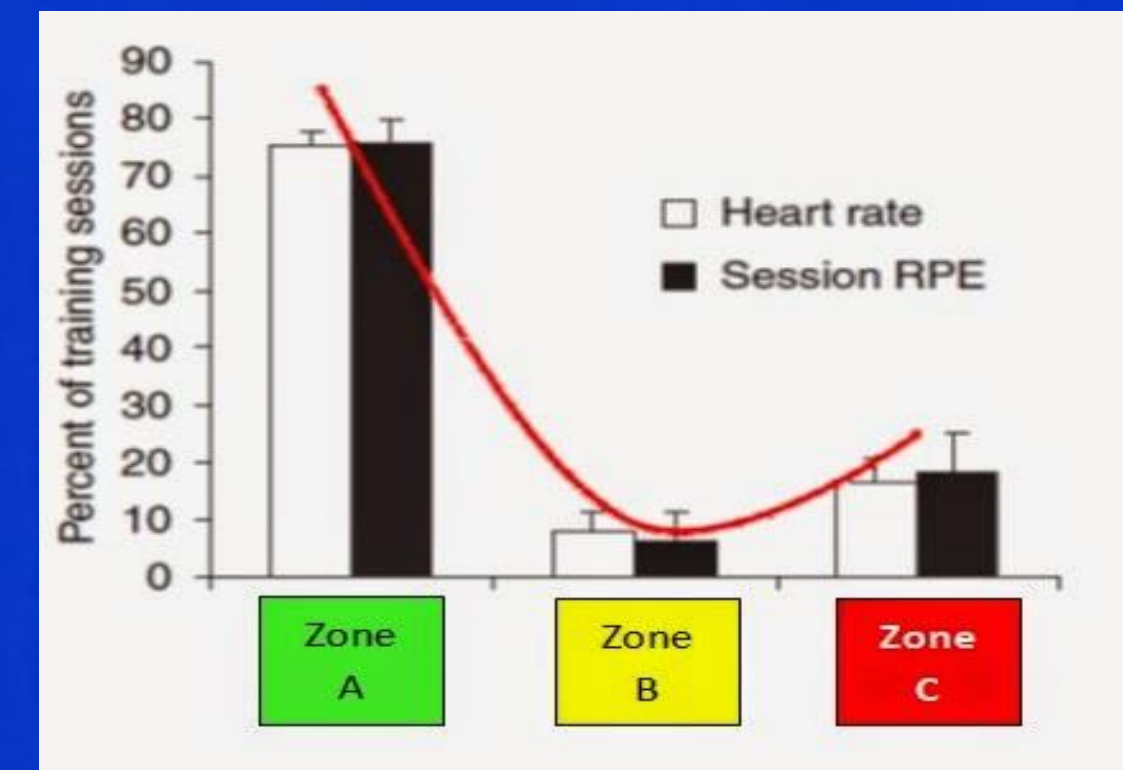
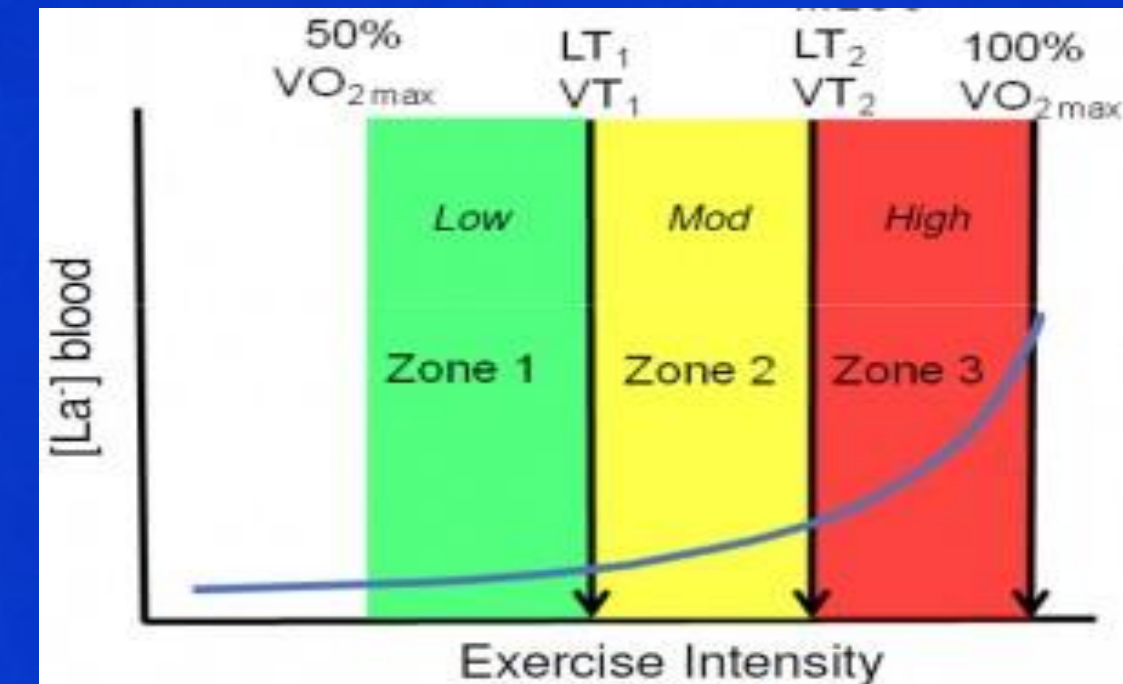
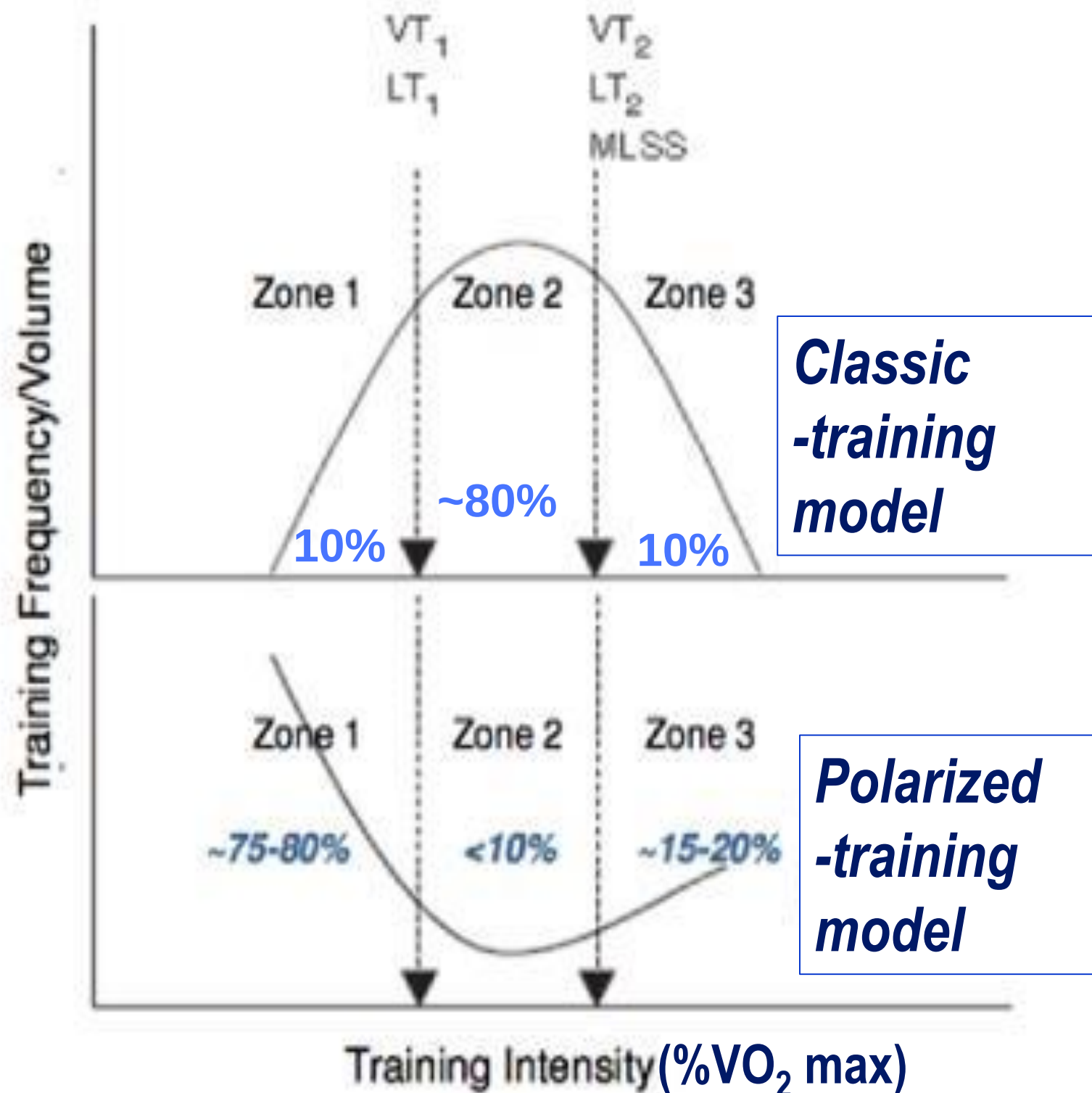


Fig. 2 Individual variability in relative $\text{VO}_{2\text{max}}$ response (% change) to exercise training in the HRR (A) and ACE-3ZM (B) groups

Polarized Trainingsmodel (80 – 20 Regel)



Training op basis van VAT en RCP

Thresholds		REG 91-112	BE1 112-169	BE2 169-177	DR 177-185	TR 185-190
Rest	36 b/min					
AT	169 b/min					
RC	185 b/min					
Max	190 b/min					
Level Description		Recovery Compensation	Basic Endurance 1	Basic Endurance 2	Developement Range	Top Range
Heartrate		91-112 b/min	112-169 b/min	169-177 b/min	177-185 b/min	185-190 b/min
Intensity		very low	low	moderate	high	very high
Performance and method		recovery continuous	submaximal continuous	intensive continuous	submaximal interval	intensive interval
Metabolism		aerobic	aerobic	aerobic/anaerobic	threshold	anaerobic
Predominant Supply		utilisation of fatty acids	utilisation of fatty acids	mixed metabolsim	aerobic glycolysis	lactacide glycolyse
Consumption		563 kcal/24h	1087 kcal/24h	1261 kcal/24h	1326 kcal/24h	1403 kcal/24h
Fatburning		281 kcal/24h	72 kcal/24h	5 kcal/24h	5 kcal/24h	5 kcal/24h

Take-Home Messages

- Trainingszones uit CPET data op te maken
- Bepaling VAT en RCP belangrijk
- Training op basis van zones effectiever dan op basis van % maximale hartfrequentie
- 80-20 regel (Polarized training)



Vragen?

