跨領域學習講座

結合穿戴式裝置與人工智慧應用於睡眠呼吸障礙

劉文德醫師

臺北醫學大學　睡眠研究中心 研發主任/呼吸治療學系 副教授

衛生福利部雙和醫院/臺北醫學大學附設醫院 胸腔內科/睡眠中心 主治醫師

e-mail: lion5835@gmail.com

北醫睡眠研究中心 Sleep Research Center

TAIPEI MEDICAL UNIVERSITY 臺北醫學大學 TAIPEI MEDICAL UNIVERSITY

Sleep Cycle alarm clock

View More by This Develope

By Northcube AB

Open iTunes to buy and download apps.

View in iTunes

This app is designed for both iPhone and iPad

Free

Category: Health & Fitness
Updated: 12 September 2016
Version: 5.3.1
Size: 79.2 MB
Languages: English, French, German, Italian, Japanese, Korean, Portuguese, Russian, Simplified Chinese, Spanish, Swedish, Traditional Chinese, Turkish
Developer: Northcube AB
© 2016 Northcube AB
Rated 4+

Compatibility: Requires iOS 8.0 or later. Compatible with iPhone, iPad, and iPod touch.

Customer Ratings

Current Version:
★★★★½ 80 Ratings

Description

Waking up made easy.

An intelligent alarm clock that analyzes your sleep and wakes you in the lightest sleep phase – the natural way to

Northcube AB Web Site ▸ Sleep Cycle alarm clock Support ▸ ...More

What's New in Version 5.3.1

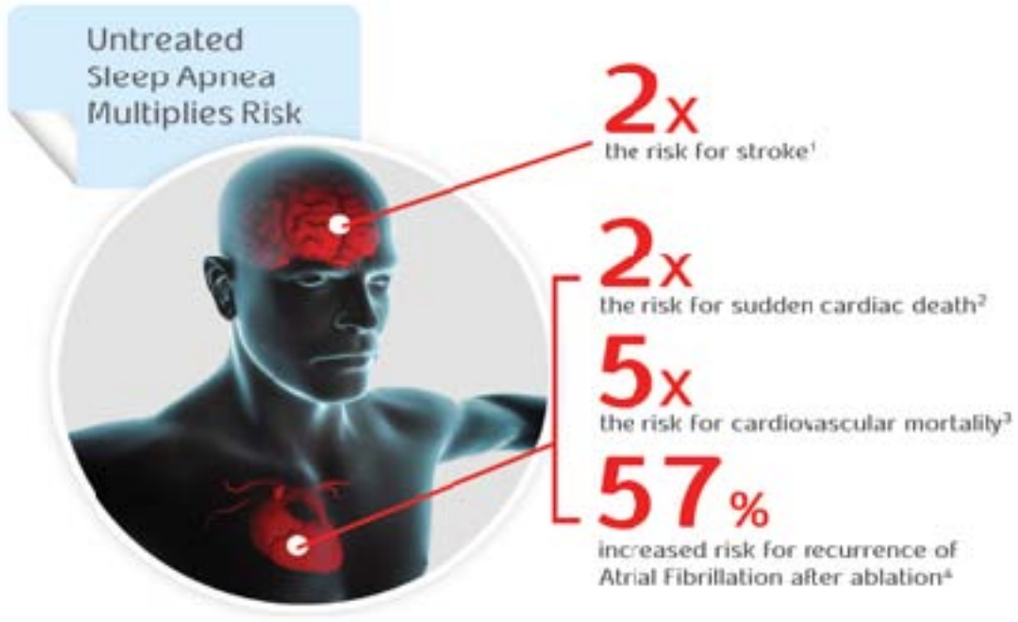
Added new languages: Russian, Turkish, Korean, Portuguese (Brazil) and Chinese (Tr.).
Minor bug fixes and improvements.

Screenshots

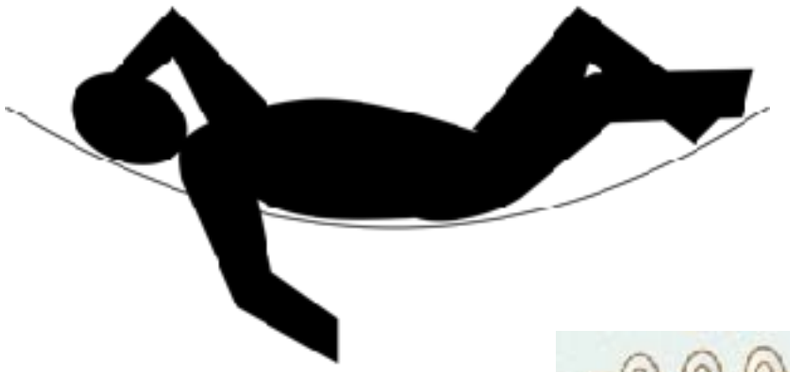
iPhone | iPad

面臨的問題

- 睡眠障礙問題：超過三成人口。
- 睡眠障礙問題：流行率**高**、併發症**嚴重**、危險因子及共病**多且複雜**
- 目前相關研究多侷限**「橫斷面」**分析：
  - 診斷技術複雜且不便
  - 診斷缺乏真正的黃金標準
  - 病患治療意願不高

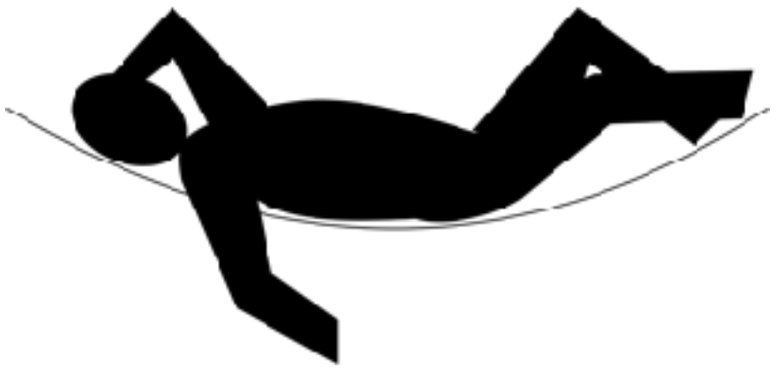


關於睡眠



我們真正在意的是？

關於睡眠



我們真正在意的是？

睡眠不足 → 併發症

工作表現 → 打鼾

情緒控制

最常見的睡眠疾病

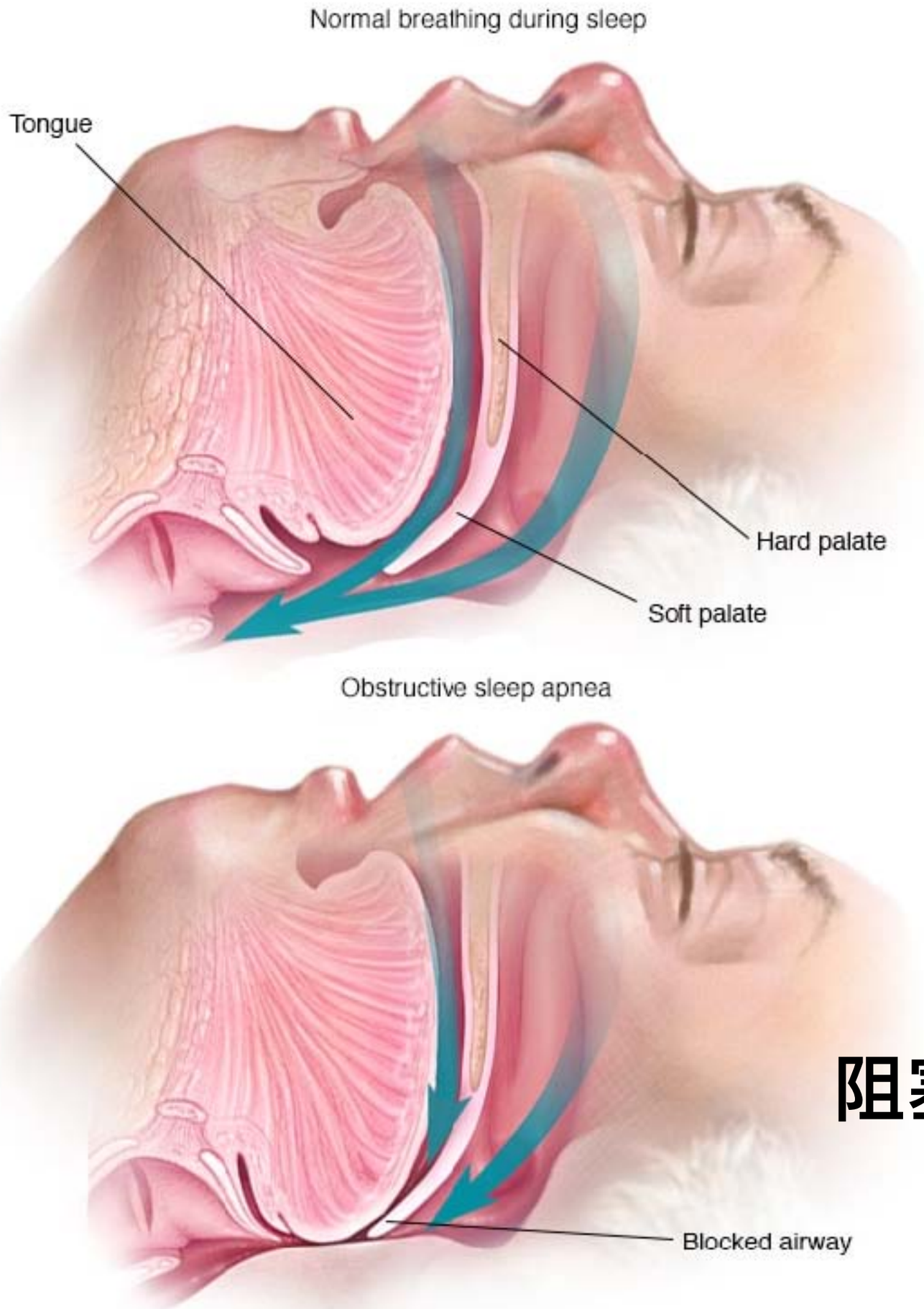
失眠

睡眠呼吸中止症

最常見的睡眠疾病

失眠

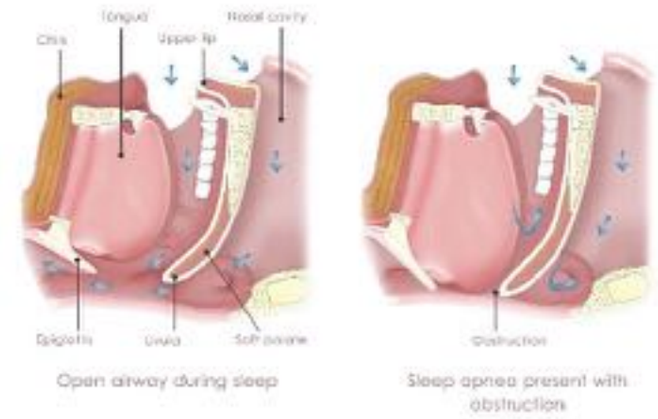
睡眠呼吸中止症



阻塞型睡眠呼吸中止症

睡眠時發生的不正常呼吸
Sleep related breathing disorders

- Abnormal respiratory pattern:
  - Apneas
  - Hypopneas
  - Respiratory effort related arousals
- Abnormal reduction in gas exchange:
  - Hypoventilation



During Sleep

Sleep apnea
Obstructive sleep apnea (OSA)
Central sleep apnea (CSA)
Mixed sleep apnea (MSA)

The Fundamentals of Sleep and Obstructive Sleep Apnea

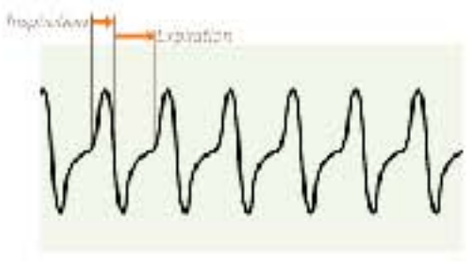
Event Type	Normal Breathing	Flow Limitation	Obstructive Hypopnea	Obstructive Apnea
	Breaths are characterized by a semi-sinusoidal wave-like pattern. Transitions from inspiration to expiration, and vice versa, are rounded and smooth.	The rounded inspiratory portion of the breath starts to flatten.	A reduction in airflow of > 50% of baseline with a 3% desaturation **OR** a reduction in airflow of < 30% with a 4% desaturation **AND** lasting for at least 10 seconds.*	A reduction in airflow of > 90% of baseline lasting for at least 10 seconds.*

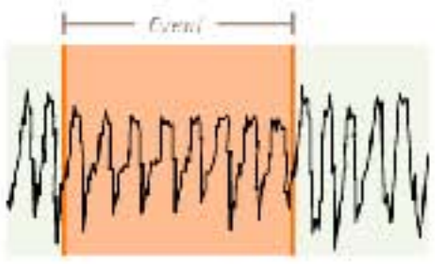
Airway Cross-section

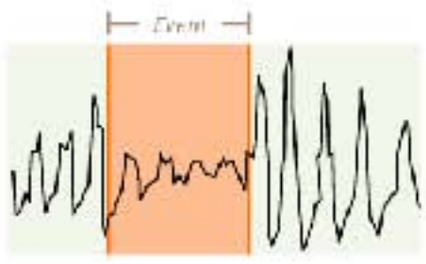
Flow Through Airway	No obstruction	Partially obstructed airway	Increasingly obstructed airway	Completely obstructed airway

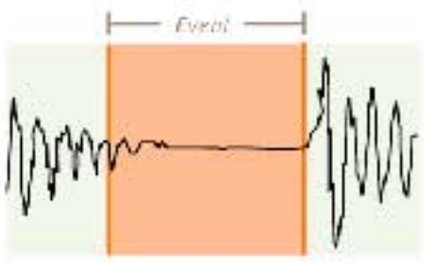
Inspiratory Flow Shape	Semi-sinusoidal – unobstructed flow	Flattening & reduced flow	Flattening & *further* reduced flow	Flat – minimal or zero flow

Flow Tracing





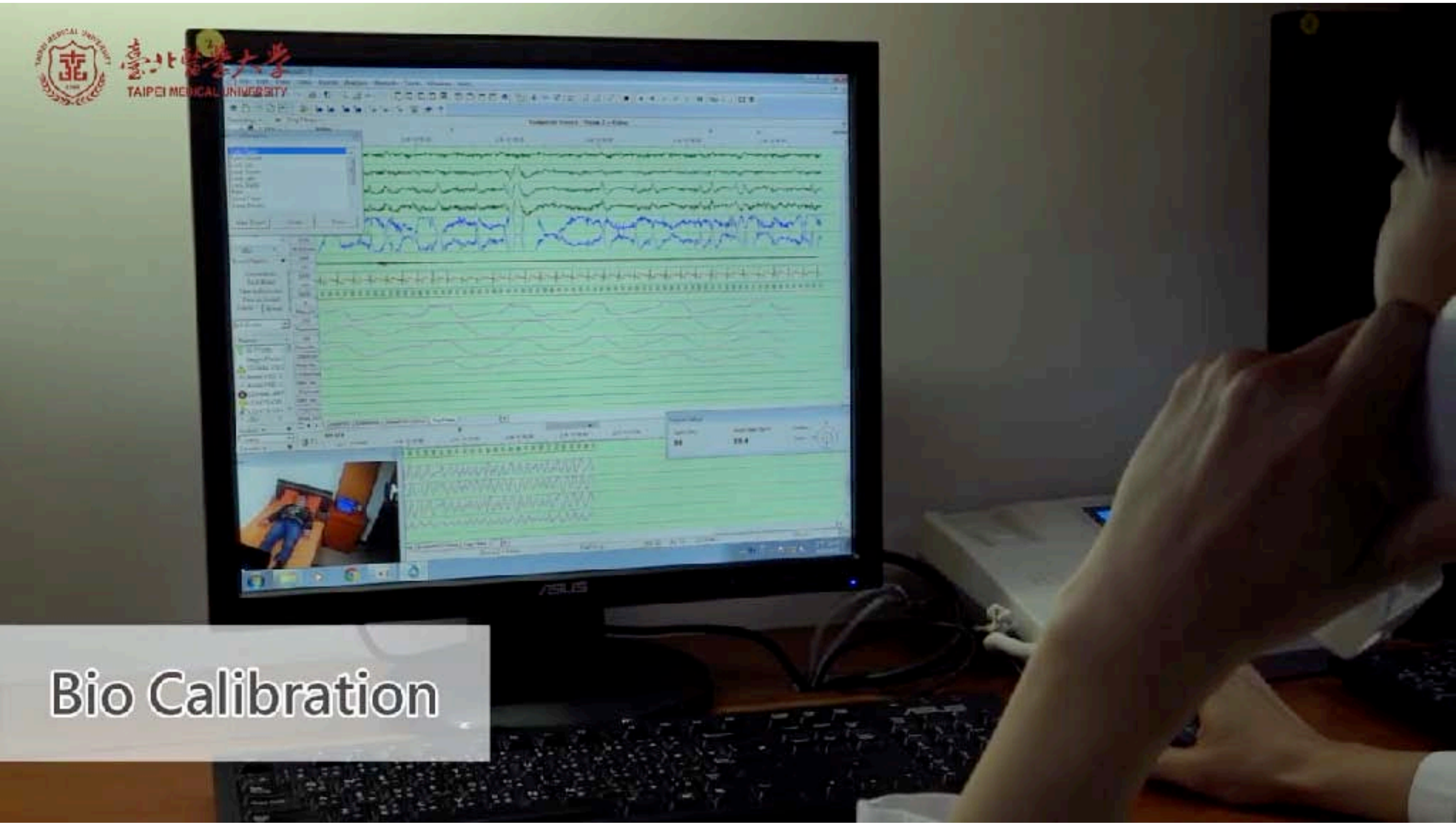




正常呼吸 **呼吸費力** **呼吸不足** **停止呼吸**

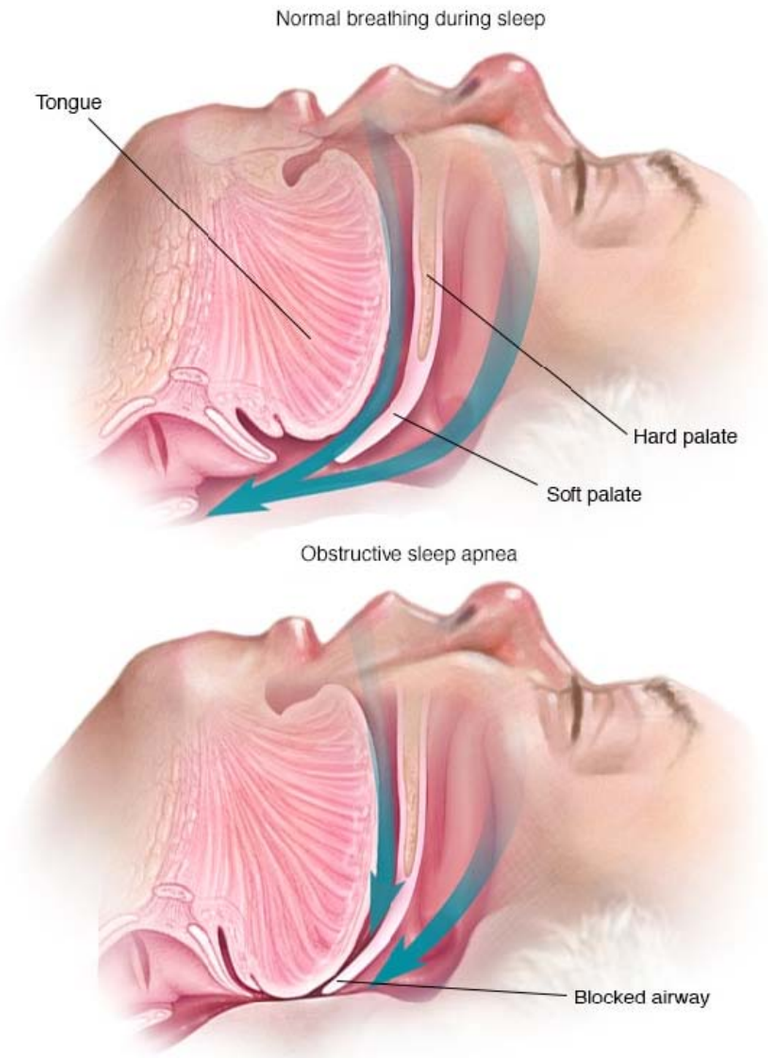
睡眠多項性生理檢查

Polysomnography




腹部呼吸綁帶

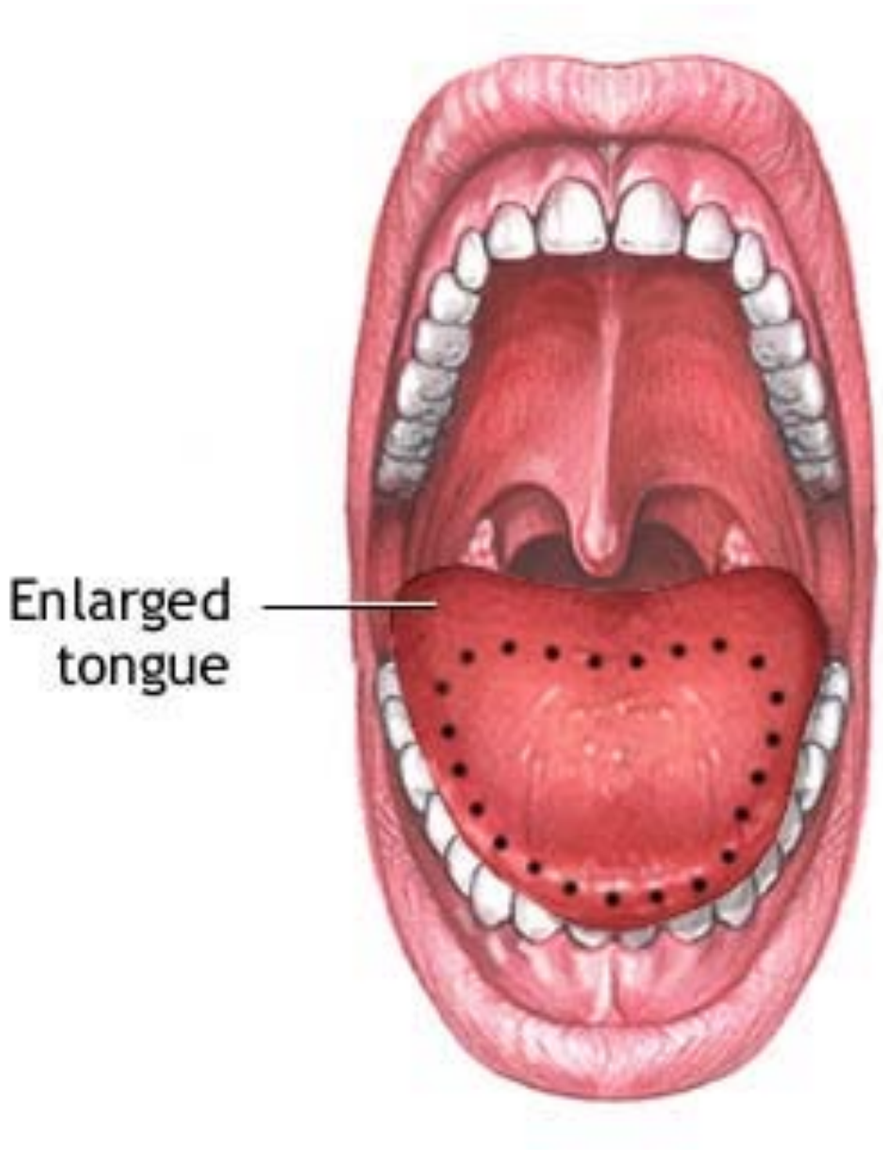
造成
阻塞型睡眠呼吸中止症
的原因？



Retrognathia

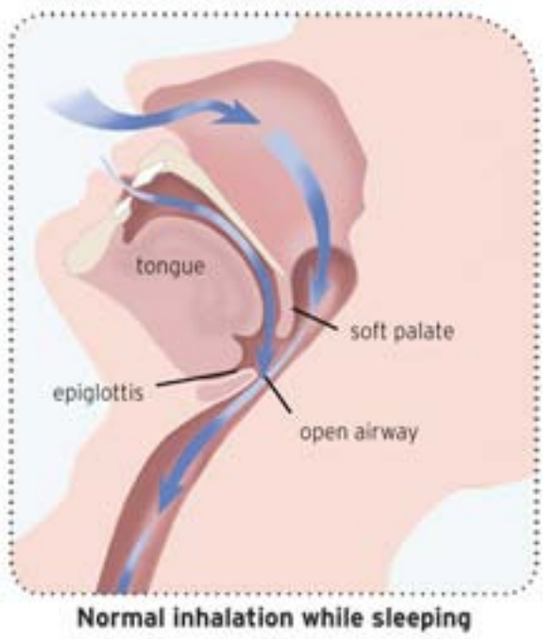
- *More **retrograde** or **posteriorly** positioned tongue*
- *Easier for the tongue to **fall back** and **block** the oropharynx (when pharyngeal muscles **relax**)*

Macroglossia

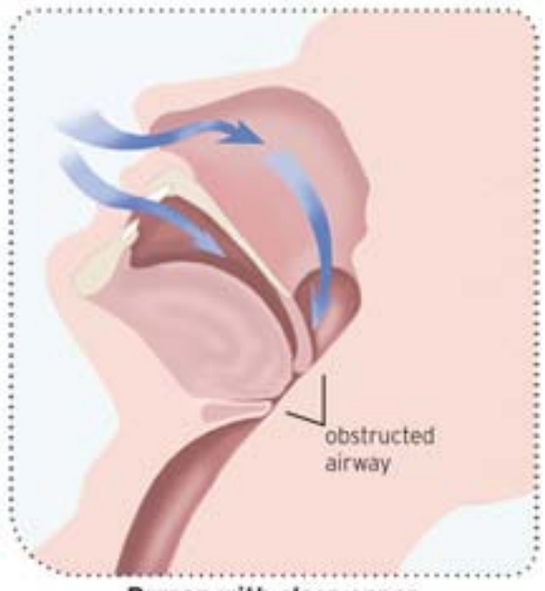


- *Down syndrome*
- *Hypothyroidism*
- *Acromegaly*

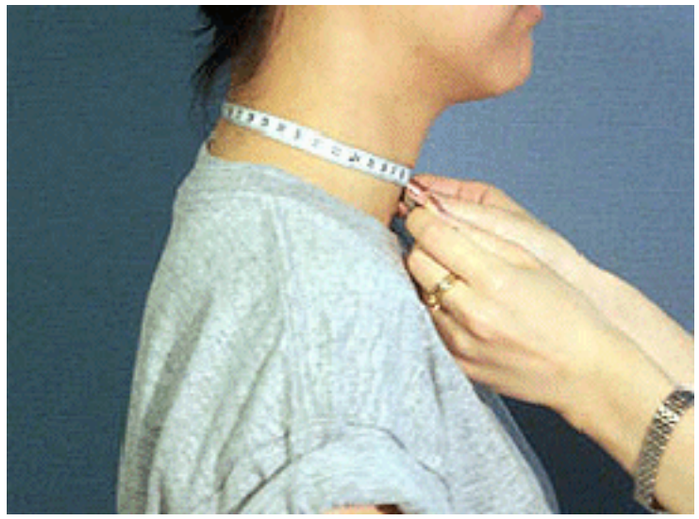
Neck circumference



Normal inhalation while sleeping



Person with sleep apnea



- *Greater than*
  - ***17 inches** in men*
  - ***16 inches** in women*

Highly correlated with obstructive sleep apnea

Effects of Nasal Cycling on Sleep-Disordered Breathing

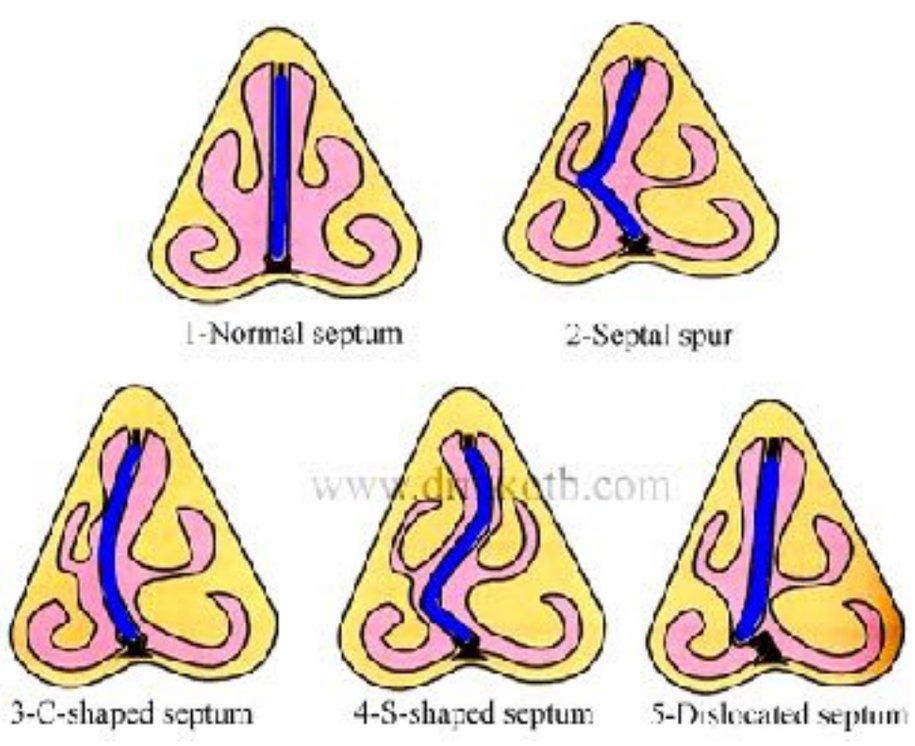
Nasal cycling :

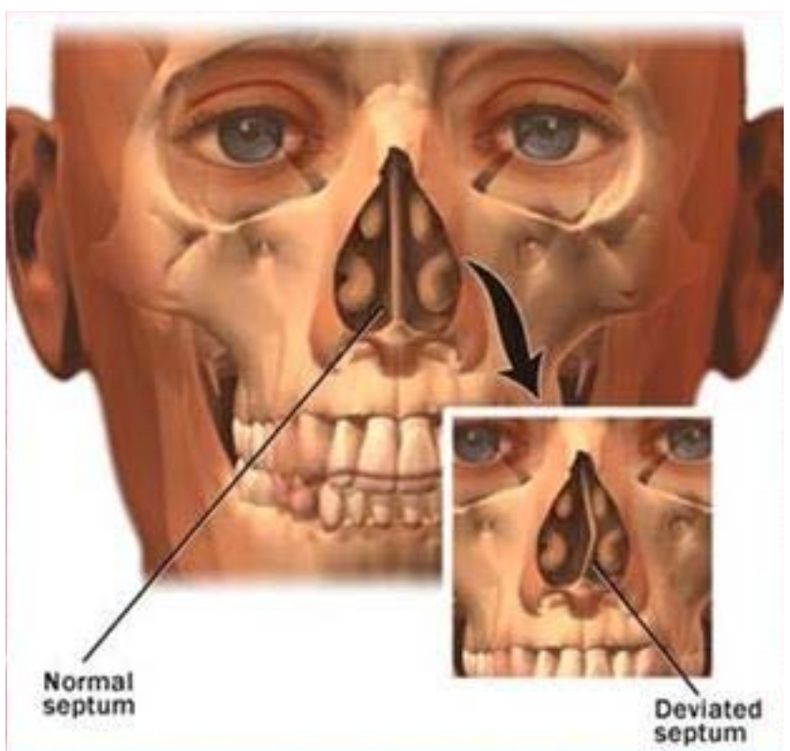
Alternation of the degree of congestion between nares

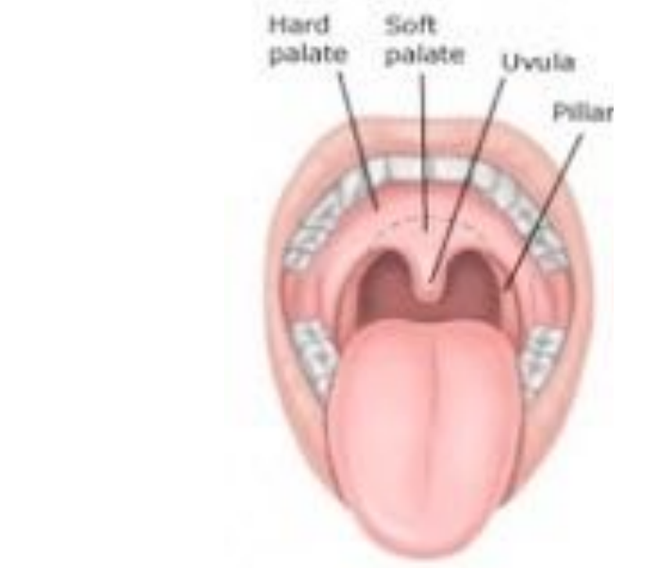
Autonomic response originate from the hypothalamus

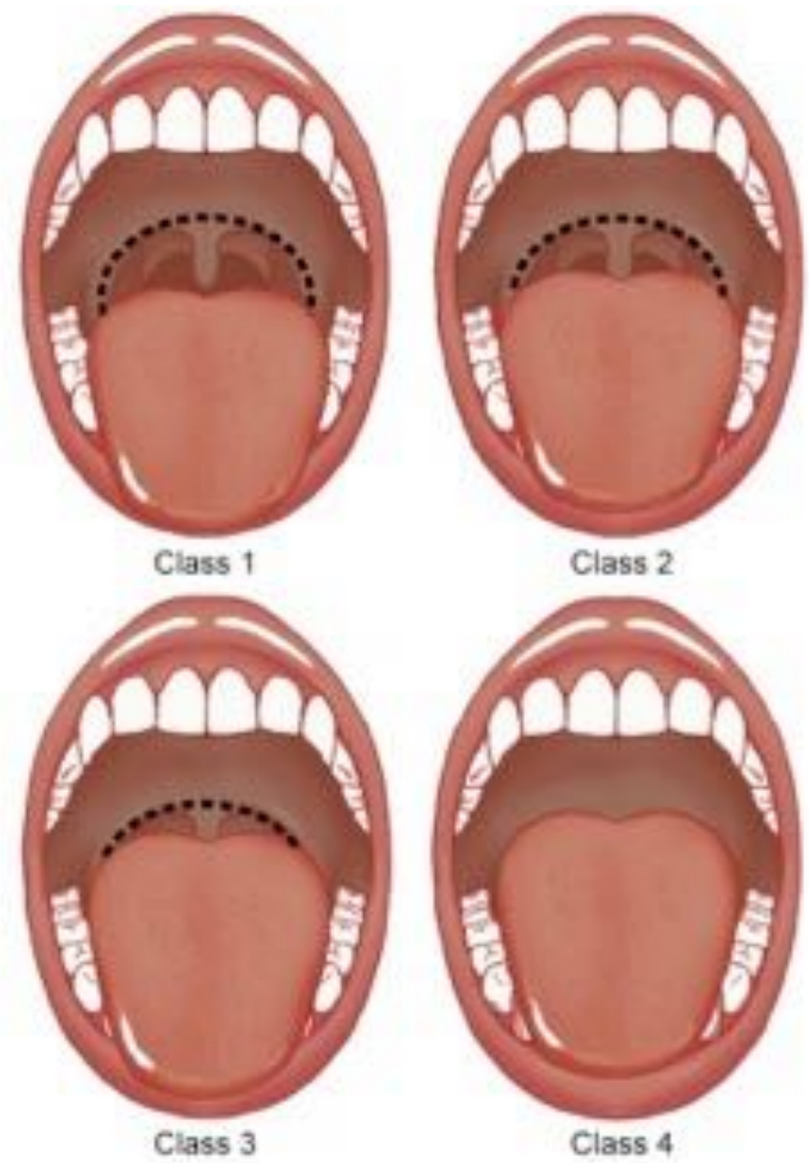
Normal event throughout the day and during the sleep

One side of nasal cavity mucosa becomes more swollen → diminished airflow through the obstructed naris









Correlation with obstructive sleep apnea

(1) Nasal septum abnormalities

(2) Open space in the oropharynx

-- Tongue, soft palate, hard palate, uvula, tonsils

(3) Mandible : retrognathia

(4) Tongue size : macroglossia

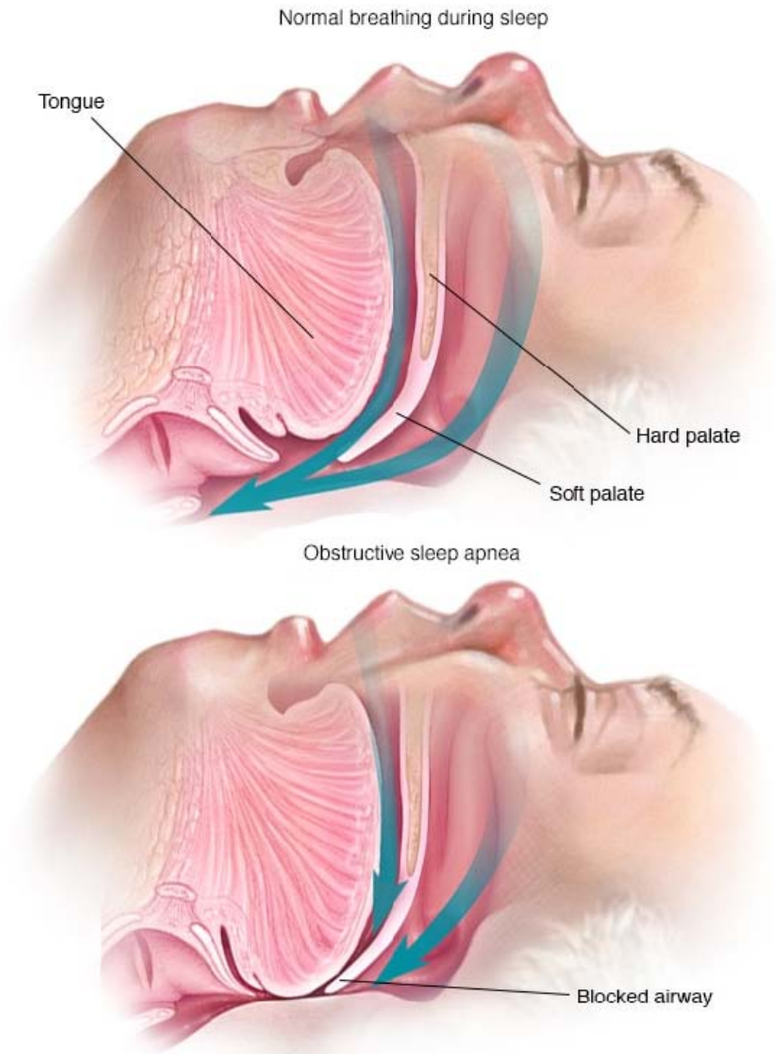
(5) Neck circumference: shorten or widen

Mallampati Score

Class 1	Normal, all five structures visible
Class 2	All five structures identified, but only the upper portions of the tonsils and uvula visible
Class 3	Only the tongue, the soft and hart palate and the base of uvula to be seen
Class 4	Only the hard palate and tongue to be seen

阻塞型睡眠呼吸中止症

會有哪些症狀？



阻塞型睡眠呼吸中止症的合併症狀

夜間多尿

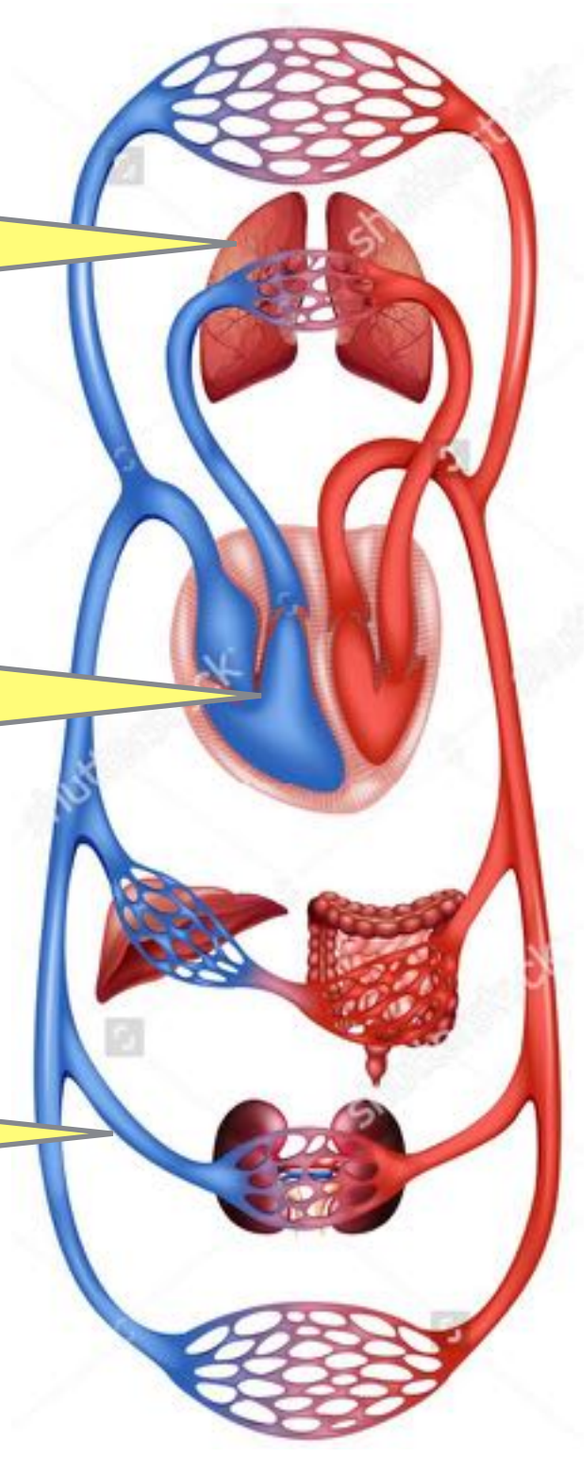
- 喝太多水？
- 膀胱功能異常？
- 腎功能不好？
- 攝護腺肥大？

阻塞型睡眠呼吸中止症的合併症狀

呼吸暫停：
缺氧導致
肺臟血管收縮

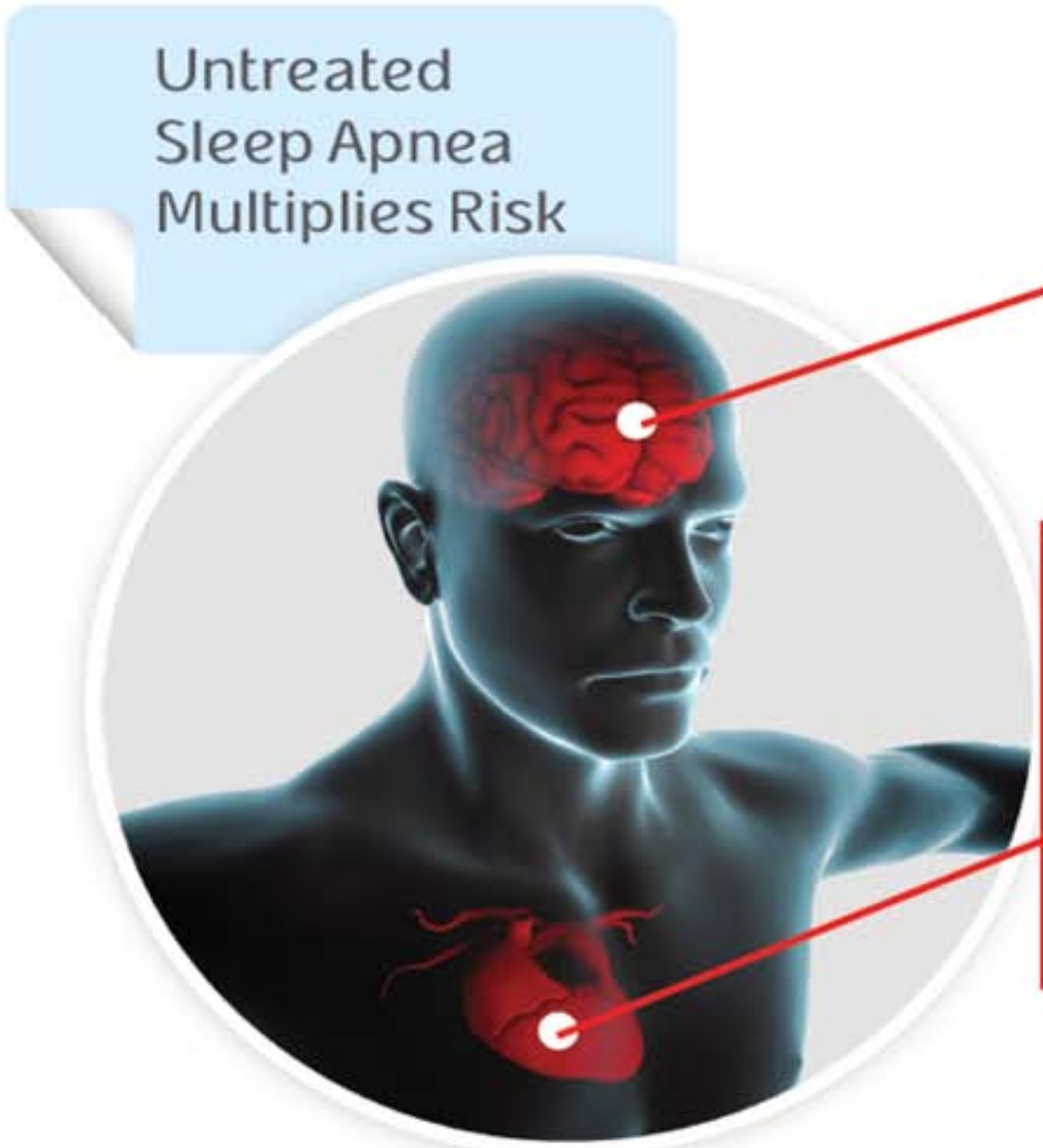
右心壓力
與體積增加：
產生心房利納素

用力吸氣：
增加回流
心臟的血流量



夜間多尿

Sleep Apnea Syndrome with Cardiovascular/Cerebrovascular Risks



2x the risk for stroke[1]

2x the risk for sudden cardiac death[2]

5x the risk for cardiovascular mortality[3]

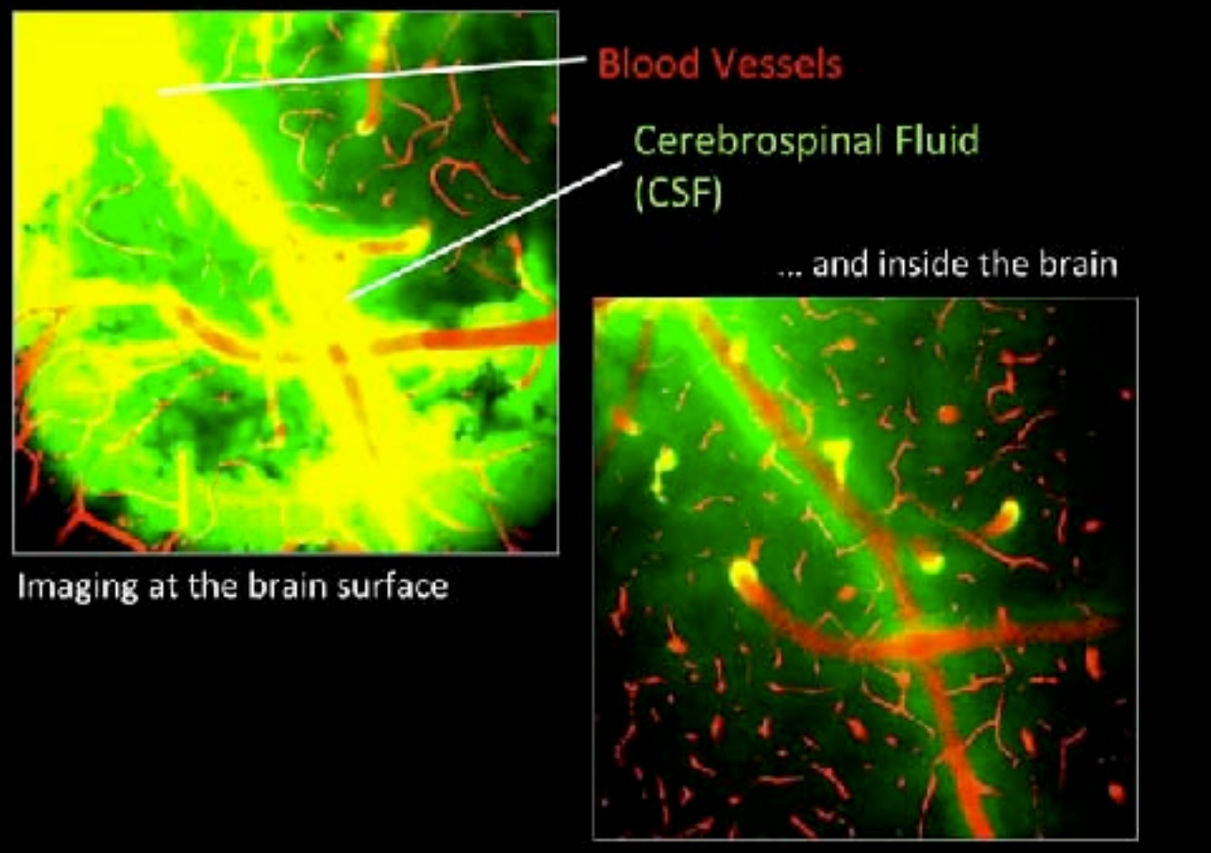
57% increased risk for recurrence of Atrial Fibrillation after ablation[4]

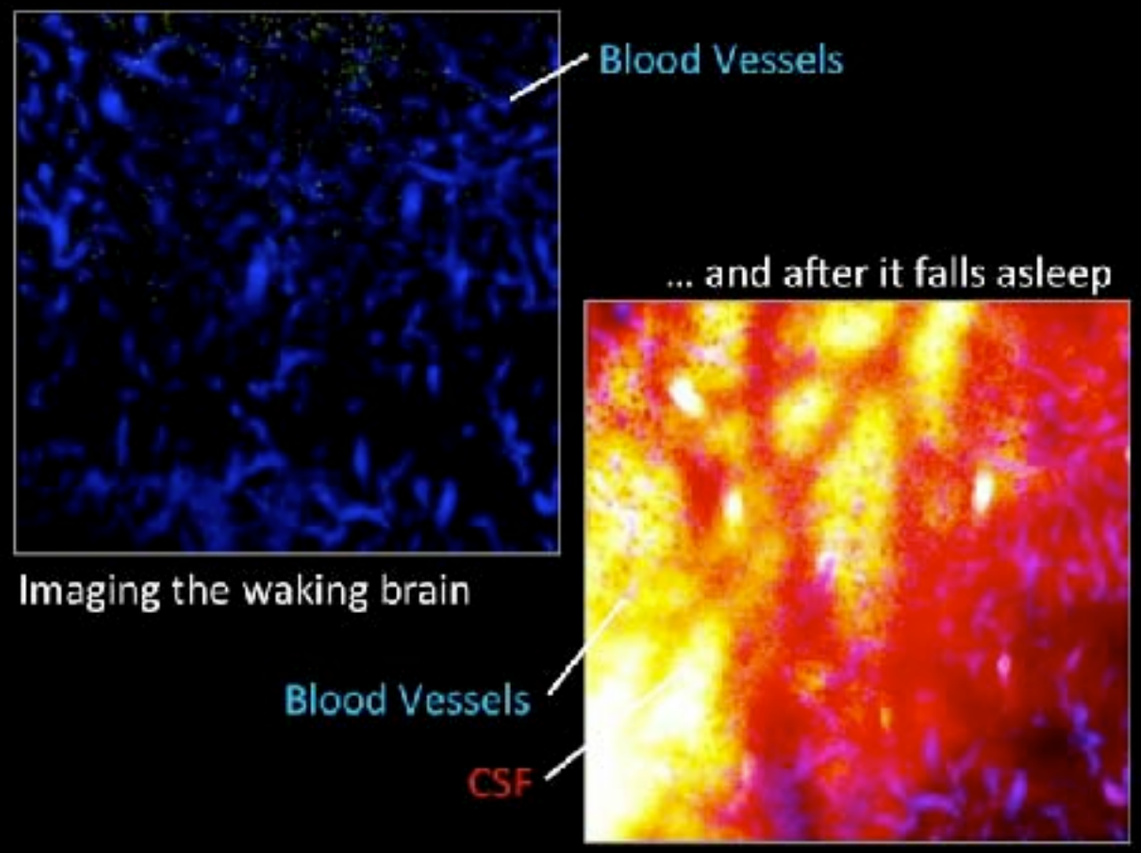
Sources:

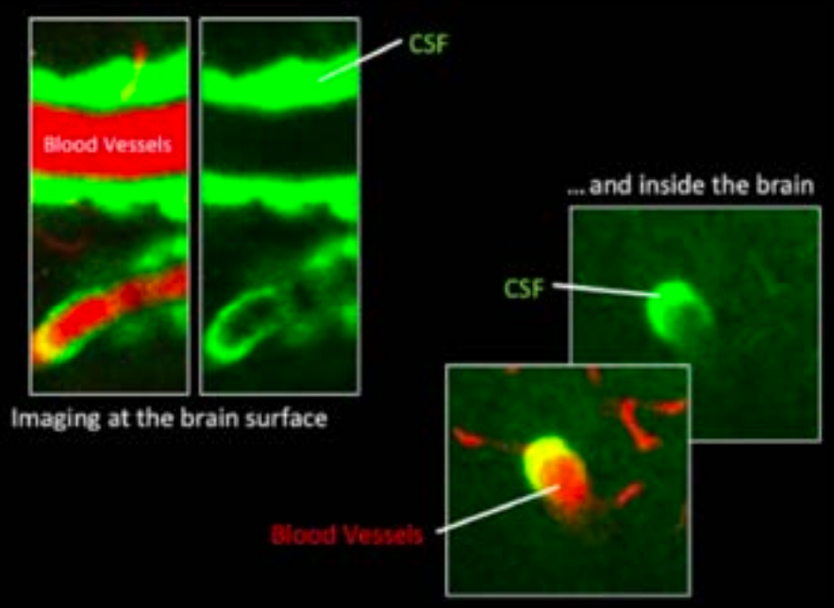
1) Redline et al, The Sleep Heart Health Study. Am J Res and Crit Care Med 2010;
2) Gami et al, J Am Coll Cardiol 2013:
3) Young et al, J Sleep 2008;
4) Li et al, Europace 2014

Sleep vs. **Cognitive** function

Sleep Drives Metabolite Clearance from the Adult Brain







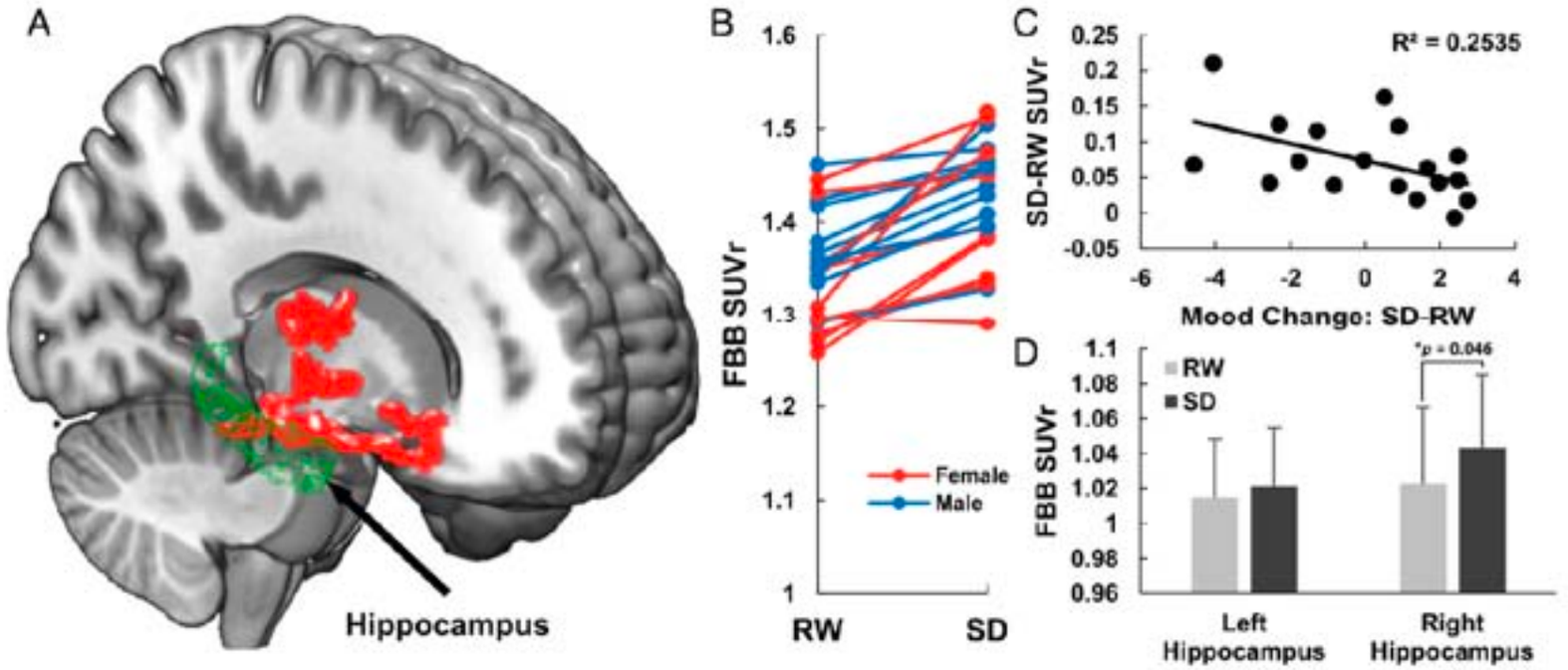
In live mice, we show that natural sleep or anesthesia are associated with a **60% increase in the interstitial space**, resulting in a striking **increase in convective exchange** of cerebrospinal fluid with interstitial fluid.

In turn, convective fluxes of interstitial fluid increased the rate of **amyloid-beta clearance during sleep.**

Science. 2013 Oct 18;342(6156):373-7

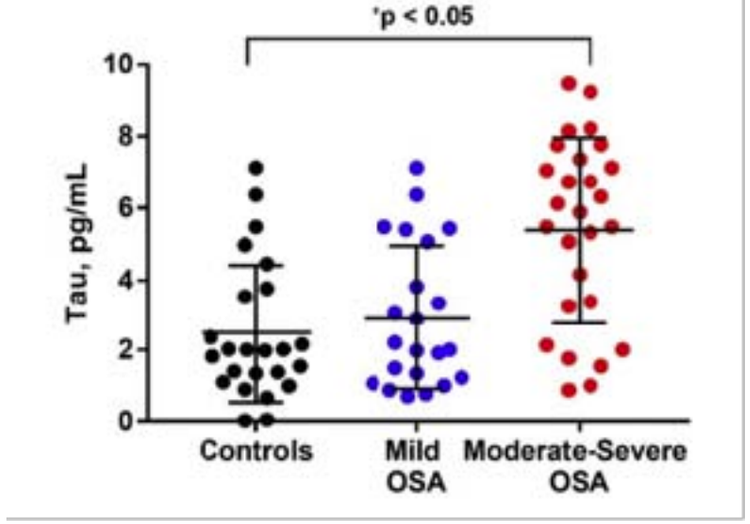
β-Amyloid accumulation in the human brain after one night of sleep deprivation

Proc Natl Acad Sci U S A. 2018 Apr 24;115(17):4483-4488.

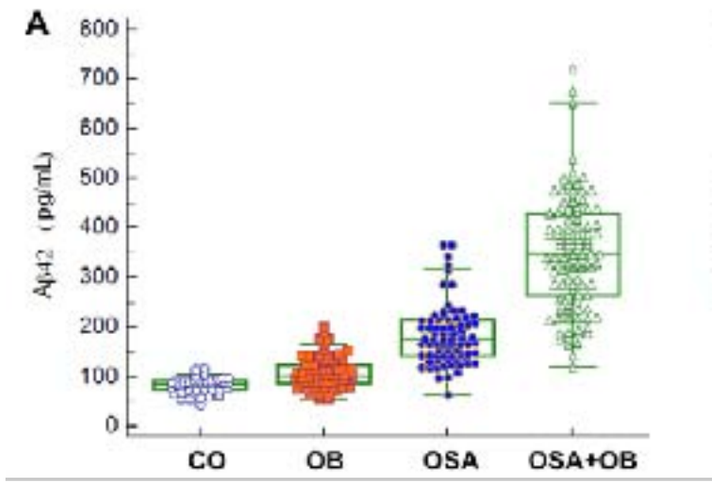


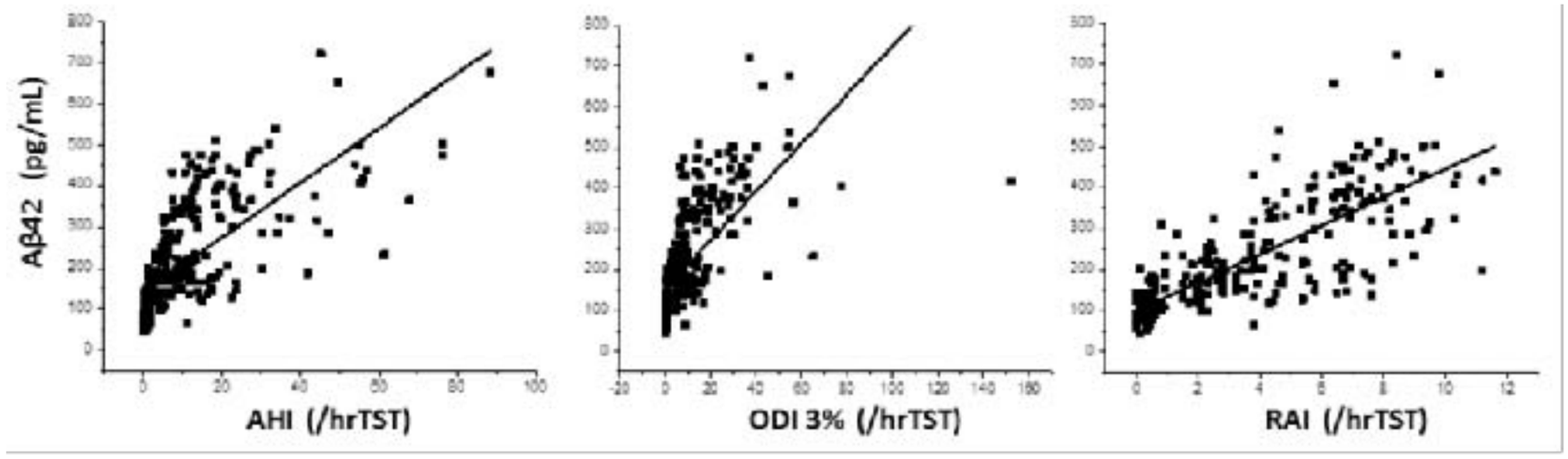
Elevated tau concentrations in adults with OSA

Sleep Med. 2018 Mar;43:71-76.



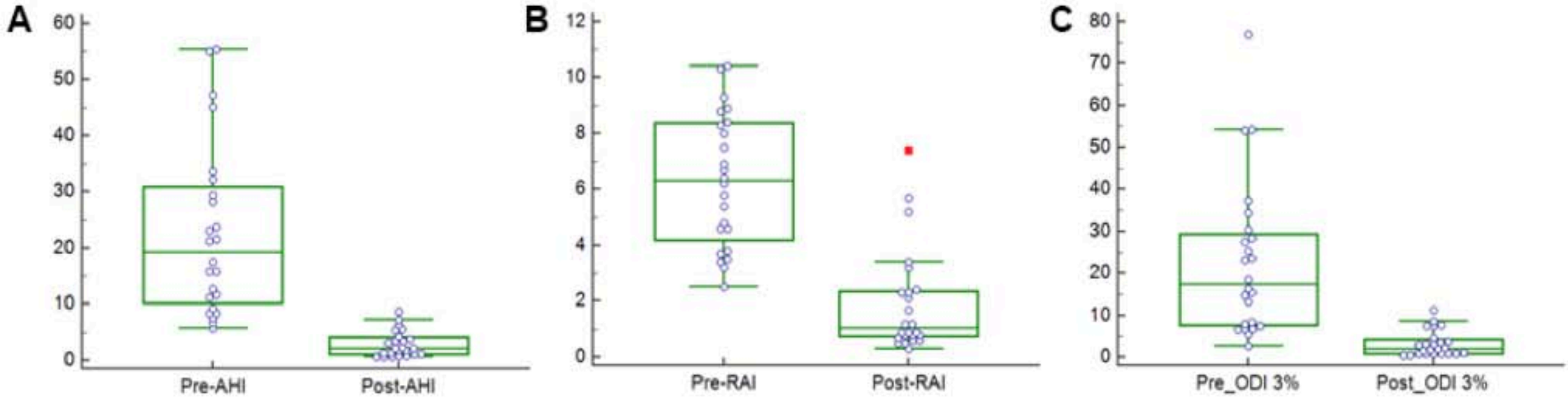
Biomarkers of Alzheimer Disease in Children with Obstructive Sleep Apnea: Effect of Adenotonsillectomy

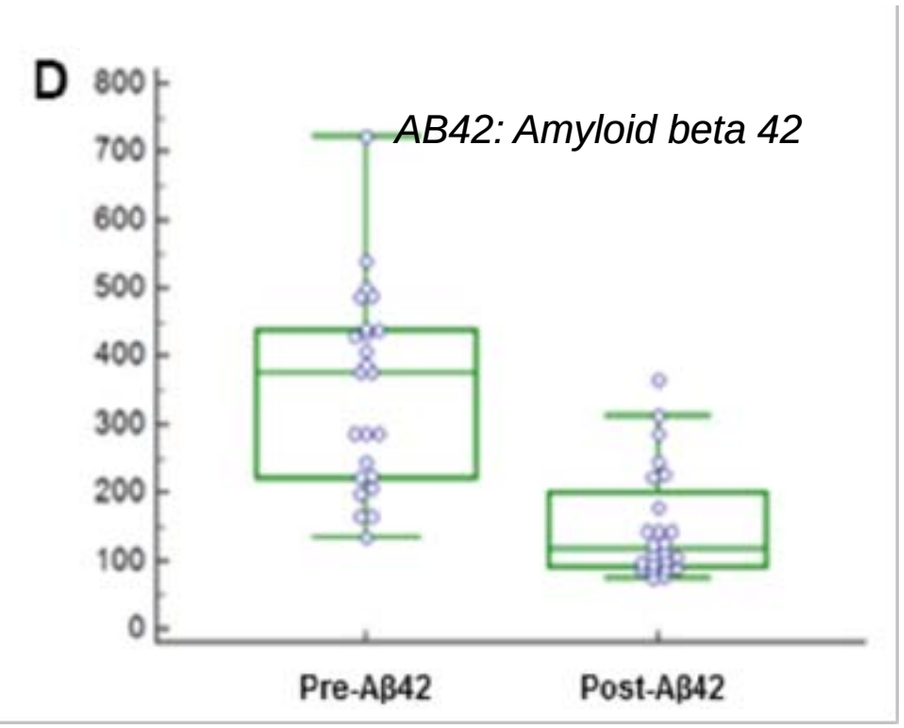




Sleep. 2016 Jun 1;39(6):1225-32.

Biomarkers of Alzheimer Disease in Children with Obstructive Sleep Apnea: Effect of Adenotonsillectomy



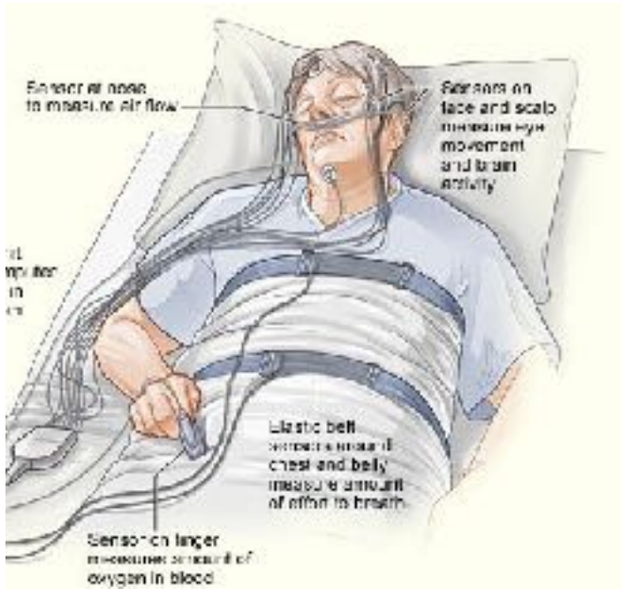


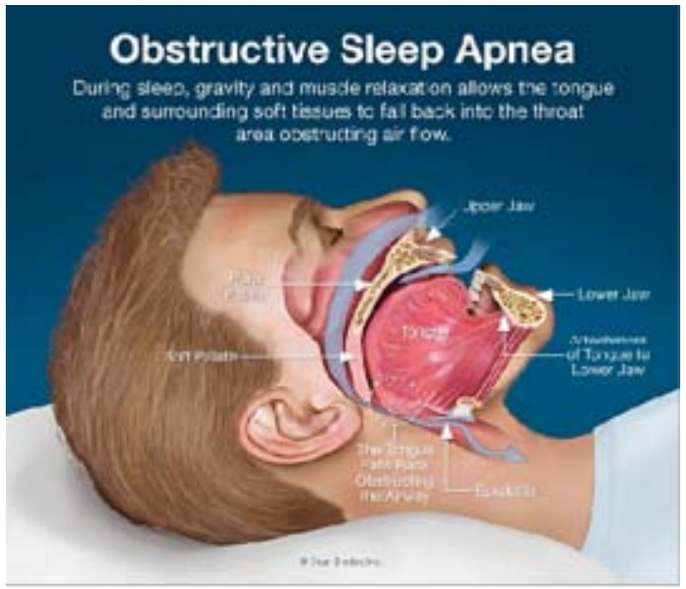
Treatment of OSA with **adenotonsillectomy** resulted in significant **Aβ42 reductions**

CO: control, OB: obesity, OSA: obstructive sleep apnea

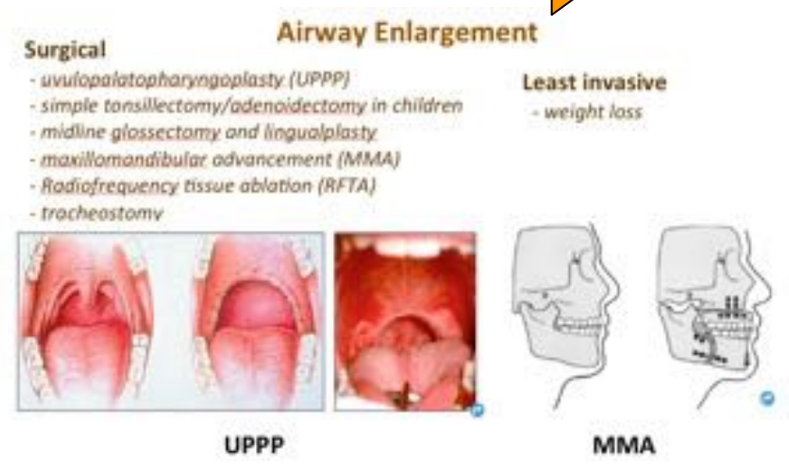
Sleep. 2016 Jun 1;39(6):1225-32.

阻塞型睡眠呼吸中止症





診斷 **生活習慣 + 病情追蹤**



睡眠檢查、呼吸器、手術治療、牙套等，還有哪些可以做的？

睡眠障礙
病患/亞健康者
相關併發症

主觀訊息
問卷
睡眠品質
睡眠程度
咳嗽、夜尿、打鼾
他人觀察
相關症狀/打鼾
胃食道逆流、焦慮
全身疲痛、記憶/專注力

客觀訊息
Anthropometric measure
檢查結果
睡眠檢查 (Lab/Home)
Biomarkers/Image test
Cardio /Neuro
穿戴量化數據
Activity/Gait/Respiration
HRV/Voice/Face

環境因素
空氣品質/氣象
PM2.5/NO2 (易感受族群)
CO2 (呼吸模式改變)
OSA嚴重度
季節變化/近身溫度
個人空汙監測
隨身空汙 (PM2.5/CO2/VPOC), GPS location

減少相關變項

增加相關項目
或新增變項

影響因子

模型預測

生活型態
(就寢)時間安排
飲食習慣
體重變化
運動習慣

精神情緒
人際關係
工作壓力
經濟壓力
挫折調適

疾病相關
睡眠呼吸中止症
精神/神經疾病
慢性病(心/肺/肢)
末期病(癌/衰竭)

藥物使用
副作用
醫囑遵從性
依賴性
交互作用

環境因素
空氣品質/濕度
室內裝潢
環境聲音/光線
他人干擾

減少相關變項

增加相關項目
或新增變項

改善策略

改善方向

睡眠呼吸中止症
體重變化

(就寢)時間安排
工作壓力

空氣品質
溫度
運動習慣

環境聲音
光線
他人干擾

精神
神經
疾病

具體方法：睡眠數據平台、個人互動介面

聊天機器
改善方向呈現
衛教建議資料
詢問相關問題
資料互動介面

睡眠管理
互動內容調整
初步評估成果
釐清改善方案
問題輕重區分

臨床醫師
治療策略定案
疾病治療轉介
發掘潛在問題
治療資源規劃

產業鏈
醫藥/器材開發
生理數據量化
居家物聯網
社群力量整合

商業模式
支付模式(供應)
獎勵/信用機制
新創服務
新醫療體系

睡眠障礙
病患/亞健康者
相關併發症

改善

惡化

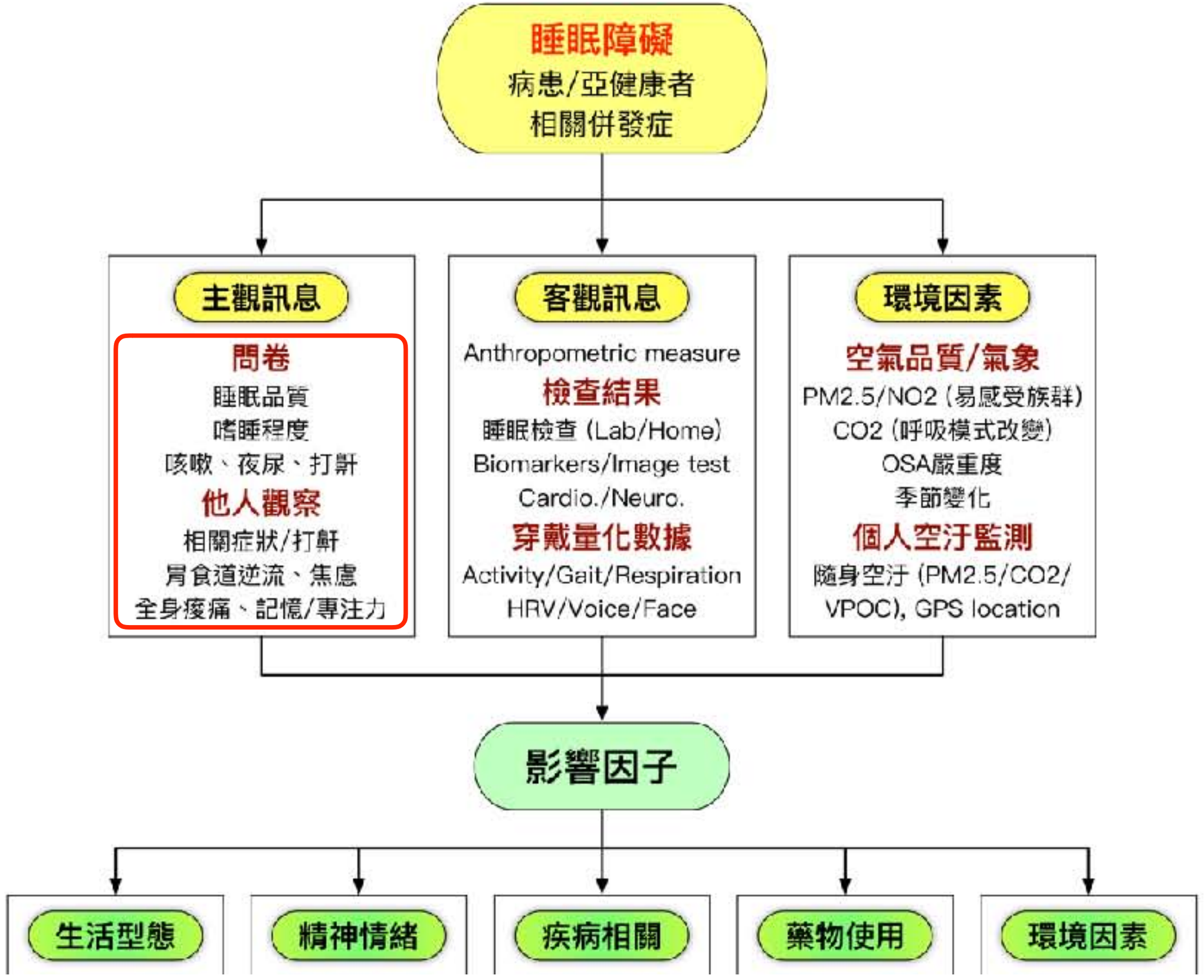
主 / 客觀數據
環境因素

選出影響因子

確立模型預測

提出改善策略
方向 / 具體方法

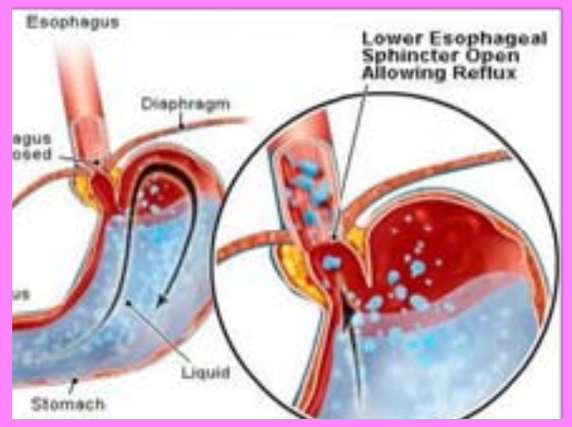
回饋調整變項
減少變項 增加變項


睡眠障礙
病患/亞健康者
相關併發症
主觀訊息
問卷
睡眠品質
嗜睡程度
咳嗽、夜尿、打鼾
他人觀察
相關症狀/打鼾
胃食道逆流、焦慮
全身痠痛、記憶/專注力
客觀訊息
Anthropometric measure
檢查結果
睡眠檢查 (Lab/Home)
Biomarkers/Image test
Cardio./Neuro.
穿戴量化數據
Activity/Gait/Respiration
HRV/Voice/Face
環境因素
空氣品質/氣象
PM2.5/NO2 (易感受族群)
CO2 (呼吸模式改變)
OSA嚴重度
季節變化
個人空汙監測
隨身空汙 (PM2.5/CO2/
VPOC), GPS location
影響因子
生活型態
精神情緒
疾病相關
藥物使用
環境因素

阻塞型睡眠呼吸中止症：四個生活習慣

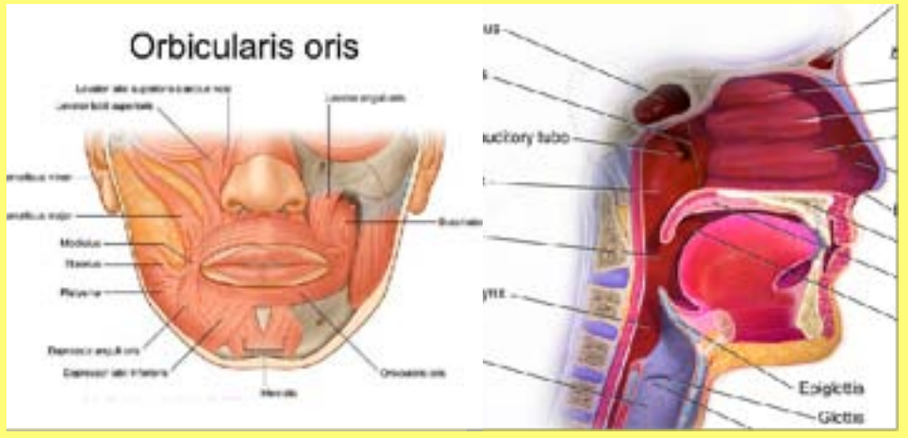
環境與慢性鼻炎

胃食道逆流



規律運動

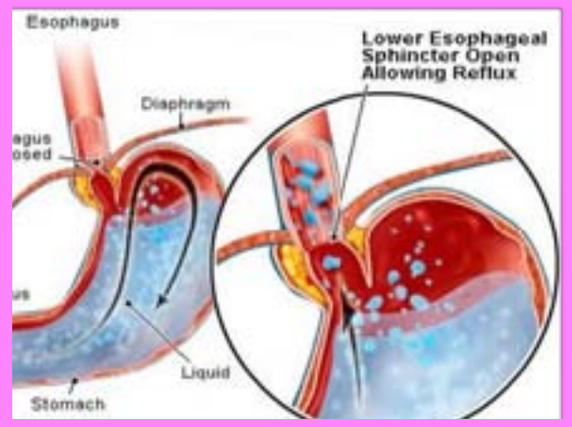
口腔舌咽肌肉訓練



阻塞型睡眠呼吸中止症：四個生活習慣

環境與慢性鼻炎

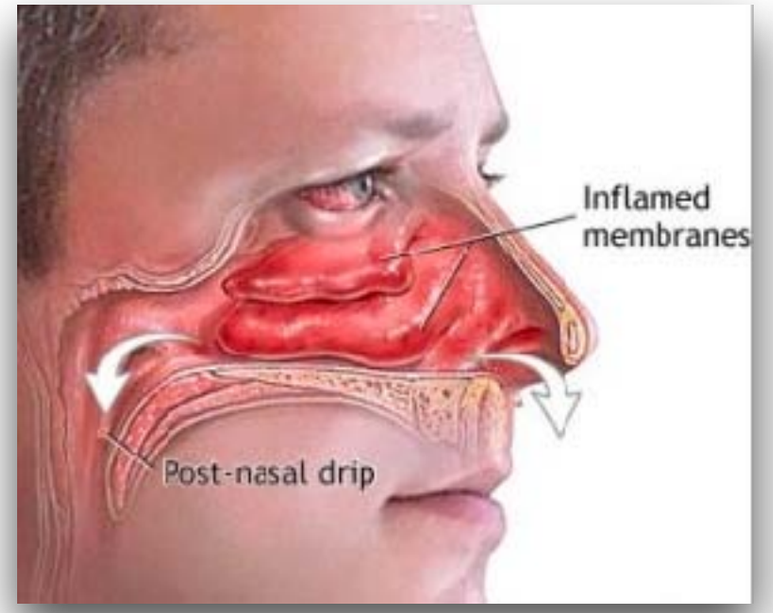
胃食道逆流

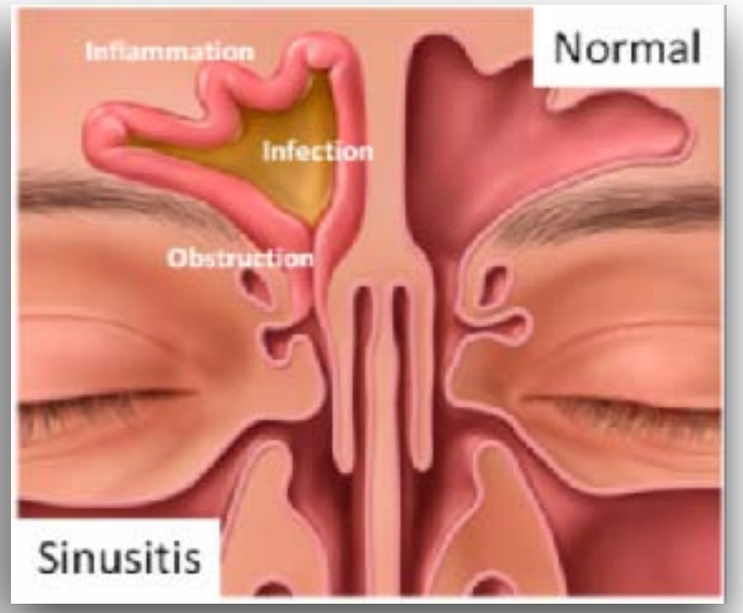


規律運動

口腔舌咽肌肉訓練

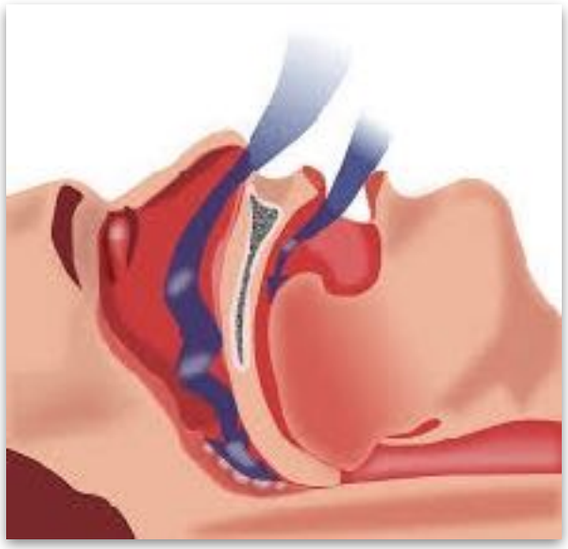
慢性鼻炎、鼻竇炎、張口呼吸

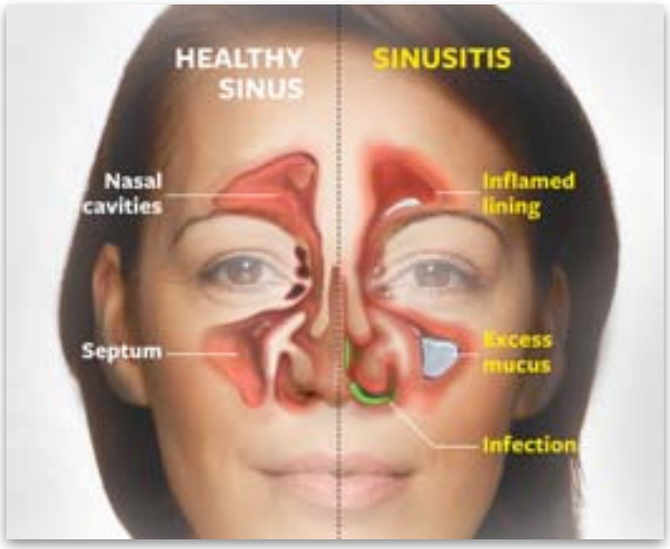


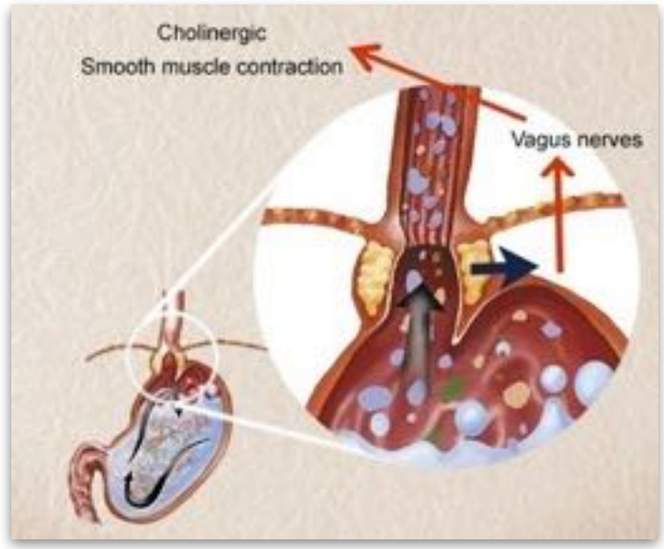


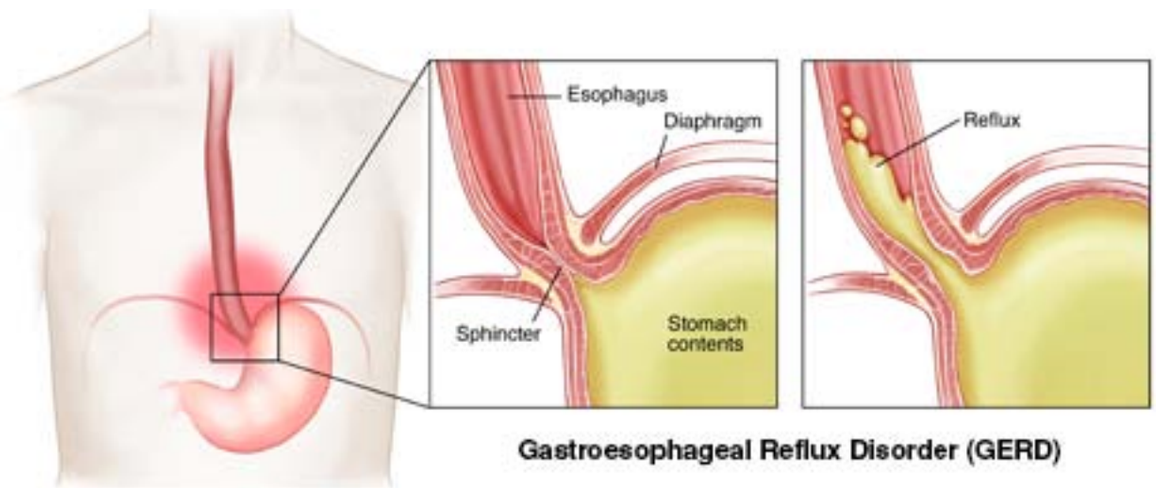
鼻塞的病患容易改成張口呼吸，導致口腔、咽喉乾燥，黏膜損傷，咳嗽受體及感覺神經變的異常敏感，一旦說話或一點點鼻涕倒流，便容易引起咳嗽。

阻塞型睡眠呼吸中止症的合併症狀

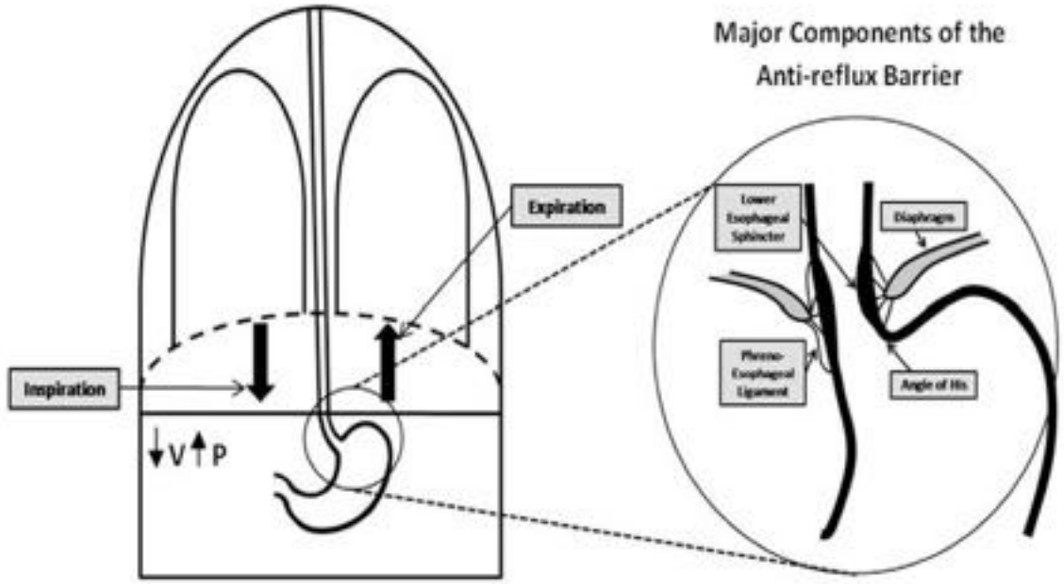






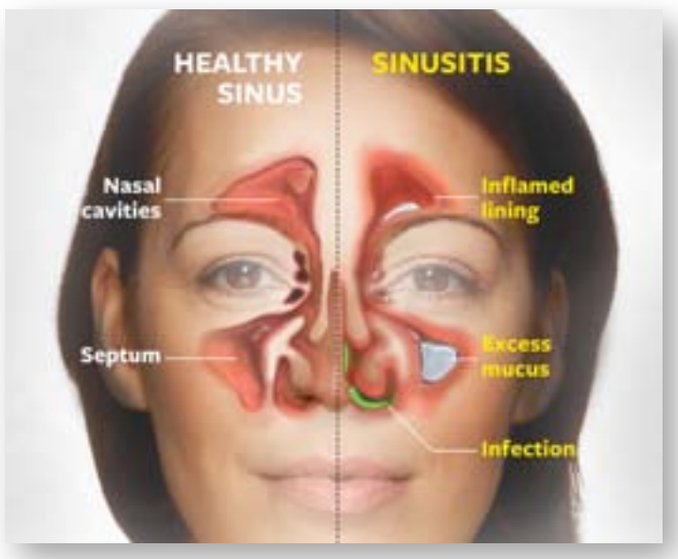


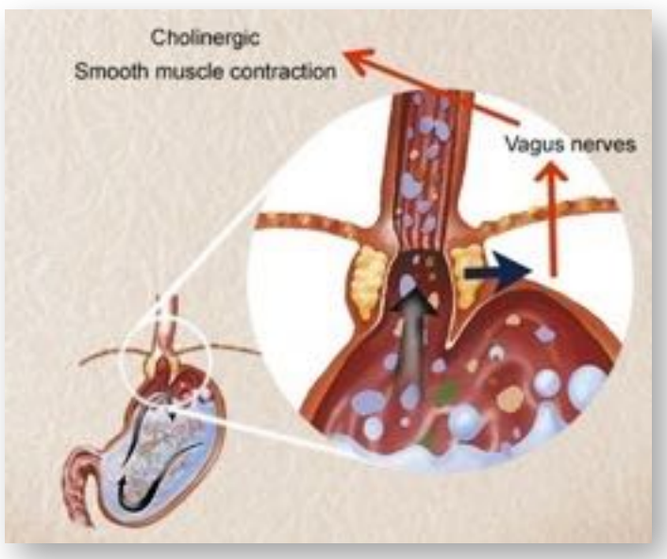
Gastroesophageal Reflux Disorder (GERD)



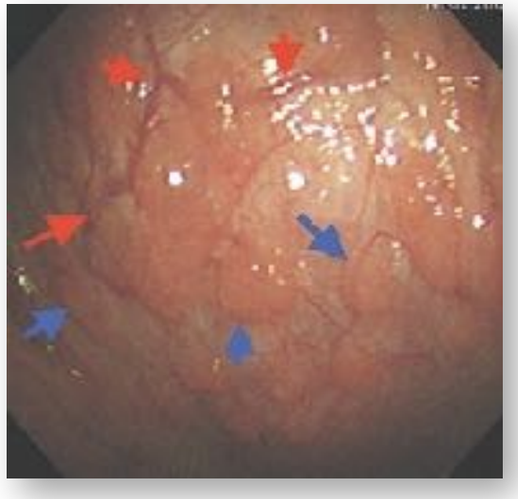
胃食道逆流

胃食道逆流 與 慢性鼻竇炎





- 治療**胃食道逆流**可有效改善慢性鼻炎與鼻涕倒流
- 胃內容物**並未發現直接逆流**至鼻腔的現象
- 胃食道「**反射** reflex」可造成鼻腔內充血腫脹的現象，並增加呼吸道分泌物

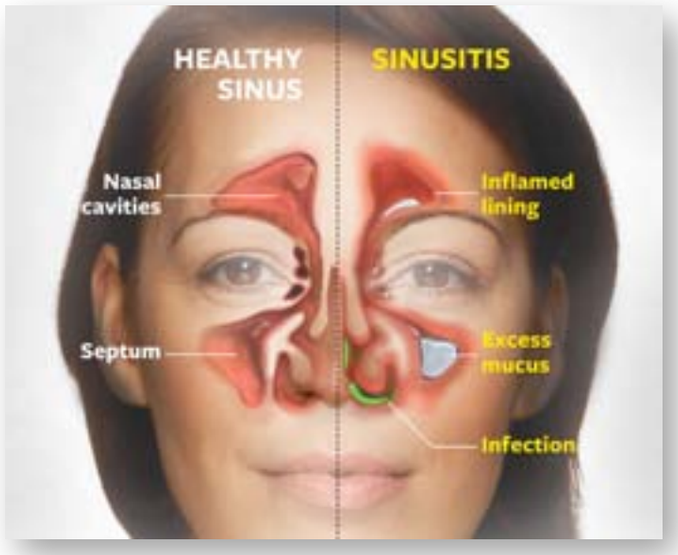


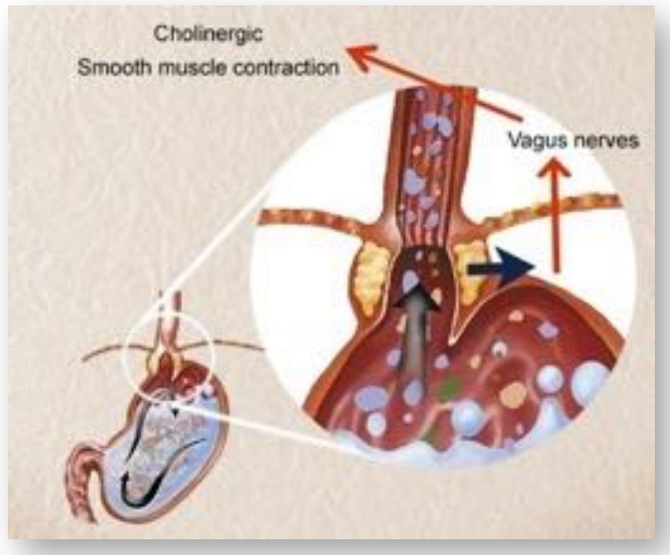
氫離子引發神經物質
（H+ induced sensory neuropeptides）

神經性發炎
（Neurogenic inflammation）

咳嗽閾值改變
（Cough receptor threshold）

胃食道逆流 與 慢性鼻竇炎





惡性循環

上呼吸道狹窄症候群 / **阻塞型睡眠呼吸中止**

(氣流受限覺醒RERAs)

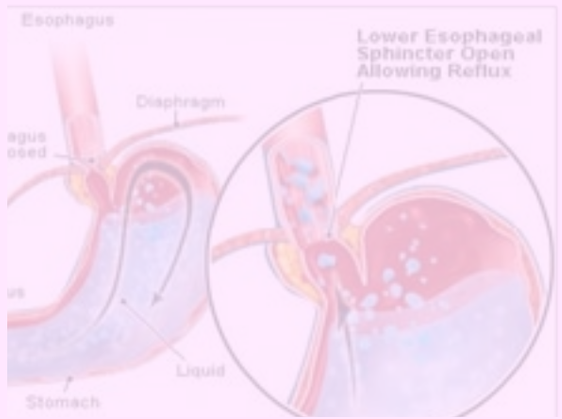
如何預防胃食道逆流


晚餐不要太晚吃，
最好離睡前兩小時以上
，也不要吃消夜
戒菸、酒、檳榔，
少吃甜食、油膩食物，
少喝碳酸飲料
BEER
cola
多運動、
減肥
穿寬鬆的衣服，
避免腹壓增大
飯後兩小時內，
最好不要平躺
健談 havemary.com

阻塞型睡眠呼吸中止症：四個生活習慣

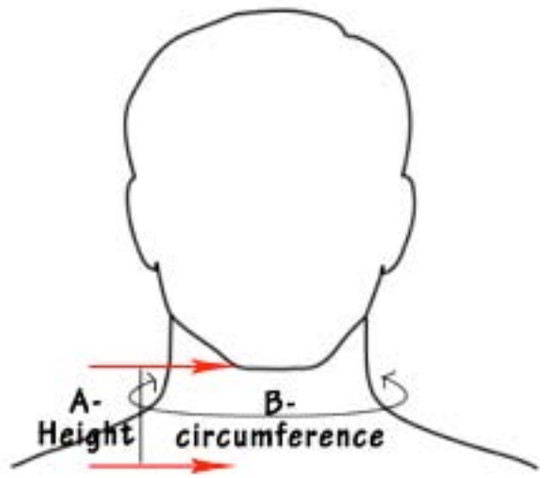
環境與慢性鼻炎

胃食道逆流



規律運動

口腔舌咽肌肉訓練



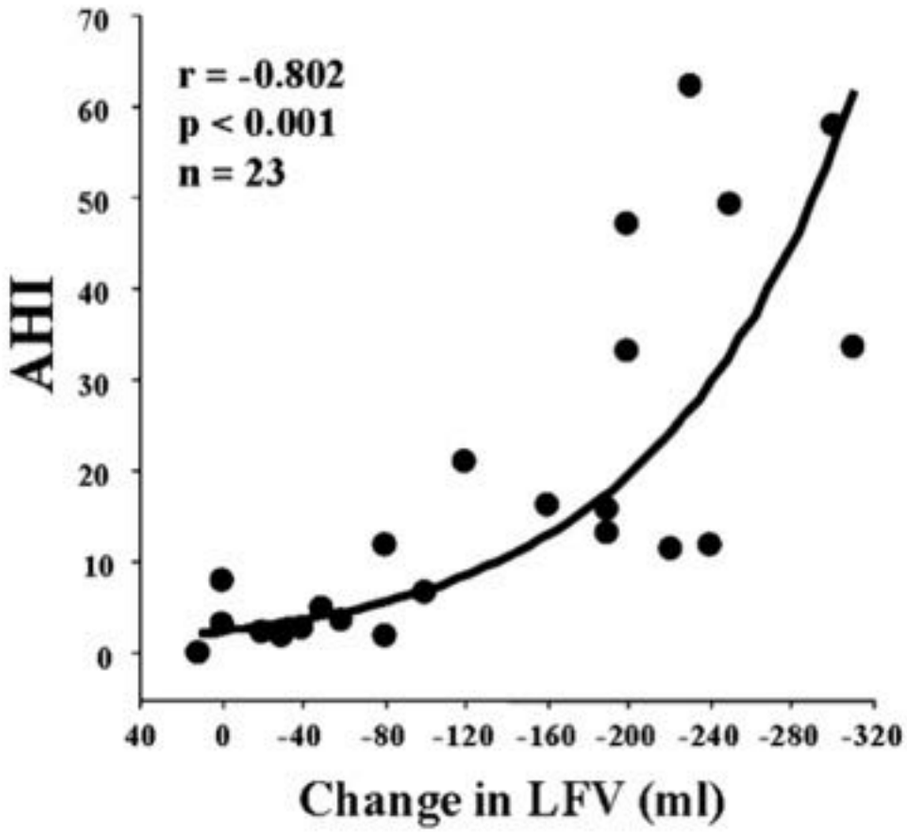


Figure 1. Relationship between the overnight change in leg fluid volume (LFV) and the apnea–hypopnea index (AHI).

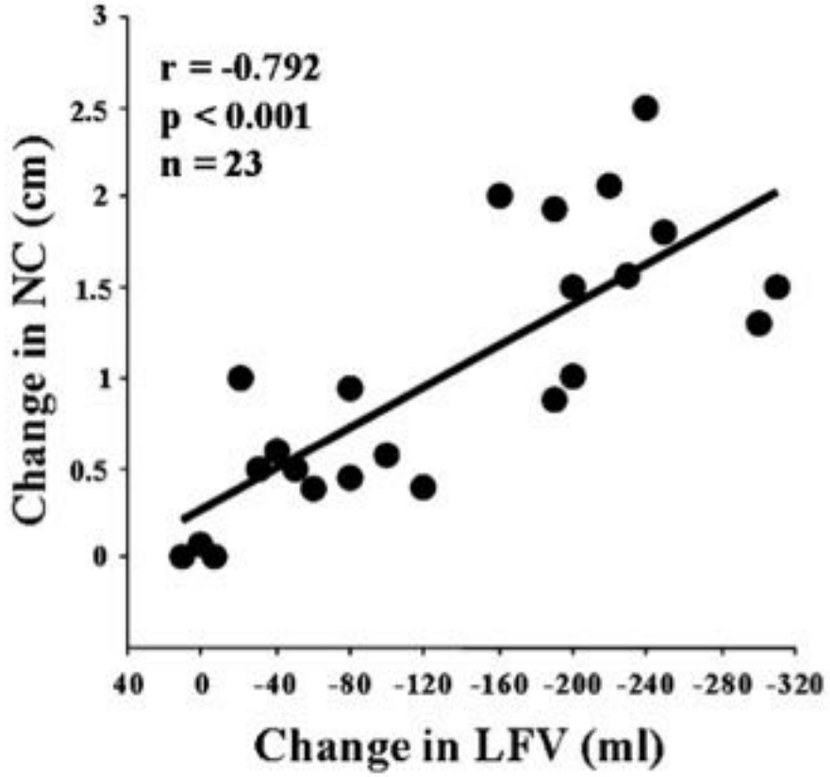


Figure 2. Relationship between the overnight change in LFV and the change in neck circumference (NC).

Am J Respir Crit Care Med Vol 179. pp 241–246, 2009

白天

夜晚

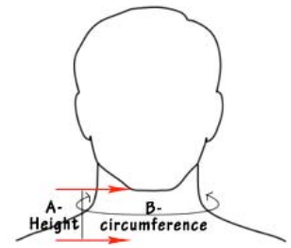
久坐/活動量少
水分堆積

加重

白天下肢
水分堆積增加

減少

運動
下肢加壓
利尿劑
洗腎



平躺時水分回流至頭側

頸部

上呼吸道截面積減少
上呼吸道容易塌陷

上呼吸道阻塞

阻塞型
睡眠呼吸中止

減少 肺部微血管壓力 增加

胸腔

肺部充血增加

刺激肺部間質神經

過度換氣增加

二氧化碳增加

二氧化碳減少

呼吸中樞：停止呼吸

中樞型
睡眠呼吸中止

肺微血管血壓增加

心臟衰竭

呼吸敏感度上升

J Physiol. 2013 Mar 1;591(Pt 5):1179-93.

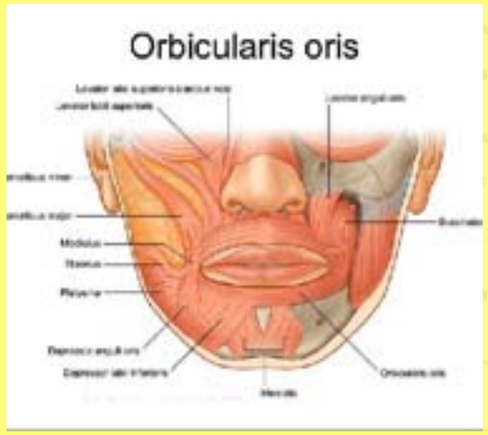
阻塞型睡眠呼吸中止症：四個生活習慣

環境與慢性鼻炎

胃食道逆流

規律運動

口腔舌咽肌肉訓練



口咽運動（Oropharyngeal Exercises)可有效改善中等嚴重度阻塞型睡眠呼吸中止症之呼吸中止程度、白天嗜睡、打鼾嚴重度

Am J Respir Crit Care Med. 2009 May 15;179(10):962-6.　　*Chest. 2015 Sep;148(3):683-91.*

迪吉里杜管 (Didgeridoo) 做為治療阻塞型睡眠呼吸中止症的另類療法

BMJ. 2006 Feb 4;332(7536):266-70.

過敏性鼻炎、鼻竇炎、慢性鼻炎

上呼吸道發炎、充血腫脹

上呼吸道狹窄、塌陷阻塞

胃食道逆流

EC junction, Mouth breathing

下肢水分堆積：平躺時回流增加

阻塞型睡眠呼吸中止

打鼾

夜間血氧低下

組織反覆缺氧/充氧

上呼吸道反覆振動造成黏膜傷害

活動量不足

過氧化物累積

氧化壓力增加

空氣污染

PM10, PM2,5, etc.

全身系統性發炎

Susceptible

過敏性鼻炎、鼻竇炎、慢性鼻炎

環境與慢性鼻炎

胃食道逆流

上呼吸道發炎、充血腫脹

胃食道逆流

EC junction, Mouth breathing

上呼吸道狹窄、塌陷阻塞

下肢水分堆積：
平躺時回流增加

規律運動

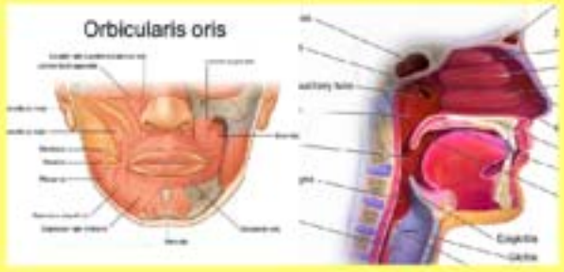
阻塞型睡眠呼吸中止
打鼾

夜間血氧低下
組織反覆缺氧/充氧

上呼吸道反覆振動造成黏膜傷害

活動量不足

口腔舌咽肌肉訓練

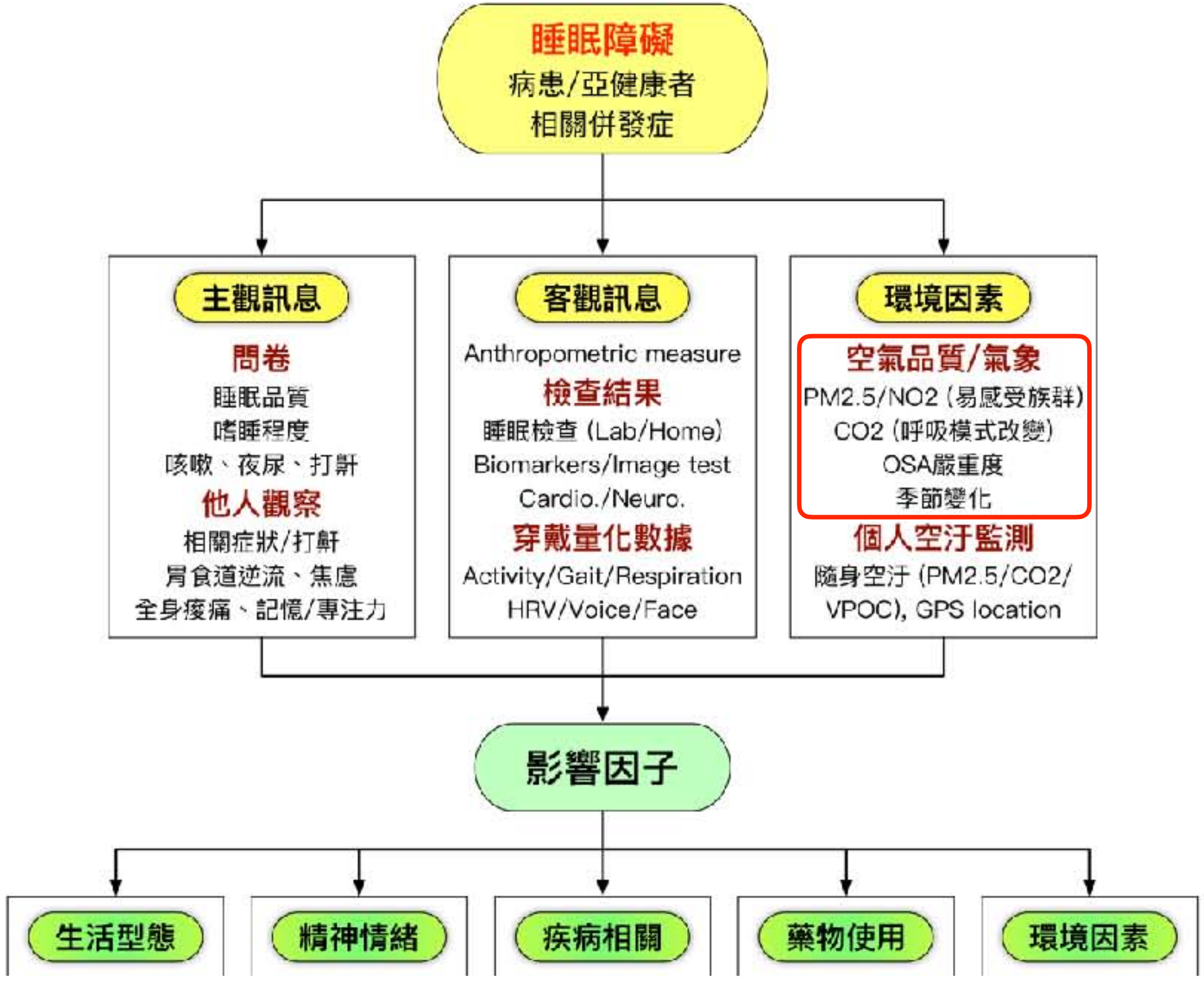


過氧化物累積
氧化壓力增加

空氣污染
PM10, PM2,5,
etc.

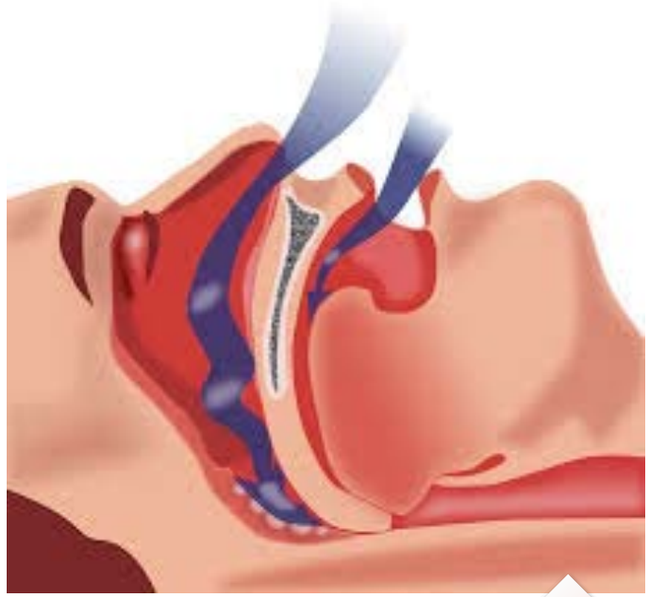
全身系統性發炎

Susceptible

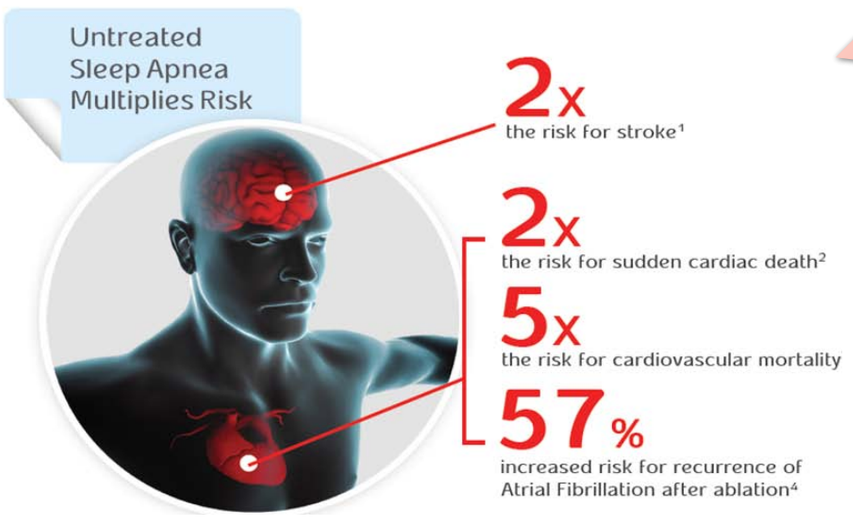

睡眠障礙
病患/亞健康者
相關併發症
主觀訊息
問卷
睡眠品質
嗜睡程度
咳嗽、夜尿、打鼾
他人觀察
相關症狀/打鼾
胃食道逆流、焦慮
全身痠痛、記憶/專注力
客觀訊息
Anthropometric measure
檢查結果
睡眠檢查 (Lab/Home)
Biomarkers/Image test
Cardio./Neuro.
穿戴量化數據
Activity/Gait/Respiration
HRV/Voice/Face
環境因素
空氣品質/氣象
PM2.5/NO2 (易感受族群)
CO2 (呼吸模式改變)
OSA嚴重度
季節變化
個人空汙監測
隨身空汙 (PM2.5/CO2/
VPOC), GPS location
影響因子
生活型態
精神情緒
疾病相關
藥物使用
環境因素

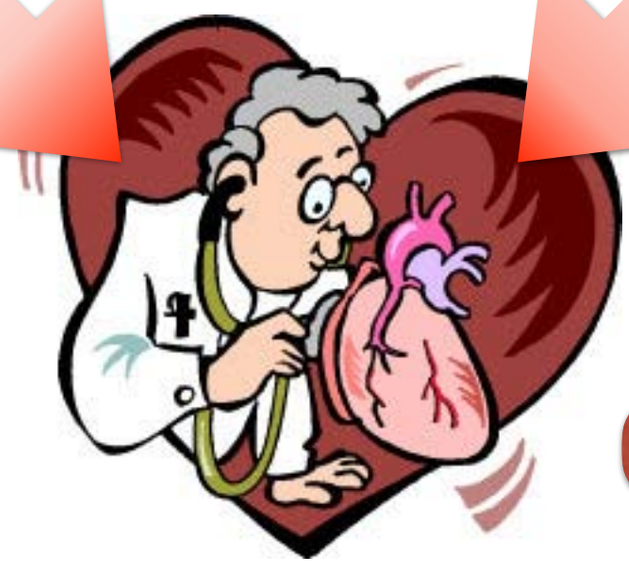
Annual air pollution exposure vs. blood pressure

Sleep-disordered breathing



Air pollution





Effects of **COMMUTING MODE** on air pollution exposure and cardiovascular health among young adults in Taipei, Taiwan

HRV index **Walking: PM2.5**

Cardiovascular disease

Wen-Te Liu et al.,
Int J Hyg Environ Health. 2015 May;218(3):319-23.

Severe sleep apnea

⬇

Greater effects?

⬇

Annual exposure to air pollution

⬇

Change of blood pressure?

Table 4

Beta coefficients (95% confidence interval) for effect modification of the association between diastolic blood pressure and 1-year mean air pollution exposure.

	$PM_{2.5}$	NO_2
Apnea–hypopnea index ≥30		
Yes	0.49 (0.01, 0.97)	0.58 (0.03, 1.14)
No	−0.35 (−0.94, 0.24)	−0.27 (−0.88, 0.34)
P-value for interaction	0.03	0.02
Body mass index >25		
Yes	0.57 (0.12, 1.02)	0.73 (0.24, 1.22)
No	0.04 (−0.36, 0.40)	−0.10 (−0.46, 0.26)
P-value for interaction	0.04	0.03

NO_2, nitrogen dioxide; $PM_{2.5}$, particles with aerodynamic diameters less than 2.5 μm.
All models were adjusted for sex, age, body mass index, temperature, relative humidity.

Severe sleep apnea (AHI ≥ 30)

⬇

Significant increases in Diastolic B.P. (by NO_2, $PM_{2.5}$)

Overweight (BMI ≥ 25)

⬇

Stronger effects of $PM_{2.5}$ & NO_2 on elevated Diastolic B.P.

Increased levels in All air pollutants

⬇

Decrease in Systolic B.P.

- Decrease in cardiac contractility?
- Shifting of ANS to parasympathetic nerve system?

Severe sleep apnea + Overweight

⬇

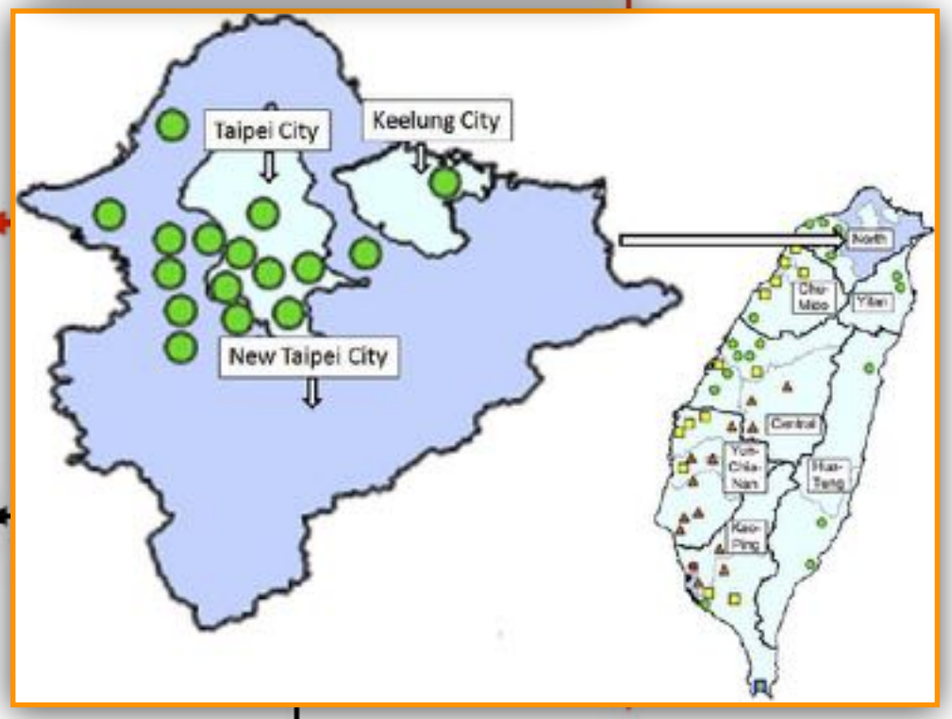
Greater effects of $PM_{2.5}$ & NO_2 on Diastolic B.P.

- AHI and BMI: modify the effect of air pollution
- Sleep apnea / Overweight: vulnerable subjects

Pathophysiology of Obstructive Sleep Apnea

Chronic rhinitis, Sinusitis

$PM_{2.5}$ vs OSA



Upper airway: Inflammation, Congestion

GERD

Increased collapsibility of upper airway

vibration trauma of upper airway

Sleep disordered breathing

OSA, intermittent hypoxia: **ischemia/reperfusion**

Interquartile (IQR) increase in PM2.5/NO2: AHI increased 4.7% and 3.6%

Environ Pollut. 2017 Oct 20;233:109-113. doi: 10.1016/j.envpol.2017.10.052. [Epub ahead of print]

Association of PM2.5 with sleep-disordered breathing from a population-based study in Northern Taiwan urban areas.

Shen YL[1], Liu WT[2], Lee KY[3], Chuang HC[4], Chen HW[5], Chuang KJ[6].

Air pollution, PM10, PM2,5, etc.

Susceptible

Systemic Inflammation

Pathophysiology of Obstructive Sleep Apnea

Chronic rhinitis, Sinusitis

Upper airway: Inflammation, Congestion

$PM_{2.5}$ vs OSA

GERD

Increased collapsibility of upper airway

Rostral fluid redistribution during sleep

vibration trauma of upper airway

Sleep disordered breathing

OSA, intermittent hypoxia: **ischemia/reperfusion**

Sedentary Lifestyle

Oxidative stress

Air pollution, PM10, PM2,5, etc.

Systemic Inflammation

Susceptible

Specific location
+
Specific timing
vs.
Sleep apnea severity
Co-morbidity

Pathophysiology of Obstructive Sleep Apnea

Chronic rhinitis, Sinusitis

GERD

vibration trauma of upper airway

Inflammation

Specific location

+

Specific timing

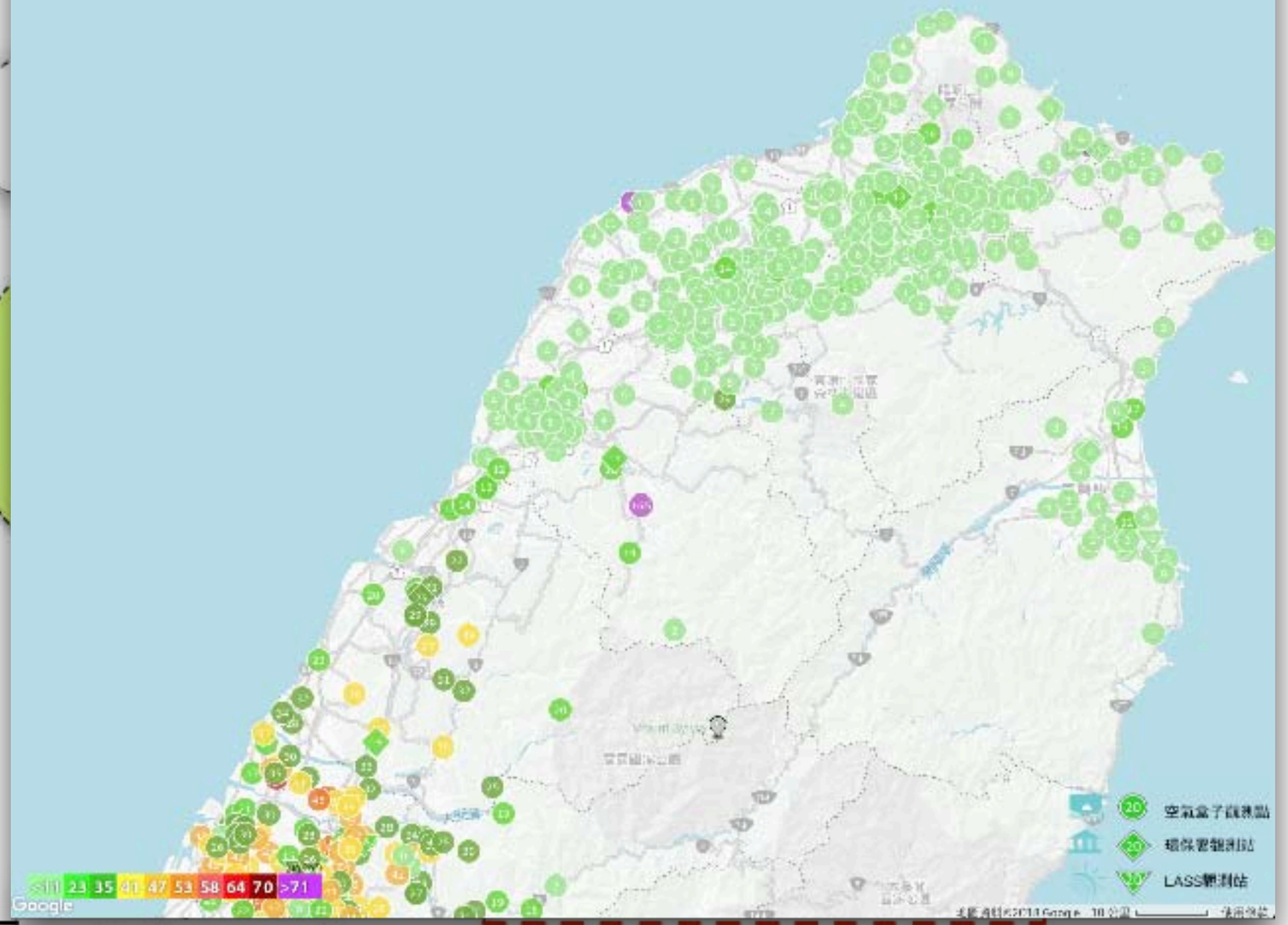
vs.

Sleep apnea severity

Co-morbidity

Airbox, LASS 社群 (Location Aware Sensing System)

中研院 陳伶志博士



Pathophysiology of Obstructive Sleep Apnea

Chronic rhinitis, Sinusitis

GERD

vibration trauma of upper airway

Inflammation

Specific location

+

Specific timing

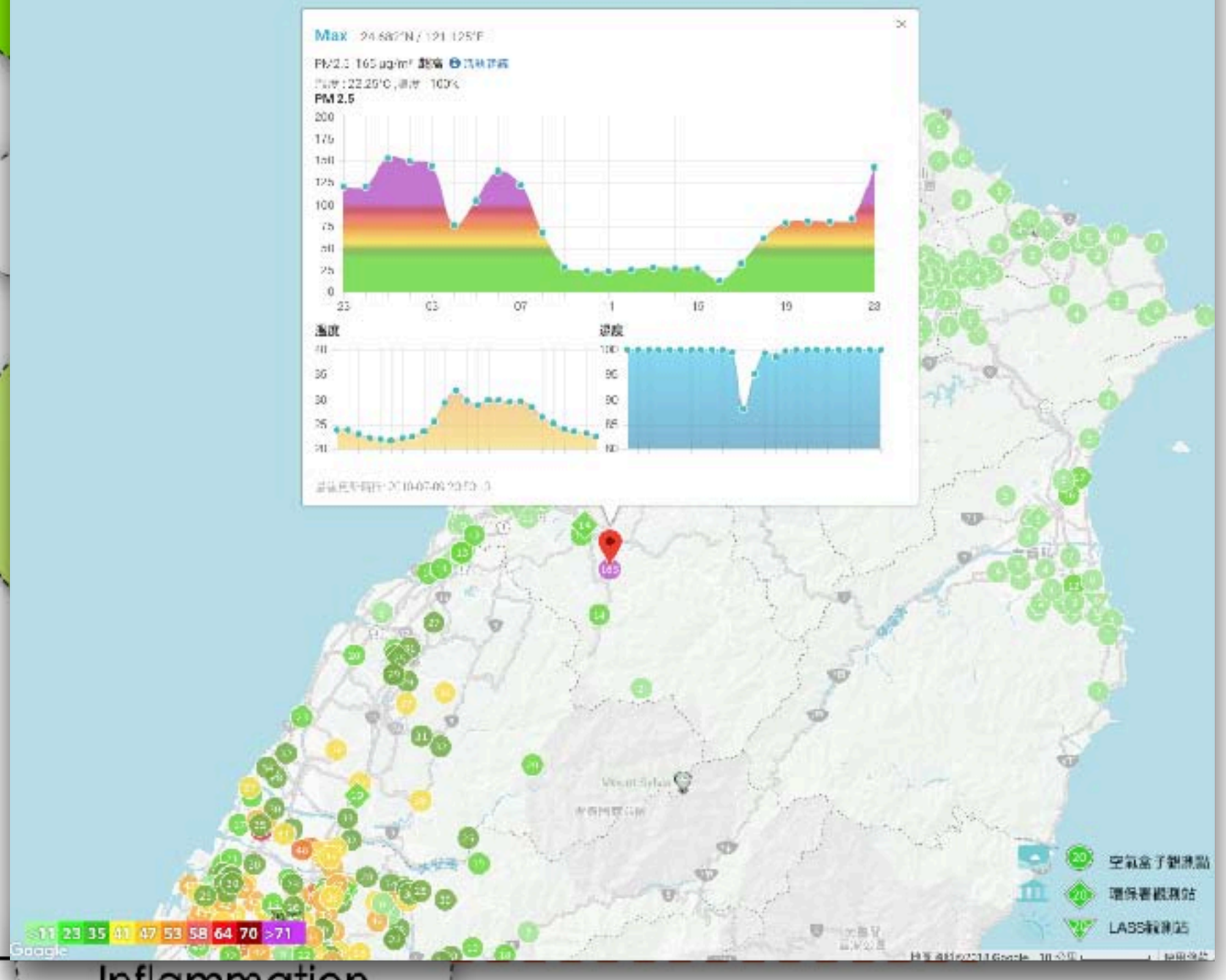
vs.

Sleep apnea severity

Co-morbidity

Airbox, LASS 社群 (Location Aware Sensing System)

中研院 陳伶志博士



睡眠障礙
病患/亞健康者
相關併發症

主觀訊息

問卷
睡眠品質
嗜睡程度
咳嗽、夜尿、打鼾

他人觀察
相關症狀/打鼾
胃食道逆流、焦慮
全身痠痛、記憶/專注力

客觀訊息

Anthropometric measure

檢查結果
睡眠檢查 (Lab/Home)
Biomarkers/Image test
Cardio./Neuro.

穿戴量化數據
Activity/Gait/Respiration
HRV/Voice/Face

環境因素

空氣品質/氣象
PM2.5/NO2 (易感受族群)
CO2 (呼吸模式改變)
OSA嚴重度
季節變化

個人空汙監測
隨身空汙 (PM2.5/CO2/VPOC), GPS location

影響因子

生活型態
精神情緒
疾病相關
藥物使用
環境因素

過敏性鼻炎、鼻竇炎、慢性鼻炎

上呼吸道發炎、充血腫脹

胃食道逆流

EC junction, Mouth breathing

上呼吸道狹窄、塌陷阻塞

下肢水分堆積：
平躺時回流增加

上呼吸道反覆振動造成黏膜傷害

阻塞型睡眠呼吸中止
打鼾

夜間血氧低下
組織反覆缺氧/充氧

活動量不足

過氧化物累積
氧化壓力增加

空氣污染
PM10, PM2,5,
etc.

全身系統性發炎

Susceptible

ADDWII 隨身空污鼻

ADDWII

Mobile Nose 隨身空污鼻

隨身・隨時・隨地

您身邊的空污監測器

個人

個人隨身、隨時、隨地的空氣品質，強調指標個人化，室內戶外兼顧

移動

將空污偵測裝置由定點帶入全移動世代，體積輕巧，在攜帶和移動上展現高度靈活與彈性。

主動偵測

多項專利的微型泵浦核心技術，提供 TVOC、PM2.5、eCO2 及溫、溼度的精準數據

全記錄

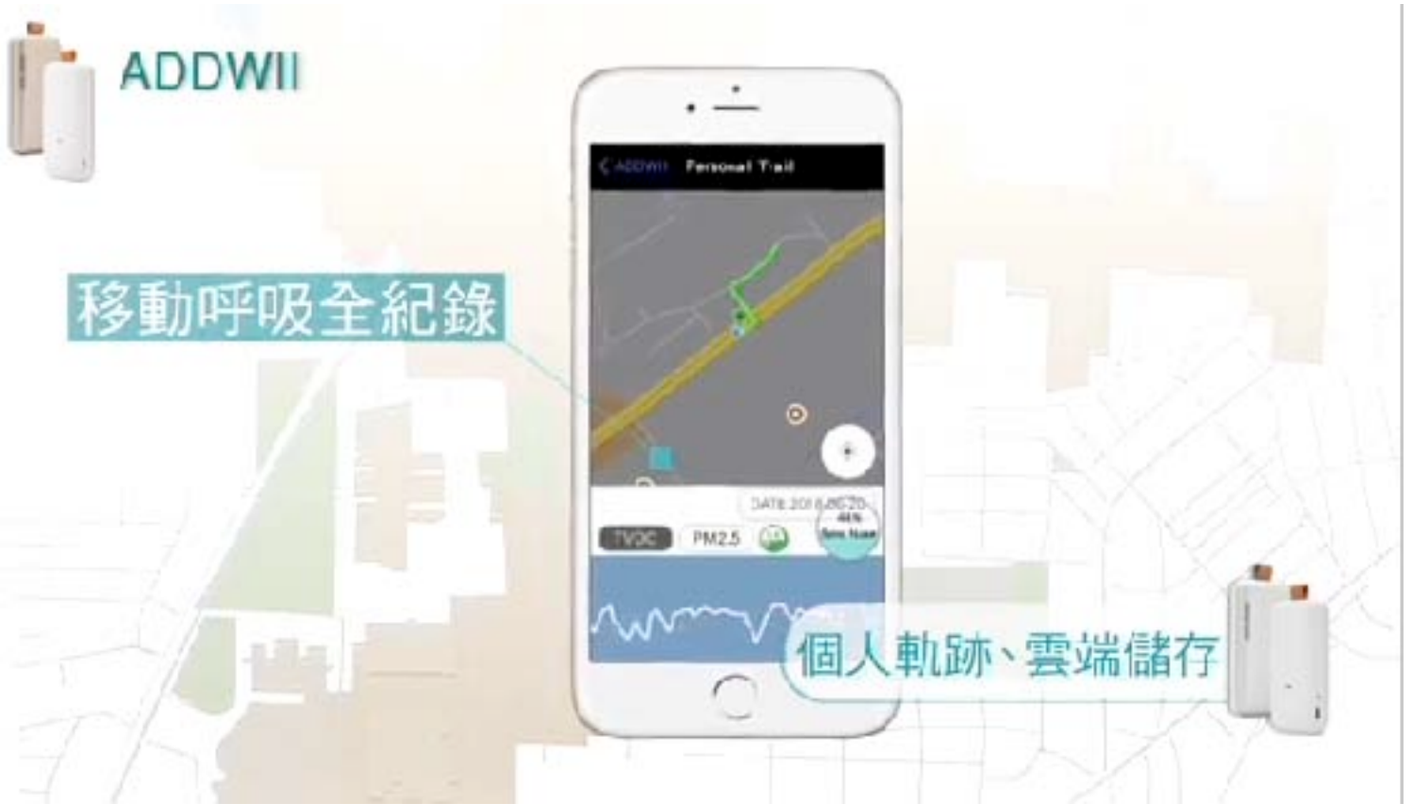
終身記錄，將使用者每分每秒所吸入的空氣品質資料，終身儲存於雲端

雲端數據

大數據資料，除了個人隱私不公開，可做為相關研究和醫療機構參考

用戶中心

透過使用裝置所蒐集的數值與使用經驗，能在社群媒體平台上交流



睡眠障礙
病患/亞健康者
相關併發症

主觀訊息

問卷
睡眠品質
嗜睡程度
咳嗽、夜尿、打鼾

他人觀察
相關症狀/打鼾
胃食道逆流、焦慮
全身痠痛、記憶/專注力

客觀訊息

Anthropometric measure

檢查結果
睡眠檢查 (Lab/Home)
Biomarkers/Image test
Cardio./Neuro.

穿戴量化數據
Activity/Gait/Respiration
HRV/Voice/Face

環境因素

空氣品質/氣象
PM2.5/NO2 (易感受族群)
CO2 (呼吸模式改變)
OSA嚴重度
季節變化

個人空汙監測
隨身空汙 (PM2.5/CO2/
VPOC), GPS location

影響因子

生活型態
精神情緒
疾病相關
藥物使用
環境因素

胃食道逆流

EC junction, Mouth breathing

上呼吸道狹窄、塌陷阻塞

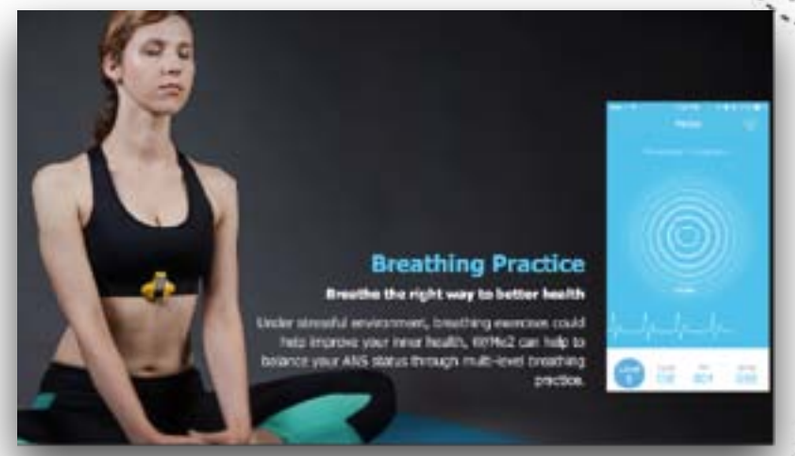
下肢水分堆積：
平躺時回流增加

上呼吸道反覆振
動造成黏膜傷害

阻塞型睡眠呼吸中止
打鼾

夜間血氧低下
組織反覆缺氧/充氧

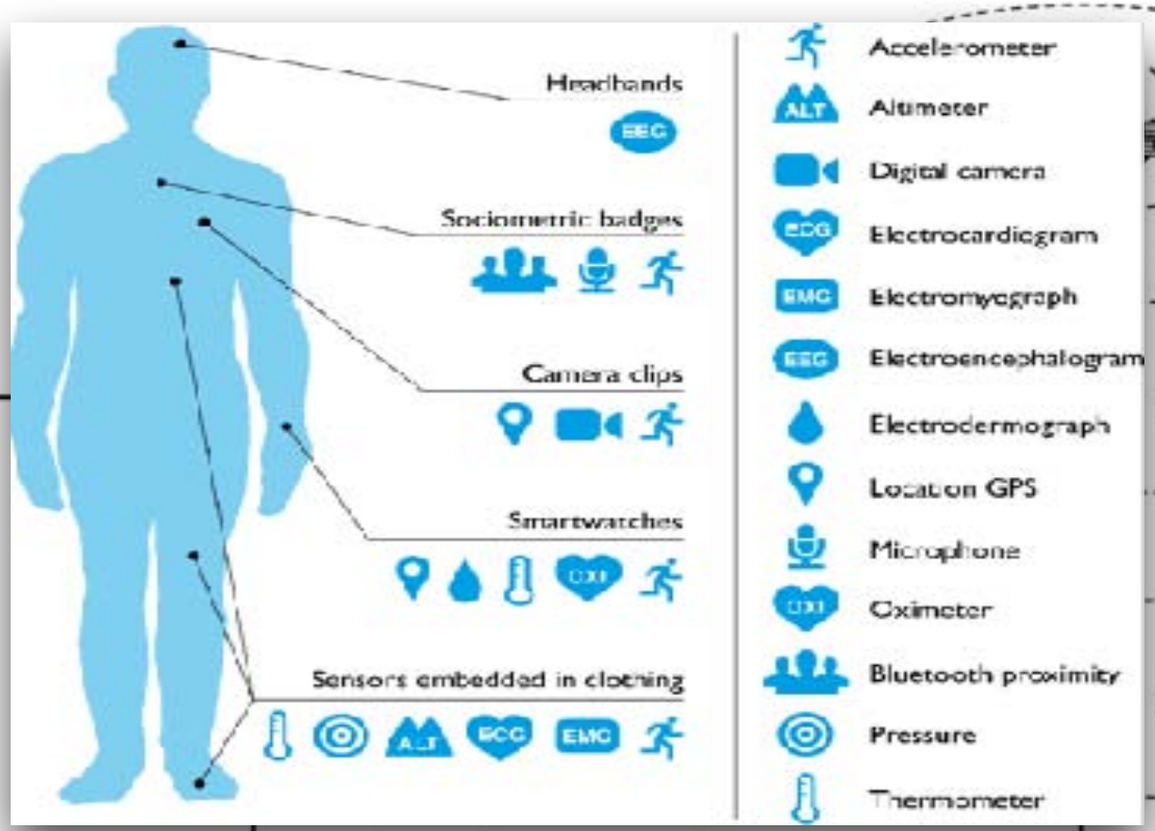
活動量不足

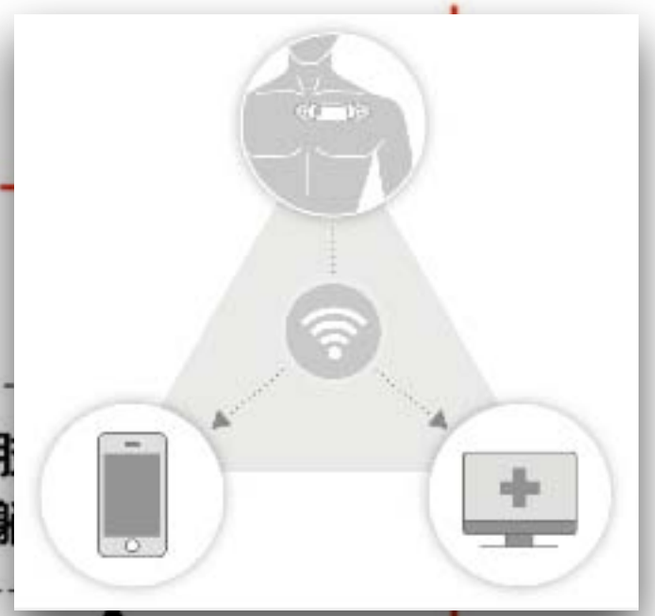


過氧化物累積
氧化壓力增加

全身系統性發炎

Heart Rate Variability, Accelerometer, Respiratory Pattern, Skin Temp





阻塞型睡眠呼吸中止
打鼾

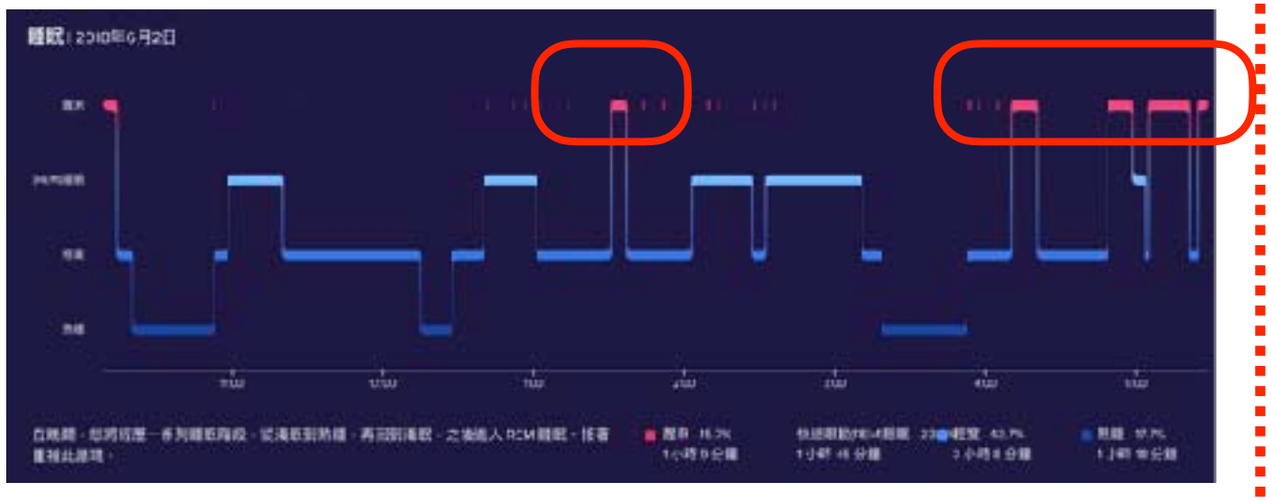
夜間血氧低下
組織反覆缺氧/充氧

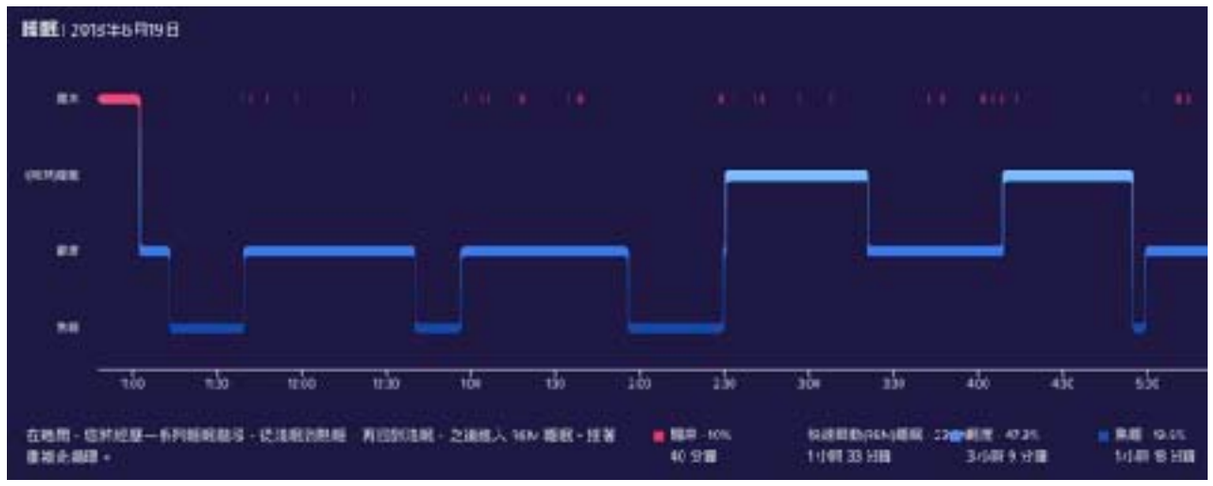
上呼吸道反覆振
動造成黏膜傷害

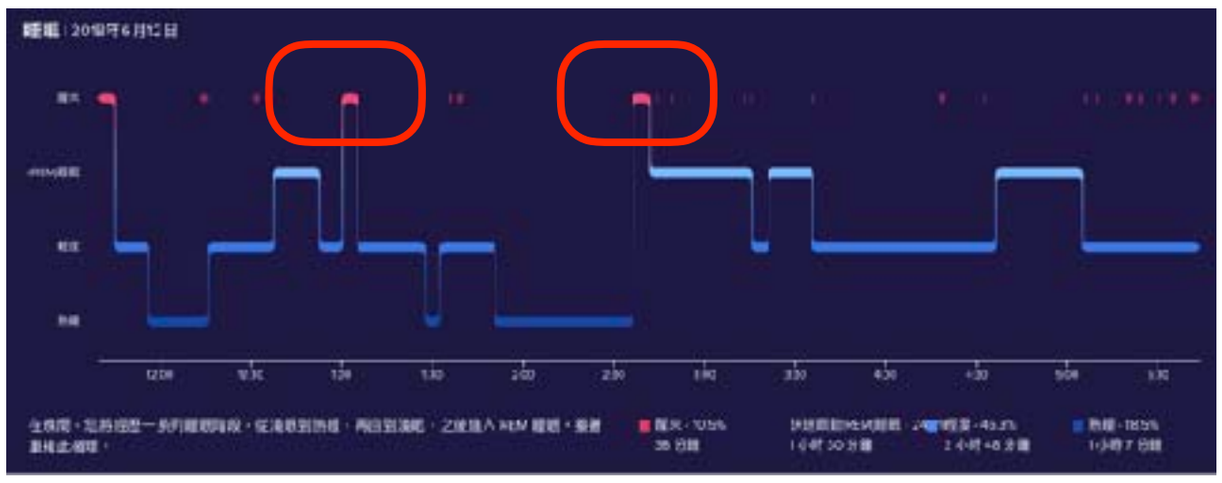
過氧化物累積
氧化壓力增加

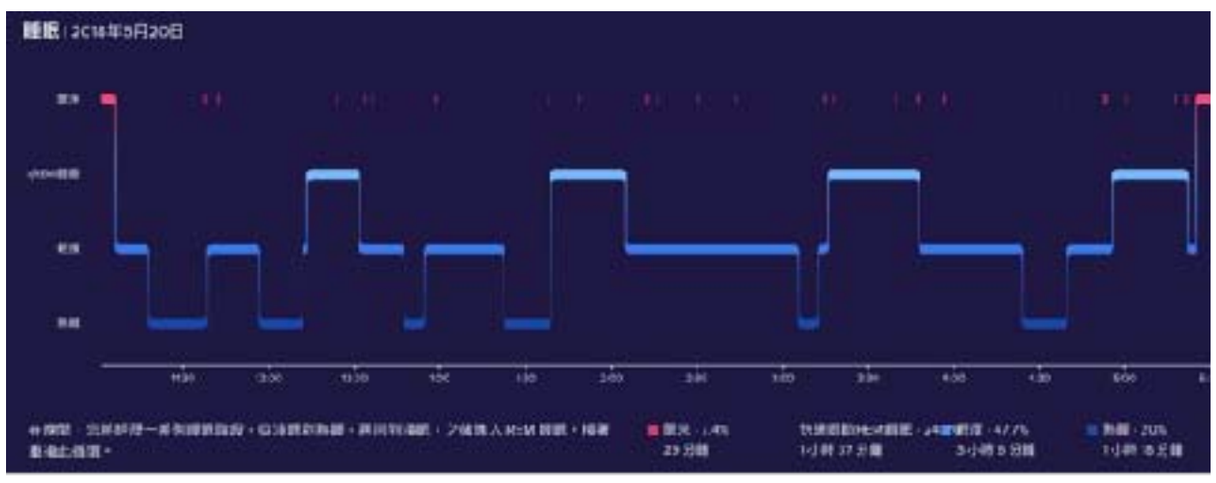
全身系統性發炎

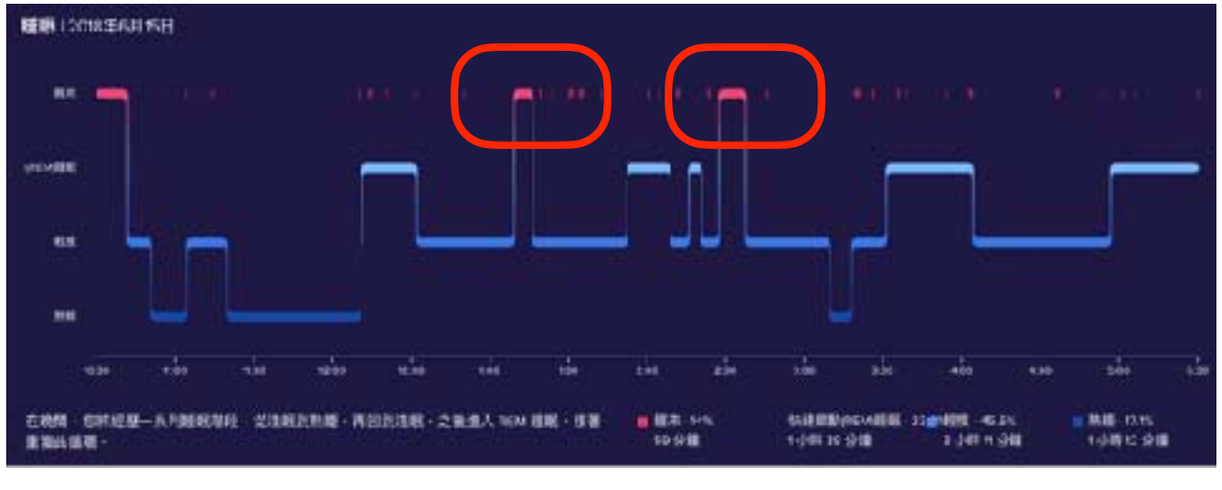
使用穿戴式裝置：智慧手錶

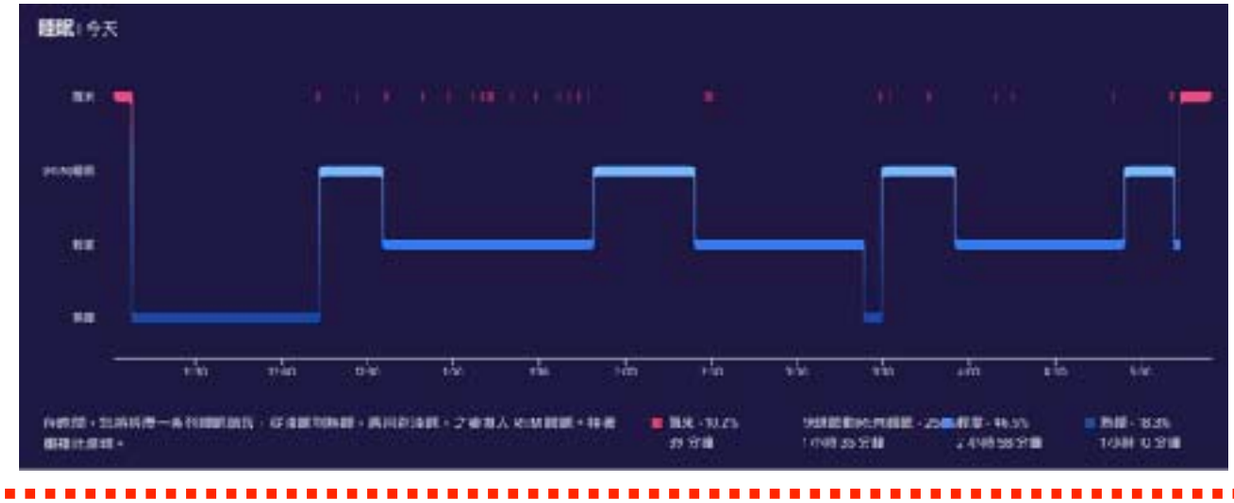












睡前禁食、運動、嘴巴貼3M膠帶

Gait analysis vs. Sleep

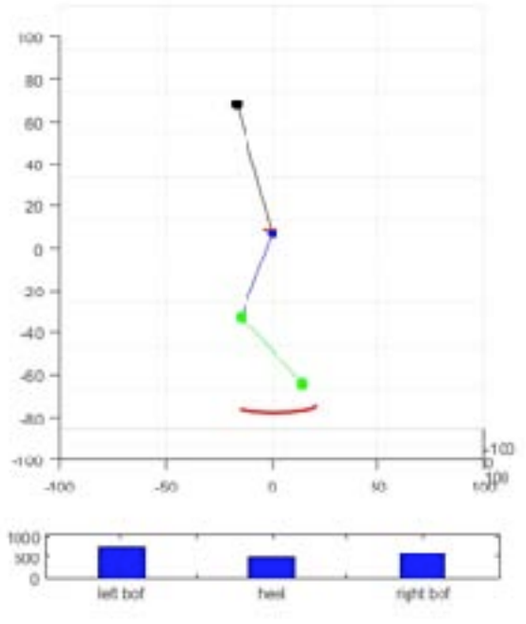
Sleep-related breathing disorders and gait variability: a cross-sectional preliminary study

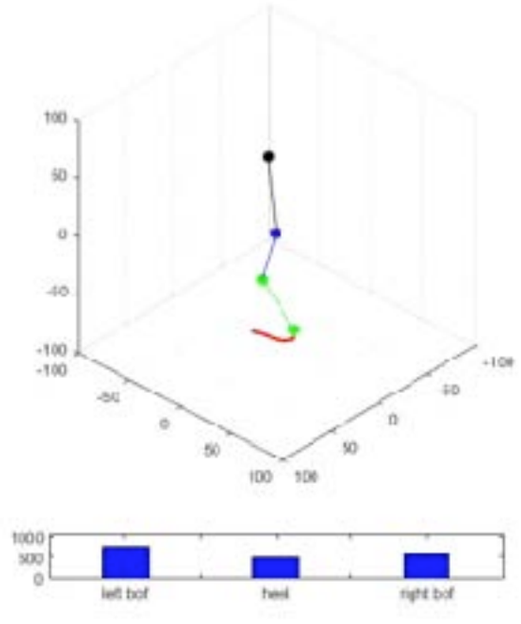
Sébastien Celle[1], Cédric Annweiler[2,3], Richard Camicioli[4], Jean-Claude Barthélémy[1], Frédéric Roche[1] and Olivier Beauchet[2*]

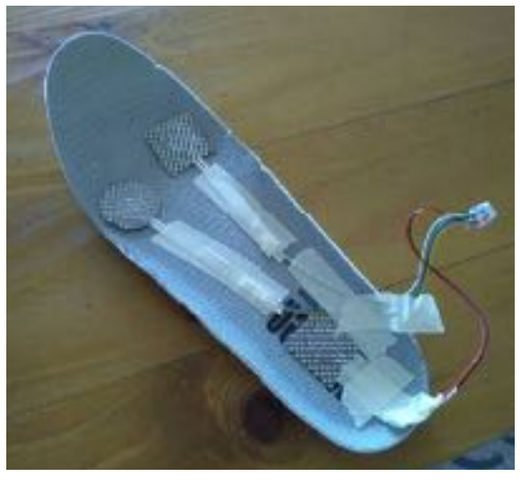
Positive association between stride-to-stride variability of stride time and sleep related breathing disorders

(innersoles pressure sensors)

BMC Pulm Med. 2014 Aug 23;14:140. doi: 10.1186/1471-2466-14-140.

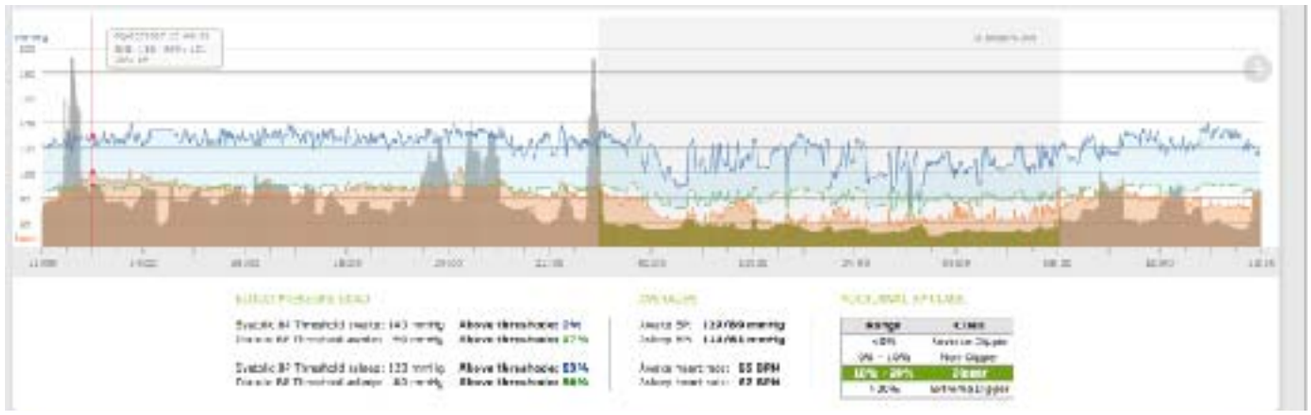






G-sensor, Gyro-Sensor for Gait Analysis

Circadian rhythm, Activity, Respiration, Arousal



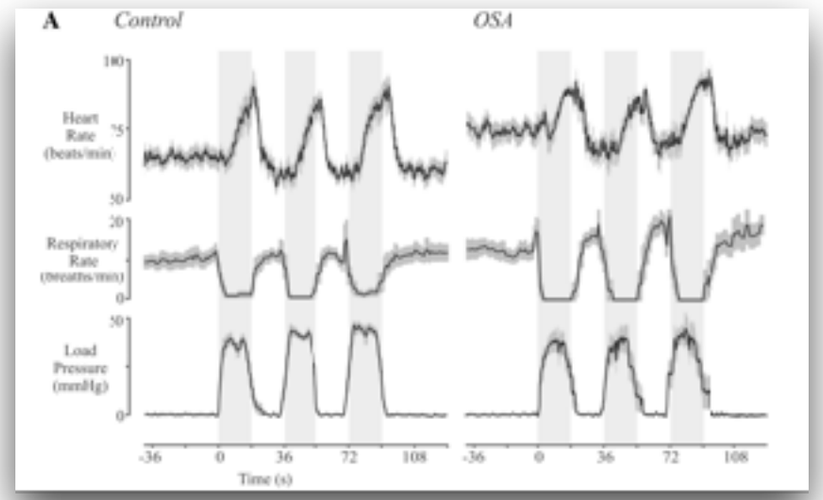
臺北醫學大學
TAIPEI MEDICAL UNIVERSITY

Physical activity of daily life

(Circadian Rhythm)

CVHR: Cyclic Variation of Heart Rate

RAI: Respiratory Arousal Index = CVHR/hours of sleep



臺北醫學大學
TAIPEI MEDICAL UNIVERSITY

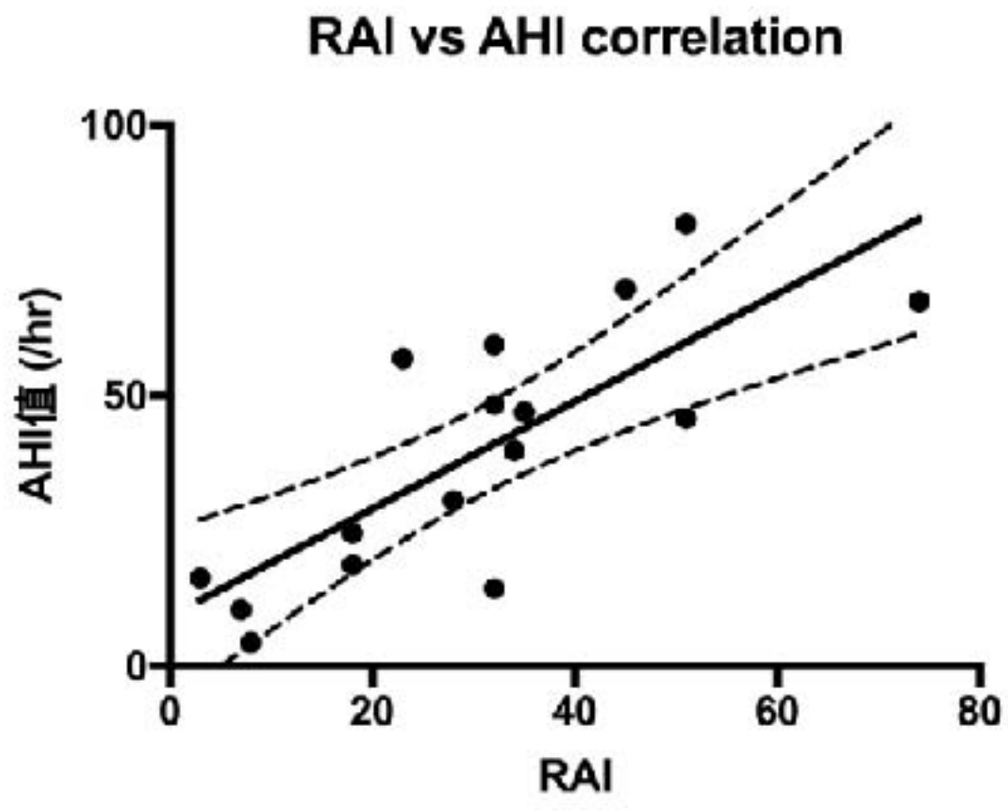
Thorax effort

根據 G-sensor之 XYZ軸 換算之Thorax effort

臺北醫學大學
TAIPEI MEDICAL UNIVERSITY

Correlation between RAI and AHI

RAI	AHI値 (/hr)	In bed (mins)	Total sleep time (mins)	Sleep Quality (%)	Onset latency	WASO
51	45.7	444	208.68	47	3	230
18	18.6	478	406.3	85	0	69
18	24.5	506	440.22	87	31	32
32	14.3	412	329.6	80	14	65
23	56.9	457	370.17	81	16	69
35	46.9	446	414.78	93	12	18
32	48.3	520	421.2	81	29	66
3	16.2	476	276.08	58	0	197
32	59.4	495	455.4	92	21	20
45	69.7	499	419.16	84	9	70
51	81.7	469	436.17	93	21	11
28	30.6	477	410.22	86	29	34
74	67.4	456	396.72	87	32	27
34	39.8	2062	1237.2	60	6	818
8	4.4	441	357.21	81	69	13
7	10.4	497	422.45	85	58	14



Pearson correlation

95% CI: 0.4683 to 0.9209

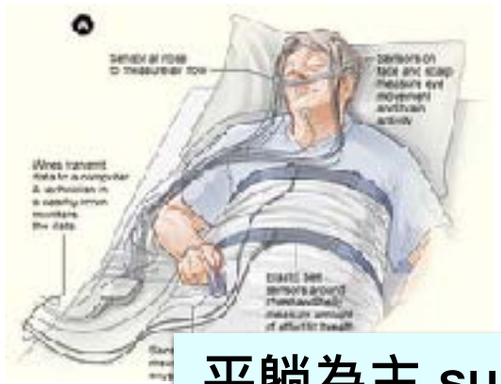
r = 0.7824, r squared = 0.6121

P=0.0003

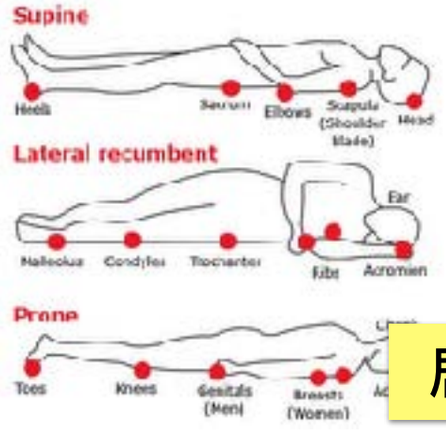
Discrepancy between Hospital and Home
Position during sleep: **Supine (hospital), Left/Right (home)**

PSG	Rooti Rx with PSG			Rooti Rx, home (1st)			Rooti Rx, home (2nd)			Rooti Rx, home (3rd)		
AHI值 (/hr)	RAI	Supine (mins)	Supine %	RAI	Supine (mins)	Supine %	RAI	Supine (mins)	Supine %	RAI	Supine (mins)	Supine %
45.7	51	207	46.5	20	63	13.6						
18.6	18	261	54.4	15	181	27.2	30	187	38.4			
24.5	18	500	98.6	8	175	31.0	19	223	45.7	0	146	73.4
14.3	32	233	56.4	23	184	88.5	34	200	51.9	16	111	46.1
56.9	23	137	29.9	26	21	8.7	10	113	19.3	17	83	23.0
46.9	35	436	97.5	11	305	61.5	0	354	59.1			
48.3	32	266	51.1	10	121	37.9	23	155	32.5	32	176	40.3
16.2	3	212	44.4	7	130	27.0	0	171	52.3			
59.4	32	476	96.0	13	211	48.8	10	160	40.5	14	227	54.8
69.7	45	247	49.4	7	76	16.5	4	89	23.7			
81.7	51	459	97.7	25	595	95.4	20	227	91.5	24	714	93.3
30.6	28	231	48.3	5	221	46.3	25	98	49.0	11	151	30.3
67.4	74	121	26.5									
39.8	34	604	29.3	60	129	23.8						
4.4	8	215	48.6	13	345	50.9	9	233	51.1			
10.4	7	84	16.9	6	139	29.3	6	141	27.9	13	67	17.6

肢動症

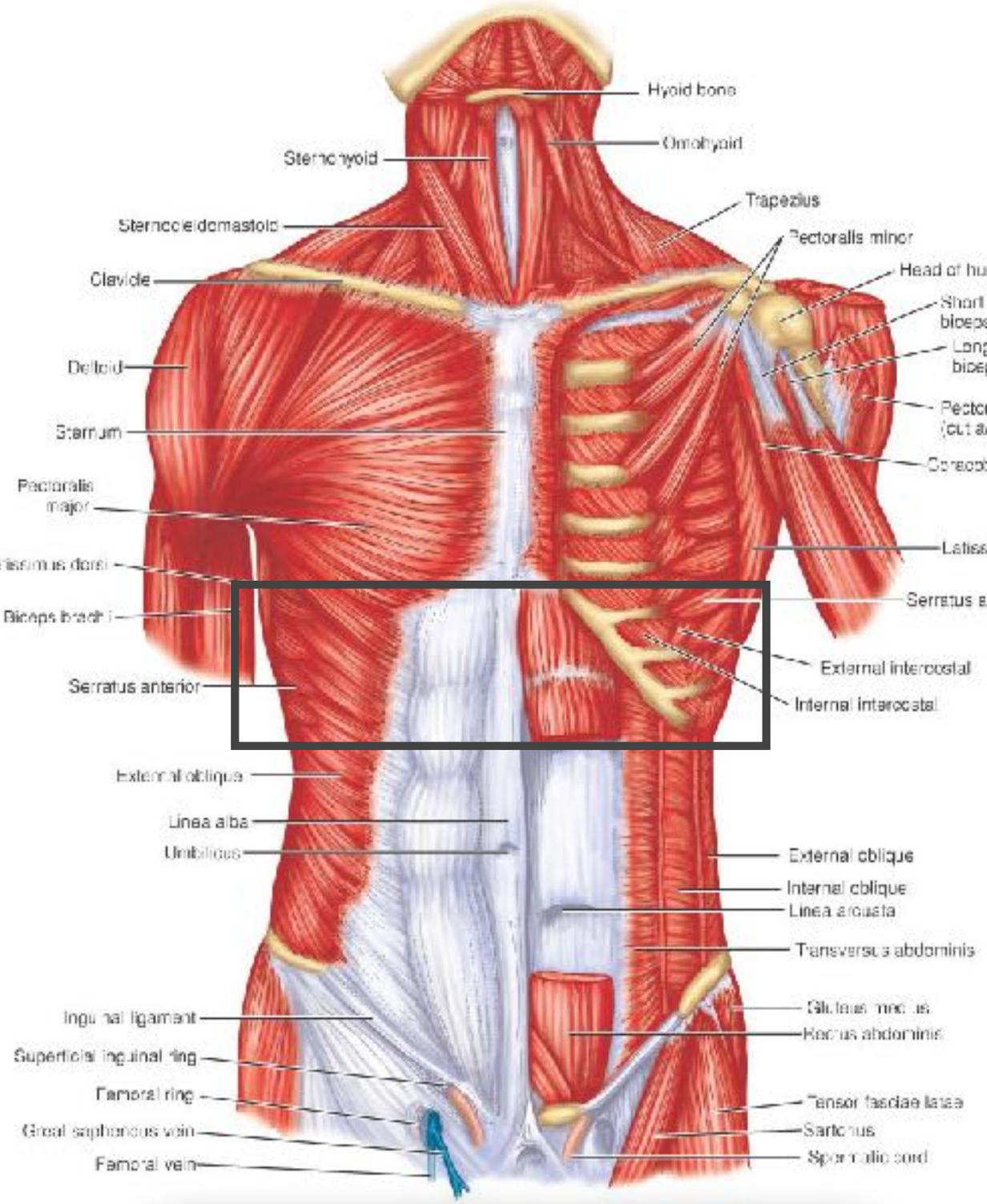


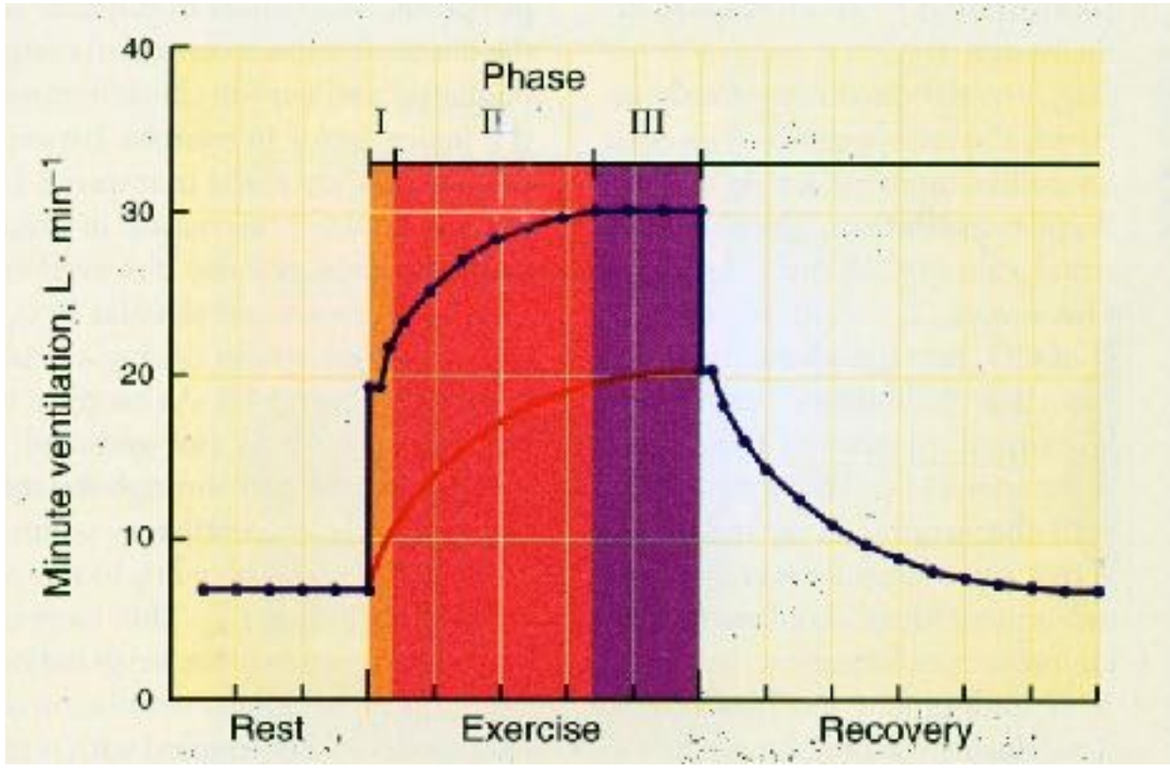
平躺為主 supine



居家：自由翻身

首次由穿戴式裝置證明：
醫院 vs 居家 檢測之睡姿不同
足以影響睡眠呼吸中止嚴重度





Morphological change

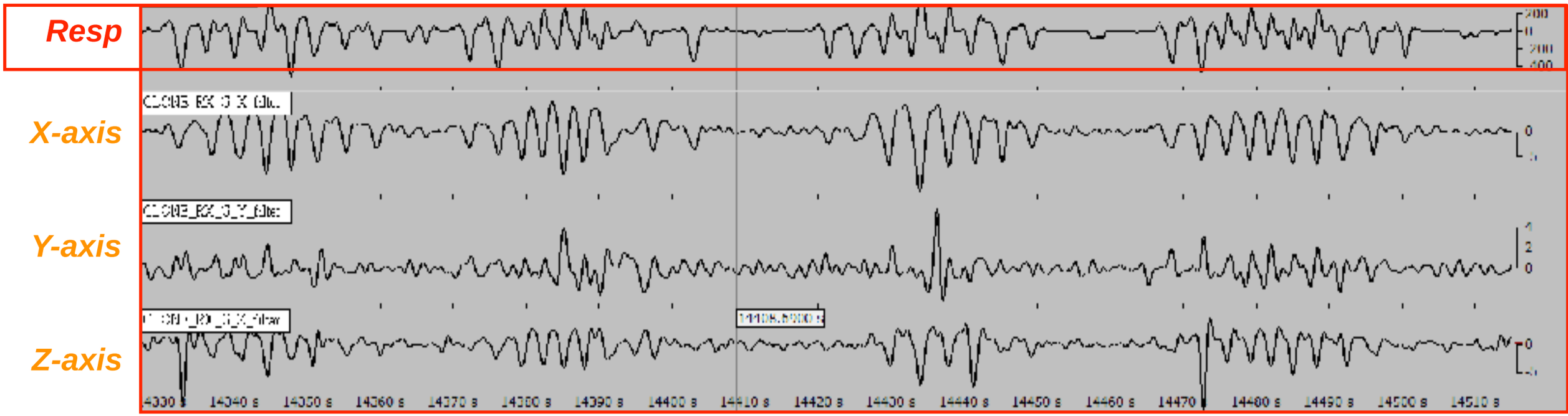
⇩

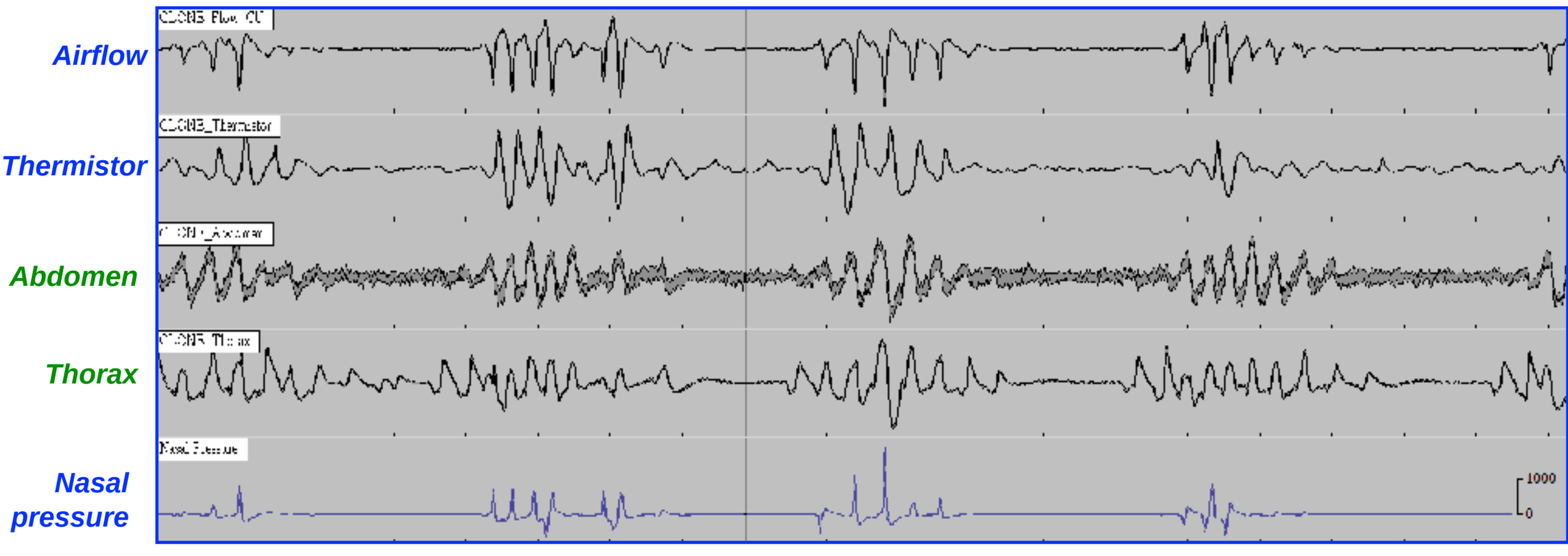
Impedance change

⇩

Voltage change

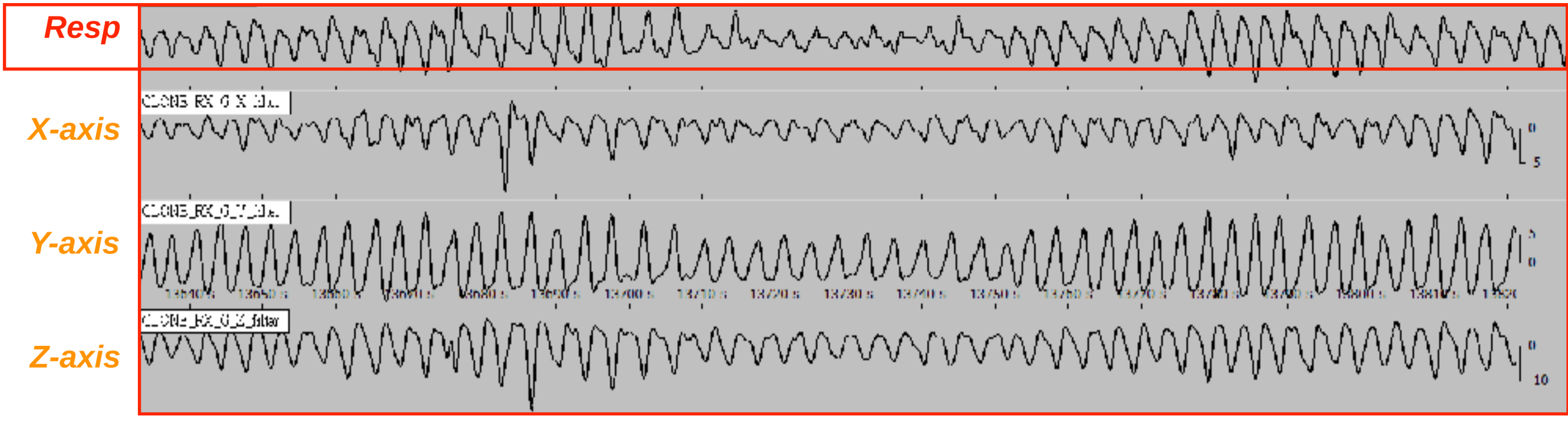
Rooti Rx

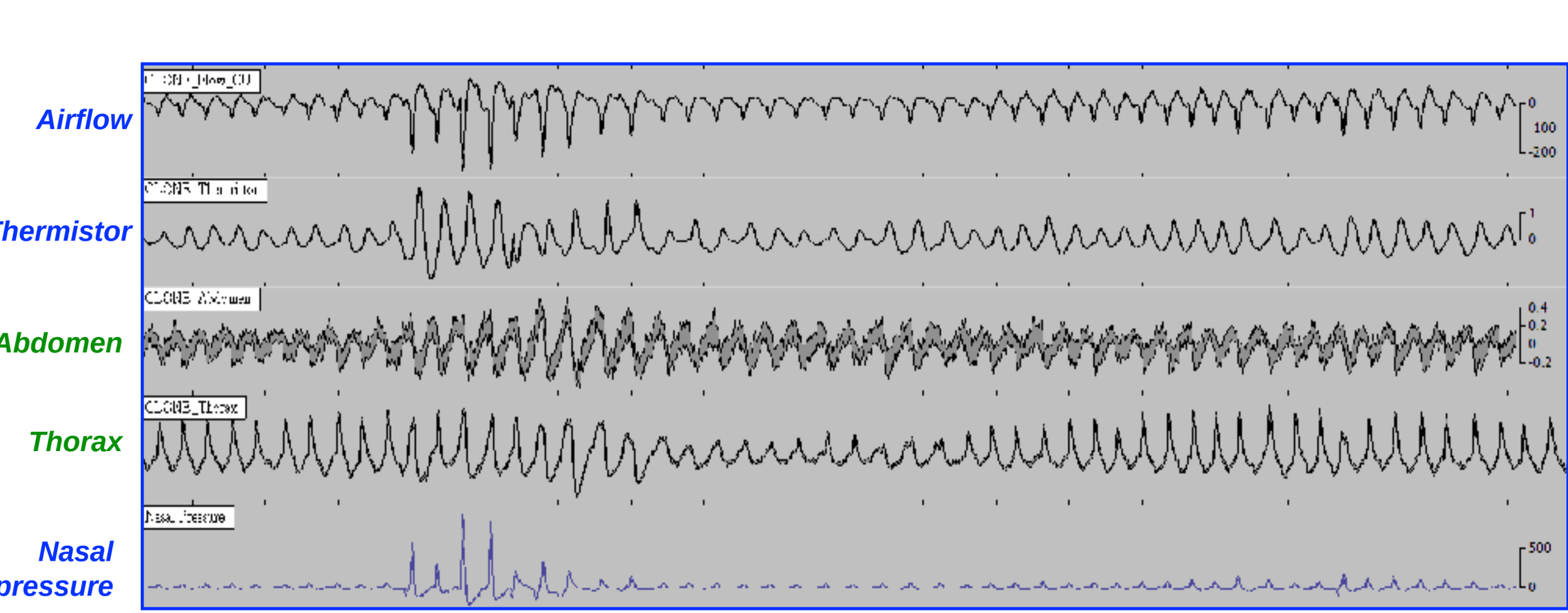




Polysomnography

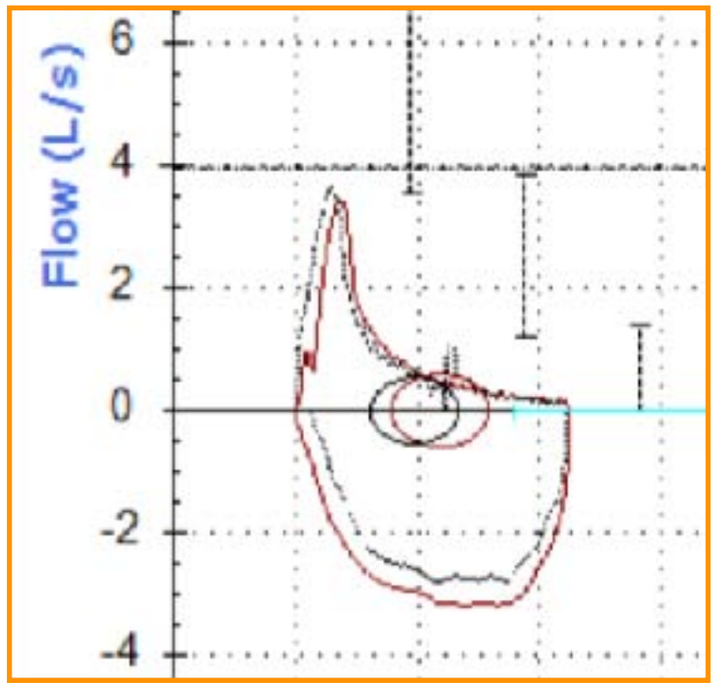
Rooti Rx





Polysomnography

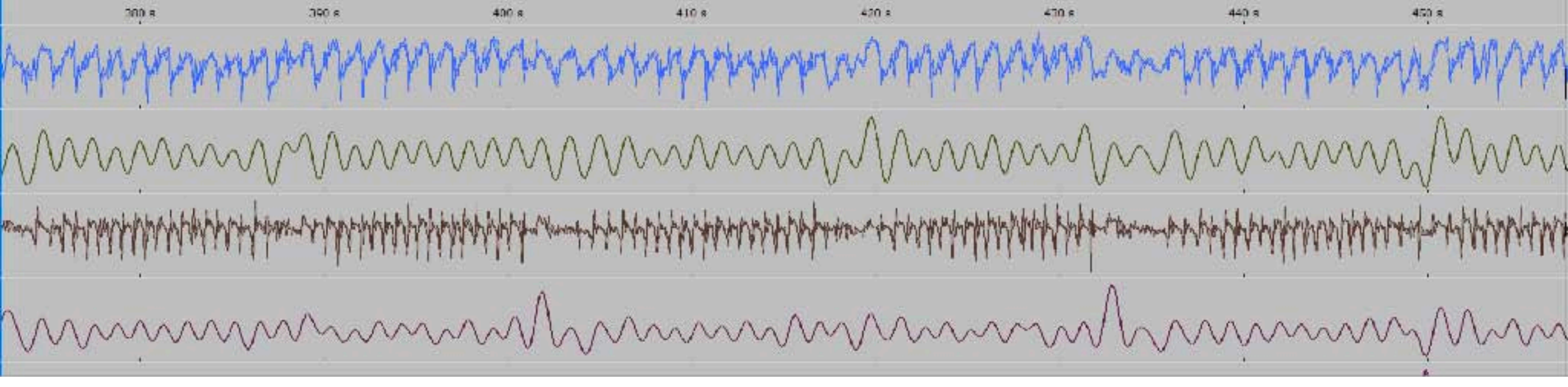
Male
61 y/o
170 cm
48kg
BMI: 16.6



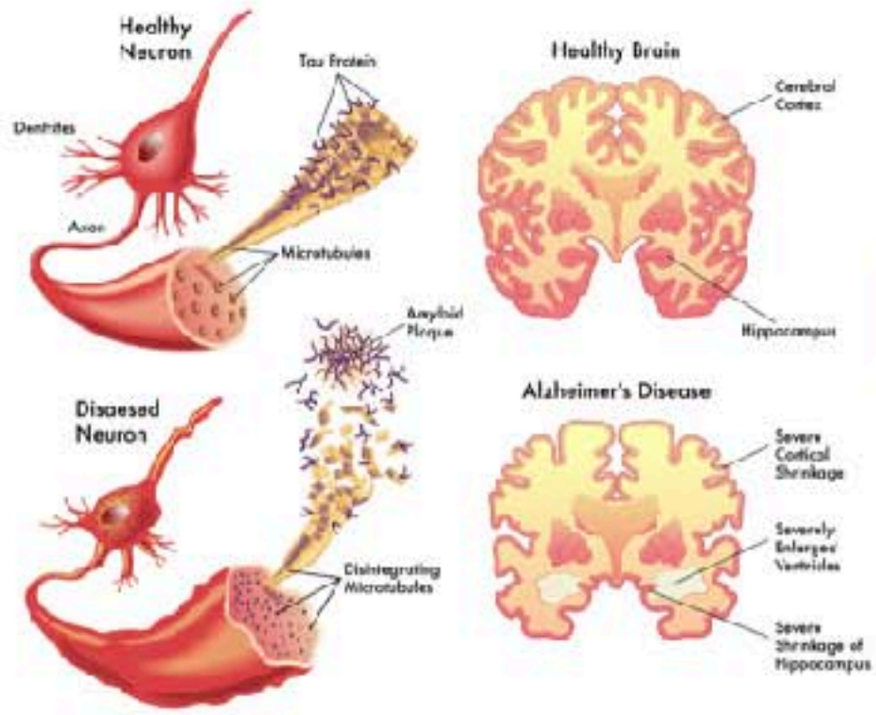
此呼吸肌肉阻抗測量，亦可作為監測慢性呼吸道疾病（如氣喘、慢性阻塞性肺病COPD）病患動態呼吸模式之應用

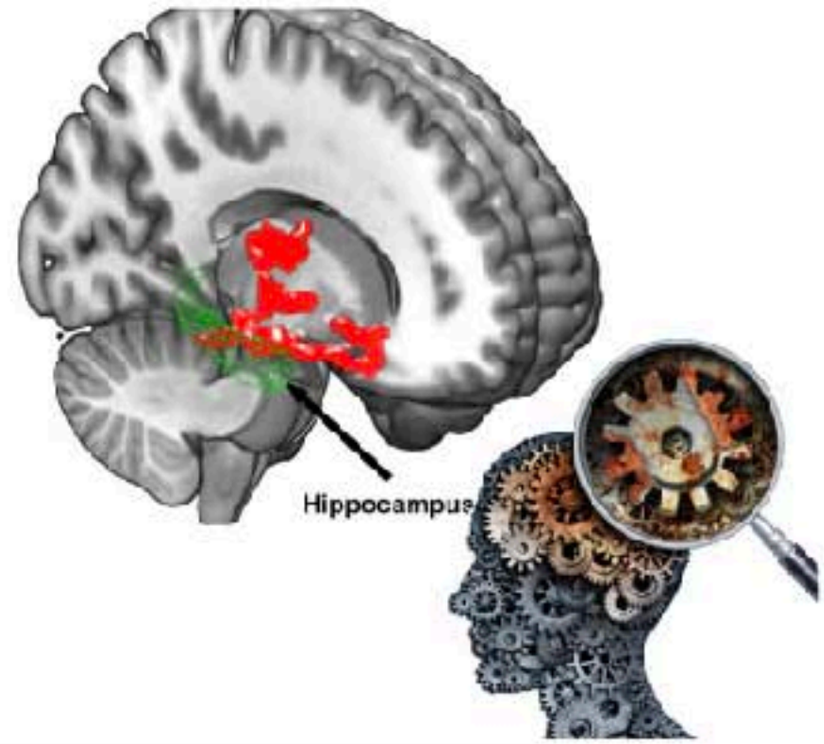
六分鐘運動肺功能

呼吸肌肉阻抗於運動當中之變化

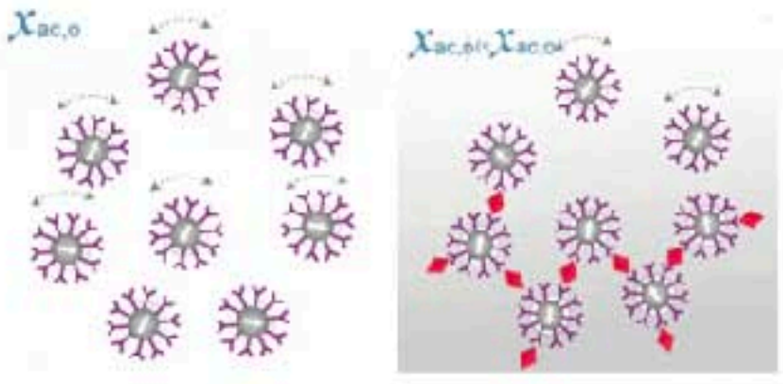


睡眠健康 vs 神經認知功能退化



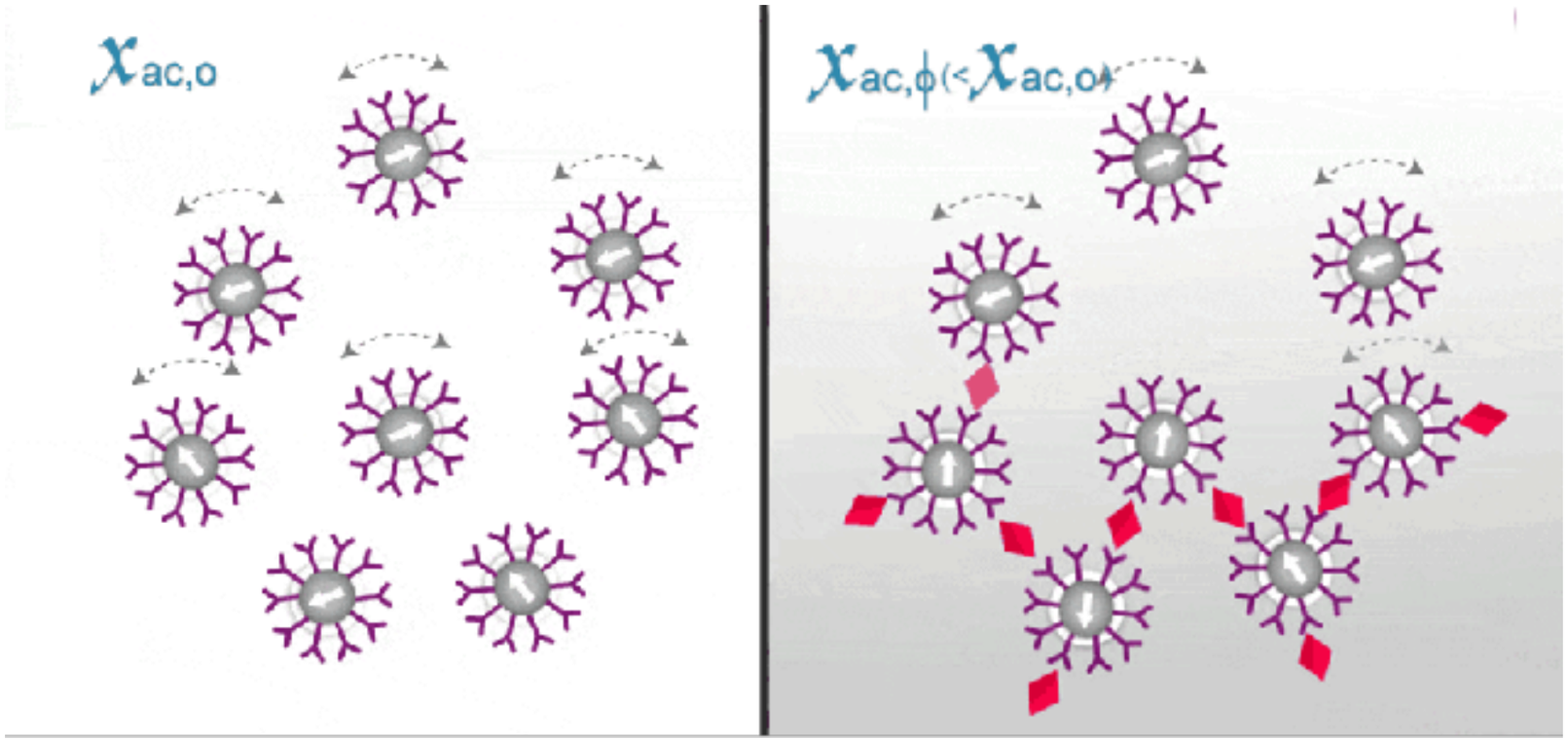


大腦運作所產生的類澱粉蛋白，堆積於神經組織將導致神經元功能喪失，引起多種神經顛化性疾病。此類澱粉蛋白可透過睡眠過程自然清除，因此睡眠呼吸中止症或失眠等，將導致大量腦部類澱粉蛋白堆積，引起神經退化性疾病如 失智症、巴金森氏症等。



免疫磁減量檢測（IMR）原理如左圖所示，乃是利用分散在水中之披覆有生物探針的磁性粒子與待測生物分子結合後，形成磁性粒子叢集（magnetic cluster）或造成磁性粒子變大變重，再藉由量測因這些磁性粒子叢集或大磁性粒子的形成而改變試劑磁性大小，以探知待測生物分子濃度的新穎檢測方式。生物探針的選擇是使用與待測生物分子具高專一性及強力結合性的抗體或抗原。該磁性試劑在外加交流磁場下，所發出的混頻交流磁訊號（xac）

ImmunoMagnetic Reduction (IMR) 免疫磁減量檢測



磁量生技

利用分散在水中之披覆有生物探針的磁性粒子與待測生物分子結合後，形成磁性粒子叢集（magnetic cluster）或造成磁性粒子變大變重，再藉由量測因這些磁性粒子叢集或大磁性粒子的形成而改變試劑磁性大小，以探知待測生物分子濃度。

Neurodegenerative biomarkers: Amyloid-beta 42, Tau protein

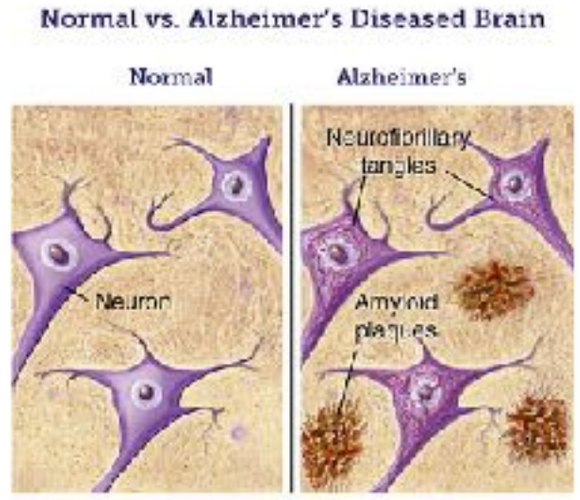
(Amyloid-beta 42 X Tau protein)

	PSG	Rooti Rx with PSG				Rooti Rx, home (1st)				Rooti Rx, home (2nd)				Rooti Rx, home (3rd)			
Tau x AB42	AHI値 (/hr)	RAI	Supine (mins)	Supine %	Total sleep time (mins)	RAI	Supine (mins)	Supine %	Total sleep time (mins)	RAI	Supine (mins)	Supine %	Total sleep time (mins)	RAI	Supine (mins)	Supine %	Total sleep time (mins)
	45.7	51	207	46.5	208.68	20	63	13.6	267.96								
	18.6	18	261	54.4	406.3	15	181	27.2	498	30	187	38.4	369.36				
	24.5	18	500	98.6	440.22	8	175	31.0	501.96	19	223	45.7	365.25	0	146	73.4	162.36
350.56	14.3	32	233	56.4	329.6	23	184	88.5	171.81	34	200	51.9	299.52	16	111	46.1	218.4
	56.9	23	137	29.9	370.17	26	21	8.7	208.8	10	113	19.3	461.36	17	83	23.0	316.8
386.49	46.9	35	436	97.5	414.78	11	305	61.5	217.8	0	354	59.1	203.32				
364.33	48.3	32	266	51.1	421.2	10	121	37.9	263.94	23	155	32.5	333.2	32	176	40.3	162.06
443.30	16.2	3	212	44.4	276.08	7	130	27.0	355.2	0	171	52.3	270.58				
216.14	59.4	32	476	96.0	455.4	13	211	48.8	396.52	10	160	40.5	366.42	14	227	54.8	379.96
204.88	69.7	45	247	49.4	419.16	7	76	16.5	307.53	4	89	23.7	258.75				
484.26	81.7	51	459	97.7	436.17	25	595	95.4	535.78	20	227	91.5	234.65	24	714	93.3	588.28

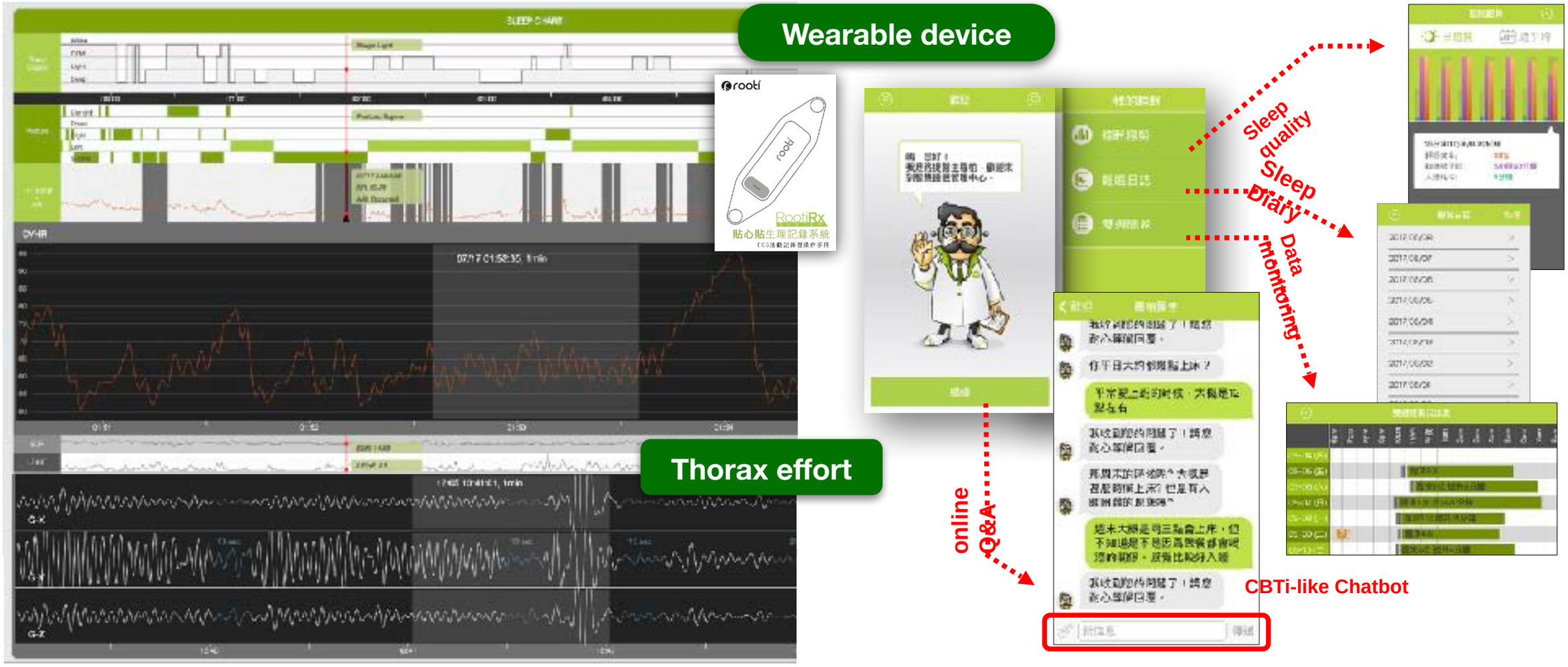
Table 4. Thresholds, Sensitivity and Specificity for Differentiation of Healthy Controls, MCI due to AD, and AD Dementia, for Various Parameters[a]

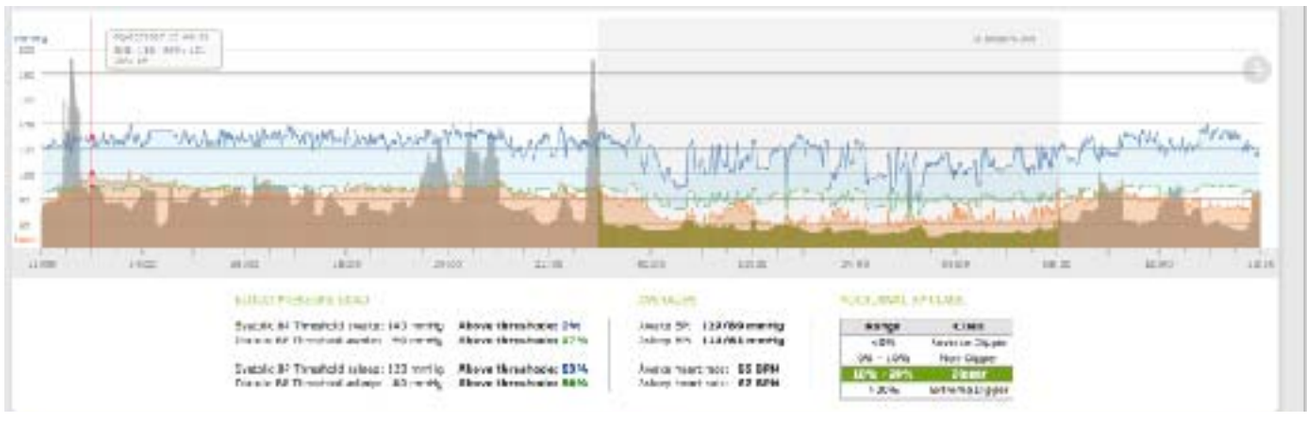
parameter	groups	threshold	sensitivity	specificity
$\phi_{Aβ42}$	HC vs Patients	16.33 pg/mL	0.91	0.88
	MCI vs ADD	17.65 pg/mL	0.69	0.68
ϕ_{tau}	HC vs Patients	23.89 pg/mL	0.97	0.91
	MCI vs ADD	38.18 pg/mL	0.78	0.82
$\phi_{Aβ42} \times \phi_{tau}$	HC vs Patients	455.49 $(pg/mL)^2$	0.96	0.97
	MCI vs AD	642.58 $(pg/mL)^2$	0.80	0.82

[a]HC, healthy controls; MCI, mild cognitive impairment due to Alzheimer's disease; ADD, Alzheimer's disease dementia, including those with very mild to severe (CDR = 0.5−3) dementia. ADD and MCI are combined to form Patients.



穿戴式裝置 與 聊天機器人 疾病管理系統



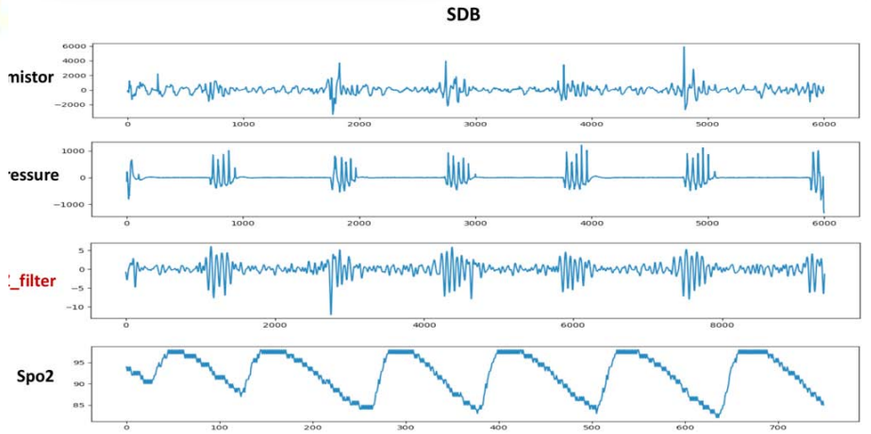


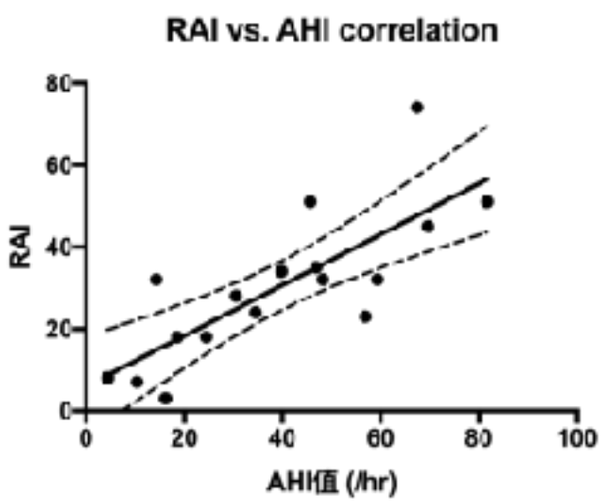
Physical activity of daily life
(Circadian Rhythm)

Autonomic Nerve System
(Heart Rate Variability)

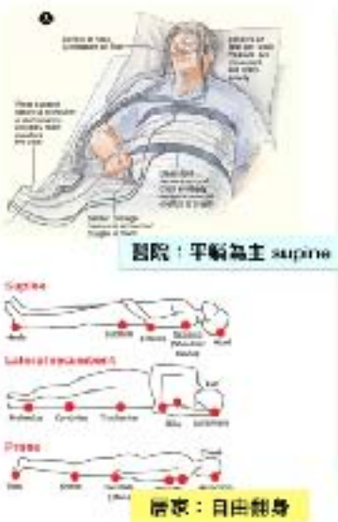
睡眠環境 ：

近身溫度 | 濕度 | 二氧化碳 | 室內空污 | 空氣流速





PSG	Rooti Rx with PSG			Rooti Rx. home (1st)			Rooti Rx. home (2nd)			Rooti Rx. home (3rd)		
AHI值 (/hr)	RAI	Supine (mins)	Supine %	RAI	Supine (mins)	Supine %	RAI	Supine (mins)	Supine %	RAI	Supine (mins)	Supine %
46.7	61	207	46.5	20	68	13.6						
18.6	16	261	64.4	16	181	27.2	30	187	38.4			
24.5	16	603	98.5	8	175	31.0	19	223	46.7	0	146	73.4
14.3	32	233	66.4	23	184	66.6	34	260	61.9	16	111	46.1
56.9	23	197	29.9	23	41	6.7	10	113	15.3	17	63	23.0
46.9	25	439	97.5	11	305	61.5	0	354	66.1			
48.3	32	268	51.1	10	121	37.0	23	155	32.5	32	176	40.3
16.2	3	212	44.4	7	130	27.0	0	171	52.3			
58.4	32	476	96.0	13	211	48.8	10	160	40.5	14	227	54.9
68.7	40	247	49.4	7	76	16.5	6	89	23.7			
81.7	61	469	97.7	25	595	95.4	30	227	91.5	24	414	80.3
30.8	28	231	48.3	9	221	46.3	25	98	49.0	11	151	36.3
57.4	74	121	28.5									
30.8	34	604	29.3	60	120	23.8						
4.4	8	215	48.6	13	345	90.8	9	233	51.1			
10.4	7	84	16.8	6	139	29.3	6	141	27.8	13	67	17.6
34.6	24	436	86.6	13	153	49.7	16	276	66.6	21	274	60.5



由穿戴式裝置證明:

醫院 vs 居家 檢測之睡姿不同

足以影響睡眠呼吸中止嚴重度評估

改善方向

睡眠呼吸中止症 體重變化	(就寢)時間安排 工作壓力	空氣品質 溫度 運動習慣	環境聲音 光線 他人干擾	精神 神經 疾病

具體方法：睡眠數據平台、個人互動介面

聊天機器	睡眠管理	臨床醫師	產業鏈	商業模式
改善方向呈現	互動內容調整	治療策略定案	醫藥/器材開發	支付模式(保險)
衛教建議資料	初步評估成果	疾病治療轉介	生理數據量化	獎勵/信用機制
詢問相關問題	釐清改善方案	發掘潛在問題	居家物聯網	新創服務
資料互動介面	問題輕重區分	治療資源規劃	社群力量整合	新醫療體系

TAPIA

睡眠健康
整合照護中心

睡眠障礙、
睡眠呼吸中止
亞健康族群

系統訓練完成
個人化自動評估

穿戴式裝置:
G-sensor（活動量）
Heart rate variability
Respiratory pattern

睡眠環境數據:
空氣品質、環境聲音、鼾聲、光線

醫療院所評估:
睡眠相關檢查
醫療人員評估

初期系統訓練（數日至數週）

大數據分析
人工智慧演算法

改善成果回饋
（數週至數月）

聊天機器人

評估與說明
睡眠前後語音變化
對話問診
治療方針介紹、回饋
認知功能評估

認知行為治療
睡眠衛生教育
認知改變治療
行為改變治療