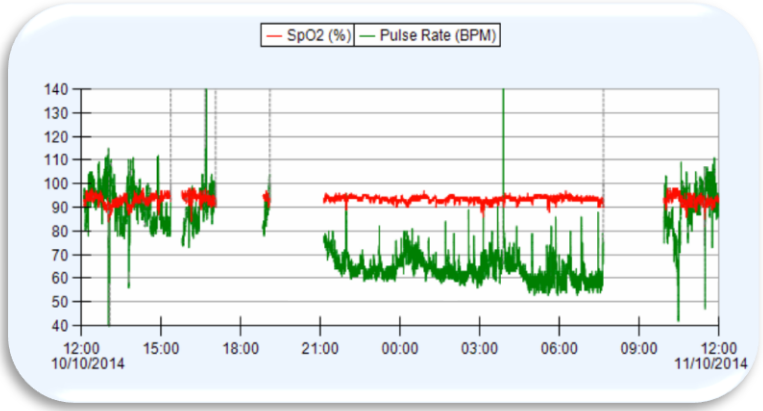
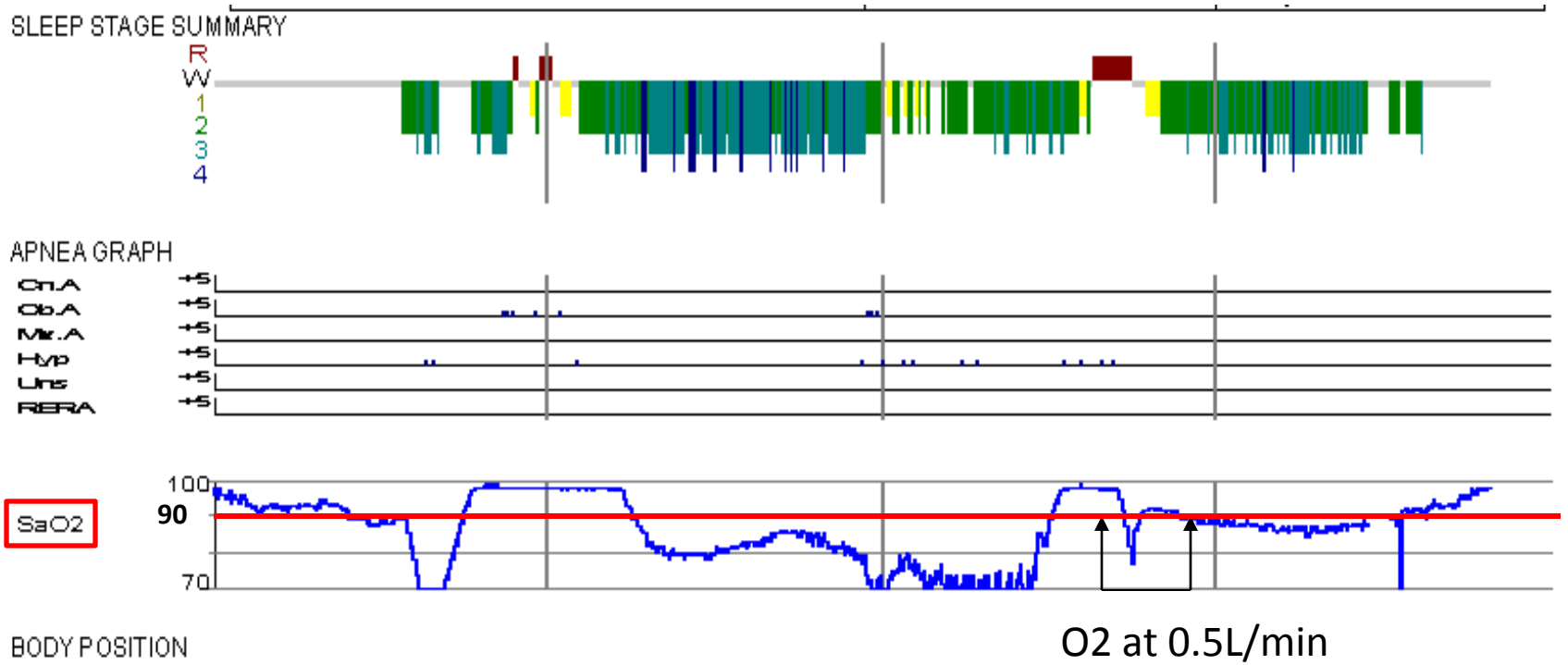


From Telemonitoring to Self-empowerment

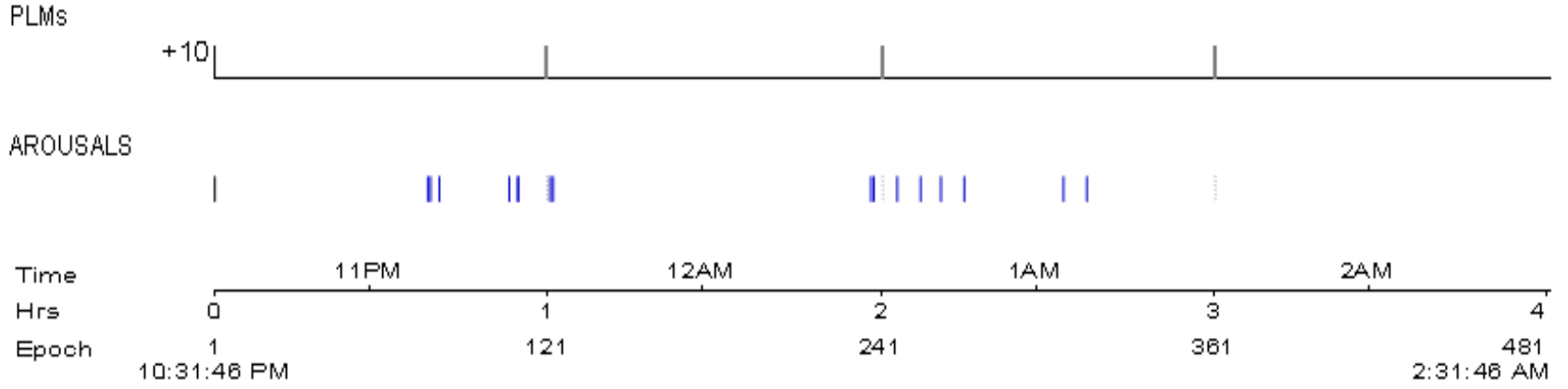
CHOO Kah Lin
Respiratory Specialist
Consultant (Medicine)
North District Hospital

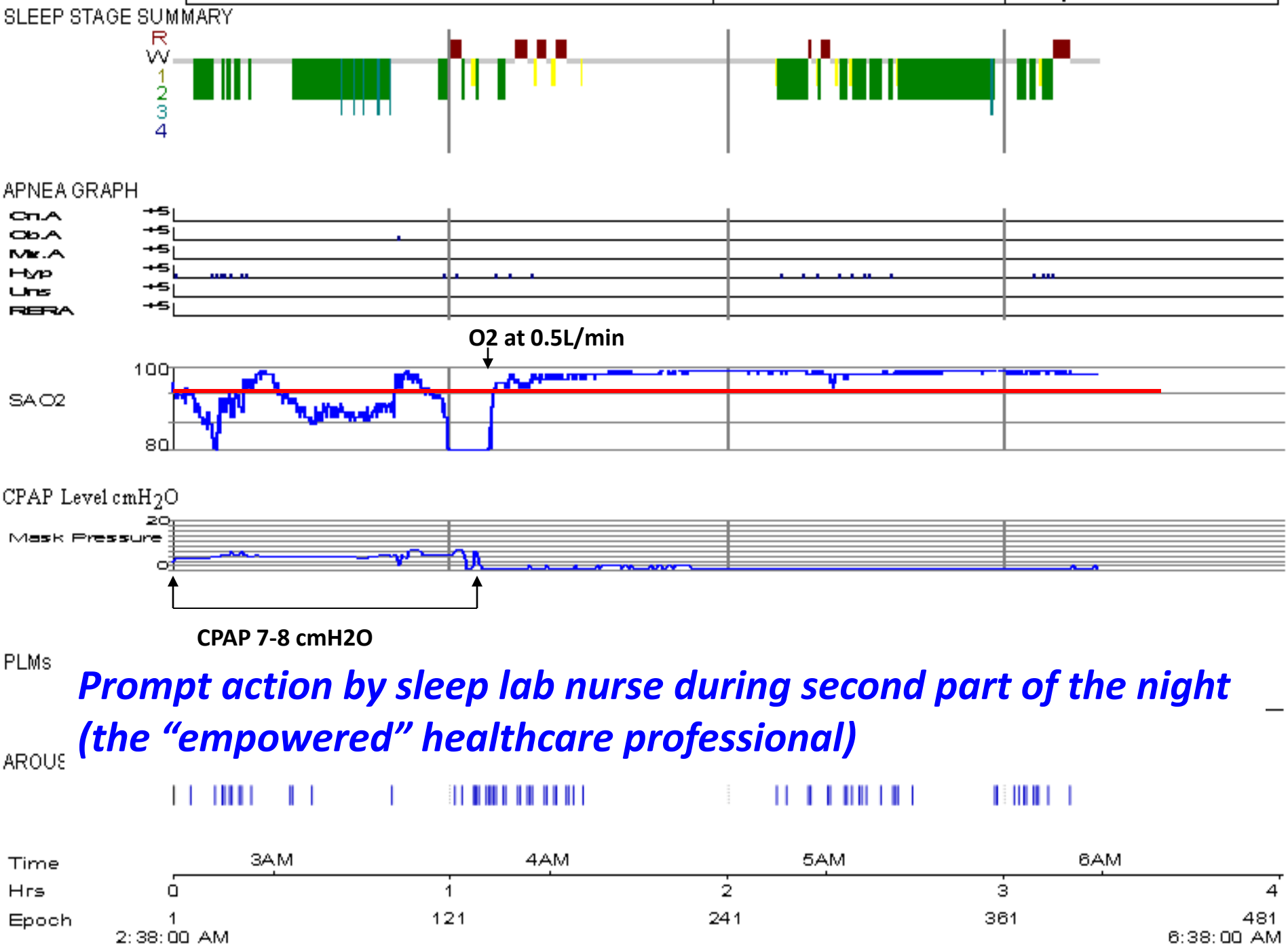
Our first telemonitored patient initially presented to the sleep lab…



O2 at 0.5L/min

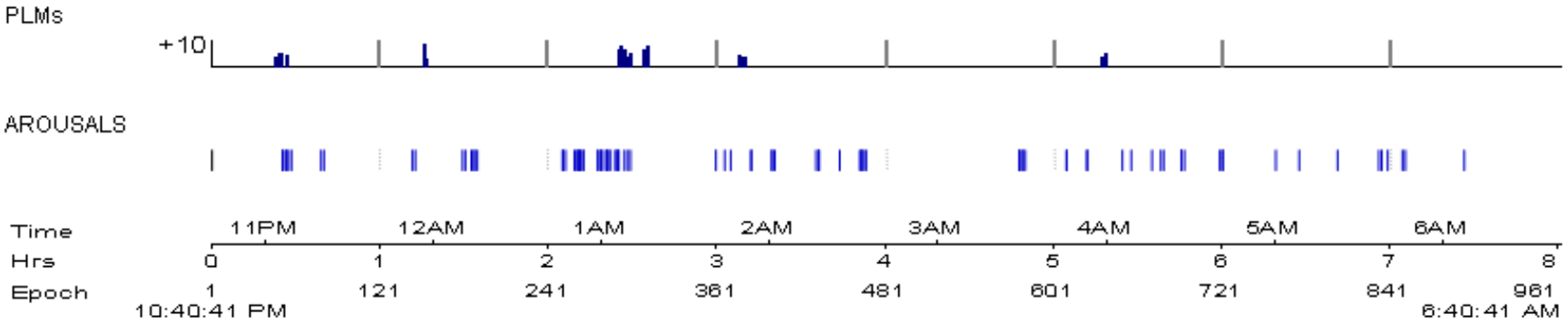
Wife complained that her husband turned blue every night!





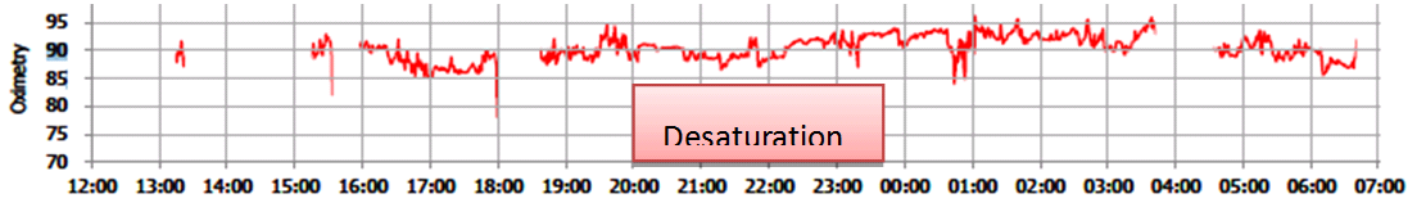
Prompt action by sleep lab nurse during second part of the night (the "empowered" healthcare professional)

Manual bilevel positive airway pressure titration in sleep lab

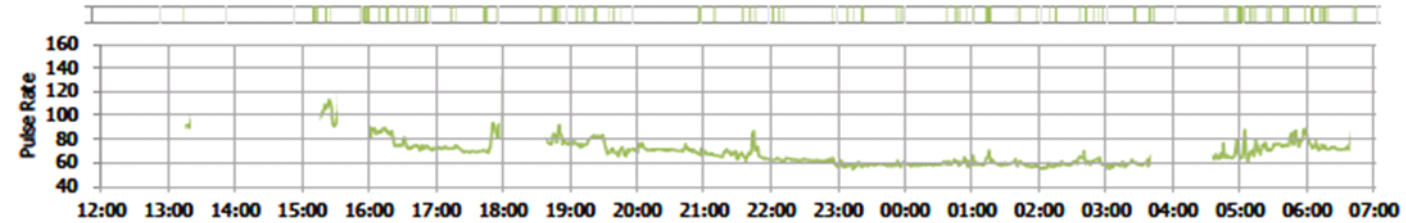


Non-Invasive Ventilation (NIV) Telemonitoring

172 patients received 244 episodes of telemonitoring

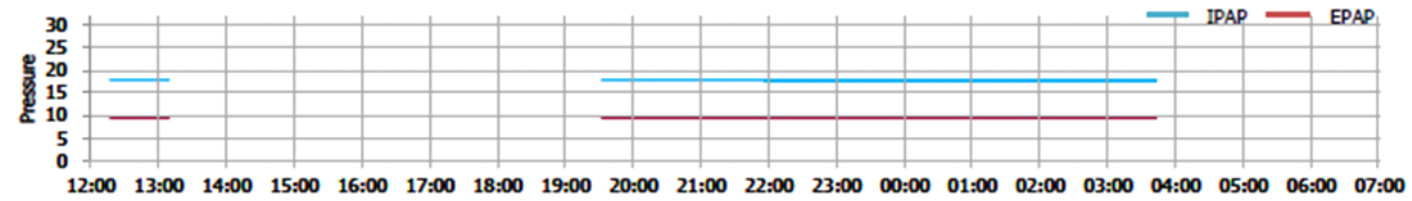


Average	91 %
Median	91 %
5th Percentile	86 %
95th Percentile	94 %



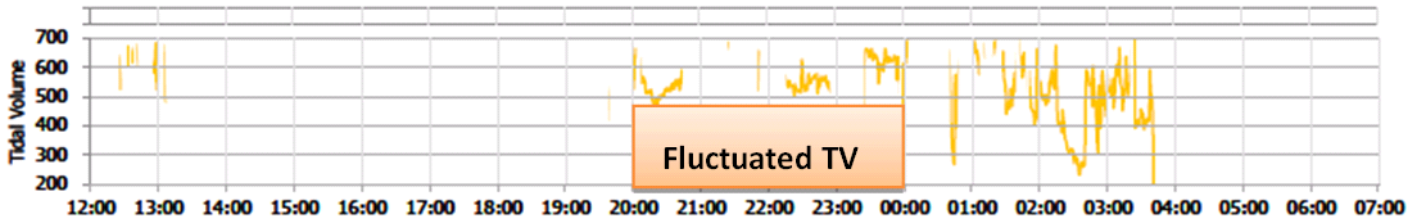
Pulse Rate

Average	69 BPM
Median	67 BPM
5th Percentile	57 BPM
95th Percentile	89 BPM



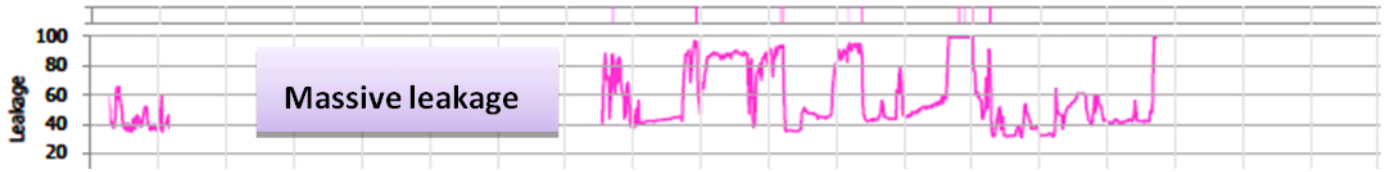
IPAP : EPAP (cmH2O)

Average	18 : 9.9
Median	17.9 : 9.8
5th Percentile	17.9 : 9.8
90th Percentile	17.9 : 9.9



Tidal Volume

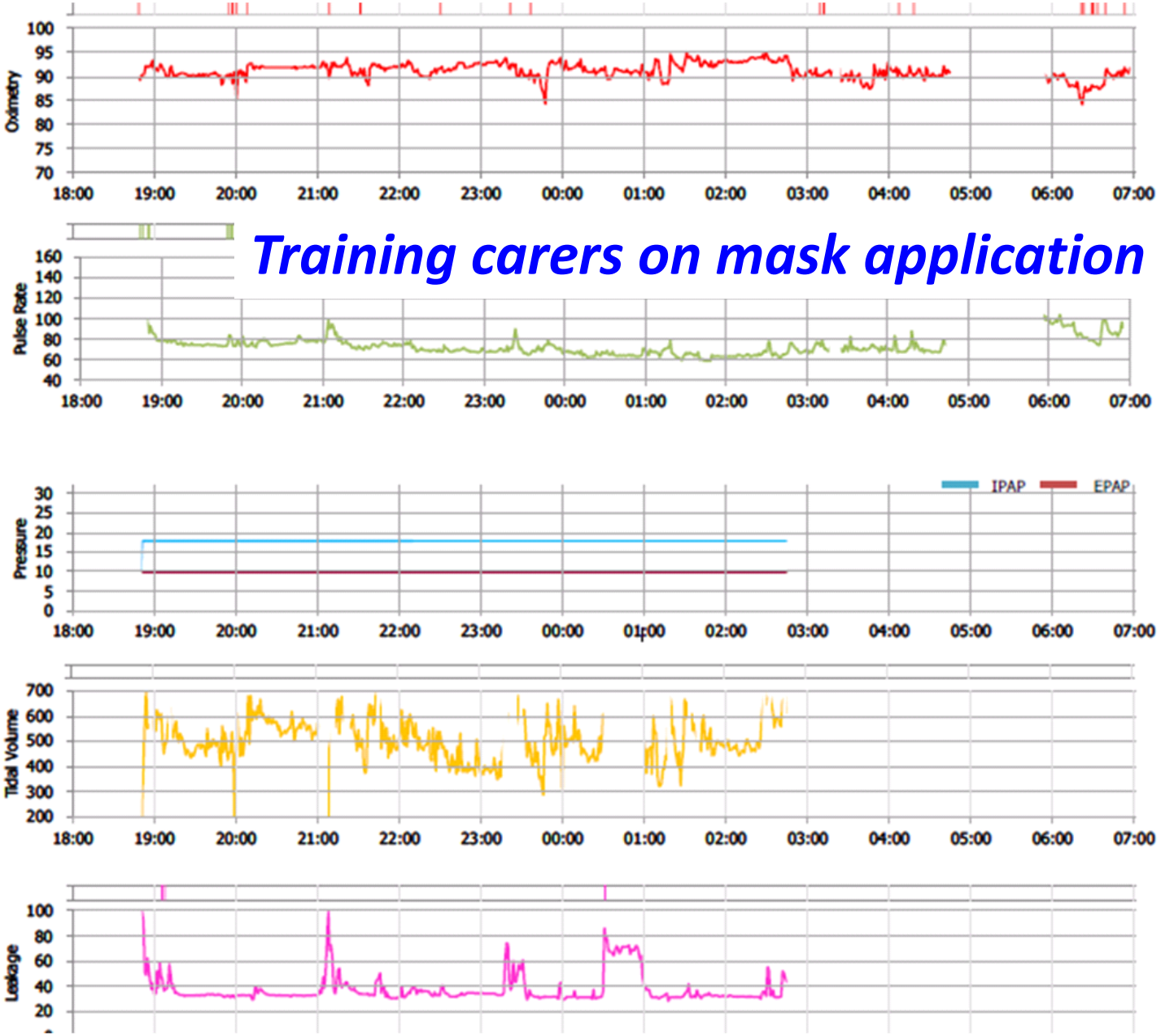
Average	532.5 ml
Median	543 ml
5th Percentile	311 ml
90th Percentile	659.1 ml



Leakage

Average	56.7 LPM
Median	47.3 LPM
5th Percentile	33 LPM
90th Percentile	89.6 LPM

Commonest problem!



Training carers on mask application

Oximetry

Average	92 %
Median	91 %
5th Percentile	88 %
95th Percentile	94 %

Pulse Rate

Average	73 BPM
Median	71 BPM
5th Percentile	63 BPM
95th Percentile	93 BPM

IPAP : EPAP (cmH2O)

Average	17.9 : 9.9
Median	17.9 : 9.8
5th Percentile	17.9 : 9.8
90th Percentile	17.9 : 9.8

Tidal Volume

Average	502.1 ml
Median	499 ml
5th Percentile	371 ml
90th Percentile	609 ml

Leakage

Average	38.2 LPM
Median	33.3 LPM
5th Percentile	31 LPM
90th Percentile	53.7 LPM

Other breathing disorders detected on telemonitoring

Average	92 %
Median	92 %
5th Percentile	86 %
95th Percentile	97 %

Pulse Rate

Average	59 BPM
Median	59 BPM
5th Percentile	49 BPM
95th Percentile	68 BPM

IPAP : EPAP (cmH2O)

Average	25.2 : 12
Median	25.1 : 11.9
5th Percentile	25.1 : 11.9
90th Percentile	25.2 : 11.9

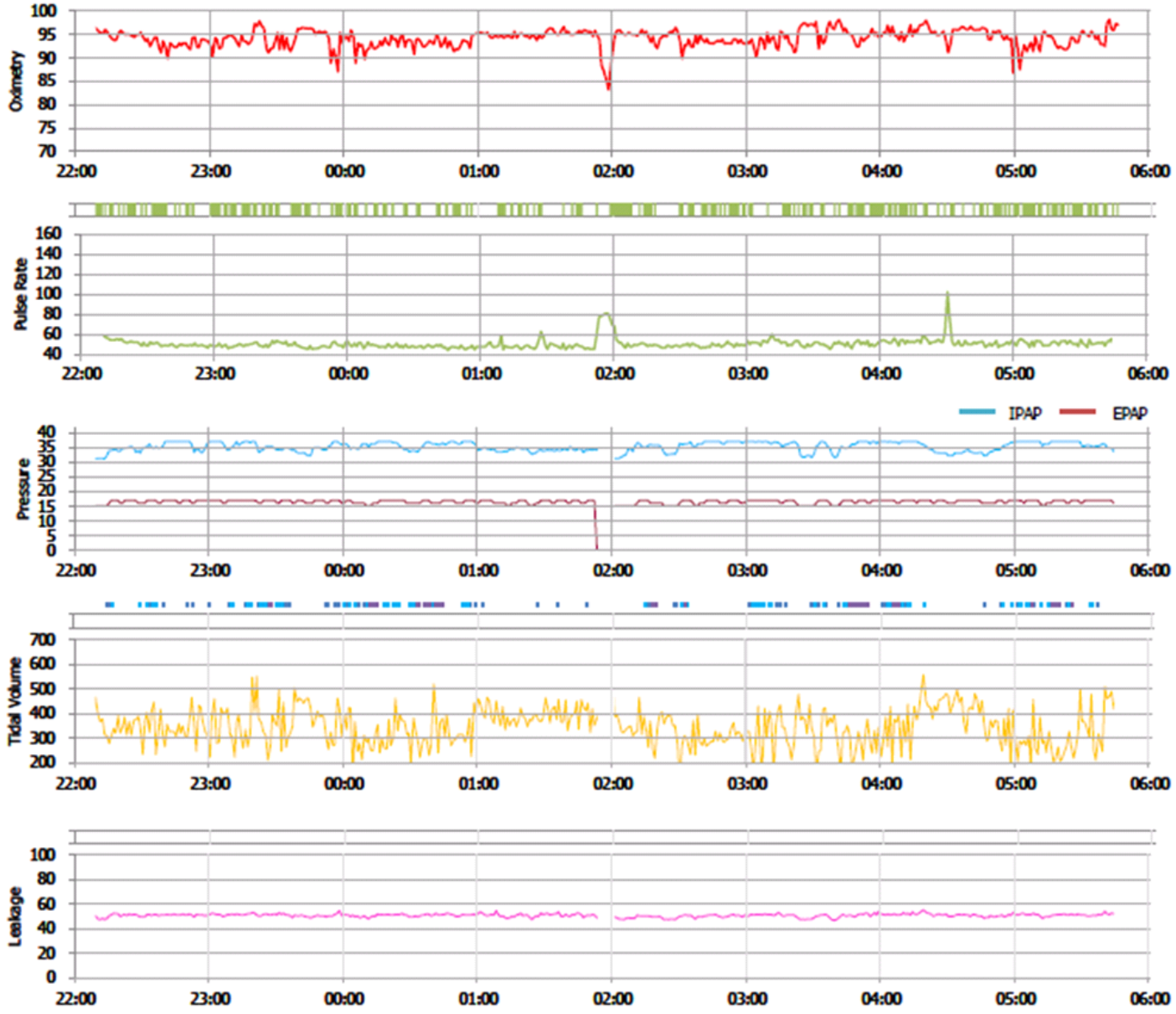
Tidal Volume

Average	304.5 ml
Median	290 ml
5th Percentile	232.7 ml
90th Percentile	377.6 ml

Leakage

Average	42.6 LPM
Median	41 LPM
5th Percentile	40.1 LPM

Concomitant sleep-disordered breathing



Average	95 %
Median	95 %
5th Percentile	90 %
95th Percentile	97 %

Pulse Rate

Average	51 BPM
Median	50 BPM
5th Percentile	44 BPM
95th Percentile	58 BPM

IPAP : EPAP (cmH2O)

Average	35.3 : 16.4
Median	35.4 : 16.9
5th Percentile	32.3 : 15
90th Percentile	37.1 : 16.9

Tidal Volume

Average	344.5 ml
Median	346 ml
5th Percentile	215 ml
90th Percentile	449 ml

Leakage

Average	50.7 LPM
Median	50.8 LPM
5th Percentile	48 LPM
90th Percentile	52 LPM

NIV telemonitoring outcomes

- **65 patients** (including 21 re-admitters) discharged with home NIV between May 2010 and May 2012 were telemonitored for ≥ 4 weeks over **99 episodes**
- 19 abnormal respiratory events despite mask leakage correction
  - 6 episodes of over-ventilation (excessive pressures)
  - 4 episodes of under-ventilation (tidal volume too low)
  - 4 episodes of suspected obstructive sleep apnoea
  - 3 episodes of desaturation
  - 2 episodes of inadequate respiratory rate
- BiPAP setting adjustment (IPAP, EPAP, respiratory rate, O_2 flow)
- ***When patients & carers feel empowered to live with their illness, readmission could be avoided (67.6% episodes)***

Wai SF *APSR* 2012

Telemonitoring

Mild-Moderate Disease

Pulse oximetry - Severe Disease with Hypoxic Risk

Very Severe Disease with Resp Failure

Physical Activity - TeleRehabilitation

Pulse oximetry telemonitoring

SpO_2 finger probe

Transmitter

Password protected Website

SpO_2 telemonitoring outcomes

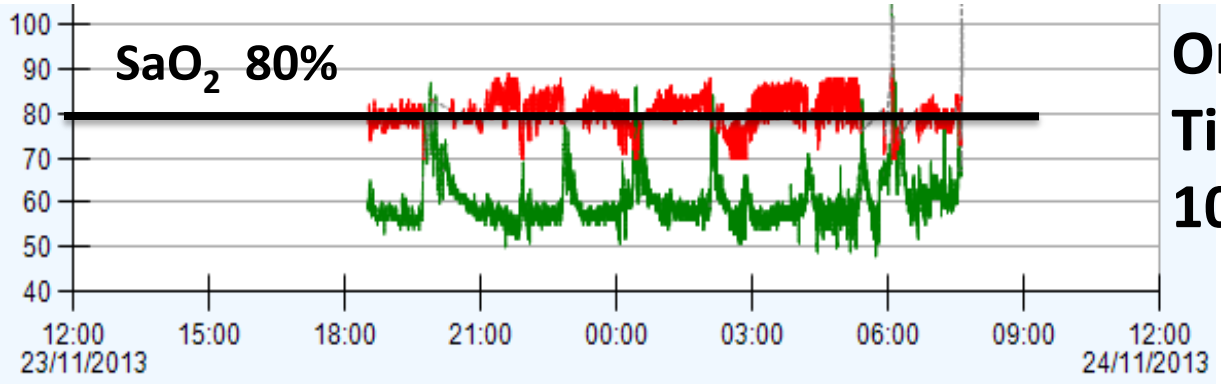
- New O_2 therapy users & long-term O_2 users with poor compliance
- Frequent admitters & community patients with symptoms of exacerbation

- 82 episodes of telemonitoring provided to 67 patients for 14 days between August 2010 and October 2011

- 63 (77%) episodes of **desaturation** among **50 patients**
  - –Acute COPD exacerbation in 27 (33%) episodes
    - •antibiotics and prednisolone were prescribed in 10 (37%) episodes
    - •Outpatient appointment advanced in three (11%) episodes
  - ***–Hospitalization was avoided for 42 (84%) of the 50 hypoxic patients***

Vong YP, *HA Convention* 2012

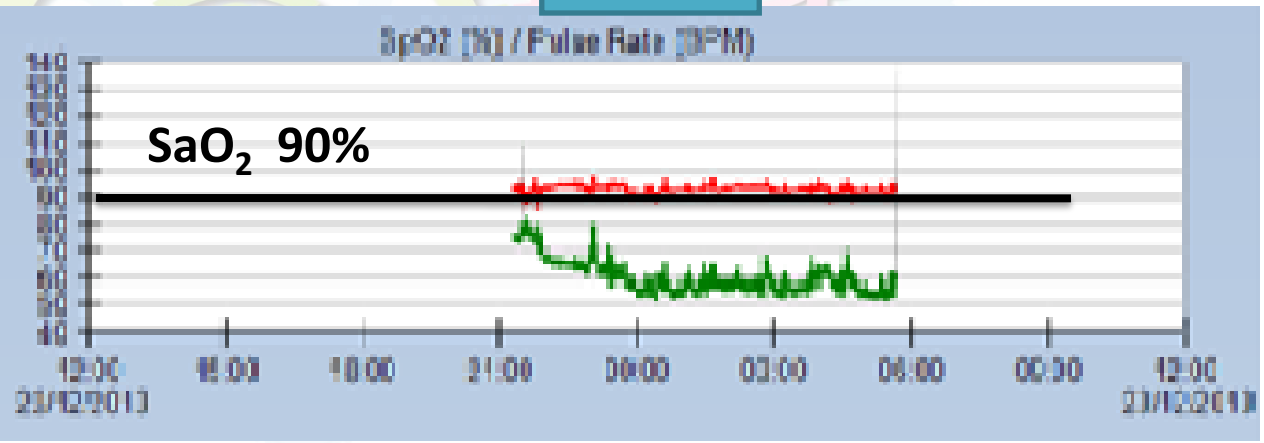
Hypoxia despite oxygen therapy…



On oxygen at 3.5 L/min
Time with SpO_2 < 88%:
10h 28min

Clinical Admission with NIV initiation & decreased O_2 flow rate

Discharged with nocturnal NIV (IPAP 20, EPAP 12, RR 12, O_2 at 1 L/min)



Telemonitoring data:
Mean SpO_2 92%
Time at SpO_2 < 88%:
19min

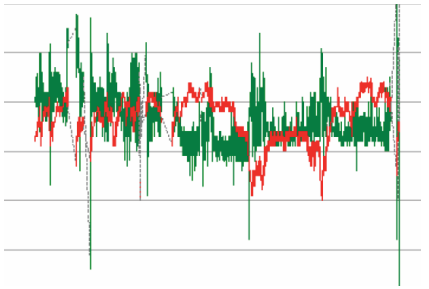
Walking with a near-empty oxygen cylinder…

I hadn't realized that my oxygen saturation went down to 70%!

The oxygen company has been informed to refill my oxygen cylinder three times a week

As I no longer feel so breathless when I exercise I can go out more often

I've not been admitted to hospital for the past 18 months!



Telemonitoring

COPD Assessment Test (CAT)

Mild-Moderate Disease

Severe Disease with Hypoxic Risk

Very Severe Disease with Resp Failure

Physical Activity - TeleRehabilitation

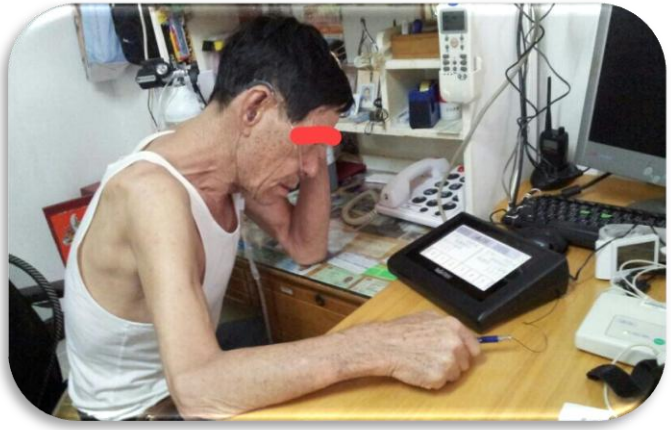
慢性阻塞肺病 COPD 評估問卷

這問卷幫助你及醫療人員評估慢性阻塞肺病(COPD)對你身心健康及日常生活的影響。 測試結果及其分數可幫助你及
肺病(COPD)的處理方法，及讓治療發揮最大的作用。

請就以下每題，選出一個最符合您現況的一格。請確保每題只選一個答案。

例子: 我十分快樂 0 ✓ 2 3 4 5 我十分傷心

1	我沒有咳嗽	0 1 2 3 4 5	我不停咳嗽	Cough
2	我肺內完全沒有痰液	0 1 2 3 4 5	我肺內完全充滿痰液	Phlegm
3	我胸口完全沒有繃緊的感覺	0 1 2 3 4 5	我胸口感到十分繃緊	Chest tightness
4	當我行上斜路或上一層樓梯時，我沒有氣喘	0 1 2 3 4 5	當我行上斜路或上一層樓 我感到十分氣喘	Walking Uphill
5	我在家中的活動不受限制	0 1 2 3 4 5	我在家中的活動十分	Home Activities
6	儘管我的肺部情況，我仍有信心離家外出	0 1 2 3 4 5	因為我的肺部情況， 我完全沒有信心離家	Confidence leaving home
7	我睡得很好	0 1 2 3 4 5	我因肺部情況而睡得	Sleeping soundly
8	我精力充沛	0 1 2 3 4 5	我完全沒有精力	Energy level



					26/1	27/1	28/1	29/1
1	我沒有咳嗽	0-5	我不停咳嗽	***Cough***	1	4	3	3
2	我肺內完全沒有痰液	0-5	我肺內完全充滿痰液	***Phlegm***	1	5	3	3
3	我胸口完全沒有繃緊的感覺	0-5	我胸口感到十分繃緊	***SOB***	1	5	3	3
4	當我行上斜路或上一層樓梯時,我沒有氣喘	0-5	當我行上斜路或上一層樓梯時,我感到十分氣喘		1	4	4	5
5	我在家中的活動不受限制	0-5	我在家中的活動十分受限制		1	4	3	3
6	儘管我的肺部情況，我仍有信心離家外出	0-5	因為我的肺部情況，我完全沒有信心離家外出		1	3	3	4
7	我睡得很好	0-5	我因肺部情況而睡得不好		1	4	4	3
8	我精力充沛	0-5	我完全沒有精力		1	2	4	3
				總分	8	31	27	27

- Overall CAT score increase **≥ 5** suggests the onset of an exacerbation
- Symptoms of exacerbation scores **> 3** highlighted in **red**

Automated Instruction based on symptom scores

Non-pharmacological treatment

- Animated demonstrations of breathing and coughing techniques

- Tips on energy conservation

Patient feedback

- 95% felt that their self-management of cough, dyspnoea and sputum clearance had improved
- 95% felt that symptom control was enhanced and anxiety was reduced when their condition worsened
- 96% felt that overall understanding of disease and self-management were enhanced

Man CS, *ISQua* 2013

Telemonitoring

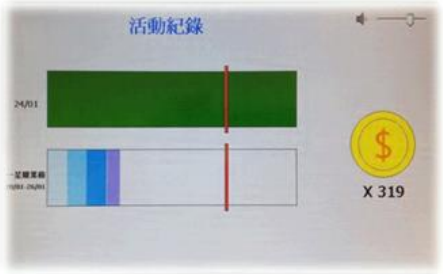
Mild-Moderate Disease

Severe Disease with Hypoxic Risk

Very Severe Disease with Resp Failure

Physical Activity - TeleRehabilitation

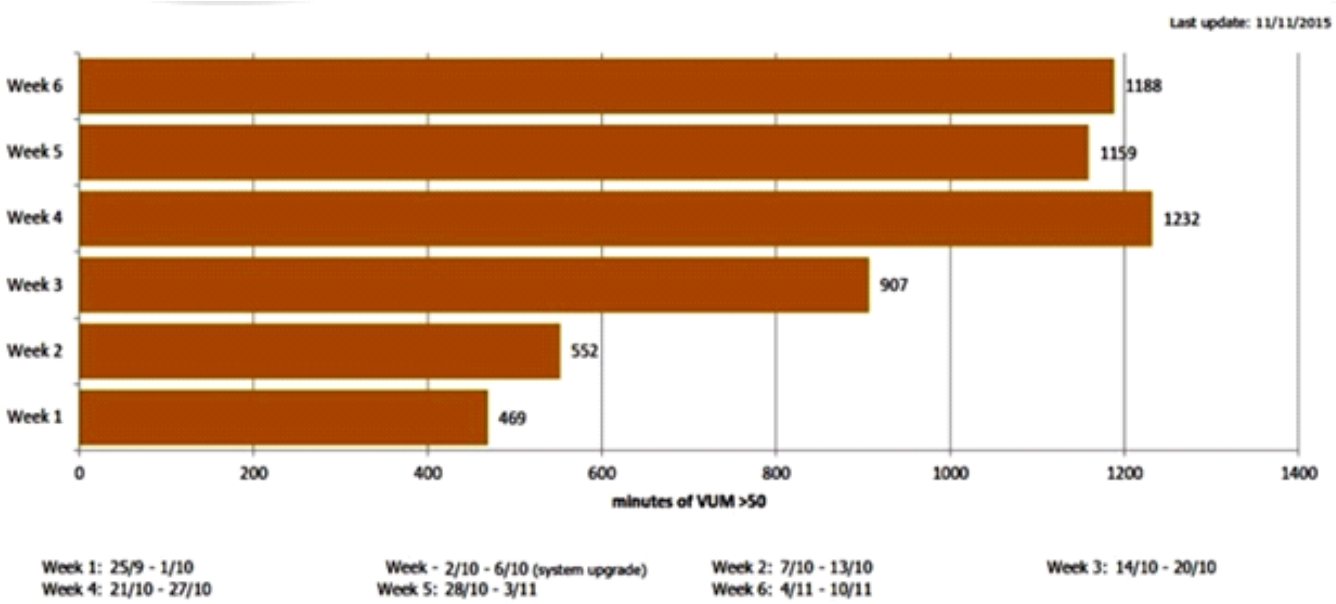
Via Bluetooth



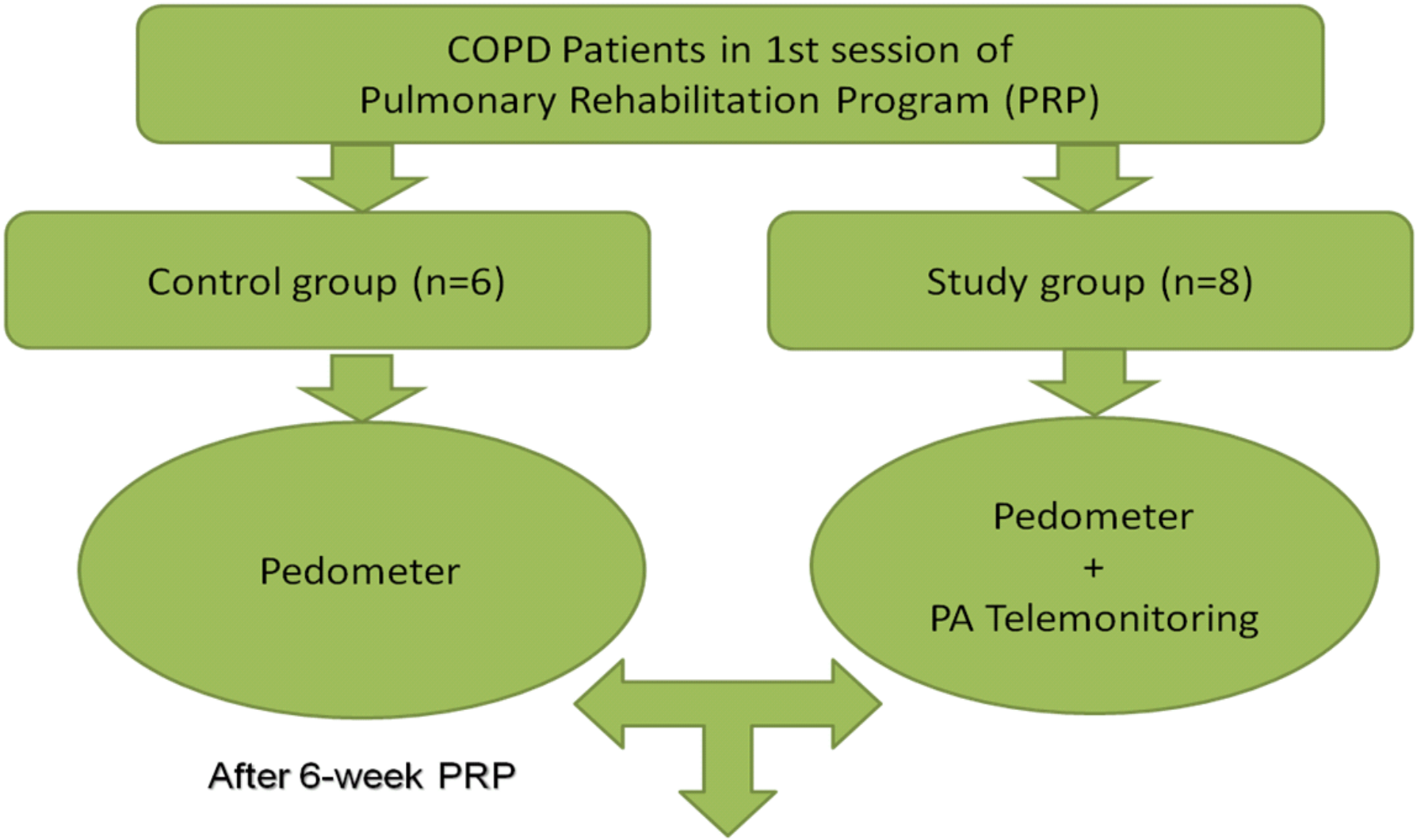
Activity sensor worn on patient's waist during daily activities

Home base station for patient data transmission

Immediate audio-visual feedback



Impact of telemonitoring on daily physical activity, self-awareness of physical activity and overall energy level



Choi T *HA Convention* 2016

Results

1. **Daily Physical Activity (mean daily step count)**

Control 5207 → 8122 steps (↑103%)
Study 3971 → 8535 steps (↑232%)

2. **Self-awareness of Physical Activity (mean VAS 1-10)**

Control 6.50 → 8.33 (↑38%)
Study 5.13 → 7.63 (↑61%)

3. **Overall Energy Level (mean of CAT component)**

Control 1.60 → 0.40 (↓ 29%)
Study 1.75 → 0.38 (↓ 81%)
(*p=0.037)

Telemonitoring

Crisis pack

康肺協盟
CCT

Maintenance treatment

Pulmonary Rehabilitation

Thank you

Acknowledgement: **Celki Vitalaire, NDH Charitable Foundation**