NON - INVASIVE VENTILATION AT HOME

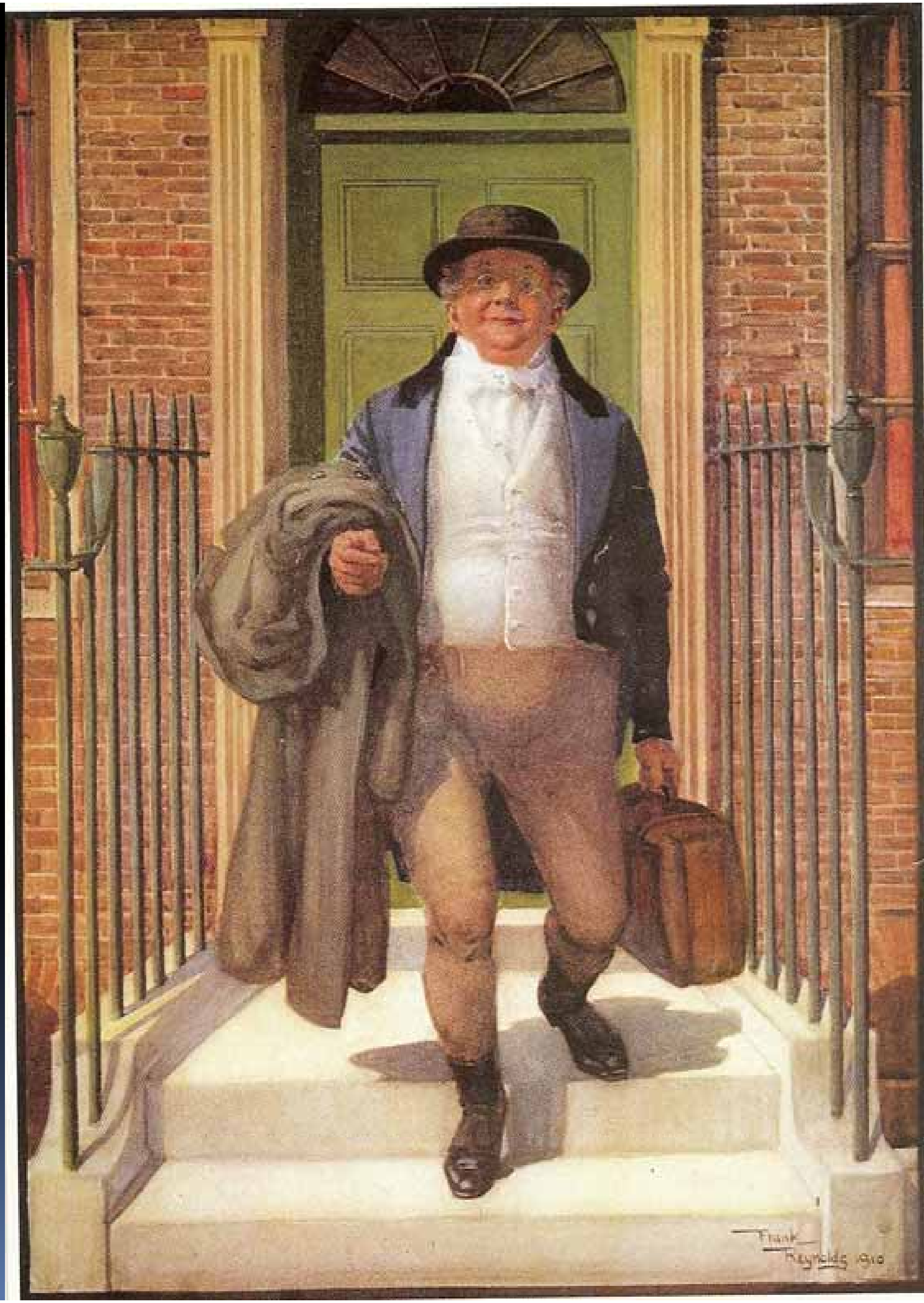
DR. D. K. PILLAI

07.09.2011

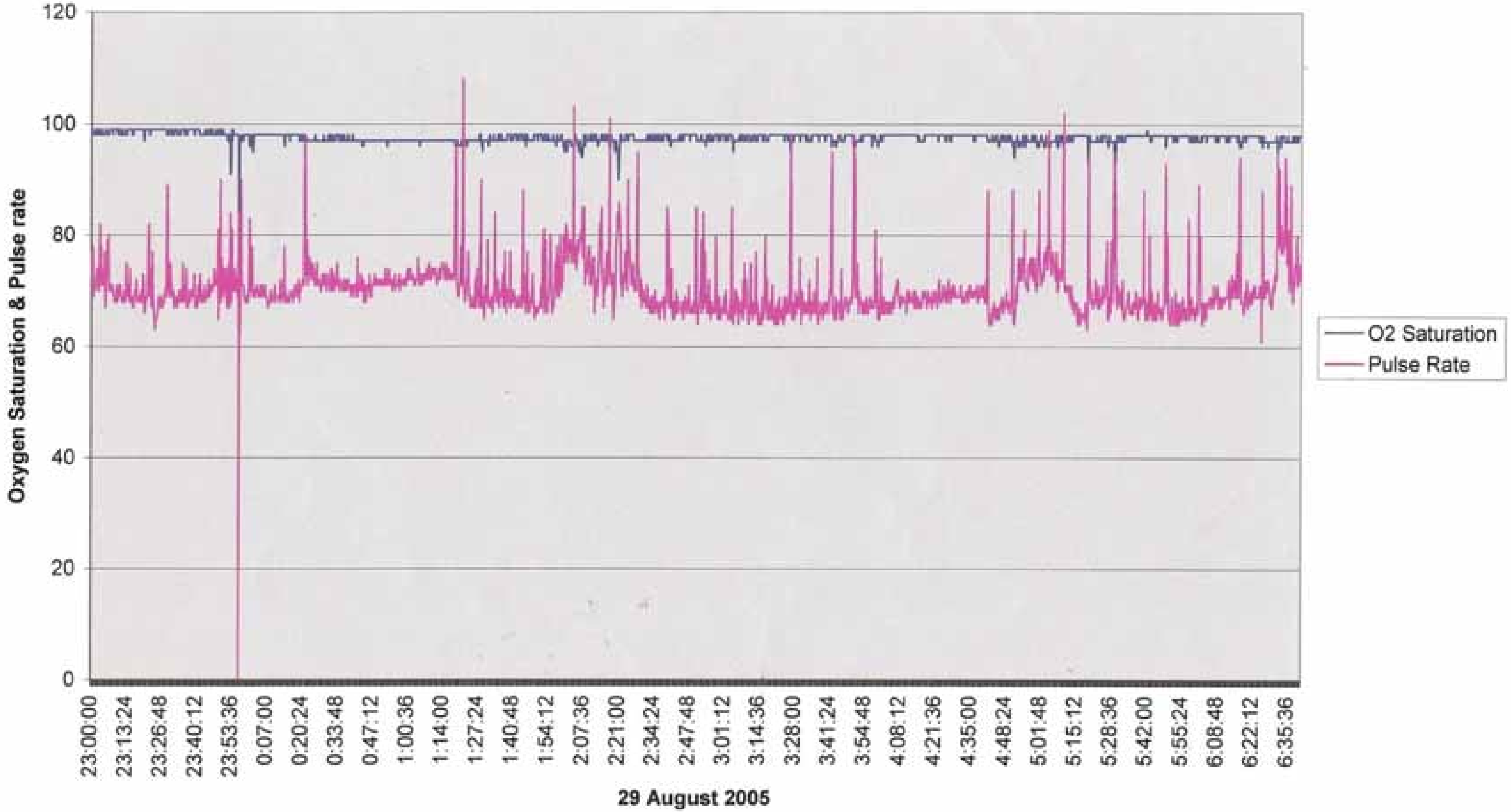
MUG @ UOM

- In the beginning came ....

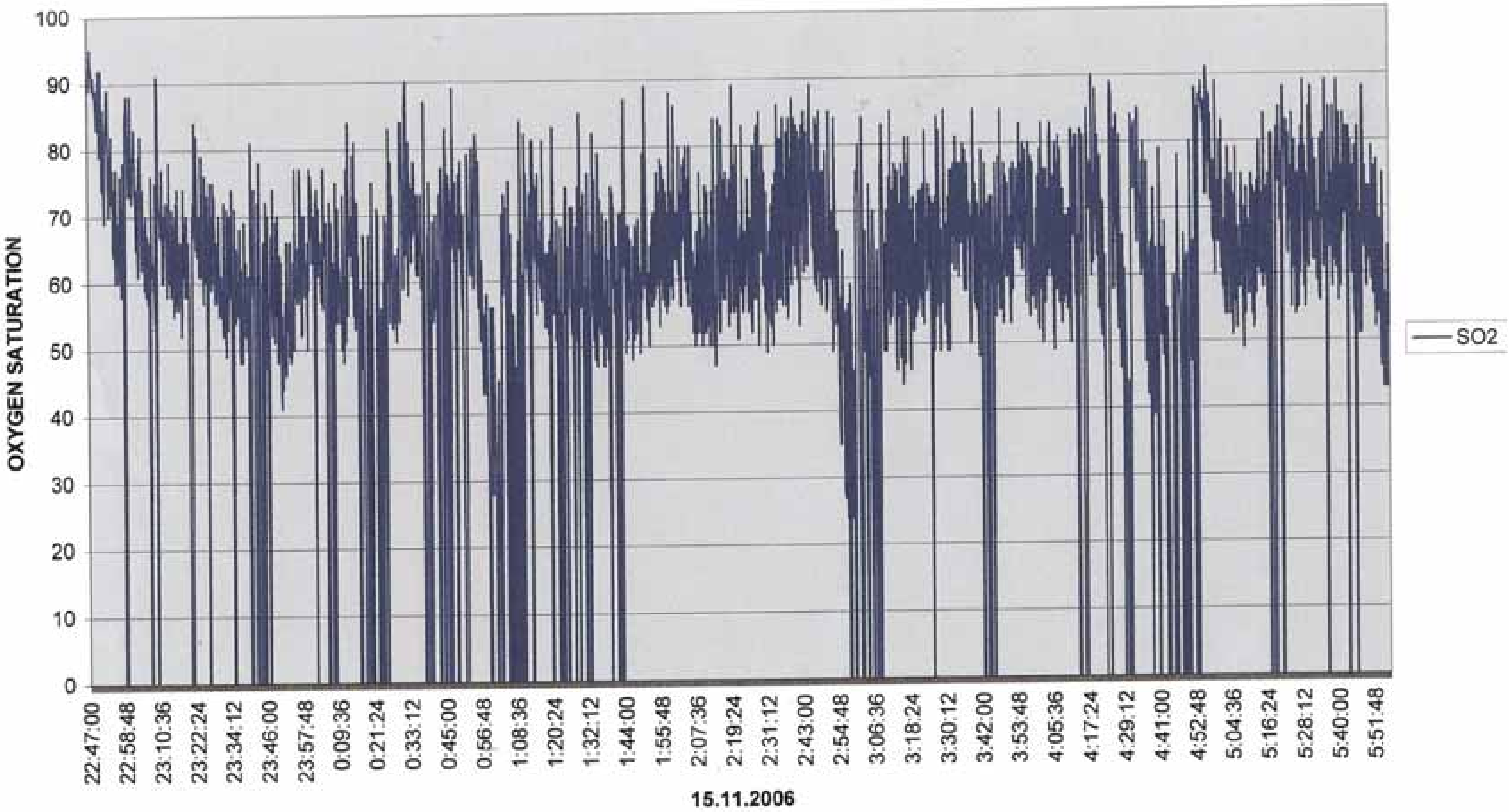
OSA (HS)


Frank Reynolds 1910

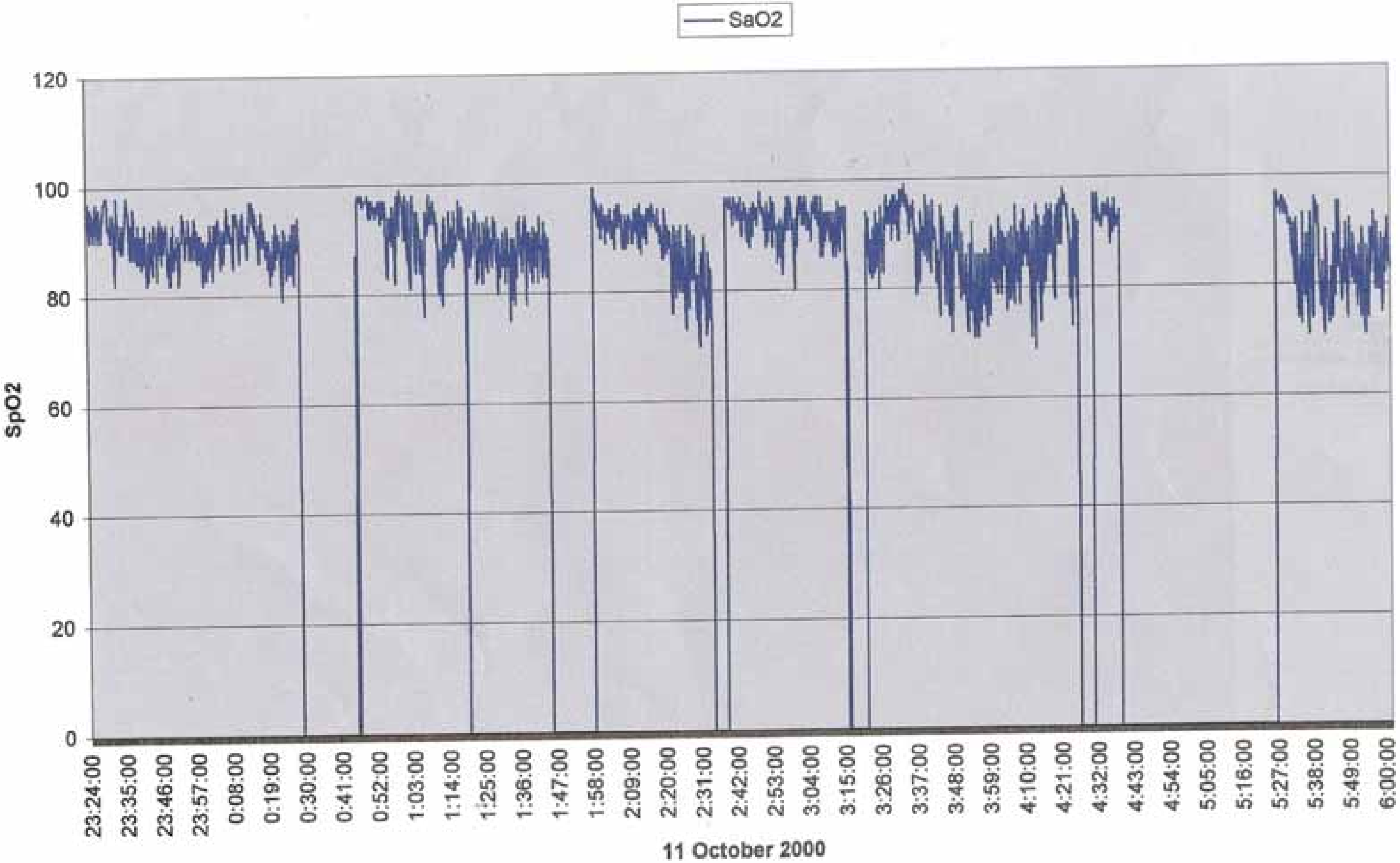

Ohmeda Biox 3740 Pulse Oximeter
SpO2%
Pulse
Display Select
Menu
Enter
BOC Health Care



120
100
80
60
40
20
0
Oxygen Saturation & Pulse rate
23:00:00
23:13:24
23:26:48
23:40:12
23:53:36
0:07:00
0:20:24
0:33:48
0:47:12
1:00:36
1:14:00
1:27:24
1:40:48
1:54:12
2:07:36
2:21:00
2:34:24
2:47:48
3:01:12
3:14:36
3:28:00
3:41:24
3:54:48
4:08:12
4:21:36
4:35:00
4:48:24
5:01:48
5:15:12
5:28:36
5:42:00
5:55:24
6:08:48
6:22:12
6:35:36
29 August 2005
O2 Saturation
Pulse Rate



OXYGEN SATURATION
100
90
80
70
60
50
40
30
20
10
0
22:47:00
22:58:48
23:10:36
23:22:24
23:34:12
23:46:00
23:57:48
0:09:36
0:21:24
0:33:12
0:45:00
0:56:48
1:08:36
1:20:24
1:32:12
1:44:00
1:55:48
2:07:36
2:19:24
2:31:12
2:43:00
2:54:48
3:06:36
3:18:24
3:30:12
3:42:00
3:53:48
4:05:36
4:17:24
4:29:12
4:41:00
4:52:48
5:04:36
5:16:24
5:28:12
5:40:00
5:51:48
15.11.2006
SO2



SaO2
SpO2
120
100
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23:24:00
23:35:00
23:46:00
23:57:00
0:08:00
0:19:00
0:30:00
0:41:00
0:52:00
1:03:00
1:14:00
1:25:00
1:36:00
1:47:00
1:58:00
2:09:00
2:20:00
2:31:00
2:42:00
2:53:00
3:04:00
3:15:00
3:26:00
3:37:00
3:48:00
3:59:00
4:10:00
4:21:00
4:32:00
4:43:00
4:54:00
5:05:00
5:16:00
5:27:00
5:38:00
5:49:00
6:00:00
11 October 2000


RESPIRONICS
www.respironics.com

STARDUST

Nom du patient:			
Sexe:	M	Poids:	106 kg
Date de naissance:	11/11/1971	Taille:	1.78 m.
Age du patient:	38 ans	IMC:	33.5
ID Patient:			
Numéro de l'étude:	540	Numéro série appareil:	2000001426
Date de l'étude:	12/30/2009 à 11:00:12 PM	Type Stardust:	Stardust II
Temps au Lit (TaL):	369 minutes		

Evénements respiratoires

	Code	Index (#/heure)	Nombre total d'évnmts	Durée moyenne (sec)	Durée max (sec)	Evénements par position	
						Dorsale (#)	Non-Dorsale (#)
Apnées centrales	AC	10.6	65	16.7	35	26	39
Apnées obstructives	AO	75.3	463	22	225	276	187
Apnées mixtes	AM	14	86	18.8	32.5	56	30
Hypopnées	HY	0.8	5	20.5	25	3	2
Total		**100.7**	619	21	225		
					Temps en position (minutes)	198.4	170.6
					IAH en position (nbre par heure)	109.2	90.7

Ronflement

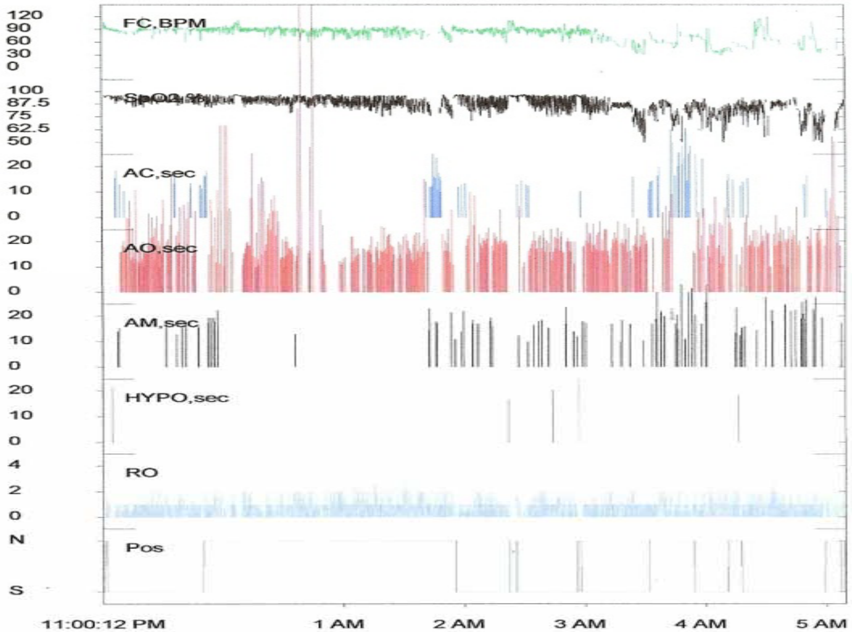
Nbre total Ronflement	1854
Index Ronflement (nbre/h)	301.5

Oxymétrie

<95 % (minutes)	256.5
<90 % (minutes)	172
<85 % (minutes)	90.5
<80 % (minutes)	43
<75 % (minutes)	22
<70 % (minutes)	12.5
<60 % (minutes)	3
<50 % (minutes)	0.5
Durée totale (min) < 90%	172
Moyenne de saturation (%)	87
Index de désat (nbre par heure)	97.5
Désat max (%)	42
Durée max désat (sec)	65
SpO_2 minimale (≥ 2 sec) (%)	38
Nbre épisodes (≥ 5 min) ≤ 90%	5
Durée max (min) SpO_2 ≤ 90%	16.6

Fréquence cardiaque (FC)

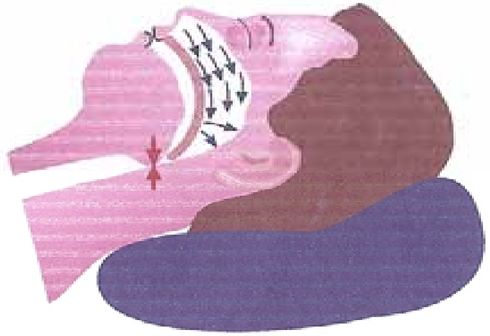
FC moyenne (BPM)	78.3
Nombre de **bradycardie**	100
Bradycardie mini (BPM)	30
Nombre de **tachycardie**	72
Tachycardie maxi (BPM)	129



Continuous positive airway pressure (CPAP)

Continuous positive airway pressure (CPAP) is the gold standard treatment for moderate-to-severe obstructive sleep apnoea. This factsheet demonstrates how to safely use CPAP at home and get the most out of the treatment.

Normal breathing

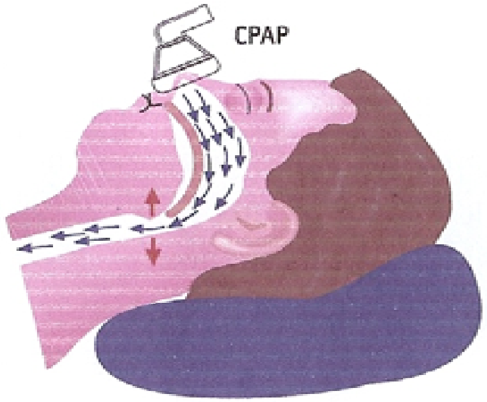


Interrupted breathing

CPAP machines work by generating an air stream that keeps the upper airway open during sleep. There are lots of different machines available and modern devices are small, comfortable and easy to use. The air stream is pushed through tubing *via* a mask to the back of the throat. Choice of machine and level of air pressure will be determined by a sleep specialist after you have undergone an overnight study, usually at a sleep centre. The levels are then adjusted or 'titrated' after you have had an opportunity to get used to the machine at home.

Alternatives to fixed CPAP

Generally speaking, most CPAP devices are set at a fixed pressure. This pressure is the one that will control at least 95% of all events during the night. However, you may find it uncomfortable to breathe out against a fixed pressure or find it difficult to tolerate. Some devices provide variable pressure and adjust automatically to the different patterns of breathing throughout the night. Very occasionally bi-level positive pressure ventilation, using a different type of machine, is used to deliver different pressures for breathing in and out.



CPAP opens the airways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1. **CPAP – for OSAHS**

(Obstructive Sleep Apnoea Hypopnoea Syndrome)

2. **NIPPV**

(Non – invasive positive pressure ventilation)

Historically

- **First NIV** – was iron lung for polio (negative pressure).

- **Positive Pressure Ventilation with Intubation** – ICU setting only.

- Technological wizardry has produced compact, powerful, simple Positive Pressure Ventilators.
- Doctors are more aware of their existence and indications.
- Exponentially greater use in the West.

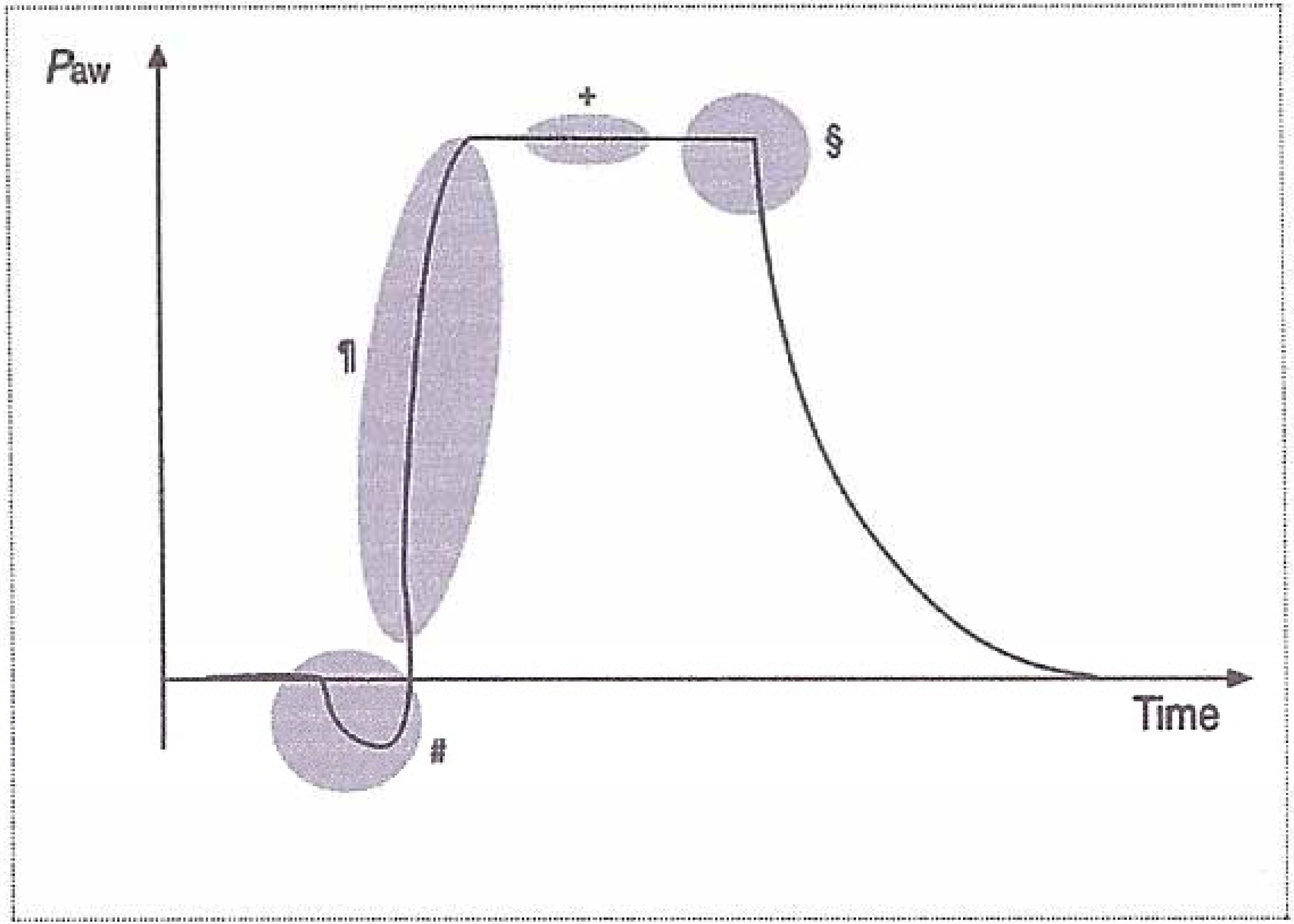
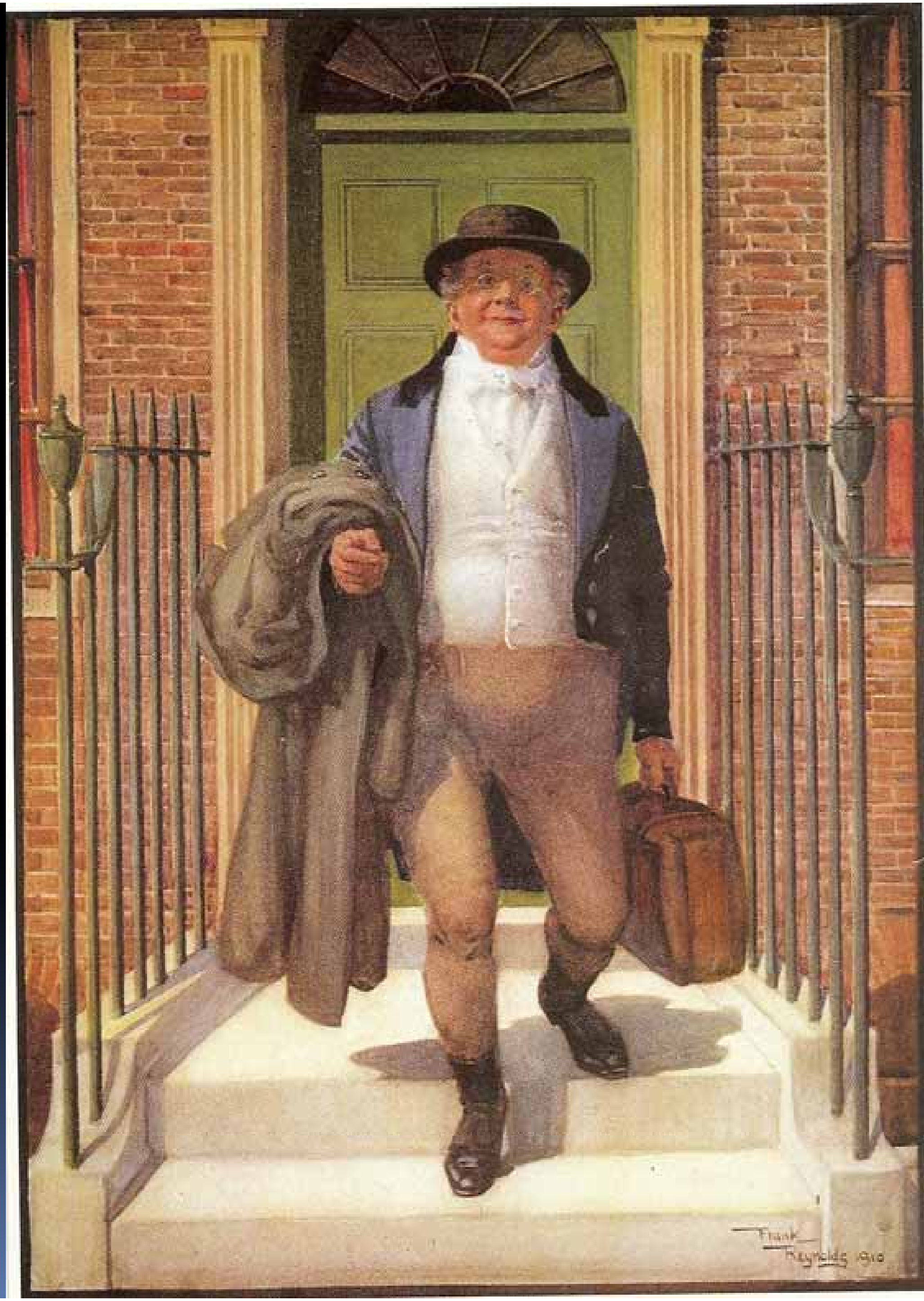


Figure 1 Key phases of a typical pressure support cycle. Paw: airway pressure. #: trigger; ¶: pressurisation; +: level of pressure support; §: cycling.

Topics to be covered

- **OSAHS**
- **OHS** (Obesity Hypoventilation)
- **- DMD** (Duchenne Muscular Dystrophy)
  - POST POLIO ; MND
- **Thoracic Restriction** (post TB syndrome, severe kyphoscoliosis, ankylosing spondilitis)


Frank Reynolds 1910

OBESITY HYPOVENTILATION SYNDROME (OHS)

- A worsening problem – in line with obesity epidemic.
- The higher the BMI, the more likely.
- 20% OSAHS have OHS.
- 90% OHV have OSAHS

OHS – Pathophysiology
Alveolar Hypoventilation

- Fat, heavy chest wall.
- Elevated, poorly moving diaphragm (abdominal fat).
- Blunted response to hypoxia / hypercapnia.
- Upper airway resistance (90% associated OSAHS).
- Leptin resistance

Table 1. – Factors contributing to respiratory failure in severe obesity

Increase in work of breathing and oxygen cost of breathing ($V'_{O_2,RESP}$)

- Increase in metabolic demand (increased V'_{O_2} and V'_{CO_2}) and in total ventilation for a given effort
- Decrease in compliance of the lung (micro-atelectasis)
- Decrease in compliance of chest wall (increased adiposity)
- Increase in upper airway resistance (when associated with OSAHS)
- Increase in airway resistance (R_{aw})

Decrease in ventilatory drive ($P_{0.1}$, ventilatory response to CO_2)

Changes in ventilatory mode (increased respiratory rate, decreased tidal volume)

Respiratory muscle dysfunction

- Mechanical disadvantage (inadequate length–tension relationship, decrease in FRC)
- Decrease in respiratory muscle strength?
- Increased respiratory load

Table 2. – Factors contributing to impaired gas exchange in severe obesity

Ventilation/perfusion mismatch and increase in $\Delta(A\text{-}a)O_2$	
	Decrease in FRC
	Increase in CV
	Decrease in FRC-CV
	Worsening of ventilation/perfusion mismatch when lying supine
Decrease in ventilatory drive ($P_{0.1}$, ventilatory response to CO_2)	
	Nocturnal and diurnal hypoventilation
Obstructive sleep apnea and hypopnea syndrome	
	Repeated episodes of nocturnal desaturation
	Progressive blunting of ventilatory response to CO_2

OHS

Why is diagnosis important?

(a) **MORTALITY** at 18 months

- OHS 23%
- Obese, No OHS 9%
- OHS on NIPPV 3%

(b) **MORBIDITY** – habitual offenders in the very obese with OSAHS i.e., Metabolic, Cardiovascular, Degenerative

How to diagnose OHS?

- Anyone with **BMI > 30**, but especially **> 35 $kg.m^{-2}$ and PaO_2 > 45 mmHg**

- **Symptoms** – Snoring, apnoea, daytime somnolence

  - Morning headaches, grogginess

  - Daytime fatigue, dyspnoea, pedal oedema

- **Signs** – BMI, OSAHS, Cor Pulmonale

OHS

Laboratory tests

A. General

- Polycythaemia
- Lipids, Thyroid
- Cardiovascular

B. Specific

- Low Sp O_2
- Increased serum HCO_3^-
- Hypercapnia (> 45mm Pn CO_2)

C. Sleep study

OHS

Treatment

1. **Weight loss** – may need bariatric surgery

2. **CPAP**

3. **NIPPV** - essentially BIPAP (Bilevel Positive Airways Pressure)

DUCHENNE MUSCULAR DYSTROPHY (DMD)

- X linked recessive
- 1 in 3500 live after birth
  (2 New cases annually here)
- Progressive muscular weakness

DMD

- 12 yrs - Wheelchair
- Mid Teens – Lung Volume Loss, Scoliosis
- Age 18 – 20 - Ventilatory failure
- If no Rx – Death within 2 yrs

DMD – Rx with NIV

- 5 yrs Survival : 70%
- May survive into Late 30's

DMD - monitoring

Annual – VC, Cough Peak Flow, SpO_2

VC < 60% - Sleep study annually

± wheelchair (REM Sleep disordered breathing)

VC < 40% - Continuous Nocturnal Hypoventilation

- Start NIV (Rideau – 1980's)

VC < 25% - Daytime Ventilatory failure

- Ventilator dependence

DMD – Cough failure

- NIV machine / Ambu Bag to "stack" breaths and produce a cough.
- Cough IN – EX - Sufflator

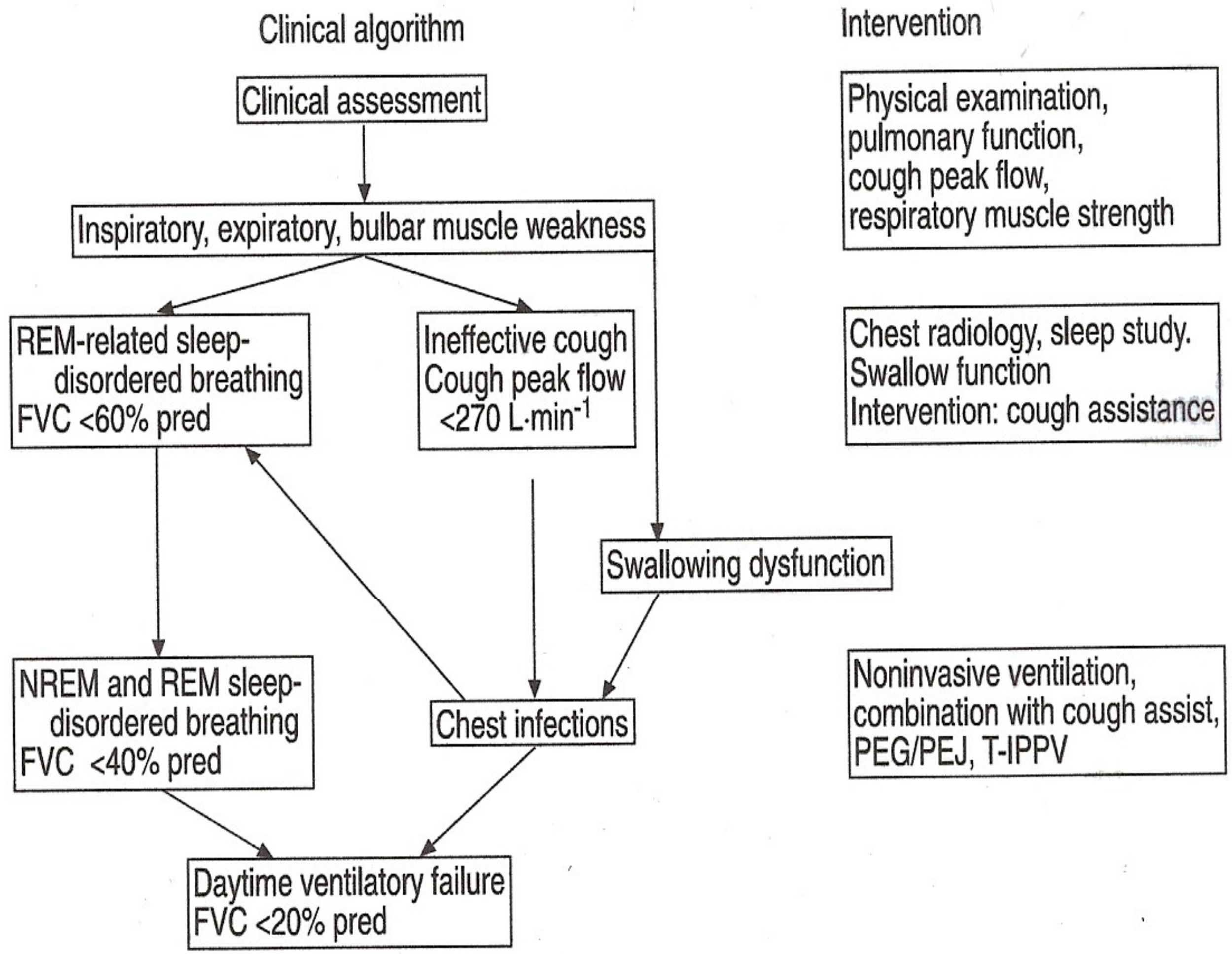
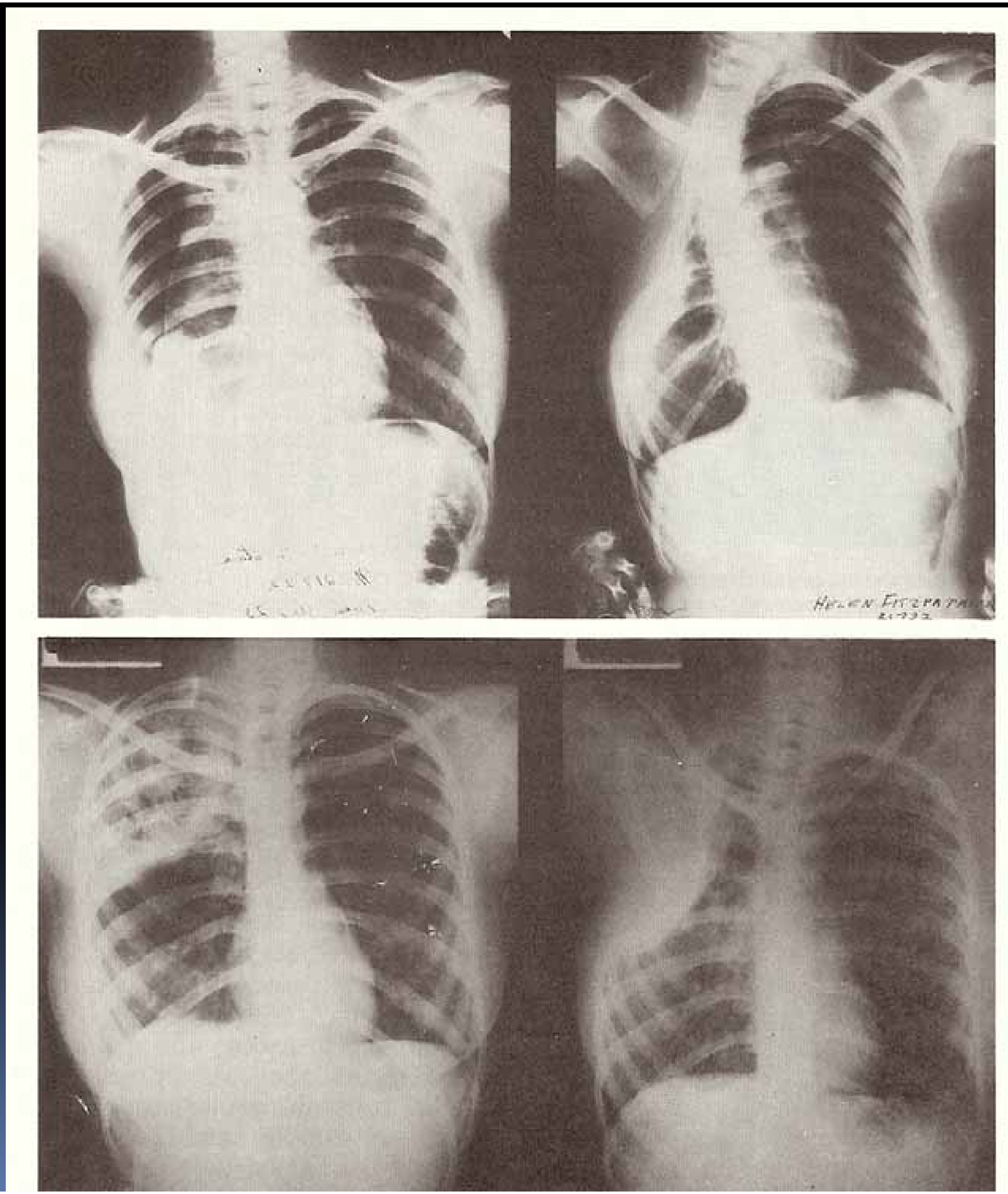
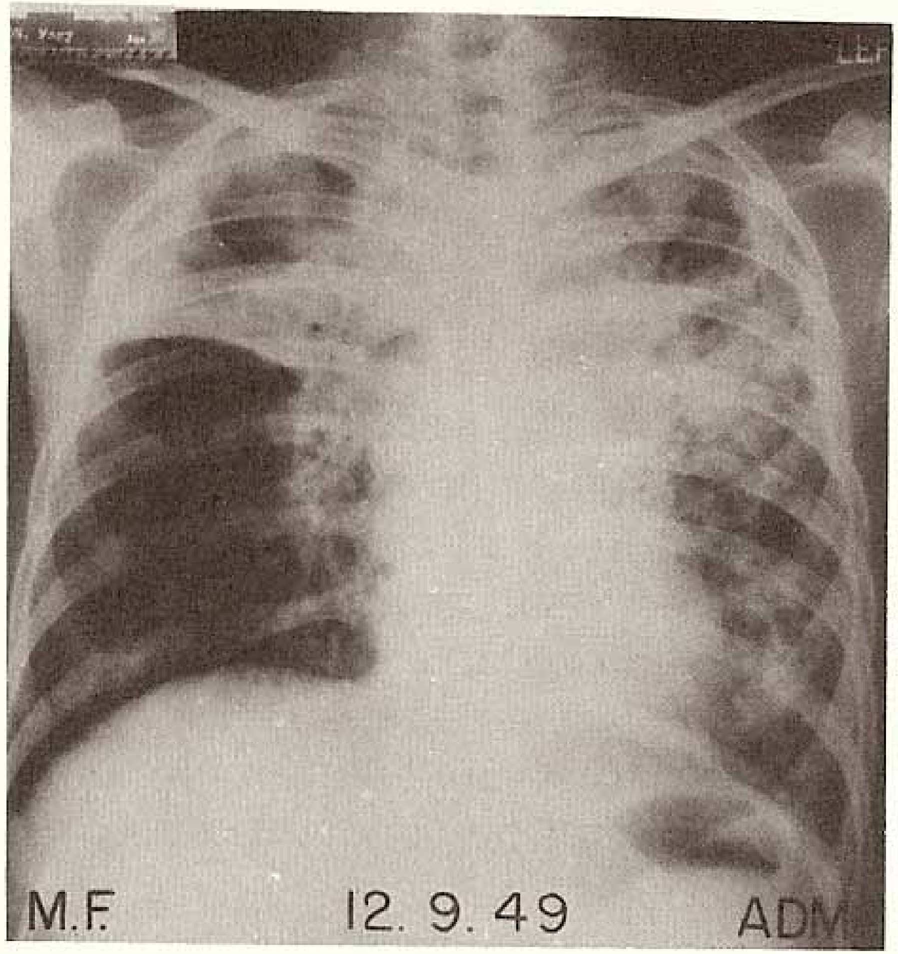
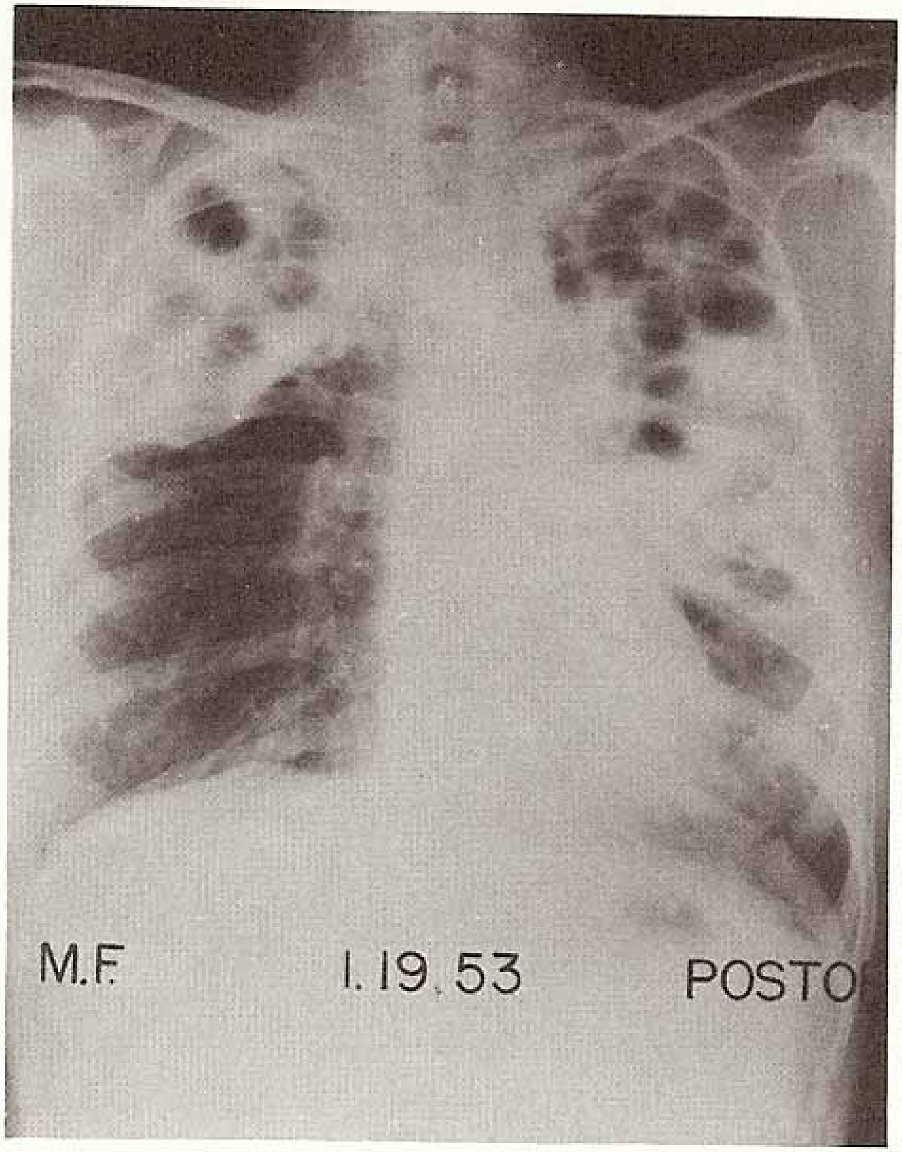


Fig. 1. – Clinical algorithm including timing of interventions. REM: rapid eye movement; FVC: forced vital capacity; % pred: % predicted; NREM: non-REM; PEG/PEJ: percutaneous enteral gastrostomy/percutaneous jejunostomy; T-IPPV: tracheostomy intermittent positive pressure ventilation.

OTHER DISEASES

- ✓ POST POLIO SYNDROME
- ✓ POST TUBERCULOSIS SYNDROME
- ✓ SEVERE KYPHOSCOLIOSIS




M.F.
12. 9. 49
ADM

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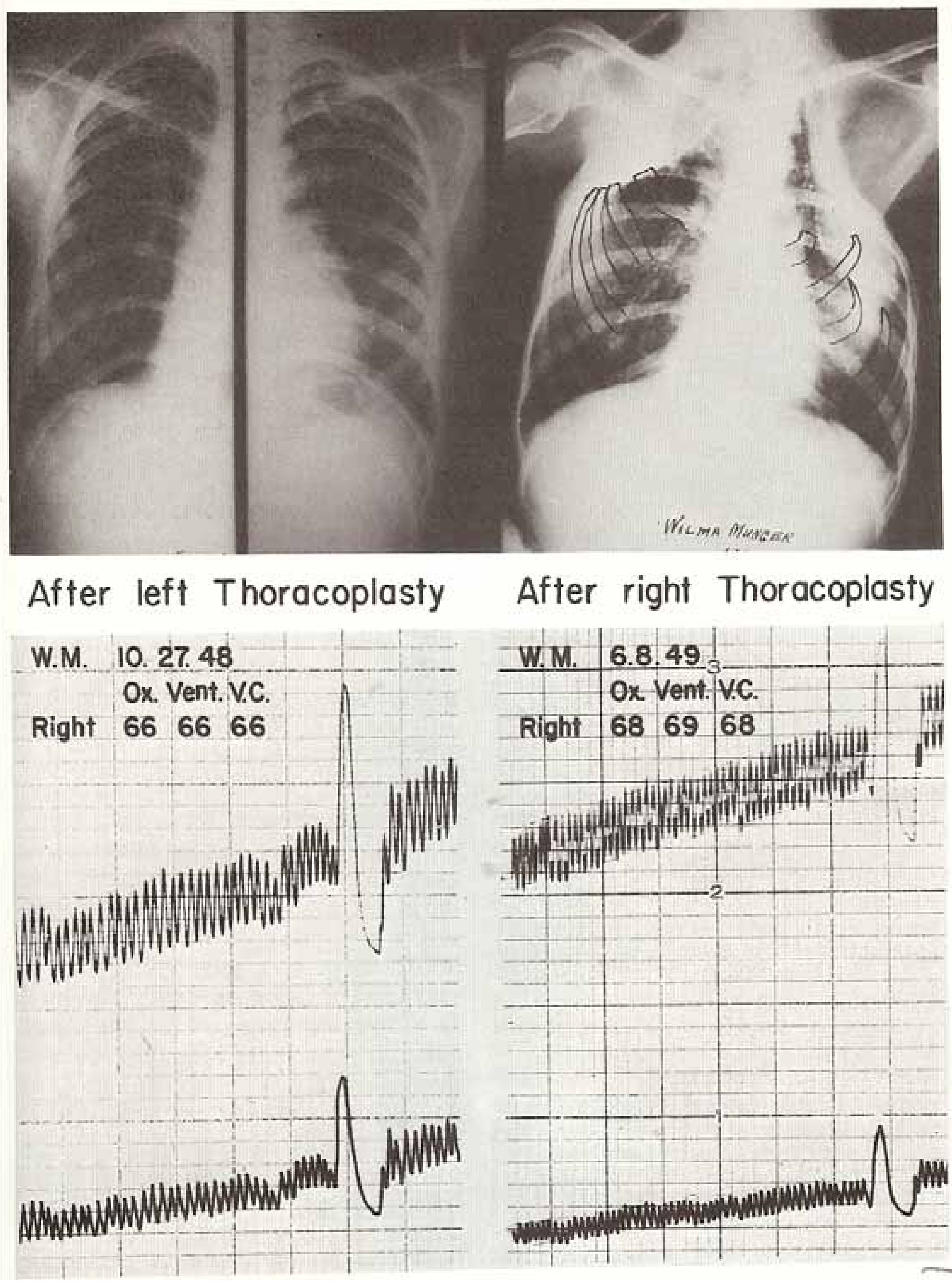
POSTO


After left Thoracoplasty
After right Thoracoplasty
W.M. 10. 27. 48
Ox. Vent. V.C.
Right 66 66 66
W.M. 6.8.49
Ox. Vent. V.C.
Right 68 69 68

NIPPV

Some practical aspects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VENTILATORY SUPPORT

- **NPV** : Negative Pressure Ventilation
- **PPV** : Positive pressure ventilation

Volume Targeted
(Volumetric)

Pressure Targeted

BPPV – Bilevel positive Pressure Ventilation
e.g. BiPAP ®

WHICH TO CHOOSE

- No clear advantage of one over the other.
- **BPPV** used in vast majority of home ventilation, irrespective of aetiology

- Cheaper, more comfortable

- Volume Targeted Ventilators used often in neuromuscular patients.

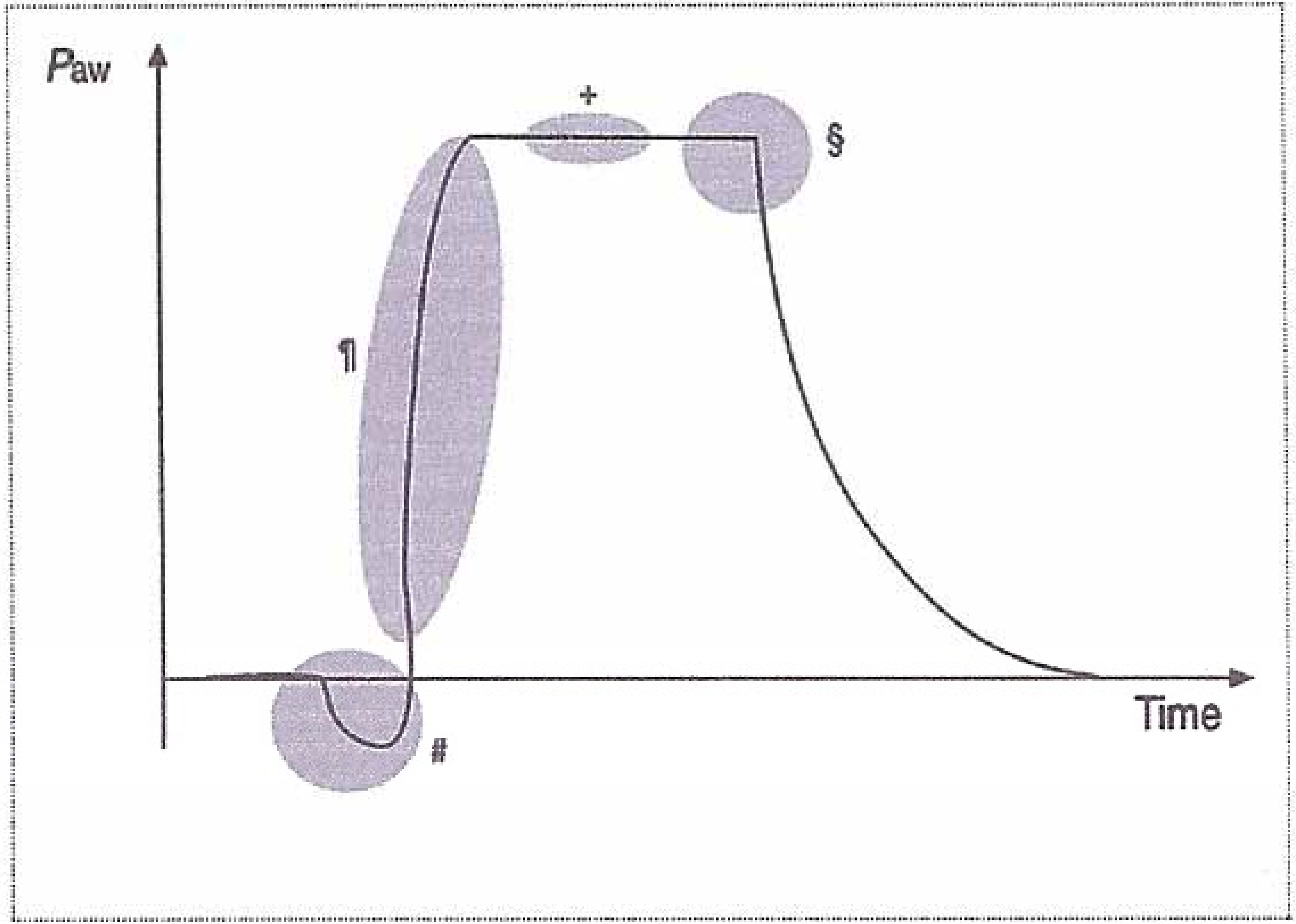


Figure 1 Key phases of a typical pressure support cycle. Paw: airway pressure. #: trigger; ¶: pressurisation; +: level of pressure support; §: cycling.

HOW DOES NOCTURNAL NIV WORK?

- Relief of respiratory muscle fatigue.

- Improved respiratory drive

(better response to hypercapnia)

? Decreased leptin resistance

- Better sleep quality (less arousals)

MACHINE - PATIENT INTERFACE

- Extremely important
- NASAL, NASOBUCCAL, FULL FACE MASKS
- NASAL CUSHIONS

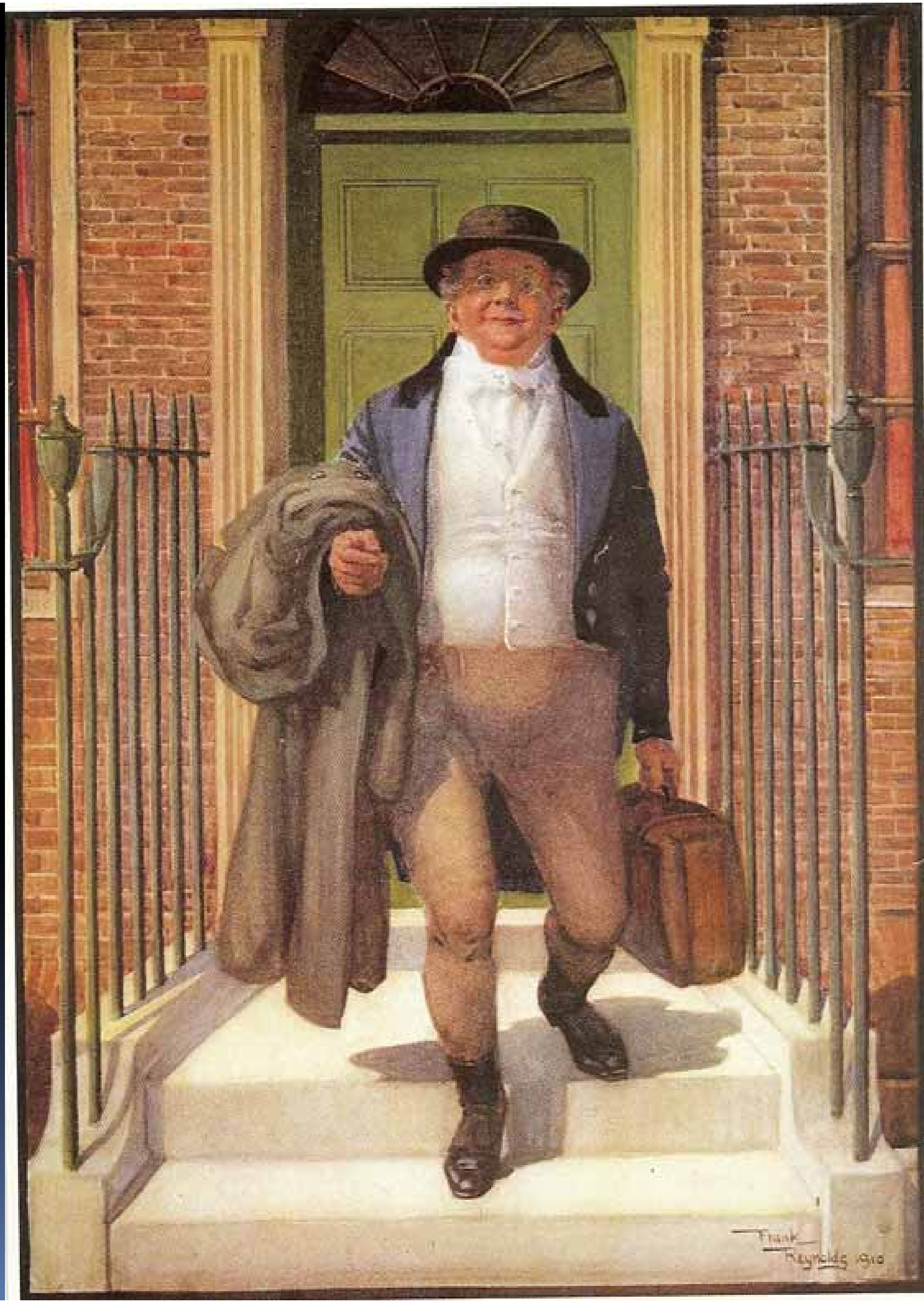
MACHINE - PATIENT INTERFACE

- First session very important (and time consuming).

- Takes time to find a mask / cushion that fits patient nicely.

- Leaks – avoid strapping too tight.
- Nose and mouth dryness - Chin Straps
  - Humidification


ON / OFF
PURITAN
BENNETT


Frank Reynolds 1910