

# Capnography - the future

Dr David Whitaker

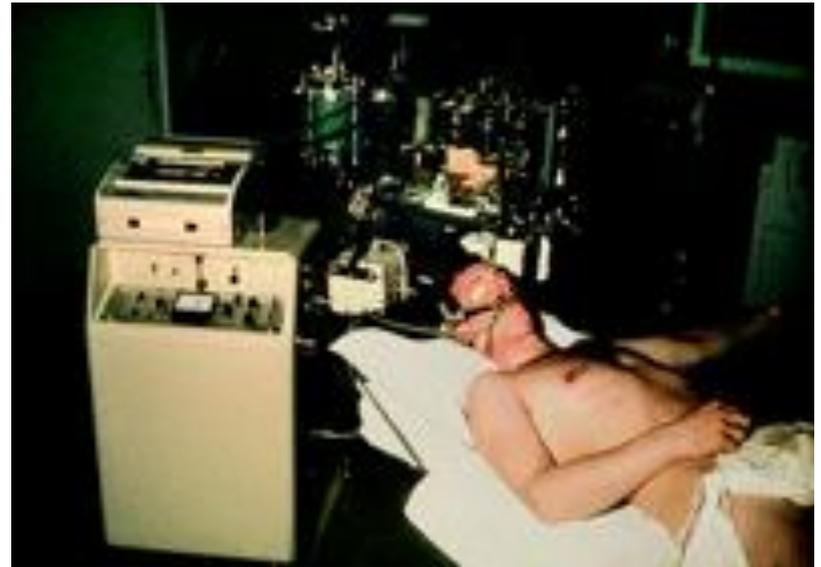
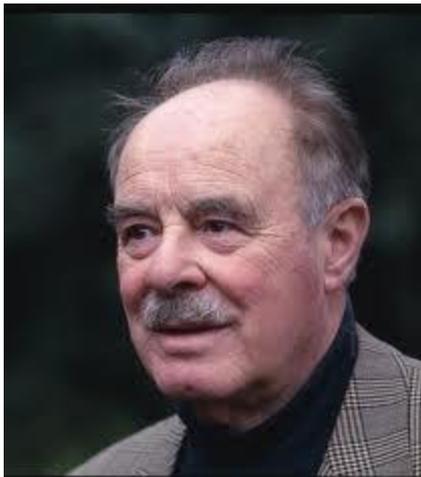
FRCA, FFPMRCA, FFICM, FCARCSI (Hon)



DIFFICULT AIRWAY SOCIETY  
Nottingham 2011

# Capnography – the past

- The first CO<sub>2</sub> analyzer (Godart Capnograph medical CO<sub>2</sub> analyzer) in the Central Military Hospital, Utrecht, The Netherlands (1962). On top is the one channel Omniascriptor.
- Prof. Bob Smalhout



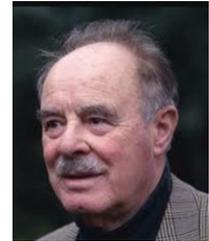
# Capnography – the past





# Capnography in Theatre

- Original minimal monitoring criteria  
Prof Bob Smalhout, 1967



- Harvard Minimal monitoring  
John Eichhorn, 1987



- AAGBI Minimal monitoring standards  
Prof Tony Adams , AAGBI Safety 1988



- Now near 100% UK evidence from NCEPOD

# Capnography in Theatre

- 1980s Capnography monitoring was introduced and sampled direct from circuit via T-piece port



- 1990s breathing filters introduced to humidify and prevent machines getting infected

# Capnography in Theatre

- Pall introduced monitoring port on filters



- 1994 After several patients on a list in Australia got Hepatitis C, Patient Breathing Filters became patient single use 

**Ragg M. Transmission of Hepatitis C via anaesthetic tubing?  
Lancet 1994; 44: 367–73**

# Capnography in Theatre

- Filter port presents a cause of unnecessary connection / reconnection, leaks and tube blockage (EGBAT)

**✗ 2 connections**



**✓ 1 connection**



**Gulati MS. Less caps, less connecting and instant monitoring.  
Anaesthesia, 2004, 59, 719–729**

# Capnography in Intensive Care

- Already heard Tim's ICU presentation
- **Continuous capnography** for all patients with tracheal tubes (including tracheostomy)
- Circuits
  - Dry - side stream capnography
  - Wet - main stream capnography
    - New Cochrane study may say no difference in circuits
- Ventilators e.g. new Hamilton Intellivent
- Better technology e.g. Microstream

# Capnography in Recovery (PACU)

- “Capnography has the potential to aid early detection of airway obstruction. It should be available and used in high risk cases.”
- NAP4 Recommendation



# Capnography in Recovery (PACU)

## 2011 AAGBI REVIEW FINAL DRAFT

- **MONITORING, EQUIPMENT AND DRUGS**

Clinical observation should be supplemented as in the operating theatre by a minimum of pulse oximetry, non-invasive blood pressure monitoring, ECG and, if patients' tracheas remain intubated or a supraglottic or other similar airway device is in place, **continuous capnography**



# Capnography in Recovery (PACU)

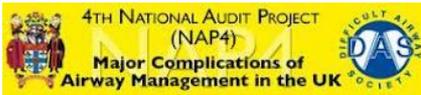
- **TRANSFER AND HANDOVER OF CARE TO THE PACU TEAM**

If the PACU is not immediately adjacent to the operating theatre, or if the patient's condition is poor, mobile monitoring is required, i.e. a minimum of pulse oximetry and non-invasive blood pressure, ECG **and capnography** if the trachea is intubated or if a supraglottic airway is in place.

# Capnography in Recovery (PACU)

- **TRACHEAL TUBES AND OTHER AIRWAY DEVICES**

The incidence of upper airway obstruction, which can lead to pulmonary oedema and severe hypoxia can be decreased by the use of oropharyngeal airways, bite blocks, airway devices incorporating them or similar devices .

Ref = 

As noted above, all patients with tracheal tubes or supraglottic airways in place in PACU should be **monitored with continuous capnography.**

# Capnography in Recovery (PACU)

- **MONITORING, EQUIPMENT AND DRUGS**

An appropriate standard of monitoring should be maintained until the patient is fully recovered from anaesthesia. Clinical observation should therefore be supplemented as in the operating theatre by a minimum of pulse oximetry, non-invasive blood pressure monitoring, ECG and, if patients' tracheas remain intubated or a supraglottic or other similar airway device is in place, **continuous capnography**

# Capnography in Recovery (PACU)

- **KEY RECOMMENDATION 8**

All patients with tracheal tubes or supraglottic airways in place in PACU should be monitored with **continuous capnography**



# Capnography in Recovery (PACU)



# Capnography in Recovery (PACU)



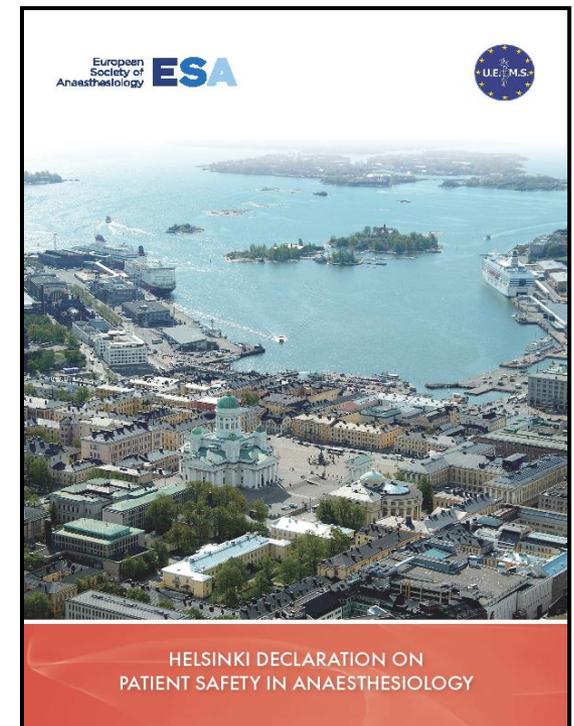
- By retaining the patient's own catheter mount and breathing filter the capnography connection can be reused for many patients (as in theatre)

# Capnography in Recovery (PACU)

- 6 patients per recovery bay per day
- 30 patients per recovery bay per week
- Disposable (£6) changed every week
- So disposable costs 20 pence per patient
  
- 10,500 patients per recovery bay per 7 years
- Capnography module costs £1000
- So capnography equipment costs 10 pence per patient
  
- **Total cost of capnography is 30 pence per patient**

# Capnography in Recovery (PACU)

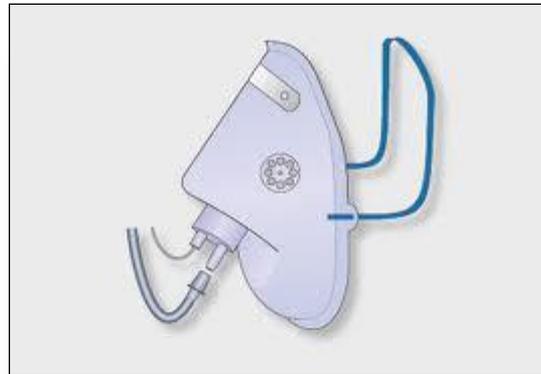
- 2010 Helsinki Declaration on Patient Safety in Anaesthesiology
- Survey of it's implementation in the Berlin-Brandenburg area of Germany showed 62% had capnography in Recovery (28 hospitals)



**Patient safety in anaesthesia: assessment of status quo in the Berlin-Brandenburg area, Germany. Balzer F et al. EJA 2011, Vol 28 No 10. 749-52**

# Capnography in Sedation

- Sedation is a major practice growth area as new procedures are developed
- Gastroenterology
- Emergency Departments
- Ophthalmology
- Dental
- Cardiology
- Radiology



# Capnography in Sedation

- Pulse oximetry has recently been the safety monitor
- Numerous articles and studies show capnography catches what oximetry can not show or show too late
- Abnormal ETCO<sub>2</sub> findings were observed with many acute respiratory events.
- A majority of patients with acute respiratory events had ETCO<sub>2</sub> abnormalities that occurred before oxygen desaturation or observed hypoventilation.

**Acad Emer Med, 2006 May; Burton JH, Harrah JD, Germann CA, Dillion DC. Department of Emergency Medicine, Maine Medical Center, Portland, ME, US**

# Capnography in Sedation

- ASA have recommended capnography for all moderate and deep sedation
- AAGBI the same
- European Board of Anaesthesiology the same
- Absolute  $F_E CO_2$  values not important
- Breathing pattern and respiratory rate are important safety assessments particularly in darkened x-ray or catheter laboratories

# Capnography in Sedation

- Spontaneously breathing patients alternate between nasal and mouth breathing
- Various devices are available but they need to take account of this to avoid false alarms
- Don't forget bacterial filter



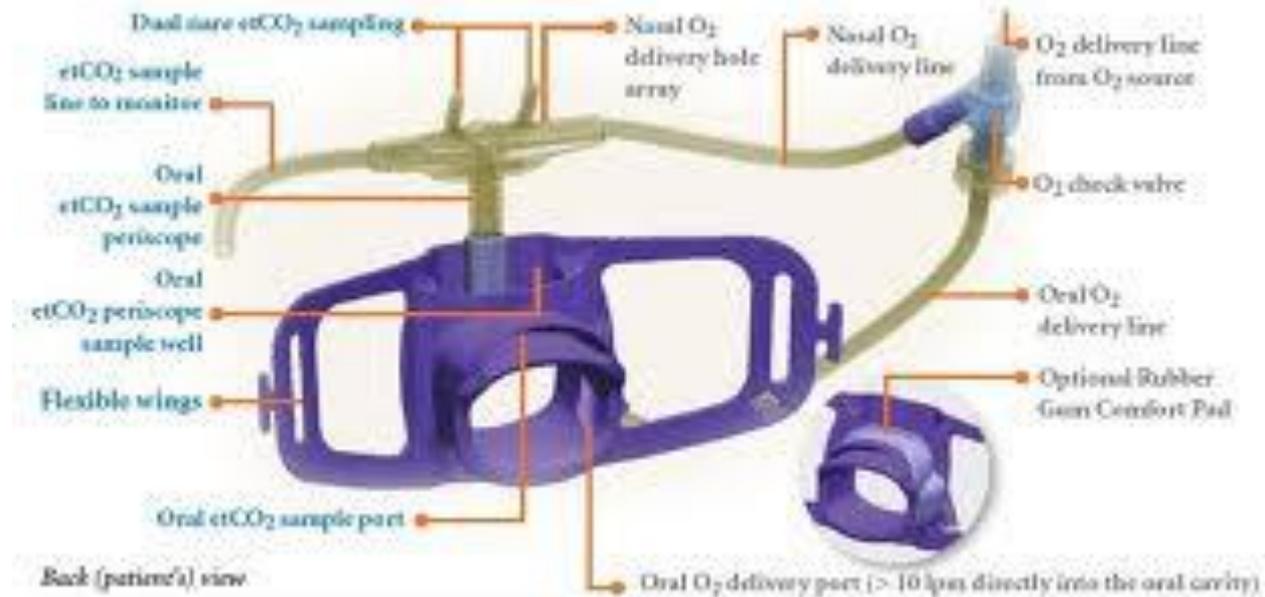
# Capnography in Gastroscopy



# Capnography in Gastroscopy



## The Capnobloc



# Capnography in Gastroscopy



# Capnography in Resuscitation

- Increased emphasis is on the use of **capnography** to confirm and continually monitor tracheal tube placement, quality of CPR and to provide an early indication of return of spontaneous circulation (ROSC)



Resuscitation Council (UK)

**Deakin CD, Nolan JP, Soar J, et al. Section 4. Adult advanced life support. *Resuscitation* 2010; 81:1305–1352.**

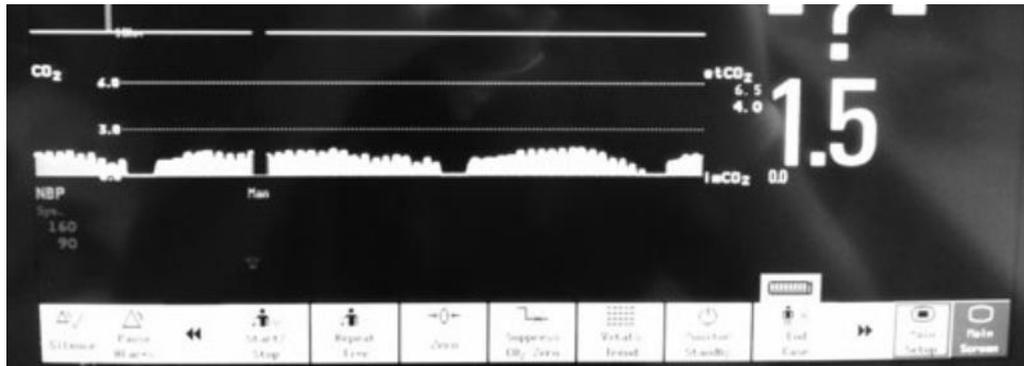
# Capnography in Resuscitation

- *Howard Snitzer's heart stopped beating for 96 mins in January 2011. responders didn't give up on him, thanks in part to capnography, a technology that let them know Snitzer still had a chance of coming back.*
- *This information helps determine whether a patient is hyperventilating or having a heart attack. It helps to decide how to treat an asthma attack, or determine whether CPR is working.*



# Capnography in Resuscitation

- Always some CO<sub>2</sub> if massaging less than 30mins



- **Do not assume that failure to detect CO<sub>2</sub> is because of cardiac arrest**
- Most manufacturers make defibrillators with capnography



# Capnography in Neonatal Resuscitation

- Confirms tube placement in very low birth wt
- In attempted intubations of 40 neonates it correctly identified 40 tracheal and 11 oesophageal



**Salthe J et al, Capnography rapidly confirmed correct endotracheal tube placement during resuscitation of extremely low birthweight babies (< 1000 g). Acta Anaesthesiologica Scandinavica 2006; 50: 1033–6.**

# Capnography on the Post op Wards

- In US study monitoring patients with PCA, respiratory depression has been found to be higher than previously reported
- Anaesthesia Patient Safety Foundation (APSF) has recently said ***“No Patient shall be harmed by Opioid induced respiratory depression”***
- Recommends Capnography as best monitor to do this
- Capnography is best resp rate monitor available

# Capnography in Emergency Dept

|                           | Anaesthesia      | ICU            | Emergency Dept |
|---------------------------|------------------|----------------|----------------|
| Death                     | 16               | 18             | 4              |
| Death + Brain Damage      | 18               | 22             | 1              |
| Denominator               | 2.9m*            | 48,000**       | 20,000***      |
| <b>Incidence Death</b>    | <b>1:180,000</b> | <b>1:2,700</b> | <b>1:5,000</b> |
| Relative Death Rate       | 1                | x 67           | x 36           |
| RR (Death + Brain Damage) | 1                | x 70           | x 38           |

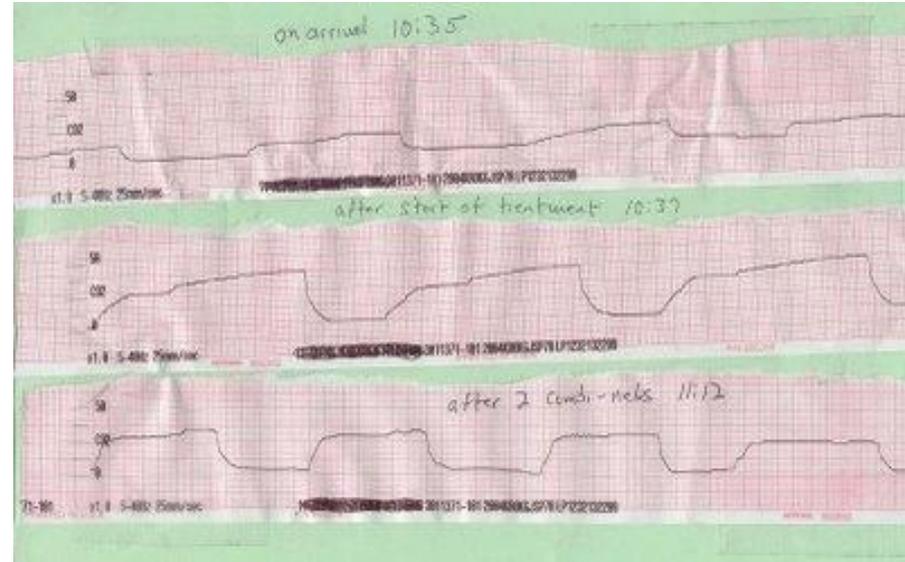
\*NAP4 Census

\*\*HES ICU data 2008/9

\*\*\* Hopkinson/Benger EMJ 2010

# Capnography in Emergency Department

- Essential safety monitor for airway
- Available for resuscitation and CPR
- Possible use in acute exacerbations of respiratory disease
- Analysis of waveform is effort independent and continuous compared to peak flow



# Capnography in Respiratory Medicine

- British Thoracic Society Guidelines for Emergency Oxygen Therapy recommends respiratory rate as single best predictor of severe illness in a breathless patient.
- Capnography is best way to measure and record and monitor this



# Capnography in Fibreoptic intubation



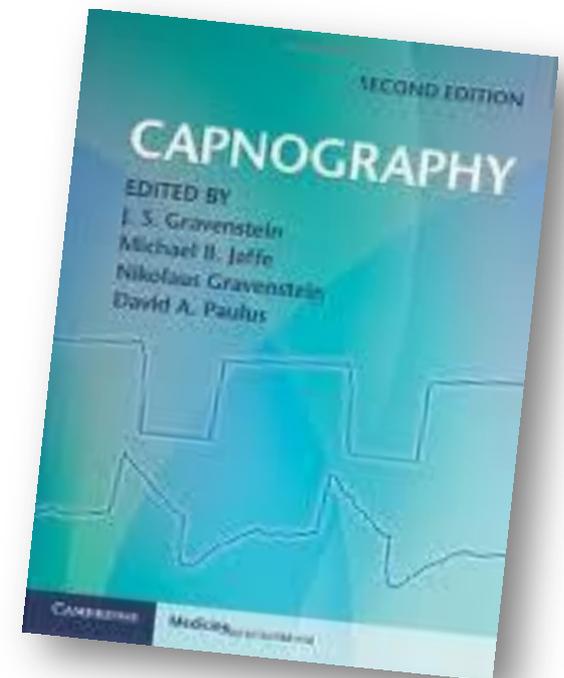
# Capnography in US Courts

- When a Paramedic was questioned, the discussion turned to **capnography**  
...I assure you it has nothing to do with  
**"cat pornography"**



# Capnography - the future

- Use in theatre using breathing filters without ports
- Continuous capnography on every intubated patient in ICU including tracheostomies
- All Recovery bays equipped with capnography and it used on intubated/ LMA patients
- All patients having sedation
- Selected post op patients on Wards
- Use at every resuscitation and all modern Defibrillators to include it
- Use at neonatal resuscitations
- Use at fiberoptic intubations



# Capnography - the future

## You know it makes sense

Time for capnography – everywhere. D. K. Whitaker

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