

Hooray for Hypoxia (or don't give too much oxygen)

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British Thoracic Society

Guideline for emergency oxygen use in adult patients

Endorsed by:

Association of Respiratory Nurse Specialists
Association for Respiratory Technology and Physiology
British Association for Emergency Medicine
British Cardiovascular Society
British Geriatric Society
British Paramedic Association
Chartered Society of Physiotherapy
General Practice Airways Group (GPIAG)
Intensive Care Society
Joint Royal Colleges Ambulance Liaison Committee
Resuscitation Council (UK)
Royal College of Anaesthetists
Royal College of General Practitioners
Royal College of Midwives
Royal College of Nursing
Royal College of Obstetricians and Gynaecologists (approved)
Royal College of Physicians (London, Glasgow, Edinburgh)
Royal Pharmaceutical Society of Great Britain
Society for Acute Medicine



O'Driscoll BR. Howard LS, Davison AG. Thorax 2008; 63 Suppl VI

Normal range for oxygen saturation

Normal range for healthy young adults is approximately 96-98%

(Crapo AJRCCM, 1999;160:1525)

SLIGHT FALL WITH ADVANCING AGE

Witting MD et al Am J Emerg Med 2008; 26: 131-136

Defining safe lower and upper limits of oxygen saturation

Effects of sudden hypoxia

(e.g Removal of oxygen mask at altitude or in a pressure chamber)

- Impaired mental function; Mean onset at SaO₂ 64% No impairment above 84% saturation
- Loss of consciousness at @ saturation of 56%

Akero A et al Eur Respir J. 2005 ;25:725-30

Cottrell JJ et al Aviat Space Environ Med. 1995 ;66:126-30

Hoffman C, et al. Am J Physiol 1946, 145, 685-692

What happens at 9,000 metres (approximately 29,000 feet) – it depends

Atmospheric pO_2 6.2 kPa ($< 1/3$ sea level pO_2) PaO_2 ~3.3 kPa
Arterial Oxygen Saturation ~70%

SUDDEN

Passengers unconscious in <60 seconds if depressurised



ACCLIMATISATION

Everest has been climbed without oxygen



What is the minimum arterial oxygen level recommended in acute illness

Saturation

Critical care consensus guidelines

Surviving sepsis campaign

Target oxygen

Minimum 90%

Aim at 88-95%

These patients have intensive levels of nursing and monitoring

The BTS guideline recommends
minimum of 94%
for most non-critically ill patients

Exposure to high concentrations of oxygen may be harmful

- Absorption Atelectasis even at FIO₂ 30-50%
- Intrapulmonary shunting
- Post-operative hypoxaemia
- Risk to COPD patients
- Coronary vasoconstriction
- Increased Systemic Vascular Resistance
- Reduced Cardiac Index
- Possible reperfusion injury post MI
- Worsens systolic myocardial performance
- Oxygen therapy INCREASED mortality in non-hypoxic patients with mild-moderate stroke

The guideline recommends a maximum of 98% for most patients – less for certain situations

*Harten JM et al J Cardiothoracic Vasc Anaesth 2005; 19: 173-5; Kaneda T et al. Jpn Circ J 2001; 213-8
Frobert O et al. Cardiovasc Ultrasound 2004; 2: 22; Haque WA et al. J Am Coll Cardiol 1996; 2: 353-7
Thomaon aj ET AL. BMJ 2002; 1406-7; Ronning OM et al. Stroke 1999; 30*

Can high dose oxygen be harmful?

- Greater tachycardia and enzyme rise in uncomplicated MI patients [old trial -1976]
- Yet we still give oxygen to MI patients
- Small trial - oxygen in labour can increase cord blood acidosis.
- Oxygen in non-hypoxic stroke patients have higher one year mortality than patients given air alone.
- What is the situation for critically ill?

Hypoxaemia Kills

■ Limited hypoxia:

- prolongs neutrophil survival,
- enhances pro-inflammatory responses (IL-8)
- increases leukocyte adhesion,
- reduces lung fluid transport

■ Prolonged/severe hypoxia:

- inflammatory response
- increased capillary leak

DIE

Hirani 2001
Hannah 1995
Madjdpour 2003
Halperin 1996



DANGER OF DEATH

KEEP OUT

Can we determine the importance of oxygenation in ARDS?



Outcome and oxygenation in respiratory failure: A study of over 100,000 ICU patients

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*Intensive Care National Audit and
Research Centre

#John Radcliffe Hospital Oxford

Methods

- Intensive Care National Audit and Research (ICNARC) Case Mix Programme data base
- 159 adult ICUs England, Wales, Northern Ireland
- Dec 1995 - June 2003
- Prospective validated data on 1st 24 hours and outcome

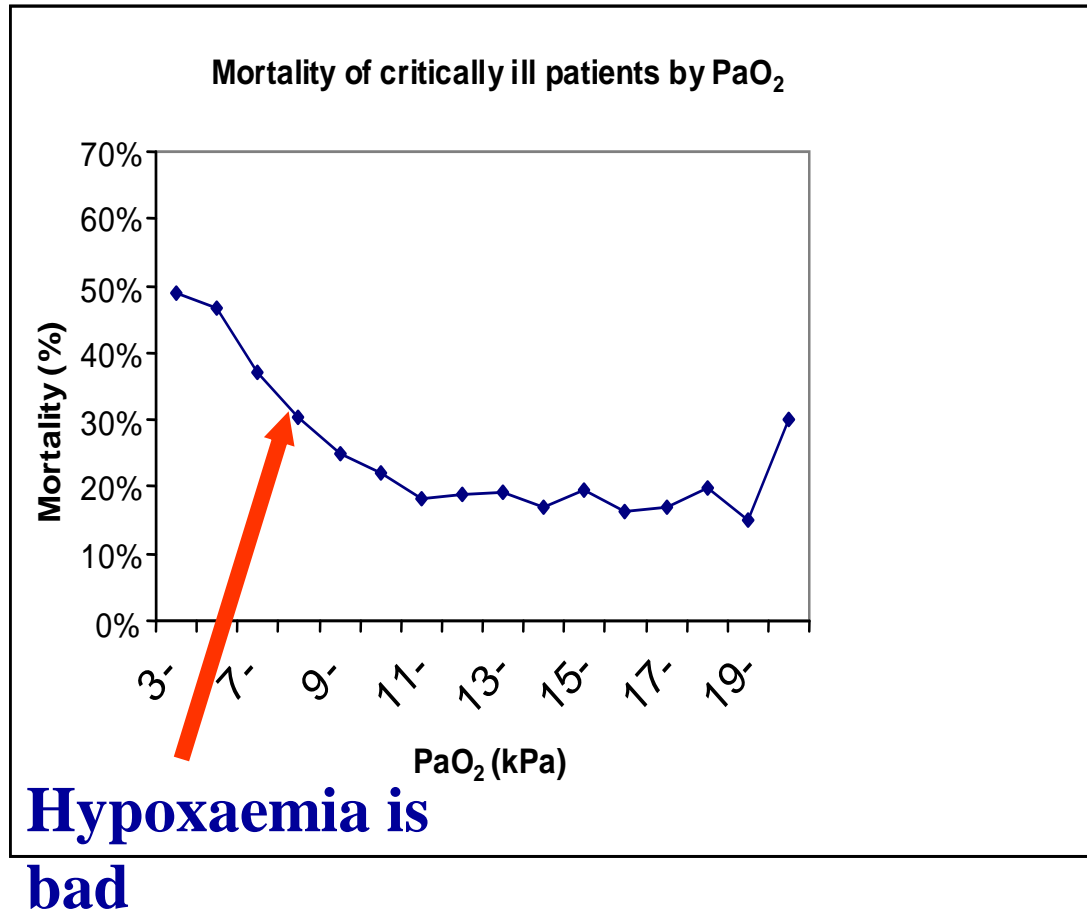
Analysis

132,828 patients



	ALI	ARDS	No Resp Failure
Age (Med IQR)	66 (52-75)	65 (51-74)	58 (36-72)
APACHE II (Med SD)	15.4 (6.3)	19.3 (7.1)	13.8 (6.3)
ICU stay (surv) (Med IQR)	1.8 (0.9-3.7)	3.0 (1.2-8.2)	1.1 (0.8-2.4)
Hospital stay (Med IQR)	17 (10-32)	21 (12-40)	14 (8-27)
Hosp mortality (%)	24.7%	41.7%	18.4%

Targeted Oxygenation



The other side of the
coin

Hyperoxia is dangerous across species

NATURE

Insects breathe discontinuously to avoid oxygen toxicity.

Hetz SK, Bradley TJ.

NATURE 2005 Feb 3;433:516-9.



Hyperoxia Kills



- 100% oxygen results in:
 - Progressive damage to the pulmonary endothelium and epithelium.
 - Free radical release,
 - Capillary leak
 - Impaired surfactant function
 - Maldistribution of microcirculatory perfusion

Death

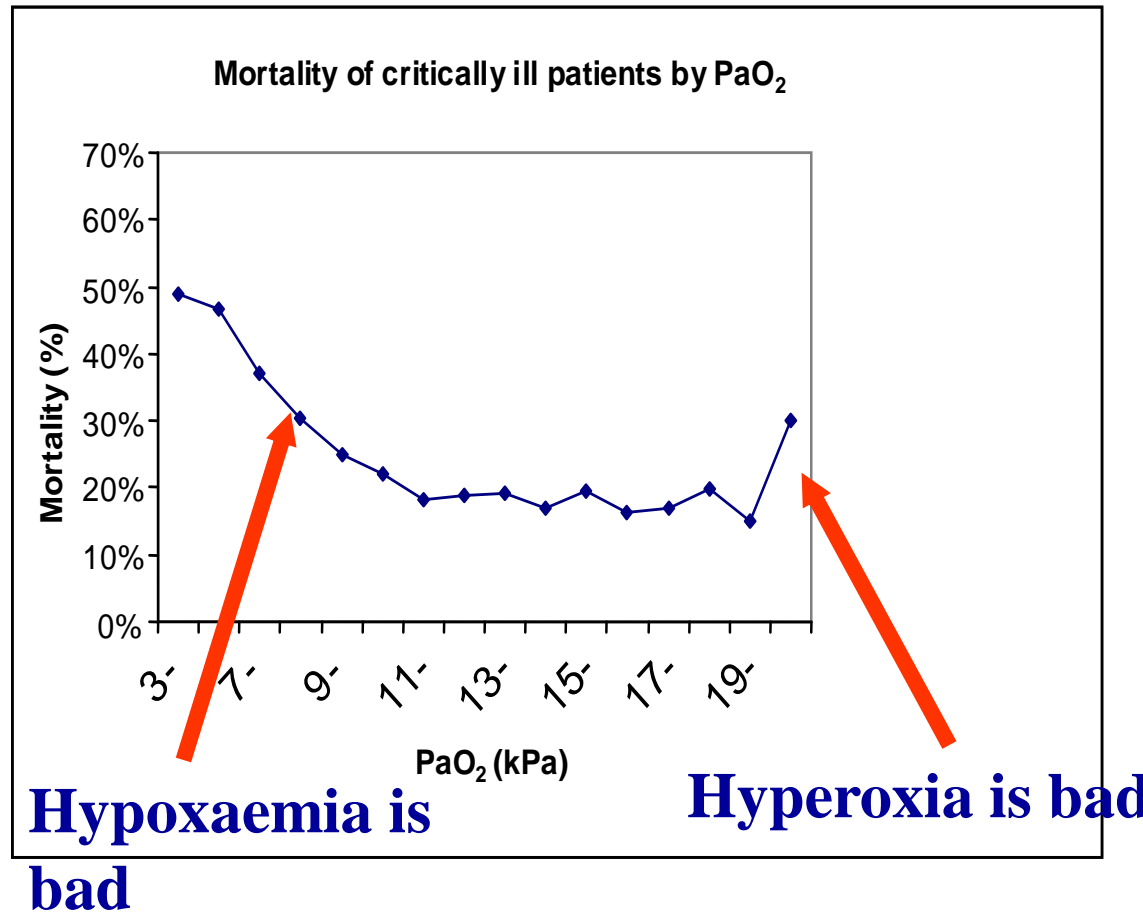


Welty-Wolf 1997

Tsai 2003

Huang 1995

Targeted Oxygenation



Hypoxia and Adenosine are anti-inflammatory



Improving oxygen is not enough

THE NEW ENGLAND JOURNAL OF MEDICINE

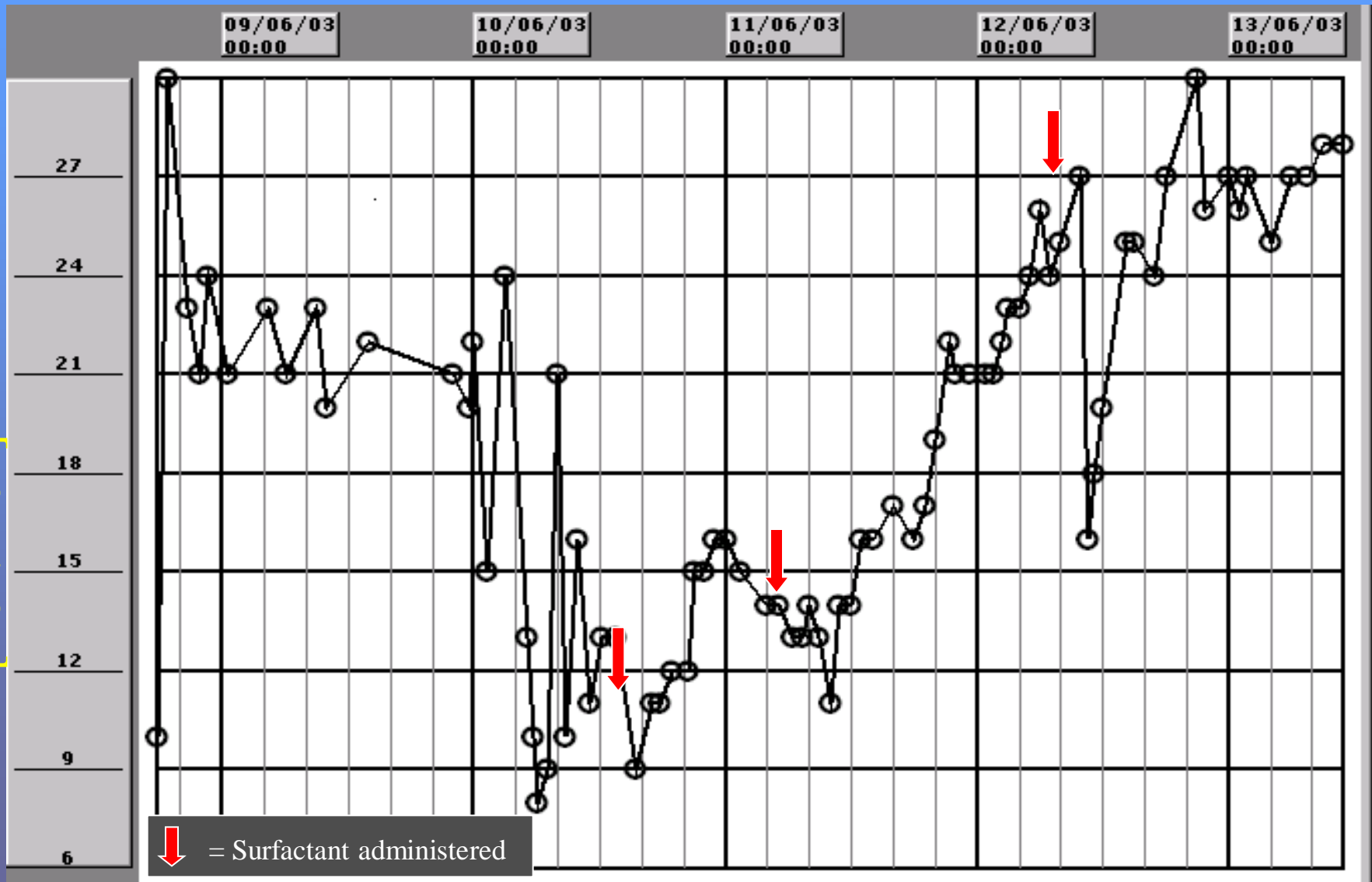
ORIGINAL ARTICLE

Effect of Recombinant Surfactant Protein C–Based Surfactant on the Acute Respiratory Distress Syndrome

Roger G. Spragg, M.D., James F. Lewis, M.D., Hans-Dieter Walmrath, M.D.,
Jay Johannigman, M.D., Geoff Bellingan, M.D., Pierre-Francois Laterre, M.D.,
Michael C. Witte, M.D., Guy A. Richards, M.D., Gerd Rippin, Ph.D.,
Frank Rathgeb, M.D., Dietrich Häfner, M.D., Friedemann J.H. Taut, M.D.,
and Werner Seeger, M.D.

$[\text{PO}_2/\text{FiO}_2]$ ratio / time

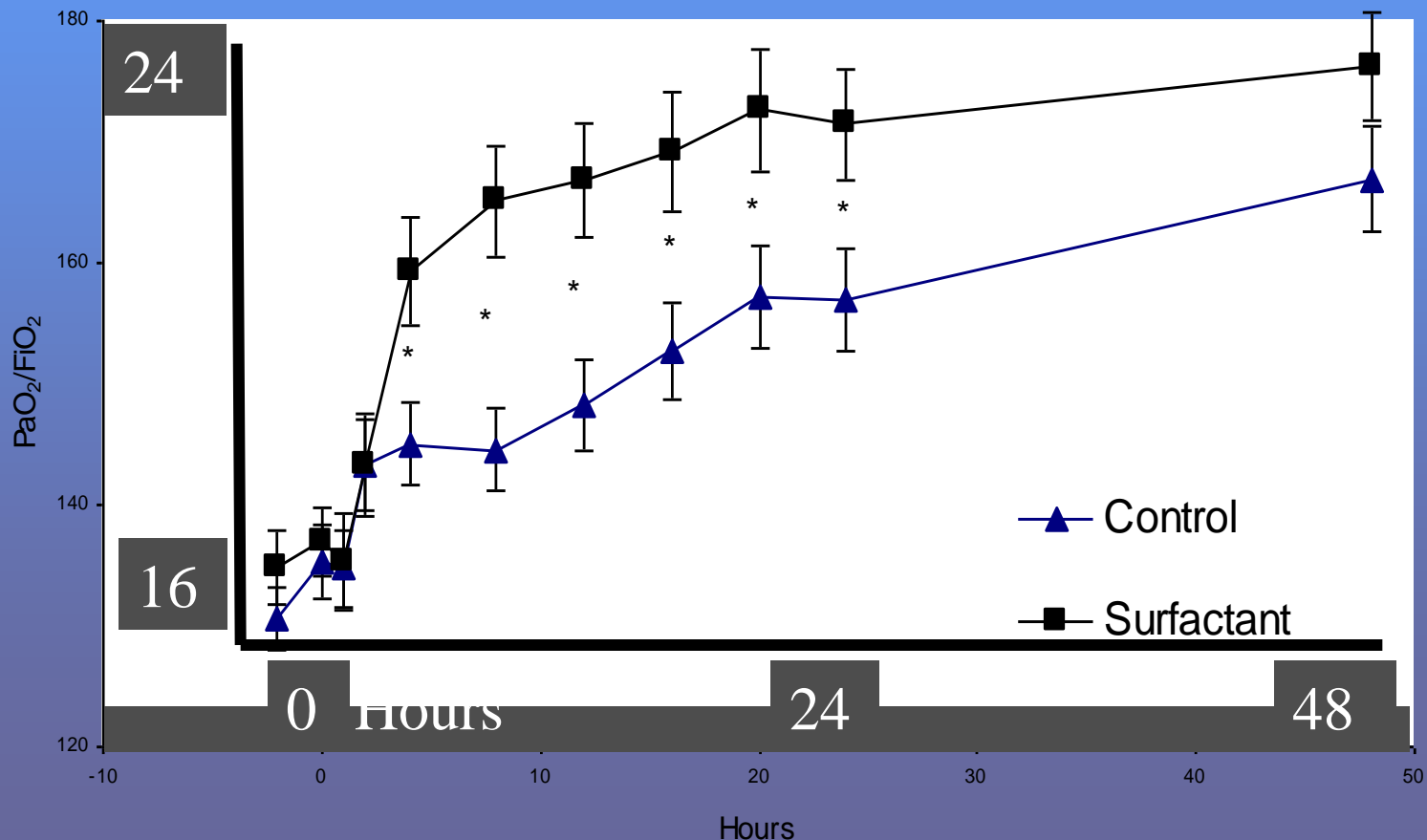
$[\text{PO}_2/\text{FiO}_2]$ ratio



Venticute Surfactant Trial: Outcome

2) Oxygenation

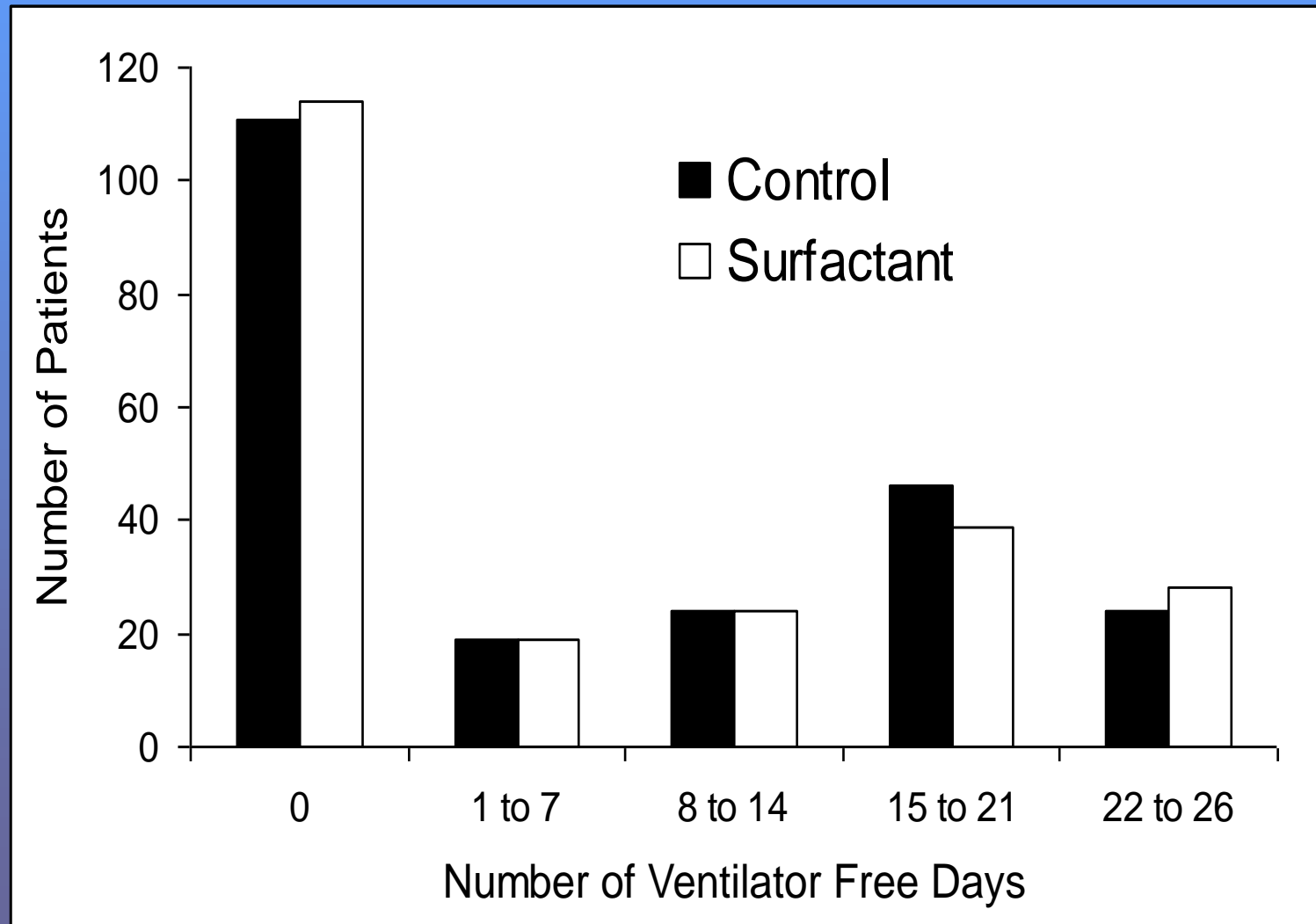
Treatment with surfactant increased significantly the area under the $\text{PaO}_2/\text{FiO}_2$ vs. time curve





Venticute Surfactant Trial: Outcome

1) Ventilator Free days



Improving oxygen is not enough

- Same for iNO, Oscillation, ECMO....

What is a safe lower Oxygen level in acute COPD?

In acute COPD

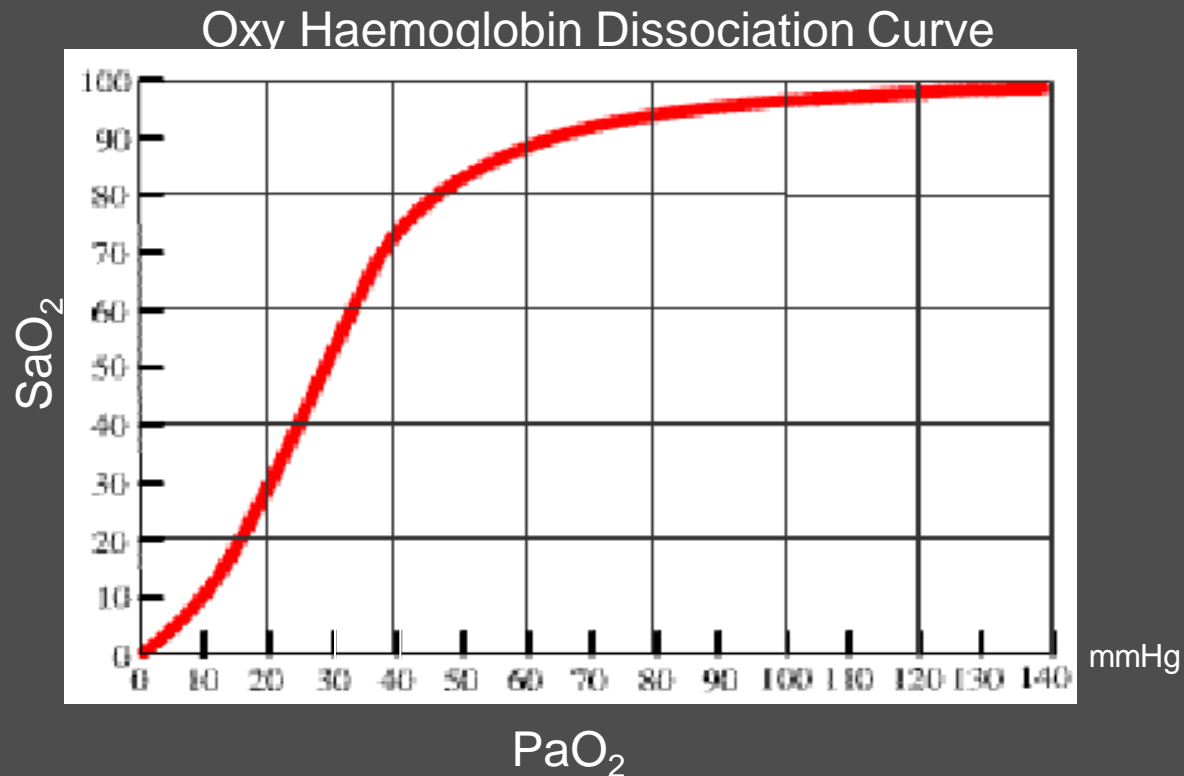
**pO₂ above 6.7kPa or
50 mm Hg**

will prevent death

**SaO₂ above about
85%**

**(Keep SpO₂ ≥88% to
allow for oximeter
error and ensure PaO₂
>85%)**

*Murphy R, Driscoll P, O'Driscoll R
Emerg Med J 2001; 18:333-9*



**This guideline recommends a minimum
saturation of 88% for most COPD patients**

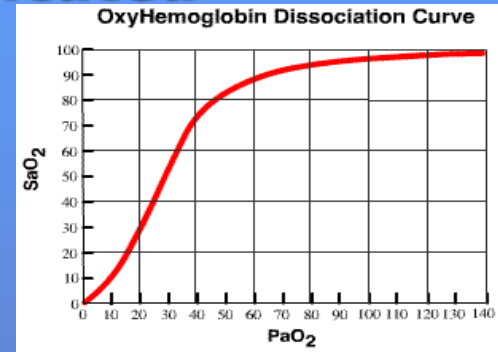
Aims of emergency oxygen therapy

- To correct or prevent potentially harmful hypoxaemia
- *To alleviate breathlessness (only if hypoxaemic)*

Oxygen has no effect on breathlessness if the oxygen saturation is normal

Fallacies regarding Oxygen Therapy

"Routine administration of supplemental oxygen is useful, harmless and clinically indicated"



- Little increase in oxygen-carrying capacity
- Renders pulse oximetry worthless as a measure of ventilation
- May prevent early diagnosis & specific treatment of hypoventilation

The guideline only recommends supplemental oxygen when SpO₂ is below the target range or CO Poisoning

Prescribing Oxygen

Oxygen prescription

Model for oxygen section in hospital prescription charts

DRUG		OXYGEN (Refer To Trust Oxygen Policy)
<i>Circle target oxygen saturation</i> 88-92% 94-98% Other_____	STOP DATE	
Starting device/flow rate_____ PRN / Continuous	PHARM	
(Saturation is indicated in almost all cases except for palliative terminal care)		
SIGNATURE / PRINT NAME	DATE ddmmyy	

Should high concentration of oxygen be given to all patients who present with severe acute illness in A&E?

21 Royal Colleges and Societies say NO. Gosh a bigger coalition than us. Targeted oxygen and a saturation of 88-94% is usually enough

