Perioperative Optimization

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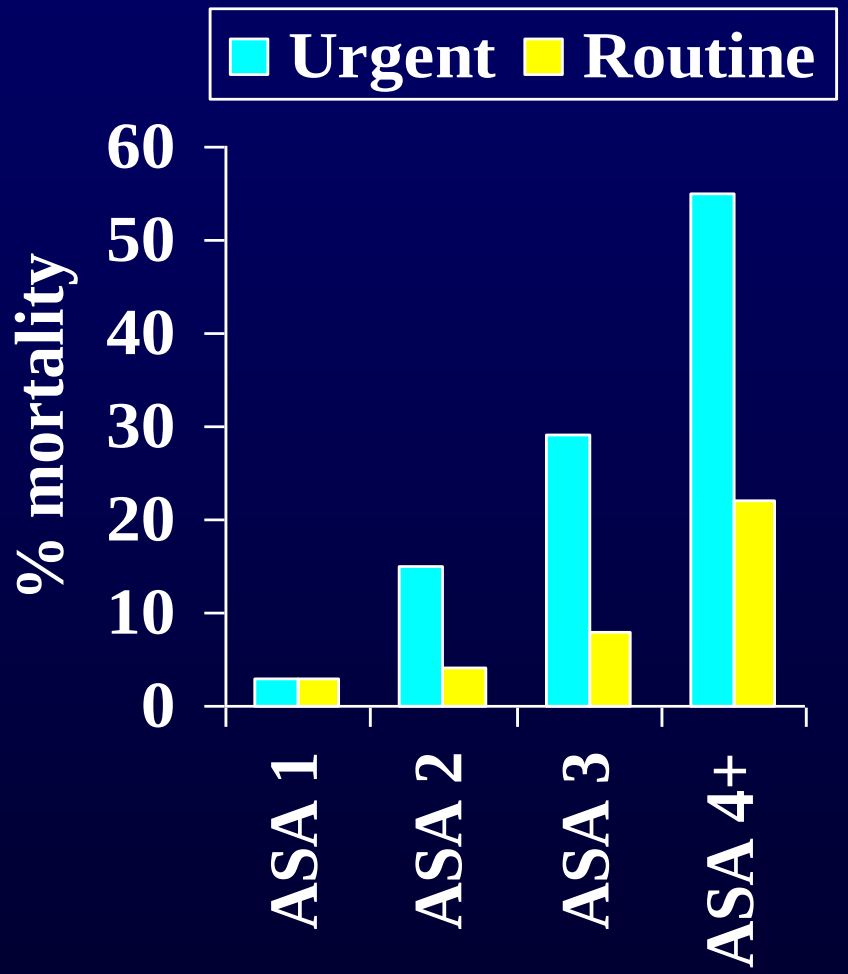
Background physiology

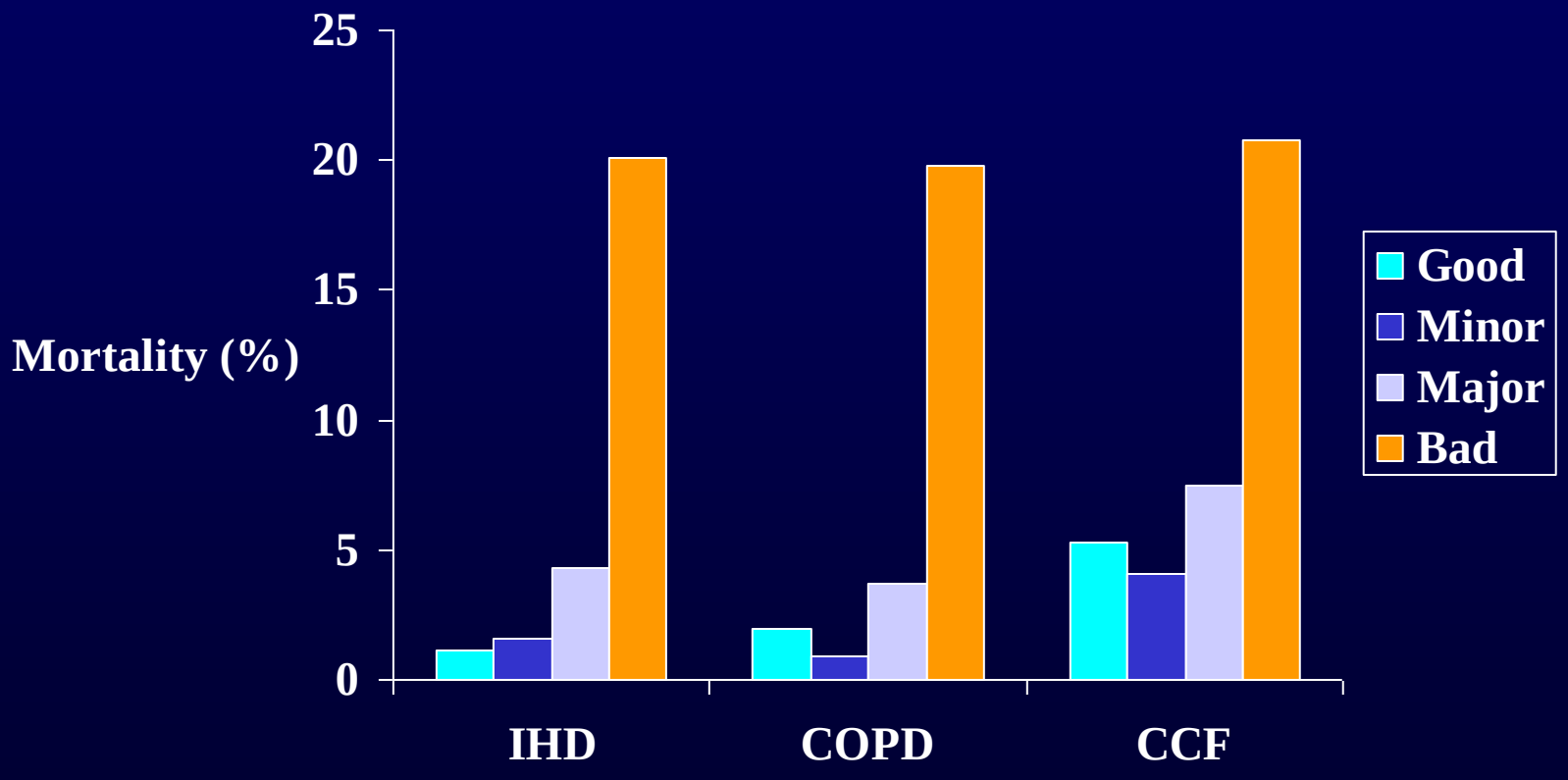
- Patients who are sicker have higher mortality
- Cardiovascular disease is most important
- Assessments of cardiovascular physiology and scoring systems are available
- Older patients have more diseases and less reserve

Surgical Mortality

- Mella BJS 98
- Colorectal surgery audit
- **Operations carried out urgently have a higher mortality rate**

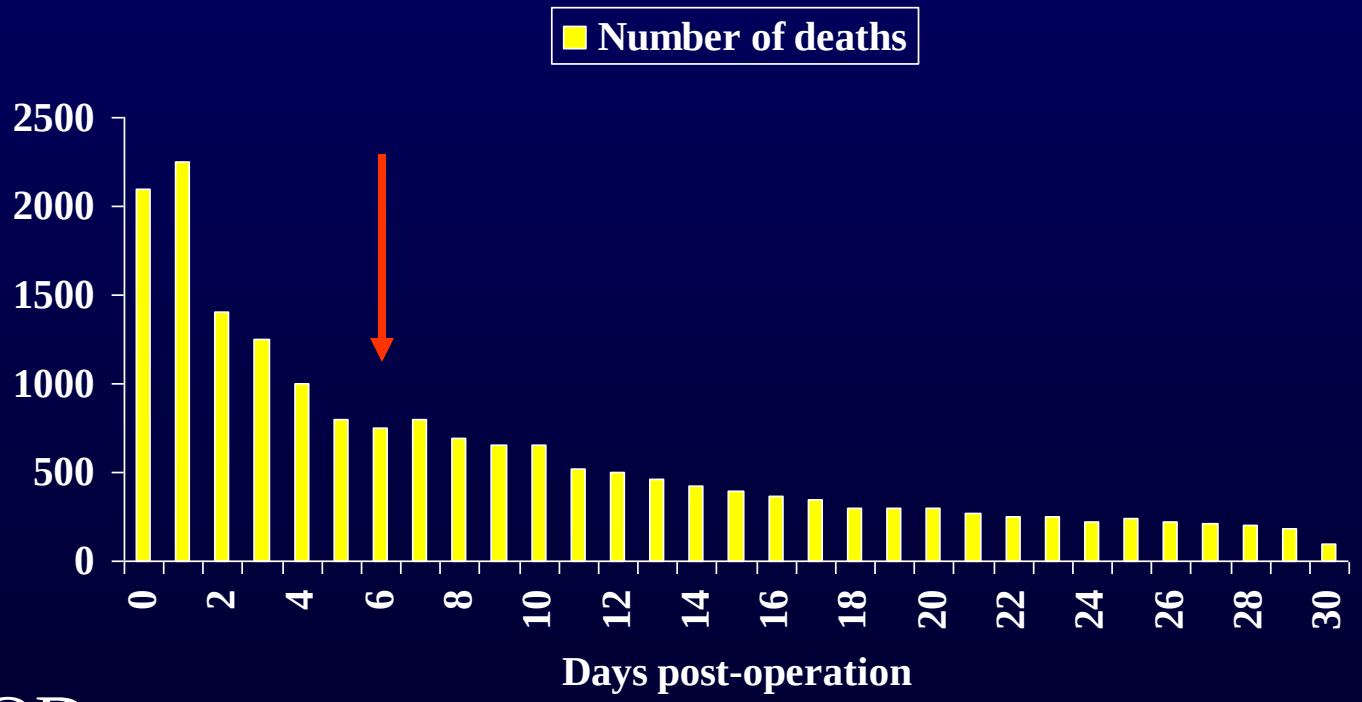


Surgical Mortality



Farrow, BJA, 82

Death is not immediate for most patients who die within 28 days of surgery



NCEPOD

Patient Selection

Shoemaker et al Crit Care Med 1982: 10; 398.
Shoemaker et al Am J Surg 1983: 1; 43.
Shoemaker et al Chest 1988: 94; 1176.

Shoemaker in a series of observational studies demonstrated a group of patients that he called “High Risk” and who had a 28 day mortality of 30- 40 %.

Shoemaker Used Simple Clinical Criteria to Identify These Patients

- Previous severe cardio-respiratory illness
- Late stage vascular disease
- Age> 70 with limited physiological reserve
- Acute abdominal catastrophe
- Septicaemia
- Respiratory failure
- Acute renal failure
- Massive blood loss > 8 units
- Extensive surgery for carcinoma

Shoemaker Asked the Questions

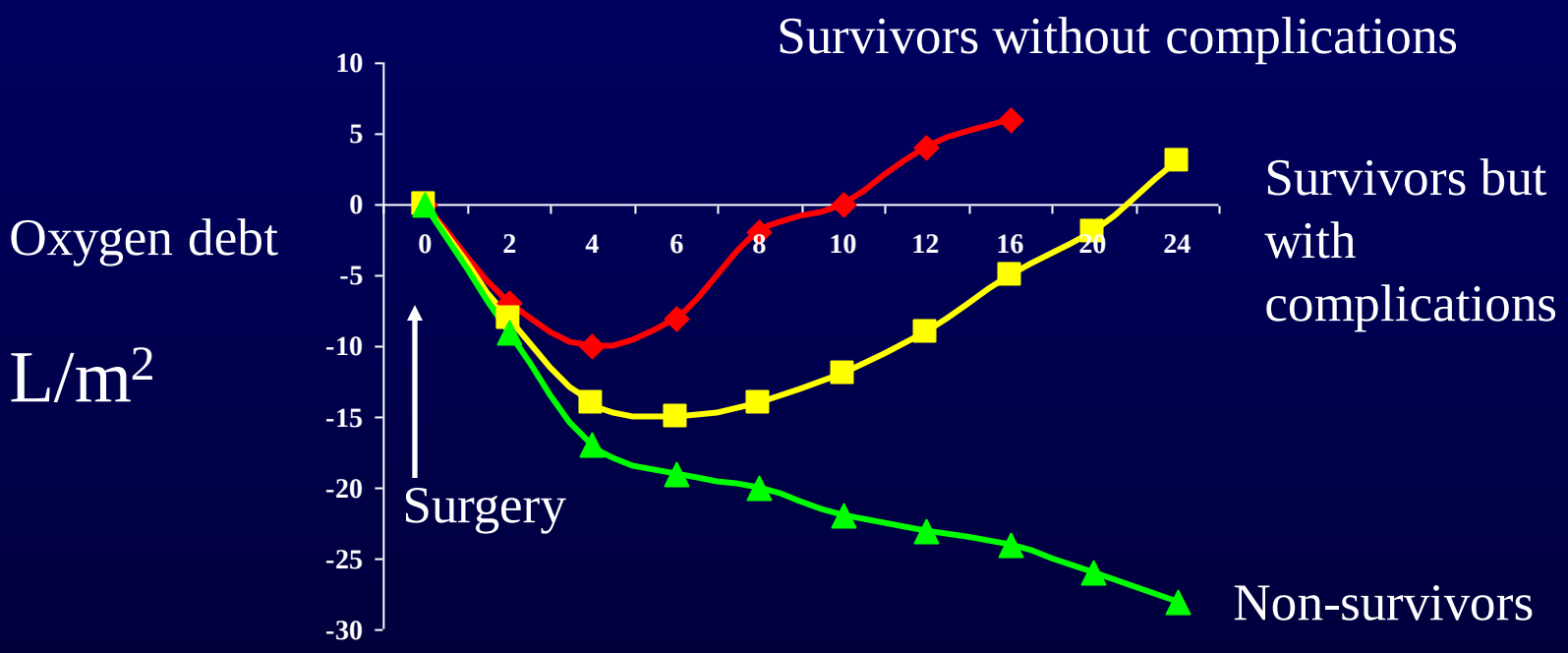
- Which of the commonly measured variables, such Blood pressure, pulse rate, respiratory rate, CVP, blood tests etc., predicted outcome in this “High Risk” group of patients?
- He examined over 30 variables in several thousand patients

Shoemaker et al. CCM. 1979: 7; 237.
Shoemaker et al. CCM 1979: 7;424.
Bland et al. CCM. 1985: 13; 85.
Bland et al CCM. 1985: 13; 91.

Best prognostic indicators of outcome in these “High Risk” surgical patients

- He demonstrated that only variables related to blood volume and flow had significant prognostic value
  - **Blood volume**
  - **Cardiac output**
  - **Oxygen delivery**
  - **Oxygen consumption**

Shoemaker and Oxygen Debt



Optimisation of Surgical Patients

Shoemaker et al. Chest. 1988: 94; 1176

Results

	Protocol	Control
ICU Stay (days)	10.2 *	15.8
Hosp stay (days)	19.3	25.2
Complications	0.39*	1.30
Deaths	4%*	33%

Optimisation of Surgical Patients

-controlled randomised studies.

O F Boyd, R M Grounds, E D Bennett. JAMA 1993: 270; 2699.

- To investigate the possible beneficial role of deliberately increasing oxygen delivery in the peri-operative phase for “High Risk” surgical patients
- Historical mortality 33%

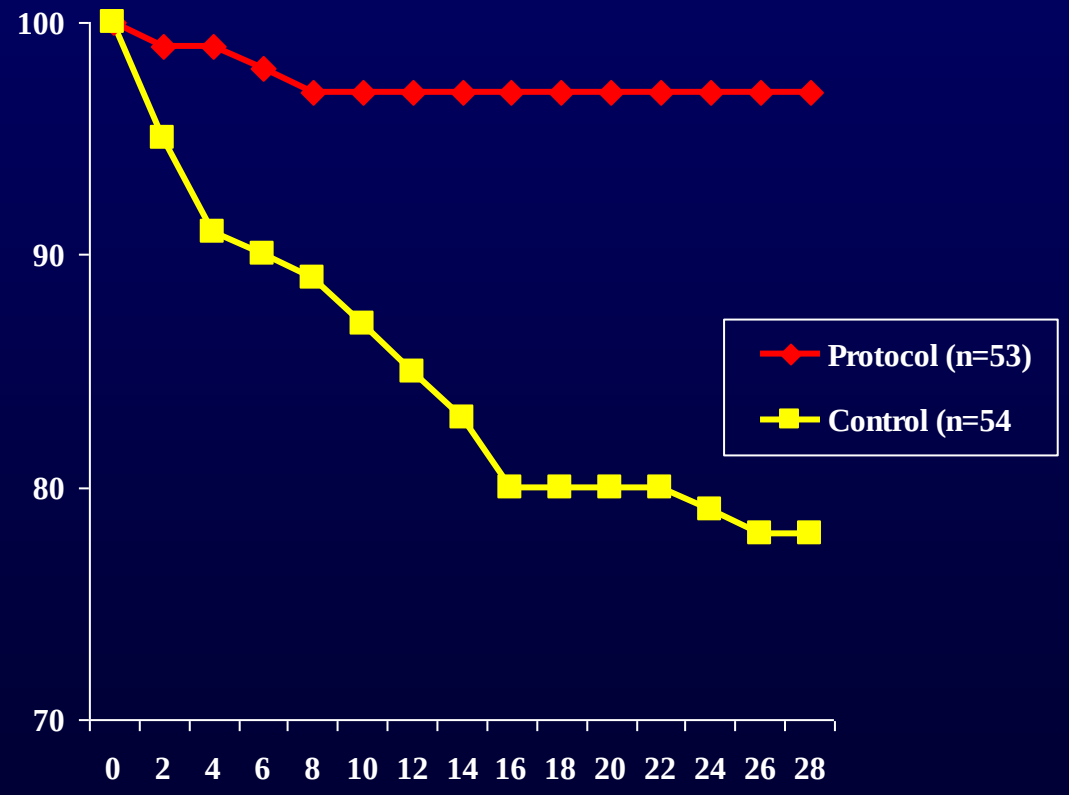
Optimisation of Surgical Patients

O F Boyd, R M Grounds, E D Bennett. JAMA 1993: 270; 2699.

- **Targets for treatment. Both groups**
  - MAP 80 – 110 mmHg
  - PAWP 12 – 14 mmHg
  - Art Oxygen Sats >94%
  - Haemoglobin >12g/dl
  - Urine output > 0.5 ml/kg.hr
- **Additional targets for protocol group**
  - Oxygen delivery 600 ml/min/m^2

Post-operative Mortality

Boyd, Grounds, Bennett, JAMA 1993: 270; 2699.



% age survivors

Days after operation

Kaplan-Meier Survival curve

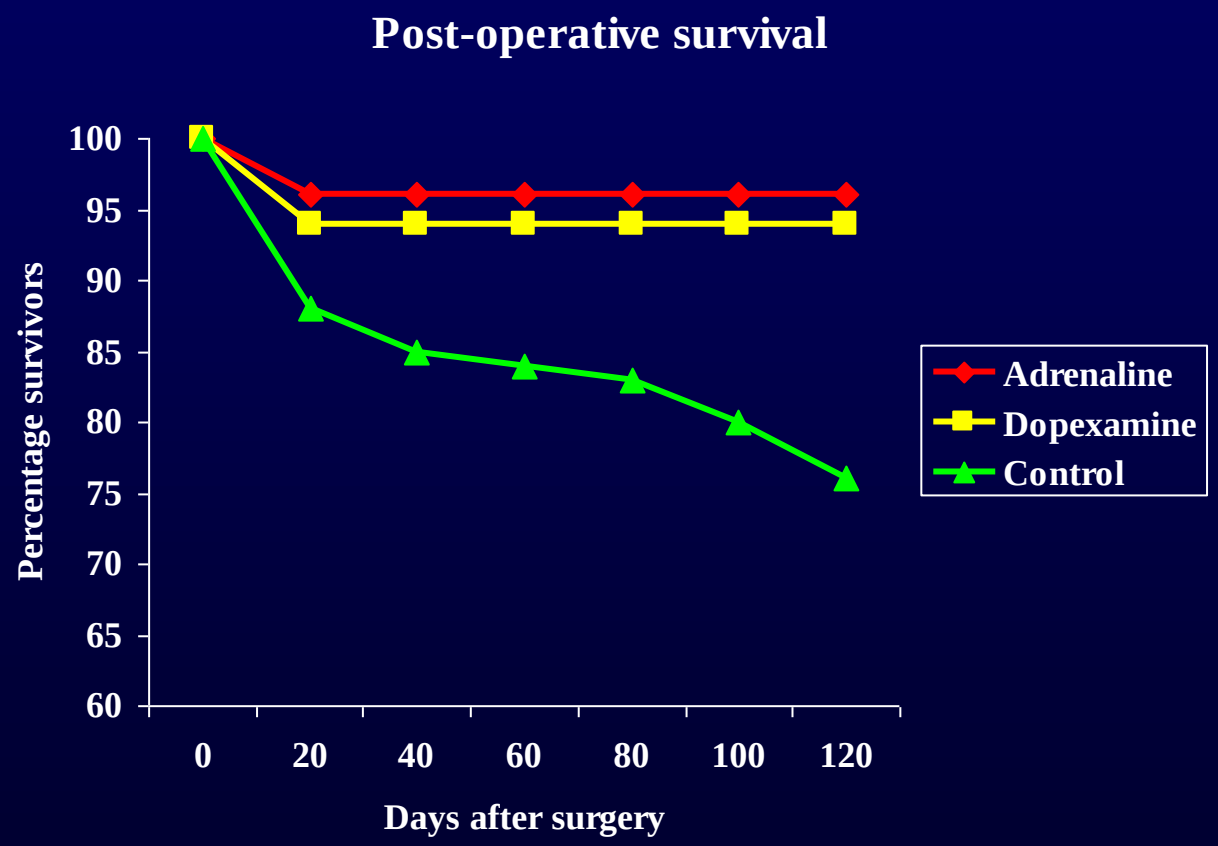
York Study

Wilson et al. BMJ 1999: 318; 1099

- Wilson and colleagues undertook a trial of pre-operative optimisation of oxygen delivery in major elective surgery
- Patients were randomised to three groups, two were monitored haemodynamically, given fluids ± adrenaline or dopexamine to increase oxygen delivery. The third group were treated conventionally.
- Main outcome measures were hospital mortality and morbidity.

York Study

Wilson et al. BMJ 1999: 318; 1099



York Study

Wilson et al. BMJ 1999: 318; 1099

	Control	Adrenaline	Dopexamine
Number of patients	46	46	46
Total bed days	1008	875	596*
ICU bed days	192	176	152*
Bed days per patient	22	19	13*

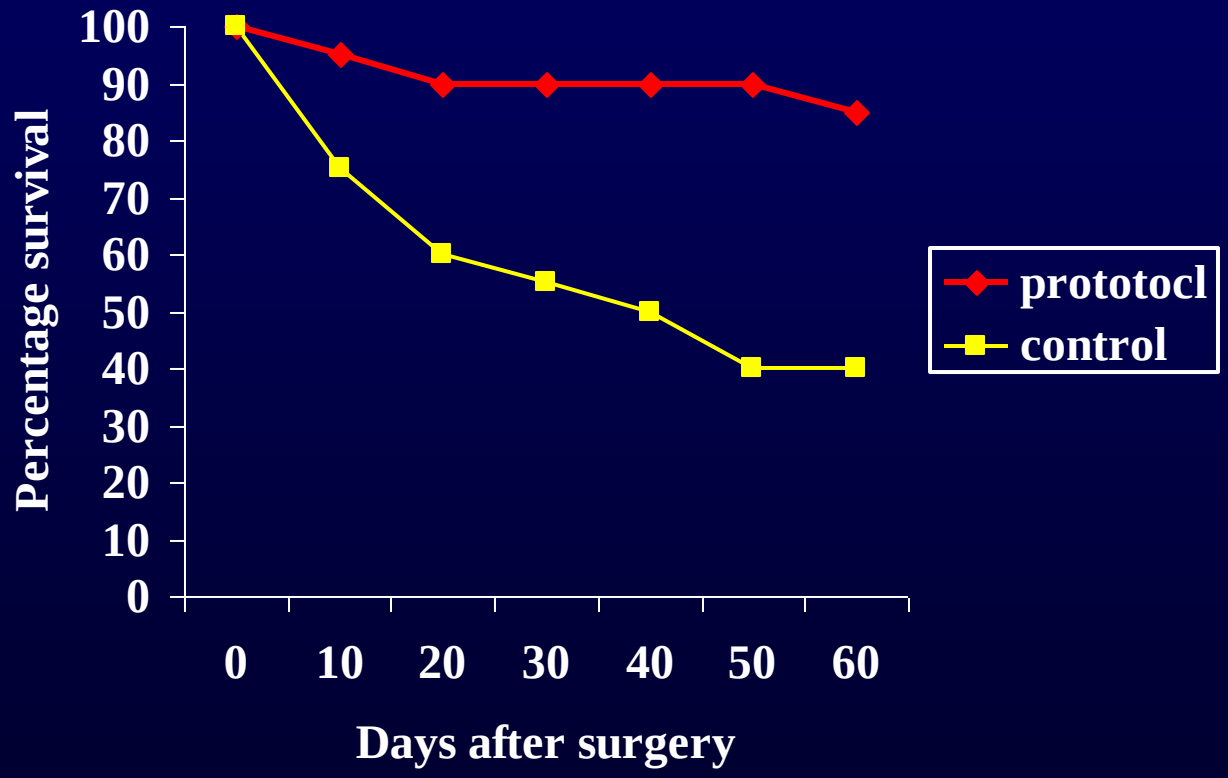
Lobo et al. High Risk Surgical Patients

Lobo et al.2000: Crit.Care Med:28;3396.

- Studied effects of increasing DO_2 in very high risk surgical patients with an historical mortality of > 50%.
- DO_2 was increased pre-operatively and maintained during surgery and post-operatively for 24 hours
- Main outcome criteria was 60 day mortality and morbidity

Lobo et al. High Risk Surgical Patients

Lobo et al.2000: Crit.Care Med:28;3396.



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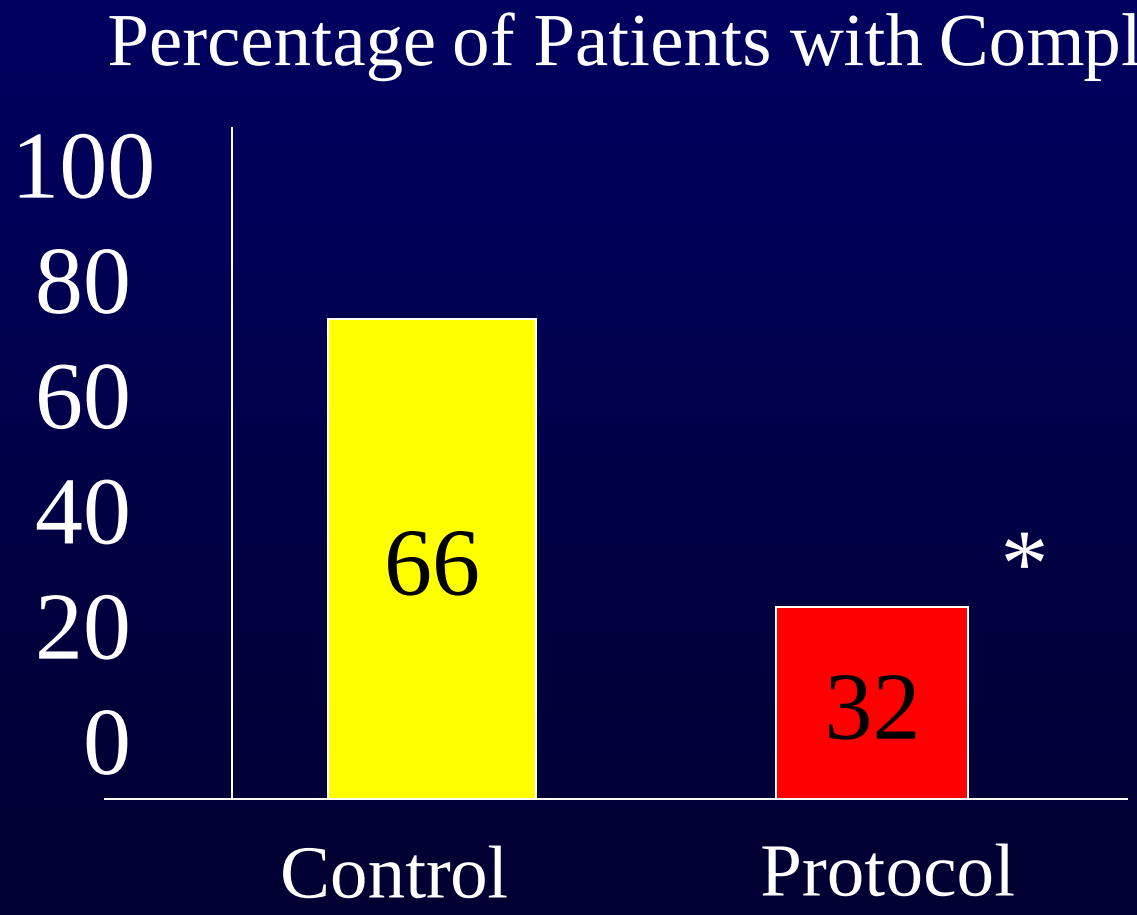


Optimisation of Patients in ITU

Hayes, Timmins et al. N Eng J Med. 1994: 330; 1717.

- Studied critically ill patients in ICU.
- Mixture of surgical and medical patients.
- Treatment goals using dobutamine were.
  - Oxygen delivery > 600 ml/min/$m^{2.}$
  - Oxygen consumption > 170 ml/min/$m^{2.}$
- Outcome. Mortality.
  - Control group 34%.
  - Treatment group 54%.

Optimisation of Patients in ITU

Gattinoni et al. N Eng J Med. 1995: 333; 1025

- Multi center study of post-operative patients who had developed sepsis, sepsis syndrome, organ failure or ARDS.
- Patients were entered into the study only after failure of 2 days conventional therapy in ICU.
- Three groups.
  - Conventional therapy.
  - Cardiac Index increased above 4.5 L/min/$m^{2.}$
  - Mixed venous saturation above 7%.
- NO DIFFERENCE IN OUTCOME.

Oesophageal Doppler.

- Sinclair et al BMJ 1997 (♯ femur)
- Venn et al. BJA 2002 (♯ femur)
- McKendry et al BMJ 2004 (cardiac surgery)
- Wakeling et al BJA 2005 (Bowel surgery)

Randomised controlled trial to investigate influence of the fluid challenge on duration of hospital stay and perioperative morbidity in patients with hip fractures.

R Venn, A Steele, P Richardson, J Poloniecki, M Grounds, P Newman. BJA 2002; 65 – 71.

- Randomised, prospective controlled trial.
- 90 patients with fracture neck of femur.
- Three groups.
  - Conventional intra-op fluid management
  - Additional colloid guided by CVP
  - Additional colloid guided by Oesophageal doppler

Venn et al BJA 2002.

- Pre-op
  - All necessary medical support
  - Regular analgesia pre-op
  - Maintenance IV fluids 1litre 12hourly
  - Blood transfusion if appropriate
- Anaesthesia
  - Fentanyl. Propofol. Vecuronium. Oxygen, Nitrous oxide. Isoflurane. Intubation. IPPV.
  - 3 in 1. inguinal perivascular nerve blockade.

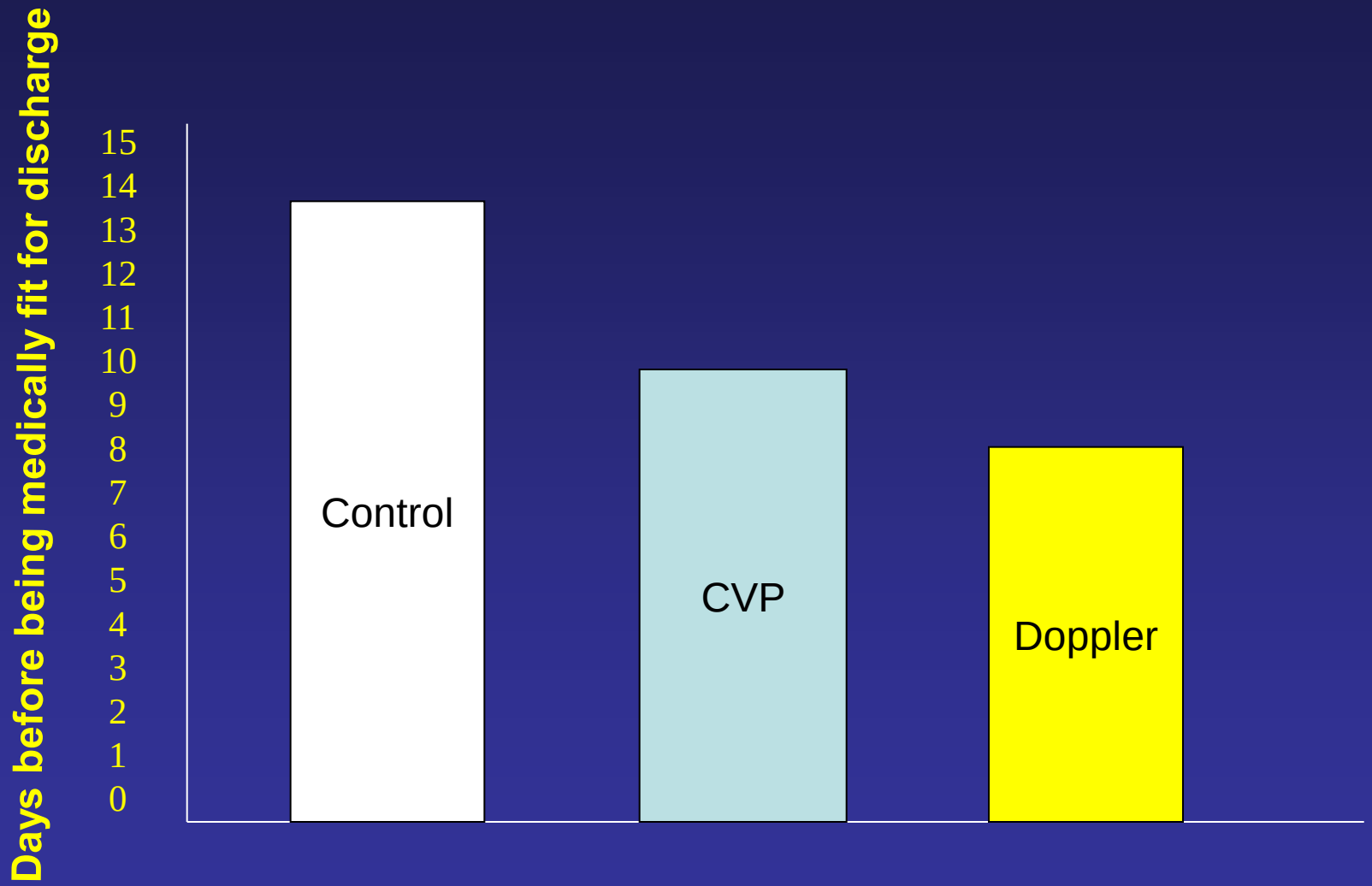
Venn et al. BJA 2002.

- Intra operatively. All patients
  - Continuous monitoring.
  - IV Hartmanns or blood to replace estimated and measured blood loss. AND to maintain heart rate and Blood pressure within 20% of pre-induction baseline.
- PLACEBO GROUP.
  - Clinicians were asked to give IV fluids as they though appropriate within above limits.

Venn et al. BJA 2002.
CVP Group. Fluid Challenges

TIME	CVP ((mmHg)	Gelofusine Challenge
Initial reading	<14	200ml
	>14	100ml
During fluid challenge	Increase > 5	Stop fluid challenge and WAIT
Following fluid challenge	Increase > 3	WAIT
	≤ 3	Repeat fluid challenge as per initial reading

Venn et all. BJA 2002.
Results



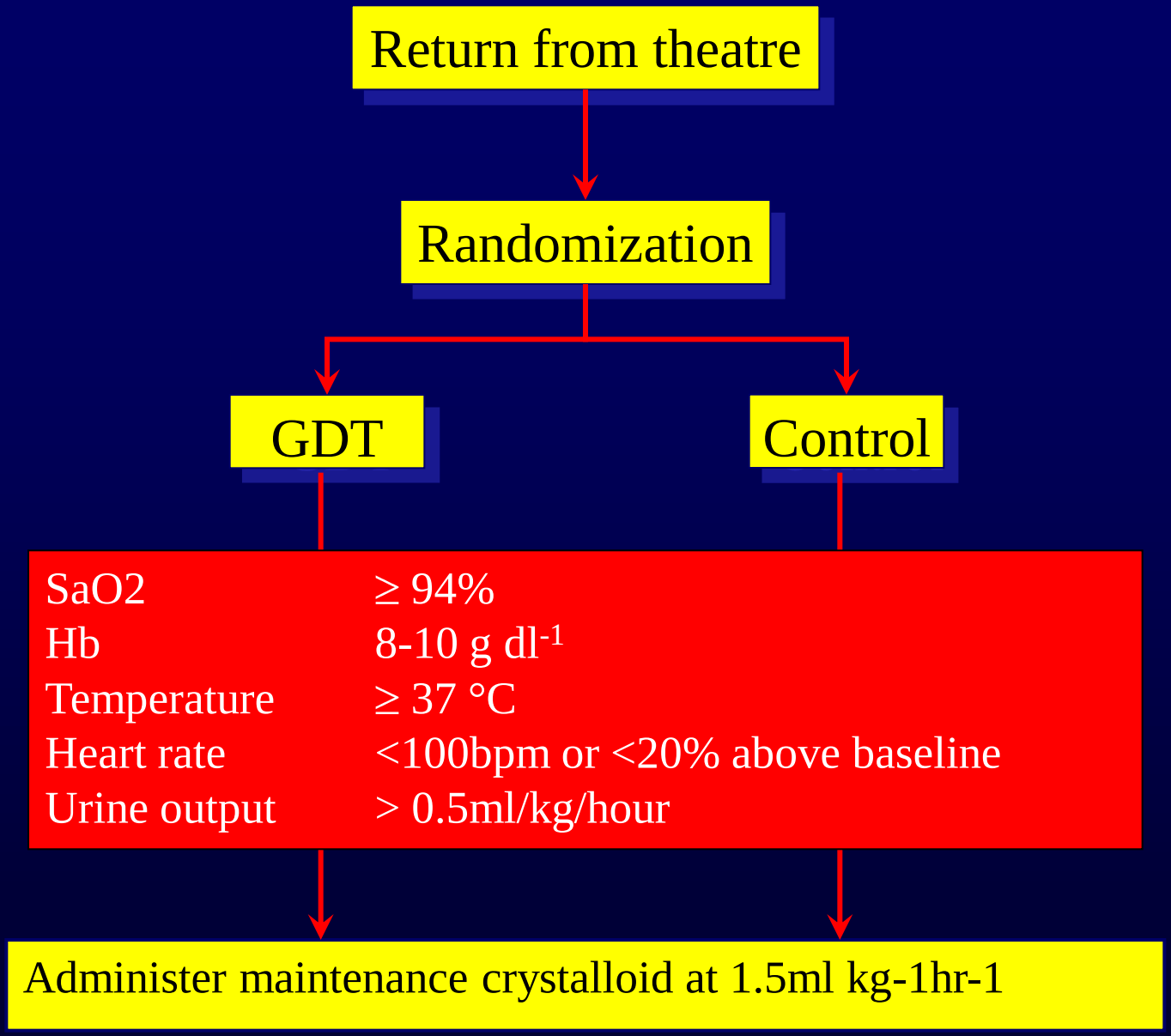
Venn et al. BJA 2002.

	Control	CVP	Doppler	P value
Days before medically fit for discharge	13.9	10	7.7	0.035
Acute hospital stay	16.7	11.1	12.5	0.17
Total hospital stay (ortho and Geriatric)	17.5	13.3	13.3	0.27

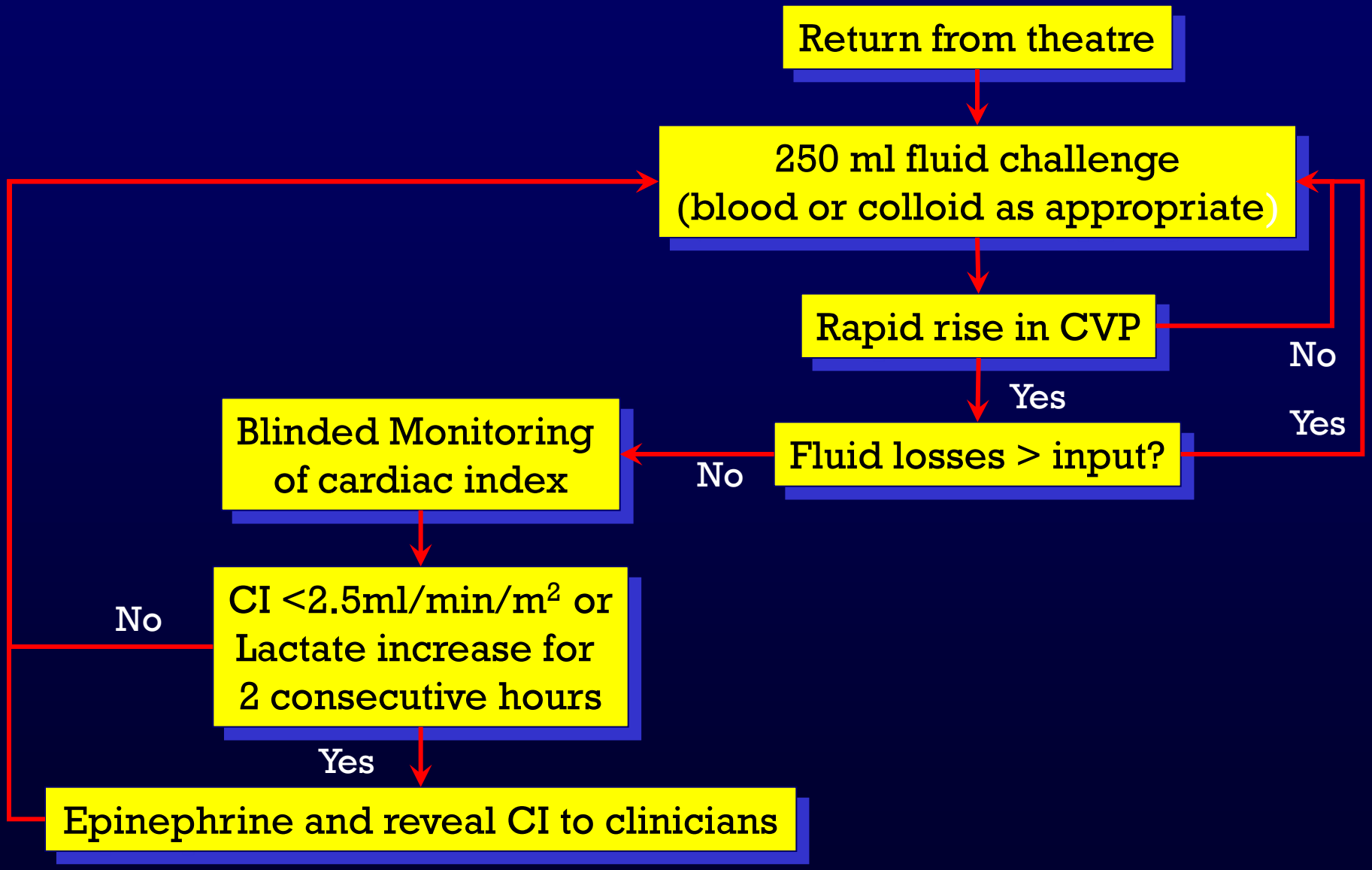
Early goal directed therapy following major surgery reduces complications and length of hospital stay. A randomised, controlled trial.

R M Pearse, D Dawson, J Fawcett, A Rhodes, R M Grounds ED Bennett
Critical Care 2005

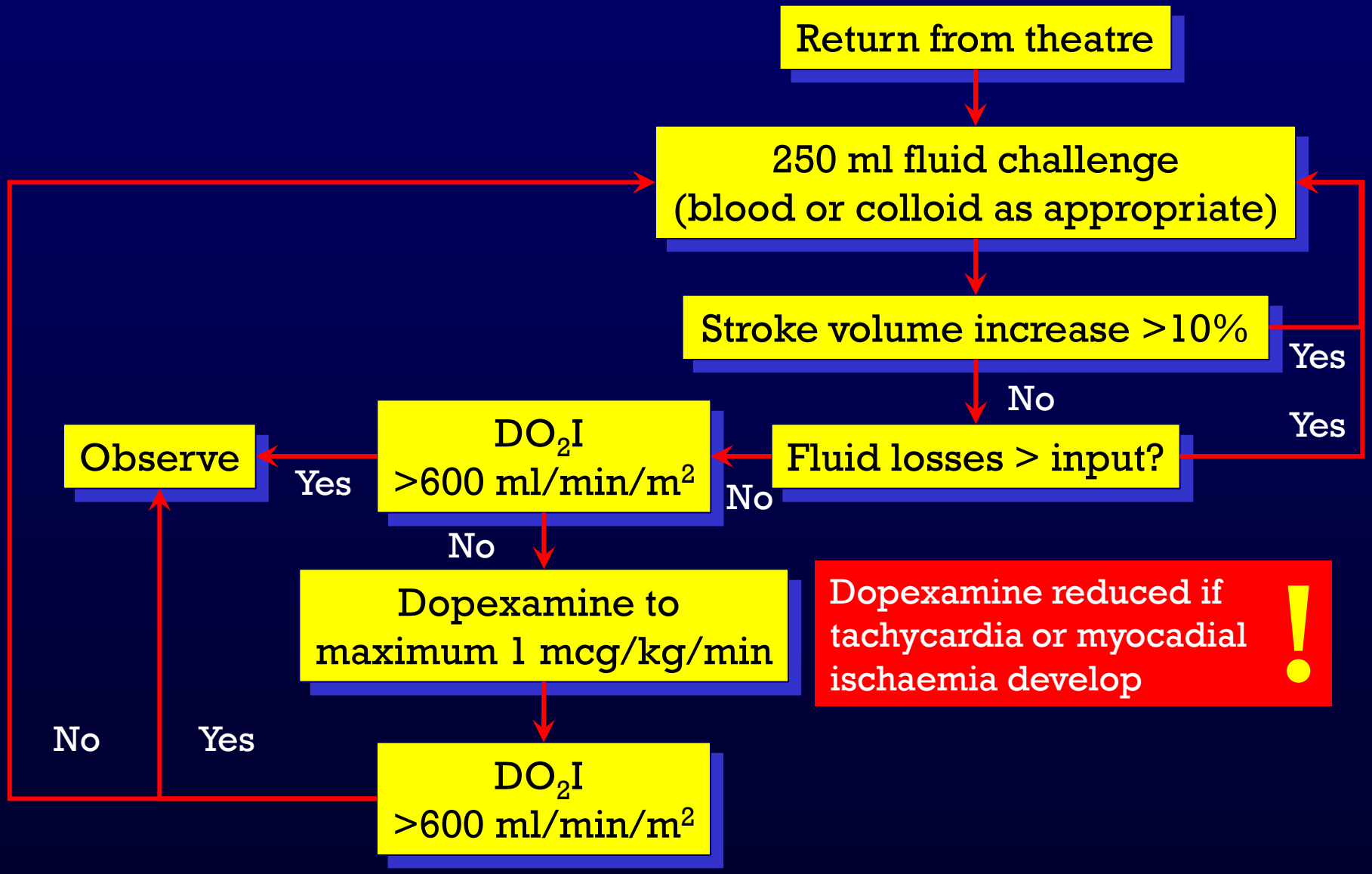
- Pragmatic Study design.
- Randomised, Controlled, Blinded.
- Eight hours of GDT in post-operative period.
- Surgical patients with co-morbidities who were booked to ITU post-operatively.
- Primary endpoint of reduction in complications.
- Prospectively defined morbidity endpoints.


Return from theatre
Randomization
GDT
Control
SaO2 ≥ 94%
Hb 8-10 g dl-1
Temperature ≥ 37 °C
Heart rate <100bpm or <20% above baseline
Urine output > 0.5ml/kg/hour
Administer maintenance crystalloid at 1.5ml kg-1hr-1

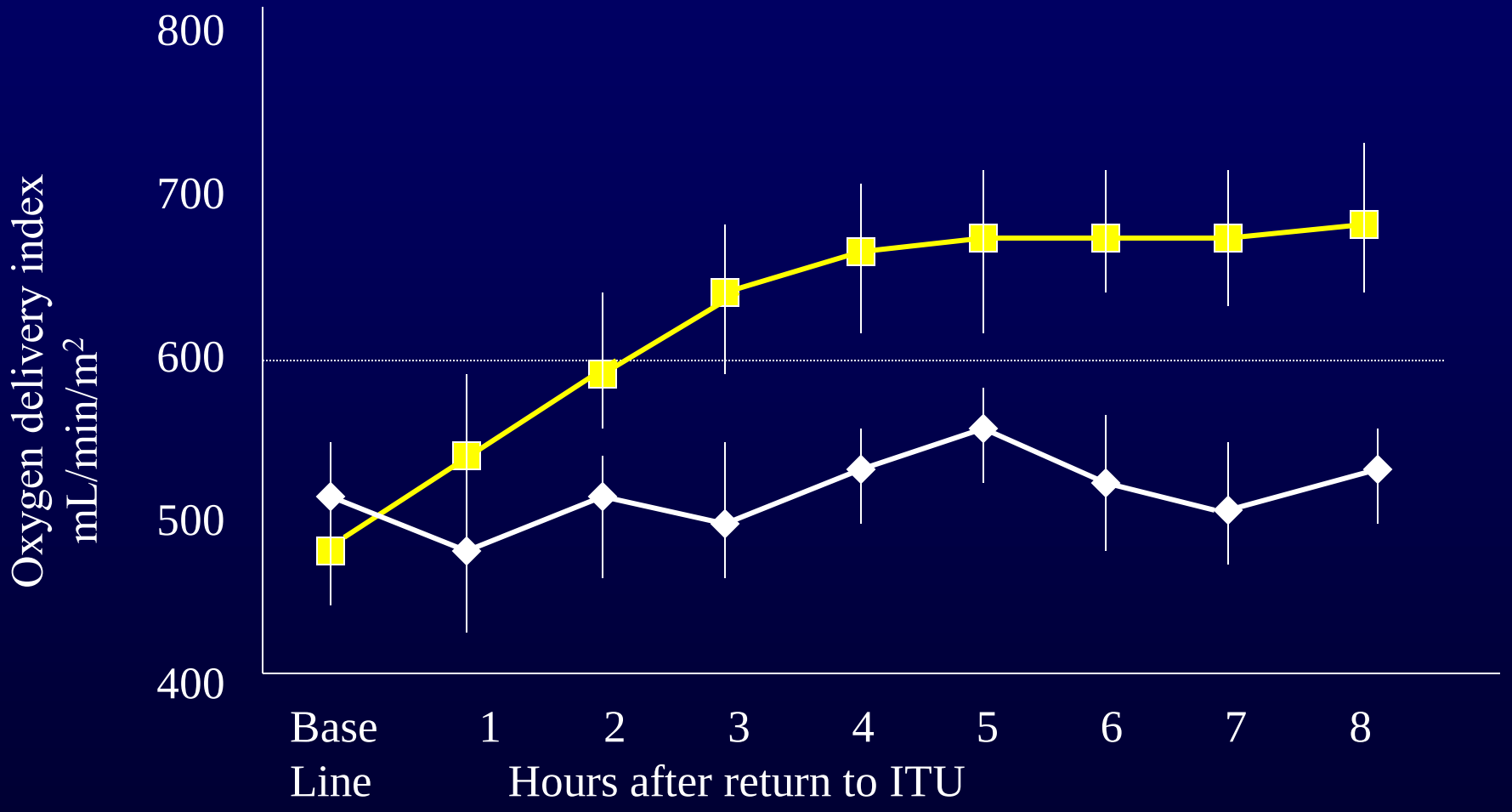
Goal Directed Protocol for Control Group

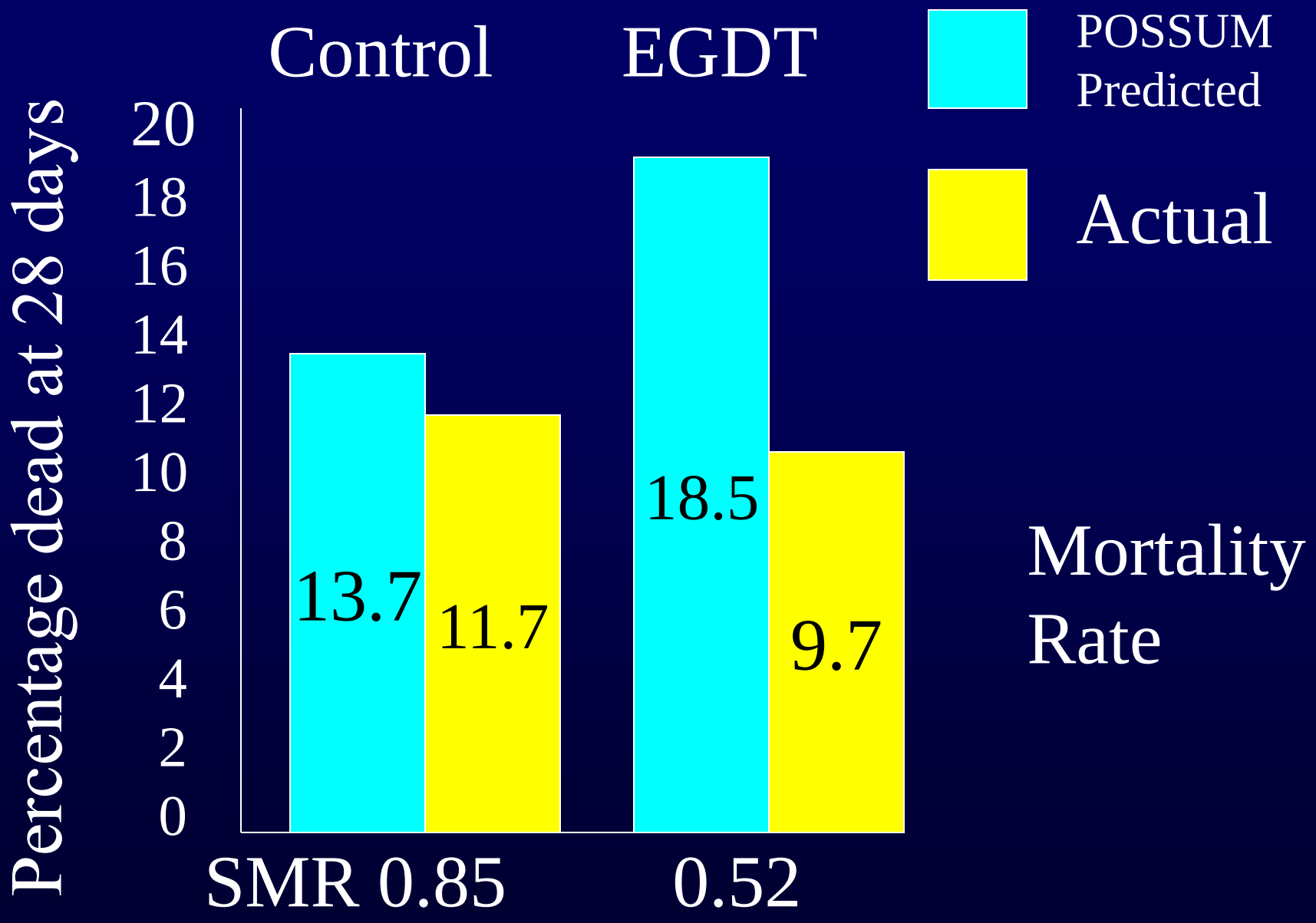


Goal Directed Protocol for Treatment Group

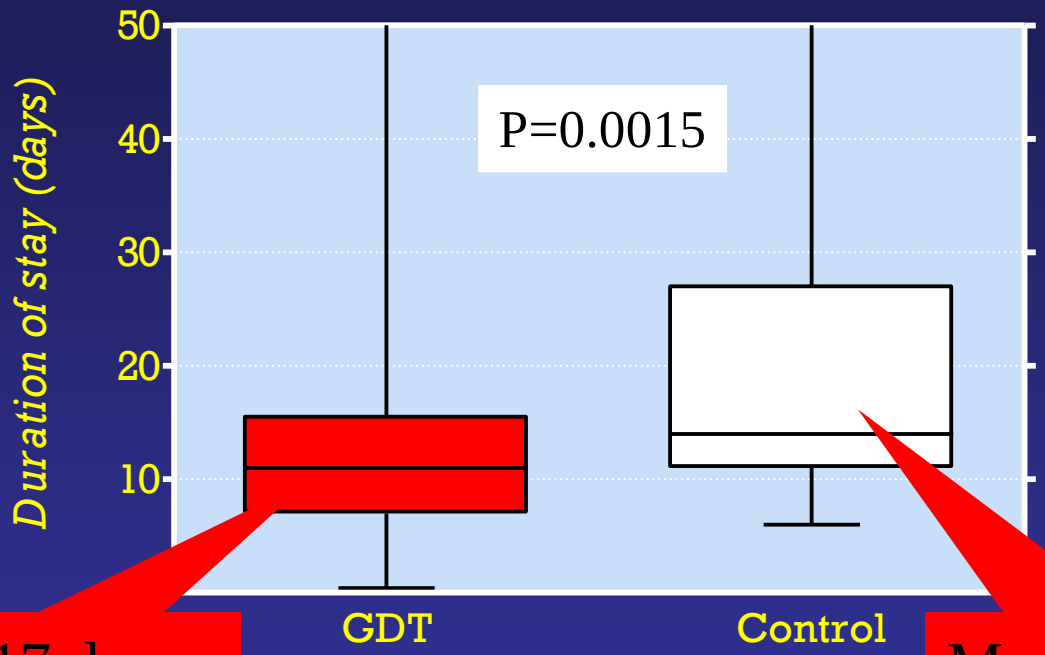


Oxygen Delivery Index During the Eight Hour Study Period.




Control
EGDT
POSSUM Predicted
Actual
Percentage dead at 28 days
0
2
4
6
8
10
12
14
16
18
20
13.7
11.7
18.5
9.7
SMR 0.85
0.52
Mortality Rate

Length of Hospital Stay Following Eight Hours of Goal Directed Therapy.

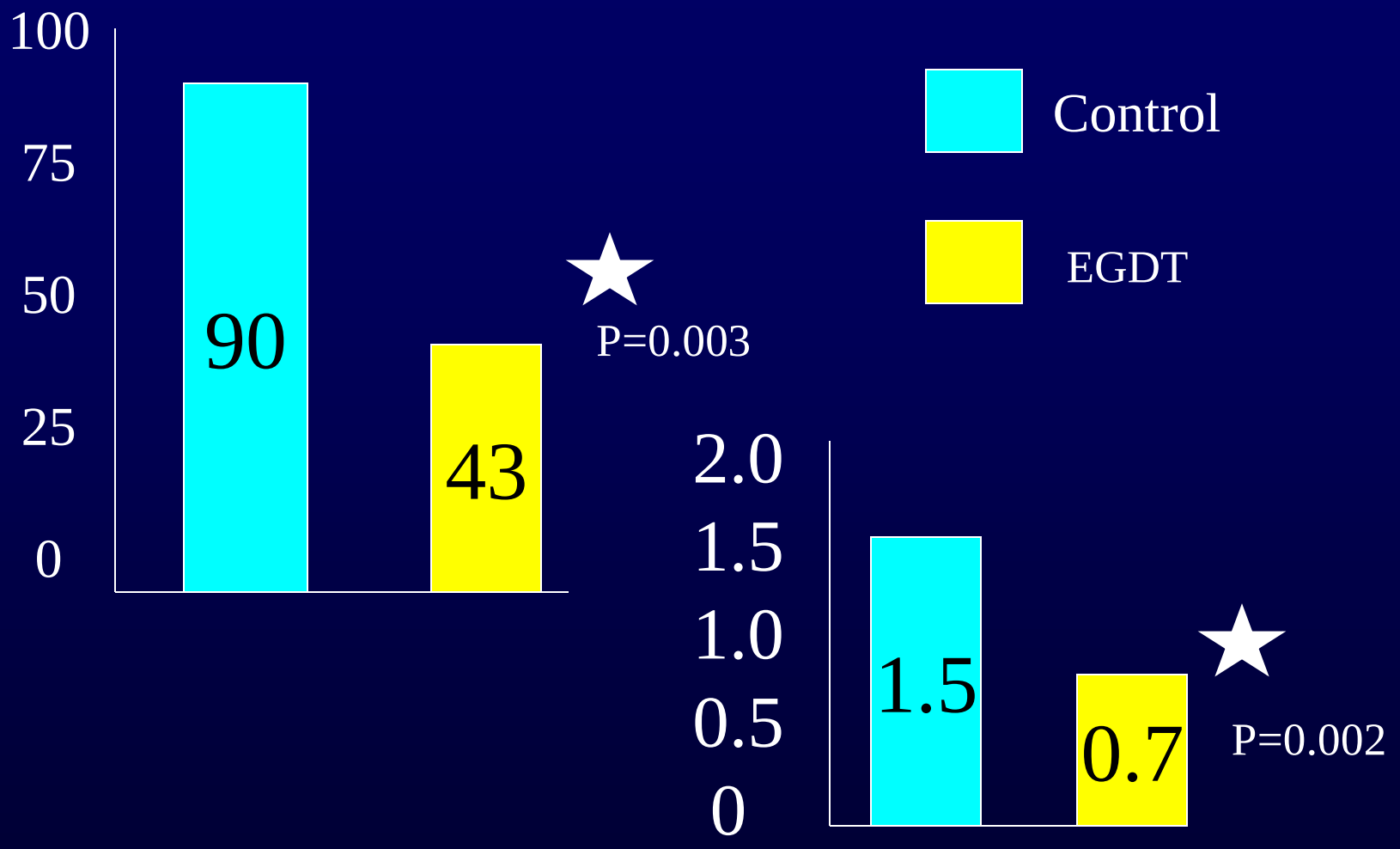


Mean 17 days
Median 11 days

Mean 29 days
Median 14 days

41 % reduction (95 CI 05% to 81%)

Total number of complications



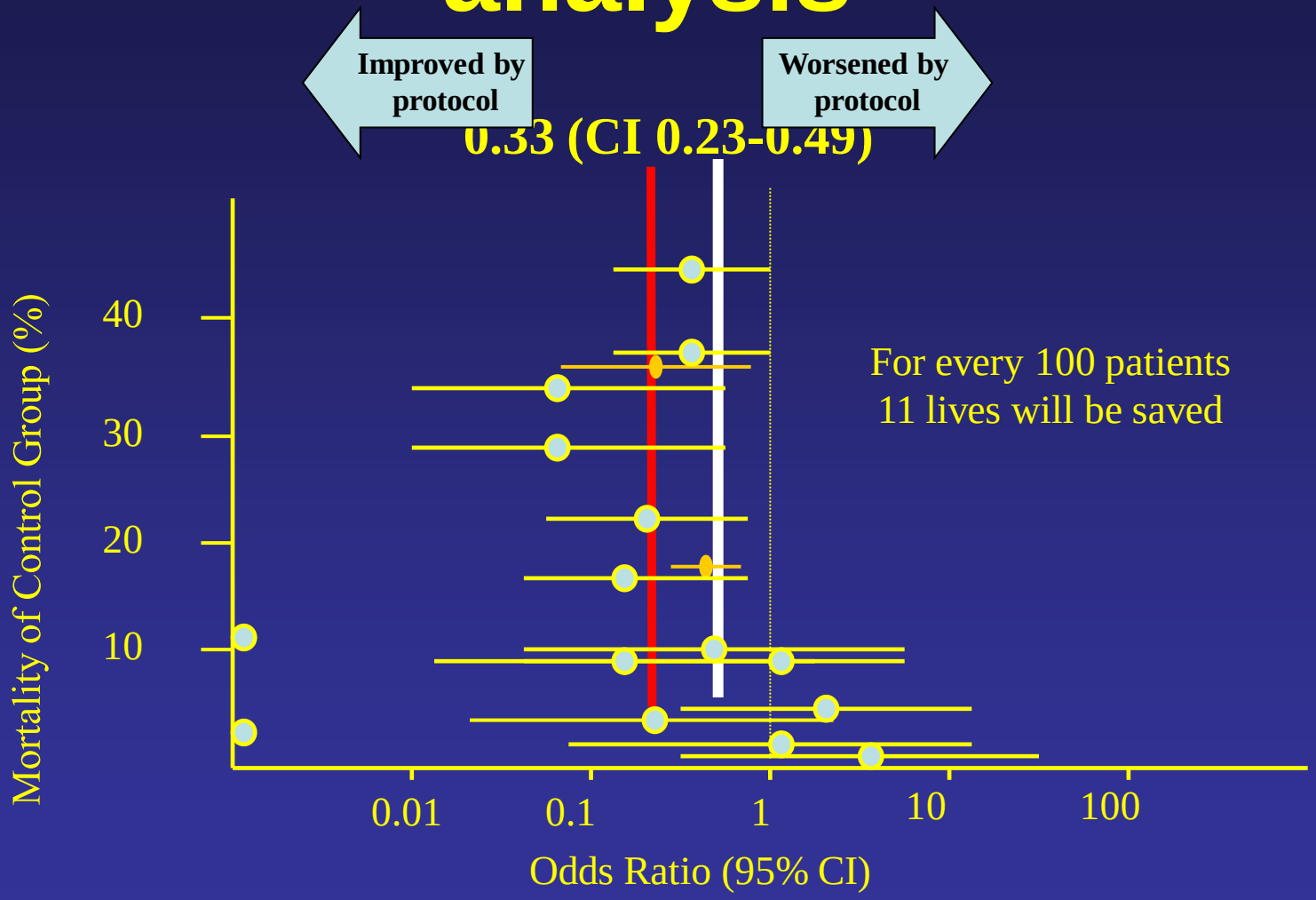
Conclusions

- Good evidence to suggest that patients with low cardiac output and oxygen have high mortality when undergoing major surgery.
- Good evidence that increasing cardiac output and oxygen delivery with IV fluids ± inodilators around the time of surgery will improve outcome

Conclusions

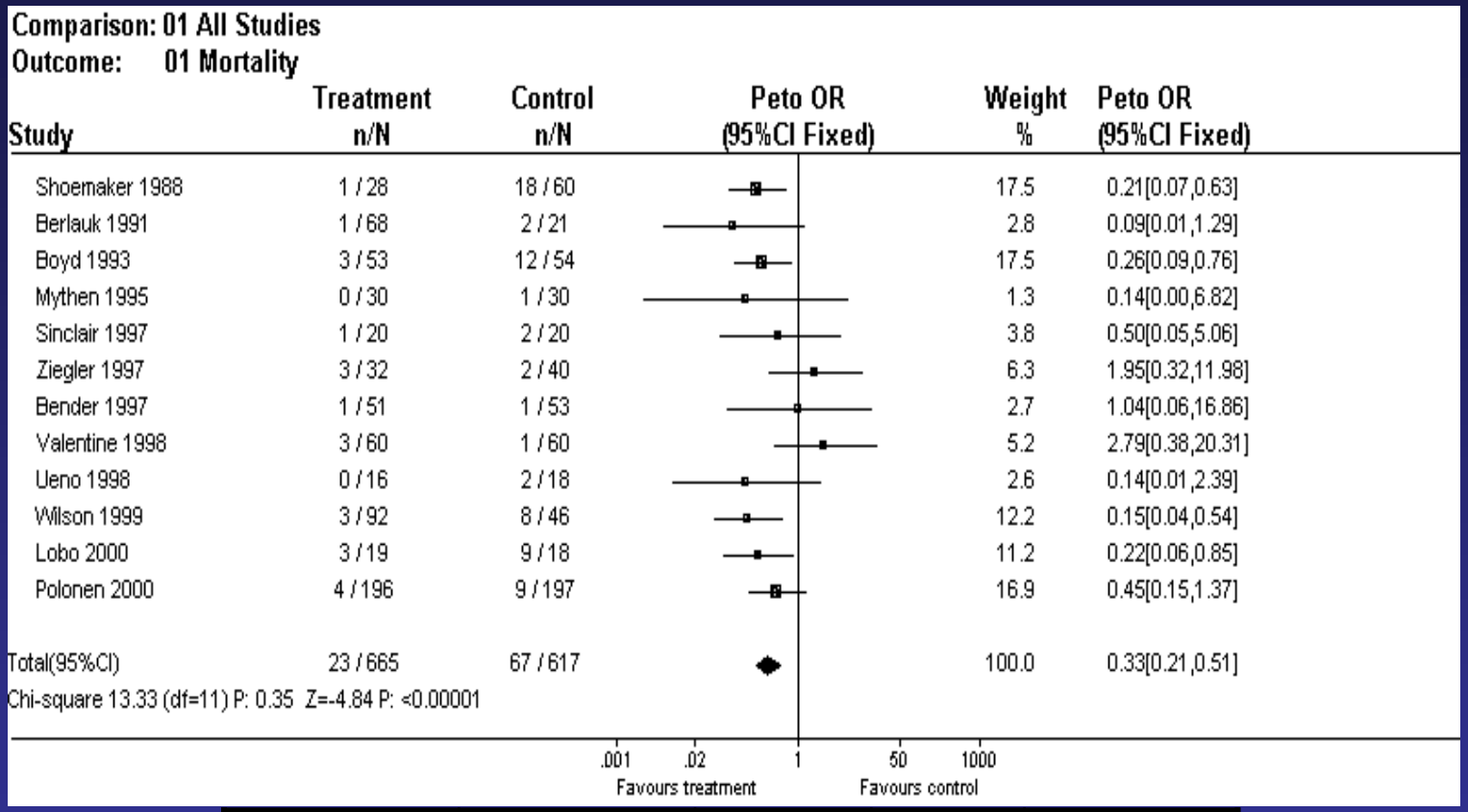
- This improvement in mortality may be due to a reduction in organ failure due to more aggressive therapy at the time of surgery.
- This aggressive therapy also leads to a reduction in postoperative complications

Optimization Meta-analysis



Grocott et al 2003

Meta-analysis



All studies Mortality	Treatment	Control	Peto OR	P
	23/665 3.5%	67/617 10.9%	0.33	<0.0001

Grocott M. et al. 2003

How to do it

- Individual therapy
- Performance during peri-operative period must attempt to reach goals that are achieved by survivors.
- IV fluids. Individually tailored. Starling curve.
- Inotropes. Vasodilators.
- Endpoints.

What not to use as goals of therapy.

- Interestingly Shoemaker found that the following commonly measured variables were of little predictive value
  - CVP
  - Urine output
  - Pulse rate
  - Blood pressure
  - Respiratory rate

Variables that give a good prediction of outcome

- Blood volume and flow
- Tissue oxygen delivery
- Myocardial performance under stress
  - Cardiac Index greater than 4.5L/min/m^2
  - Oxygen delivery greater than 600 ml/min/m_2
  - Oxygen consumption greater 170 ml/min/m_2

Targets for early studies

- Maximise intravenous fluid therapy to try and achieve “best” position on Starling Curve for each individual patient.
- If this is insufficient to achieve DO_2I of 600ml/min/m^2. Then inotropes would be added. (Dobutamine;dopexamine;adrenaline have all been used.)

Pulmonary artery catheters

- A number of studies have used these successfully.
- Used to maximise intravenous volume therapy.
- If goals still not achieved then inotropes or ino-dilators used to achieve goals.
- Reductions in post operative complications and post-operative mortality.

Oesophageal doppler

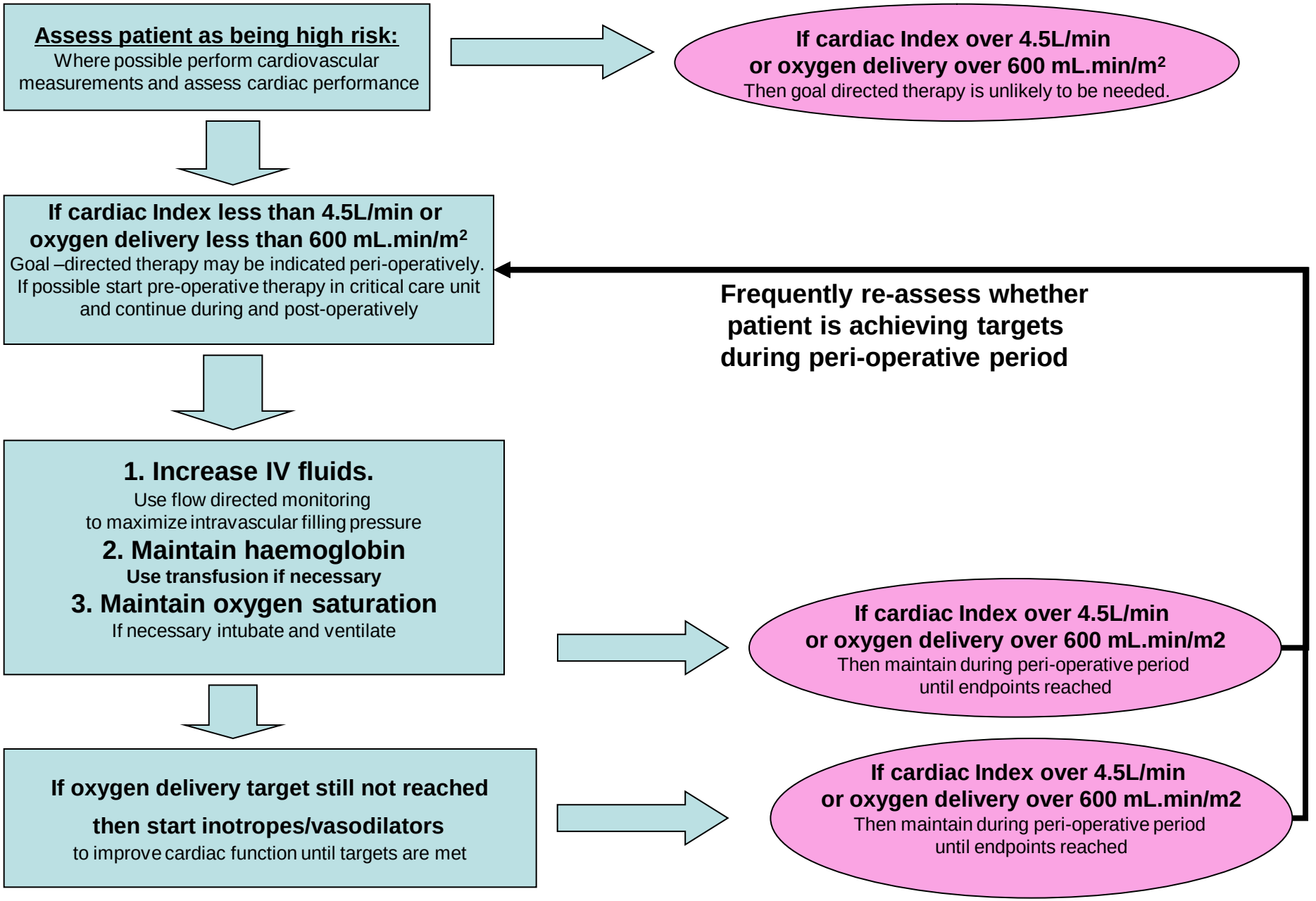
- Used to monitor cardiac output (or more specifically stroke volume) during surgery.
- Intravenous fluid therapy maximised
- If this fails to achieve goals then inotropes may be added.
- Reduction in hospital stay.
- Reduction in post-operative complications.

LiDDCo. Pulse contour analysis.

- Used to guide therapy in 8 hours immediately following surgery.
- Nurse led Goal Directed Therapy in high risk patients.
- Reduction in hospital stay.
- Reduction in post-operative complications.

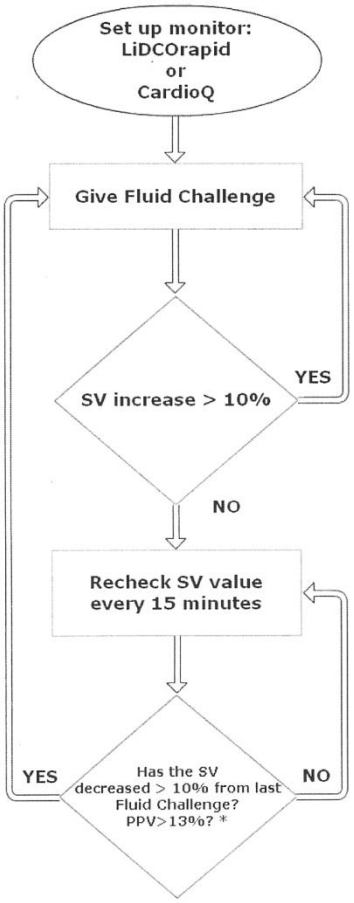
Pulmonary Artery Catheters

- Shoemaker et al. Chest 1988
- Boyd et al. JAMA 1993
- Woods et al. BMJ 1999
- Lobo et al. Crit Care Med 2000
- Polonen et al. Anesth Analg 2000


Assess patient as being high risk:
Where possible perform cardiovascular measurements and assess cardiac performance
If cardiac Index over 4.5L/min or oxygen delivery over 600 mL.min/m²
Then goal directed therapy is unlikely to be needed.
If cardiac Index less than 4.5L/min or oxygen delivery less than 600 mL.min/m²
Goal –directed therapy may be indicated peri-operatively.
If possible start pre-operative therapy in critical care unit and continue during and post-operatively
Frequently re-assess whether patient is achieving targets during peri-operative period
1. Increase IV fluids.
Use flow directed monitoring to maximize intravascular filling pressure
2. Maintain haemoglobin
Use transfusion if necessary
3. Maintain oxygen saturation
If necessary intubate and ventilate
If cardiac Index over 4.5L/min or oxygen delivery over 600 mL.min/m2
Then maintain during peri-operative period until endpoints reached
If oxygen delivery target still not reached then start inotropes/vasodilators
to improve cardiac function until targets are met
If cardiac Index over 4.5L/min or oxygen delivery over 600 mL.min/m2
Then maintain during peri-operative period until endpoints reached

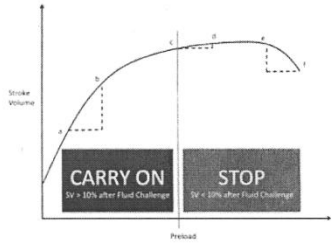
Intraoperative Optimisation Protocol
Department of Anaesthesia

St George's Healthcare NHS
NHS Trust



SV maximisation:
Use LiDCOrapid or CardioQ to monitor the change in SV during a Fluid Challenge.
Achieve maximal stroke volume by repeating Fluid Challenges until the SV does not increase > 10%

Fluid Challenge:
1) 250/500 mL of fluid as a rapid bolus in less than 5 minutes
2) Preferentially use a peripheral cannula
3) Use:
a) pressure bag or
b) a 50 mL syringe



Time	SV Pre FC	SV Post FC	SV > 10% Yes?

*** Consider PPV only if patient:**
1) is completely ventilated
2) and tidal volumes > 7 ml/Kg of IBW
3) and is in sinus rhythm