



PULSION CeVOX



CeVOX - central venous oxygen saturation monitoring



ScvO₂ Rationale

- ▣ **A major goal in managing critically ill patients is to ensure adequate tissue oxygenation. Hemodynamic monitoring assists the clinician in meeting that goal.**
- ▣ **ScvO₂ is a major component of hemodynamic monitoring.**



Basic Physiology

Oxygen Delivery and Oxygen Consumption



Oxygen Delivery (DO_2)

- ▣ **Oxygen Delivery (DO_2) is the amount of oxygen delivered to the body by the circulation**
- ▣ **Components of Oxygen Delivery**
 - **Oxygen Content**
 - a. Hemoglobin (Hb)
 - b. Saturation of hemoglobin with oxygen (SO_2)
 - **Cardiac Output (C.O.)**

$$DO_2 [ml/min] = C.O. \times [(1,38 \times Hb \times SaO_2) + (0,003 \times paO_2)]$$



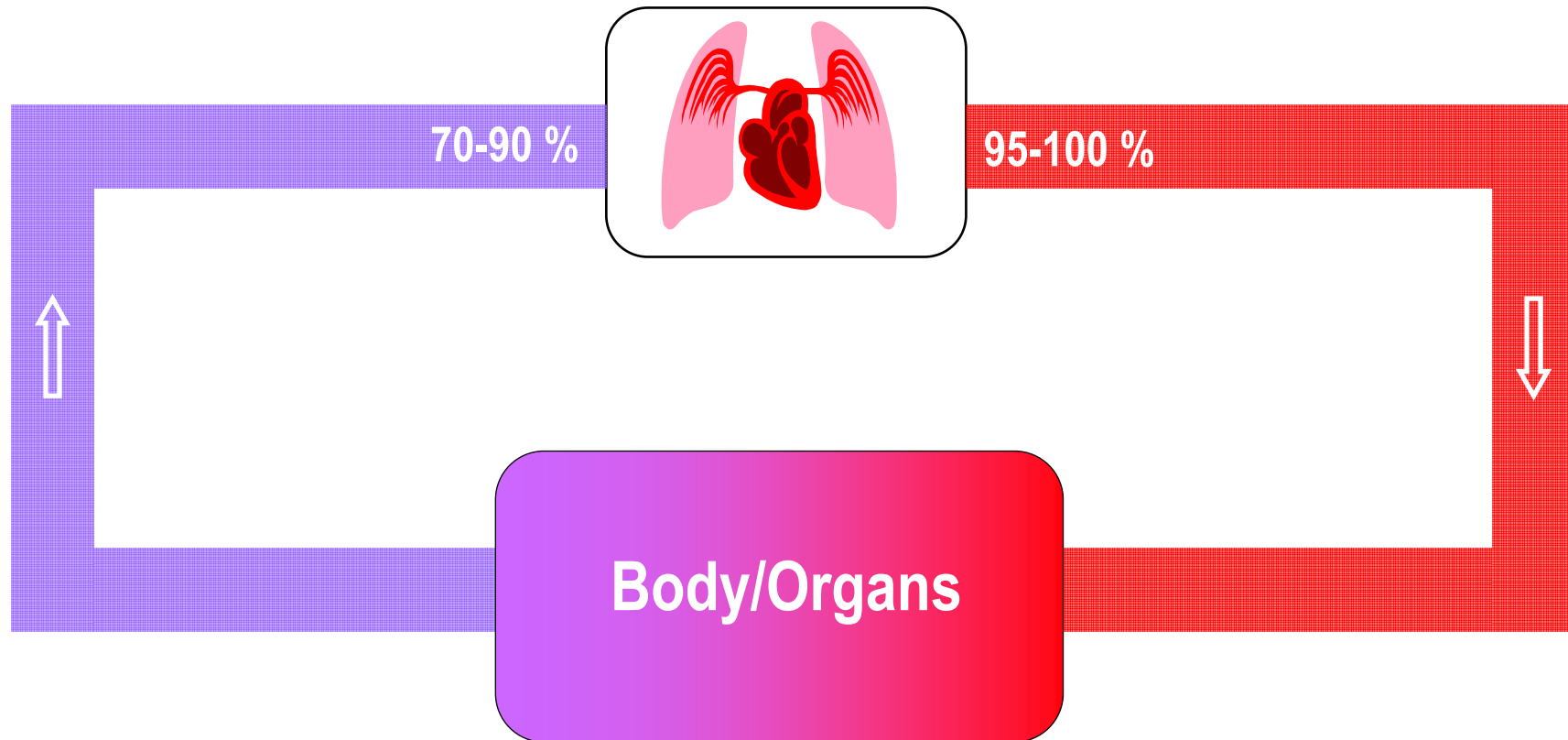
a. Hemoglobin (Hb)

- ▣ Role of hemoglobin is to carry oxygen
 - Oxygen is carried on binding sites
 - Fully saturated hemoglobin can carry 1.38 ml of oxygen per gram of hemoglobin



b. Oxygen Saturation (SO_2)

- ▮ The percentage of hemoglobin saturated with oxygen





Cardiac Output (CO)

- ▣ Cardiac Output is one of the major determinants of oxygen delivery. It depends on preload, afterload and contractility.

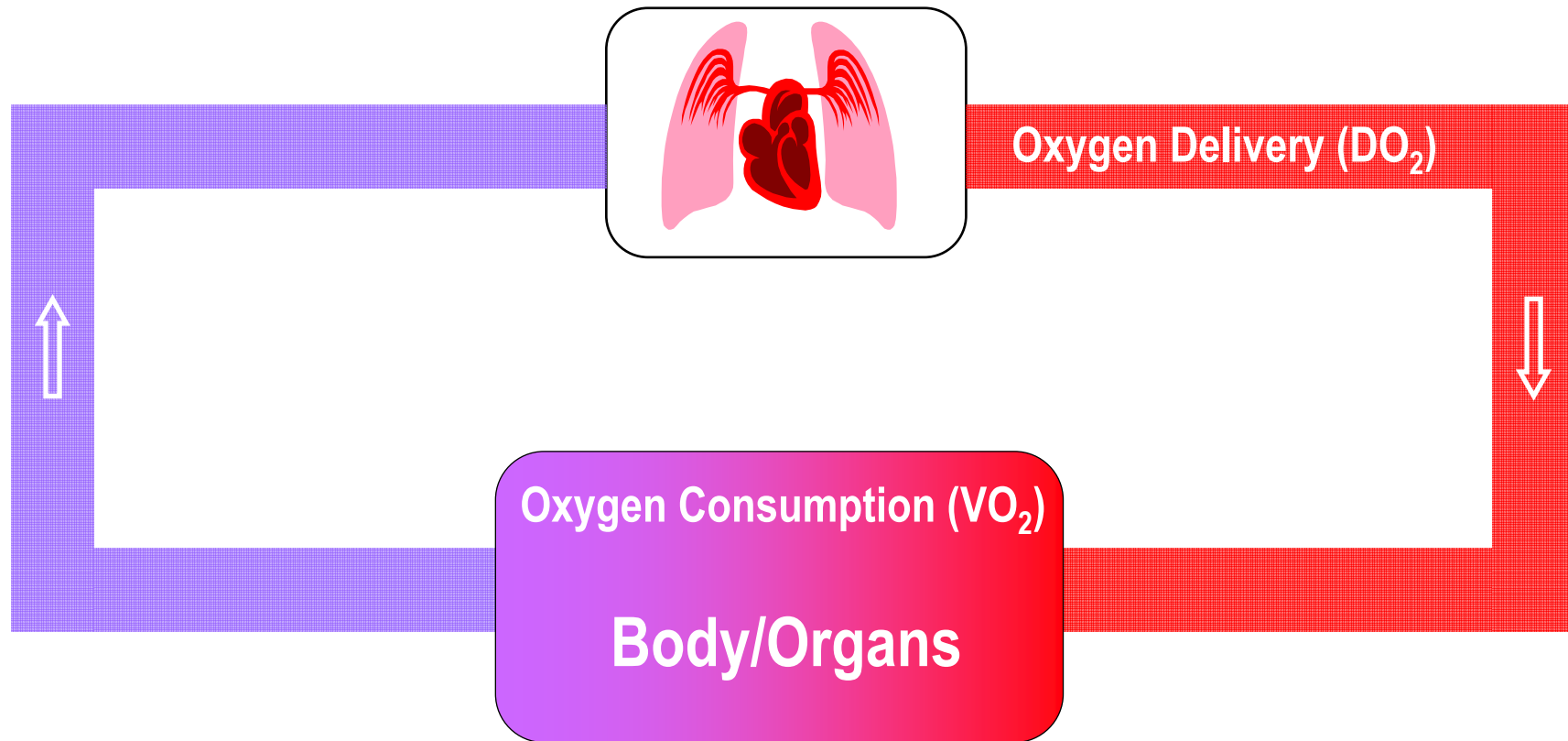


Oxygen Consumption (VO_2)

- ▣ Amount of oxygen consumed by the tissues
- ▣ Dependent on body conditions i.e.
 - exercise
 - fever



Oxygen Delivery and Consumption





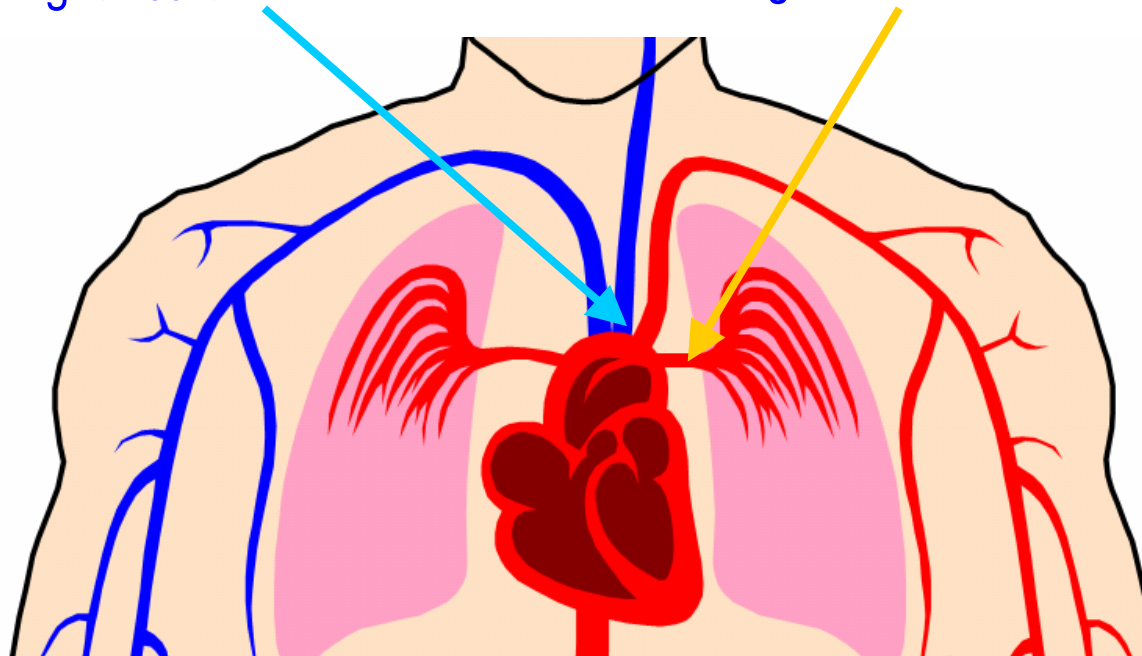
ScvO₂ and SvO₂

▣ ScvO₂ – central venous oxygen saturation

Oxygen saturation of the hemoglobin in the venous blood in the vena cava superior just before the right heart.

▣ SvO₂ – mixed venous oxygen saturation

Oxygen saturation of the hemoglobin in the venous blood in the pulmonary artery, after the right heart.





Equivalency of ScvO₂ and SvO₂

Excellent correlation, but ScvO₂ is systematically higher than SvO₂

“In approximately 90% of the occasions when changes in either ScvO₂ or SvO₂ greater than 5% occurred in an individual, they were paralleled by changes in the other monitor in the same direction.”

Reinhart K et al: Intensive Care Med 60, 1572-1578, 2004

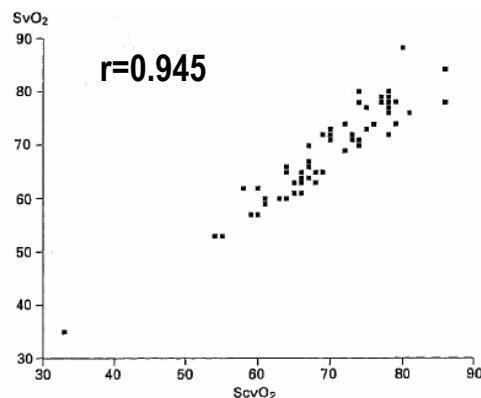


Fig. 1. Correlation between ScvO₂ and SvO₂. A significant correlation was found.

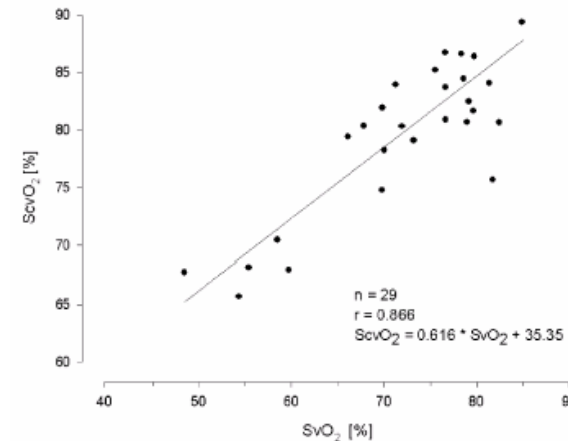


Fig. 3 Plot of mean SvO₂ and ScvO₂ values for each subject

“...our result suggest that the two parameters are closely correlated and that ScvO₂ maybe used as a mirror of SvO₂ for the initial evaluation of critically ill patients.”

Ladakis C et al: Respiration 68, 279-285, 2000



Central Venous Oxygen Saturation (ScvO₂)

Clinical Relevance of Continuous Measurement of ScvO₂

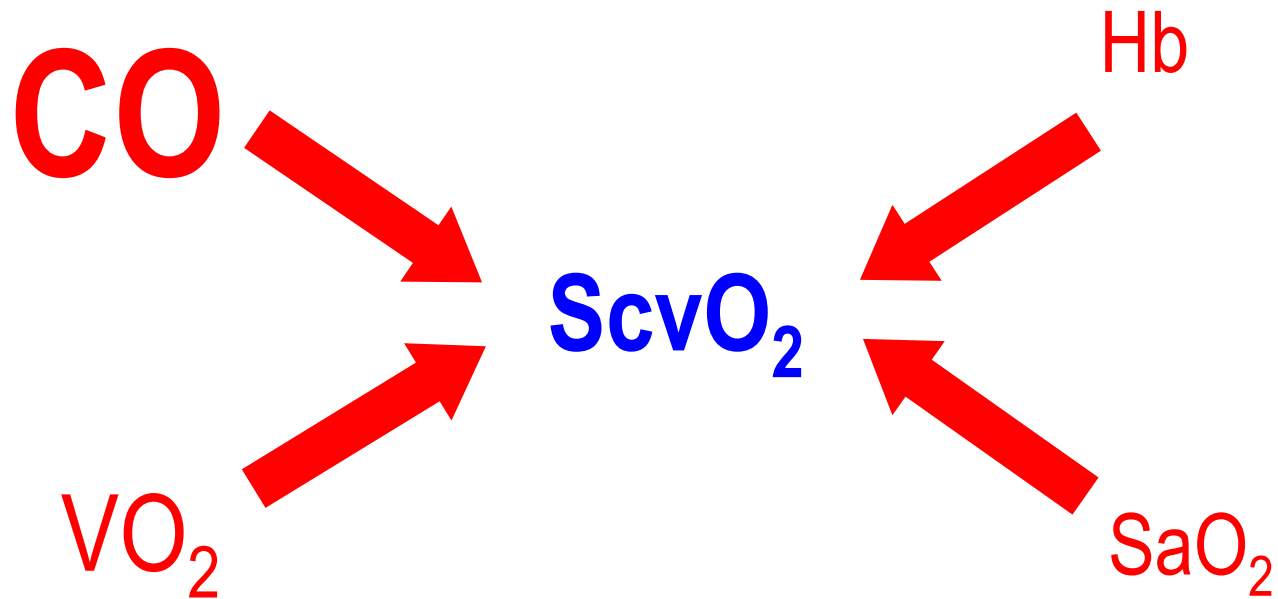


Central Venous Oxygen Saturation (ScvO₂)

- ▣ The percentage of hemoglobin saturated with oxygen in the central venous blood, directly before the right atrium
- ▣ Reflects the global balance between oxygen delivery and consumption
- ▣ Normal range: 65-80 %



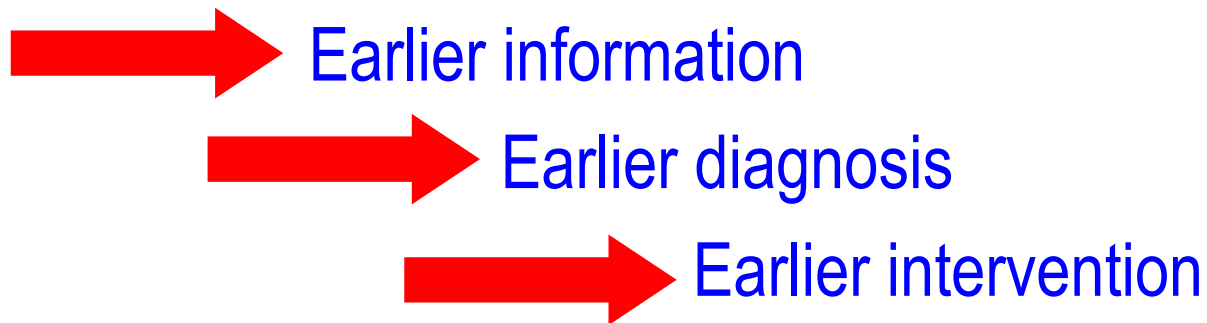
Factors Influencing ScvO₂





Why measure ScvO₂ continuously

- Typically, a decrease in ScvO₂ is one of the earliest indicators of a threat to tissue oxygenation.





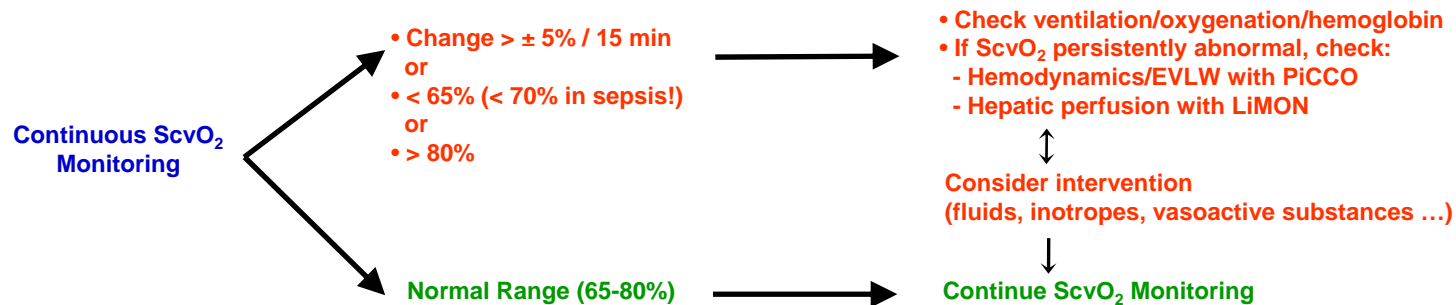
Clinical Importance of ScvO₂

Indications to set up ScvO₂ monitoring

- Blood sample ScvO₂ < 65%, pre-sepsis, sepsis (< 70%) or risk of hemodynamic instability

or

- Signs of reduced tissue perfusion: Clinical inspection, Lactate ↑ or diuresis ↓ or GEDVI ↓, ICG-PDR ↓



* Global Enddiastolic Volume Index, volumetric preload indicator by PiCCO

** Plasma disappearance rate of indocyanine green, parameter of splanchnic perfusion/hepatic function by LiMON



Decrease of ScvO₂

Causative Factors

▣ Decreased Oxygen Delivery (DO₂)

- ↓ Hemoglobin Concentration (Hb) Anemia, Hemorrhage
- ↓ Arterial Oxygen Saturation (SaO₂) Hypoxemia, Lung Disease
- ↓ Cardiac Output (CO) Left ventricular dysfunction, Shock, Hypovolemia

▣ Increased Oxygen Consumption (VO₂)

- ↑ Metabolism Fever
- ↑ Muscle Work Seizures, Shivering
- ↑ Work of Breathing Pneumonia, Acute Lung Injury, ARDS

Clinical Conditions



Increase of ScvO₂

Causative Factors

- Peripheral Maldistribution
- Hyperdynamic Circulation.....

Clinical Conditions

- Severe Sepsis with reduced microcirculation
- Centralization and low peripheral perfusion
- Sepsis
- Vasodilation
- High catecholamine dosage



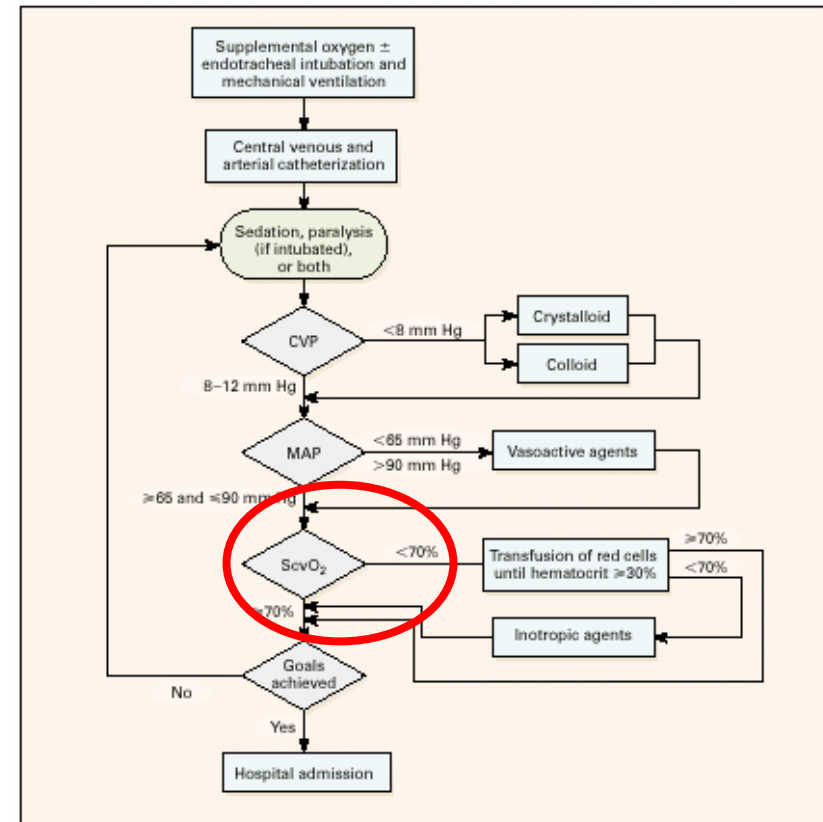
“Early Goal Directed Therapy”

- ✦ The “Rivers Study”
- ✦ SIRS (Systemic Inflammatory Response Syndrome) can progress to severe sepsis and septic shock.
- ✦ SIRS leads to an imbalance between oxygen delivery and oxygen consumption.
- ✦ Transition from SIRS to sepsis occurs in the early phase (‘golden hours’).
- ✦ Early detection of oxygen delivery/consumption imbalance and goal directed therapy can prevent patients from septic shock.



The “Rivers Study”

- Early ScvO₂ measurement and optimization as part of a treatment algorithm for patients fulfilling SIRS criteria
- Threshold value of ScvO₂ of <70% start aggressive therapy with RBC and vasoactive agents
- Results:
 - 34% reduction in mortality
 - 3.8 day reduction in hospital stay
 - 12.000 \$ reduction in hospital charges



Rivers E et al: N Engl J Med 345 (19), 1368-1377, 2001



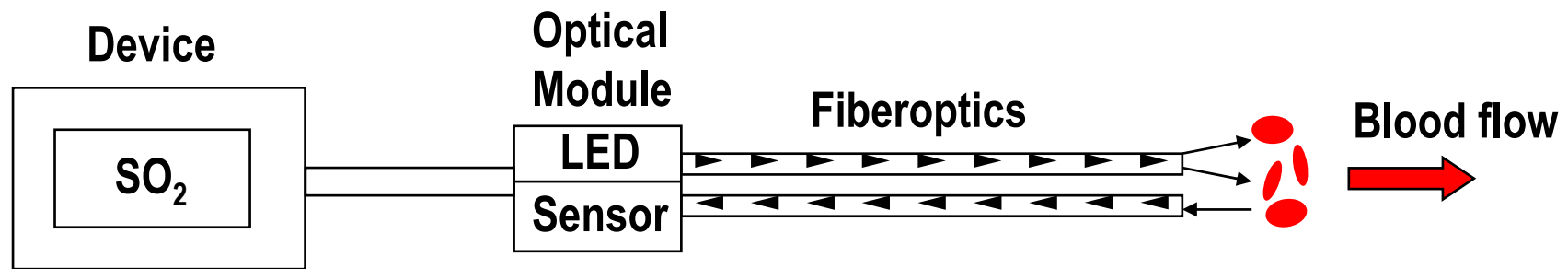
CeVOX

Practical Application



ScvO₂ Measurement Principle

▣ Spectrophotometry

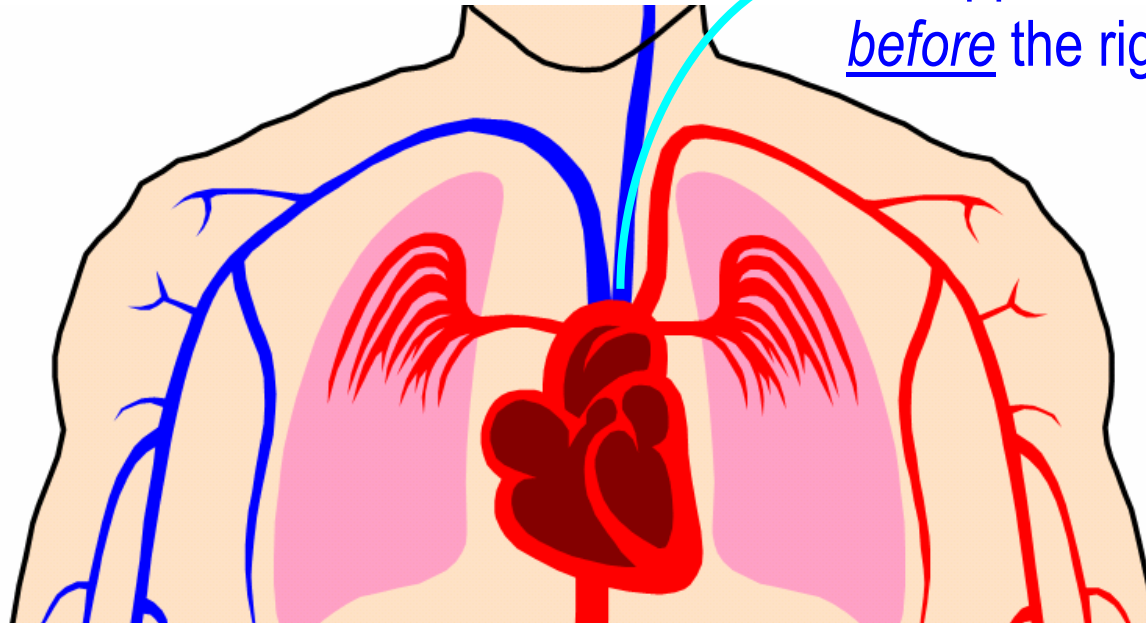


- ▣ LED in the optical module sends light of different wave lengths by fiberoptics into the vessel.
- ▣ Light is reflected by the hemoglobin in the red blood cells.
- ▣ Reflected light is transmitted back by a second fiberoptic line.
- ▣ Sensor in the optical module analyses the reflected light and determines oxygen saturation.
- ▣ Result is transferred to the device and displayed on the screen.



Practical Application

Fiberoptic probe placed in the upper vena cava, directly before the right atrium





CeVOX Technology

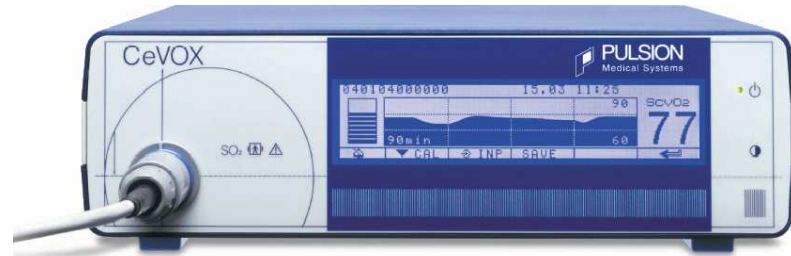
Device and Disposables



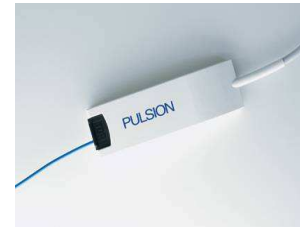
Components

▣ CeVOX-Technology consists of:

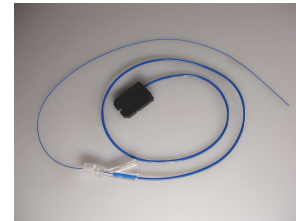
CeVOX (PC3000)



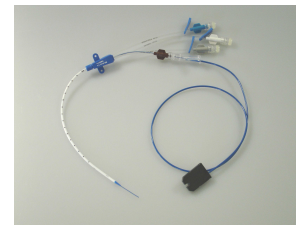
Optical Module (PC3010)



Probe (PV2022-xx)



Probe placed in CV line
(PV20x8L20CVC)

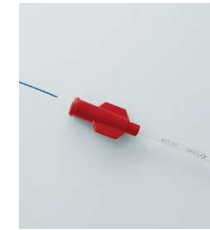




Startup Procedure I

Insertion of the CeVOX fiberoptic probe

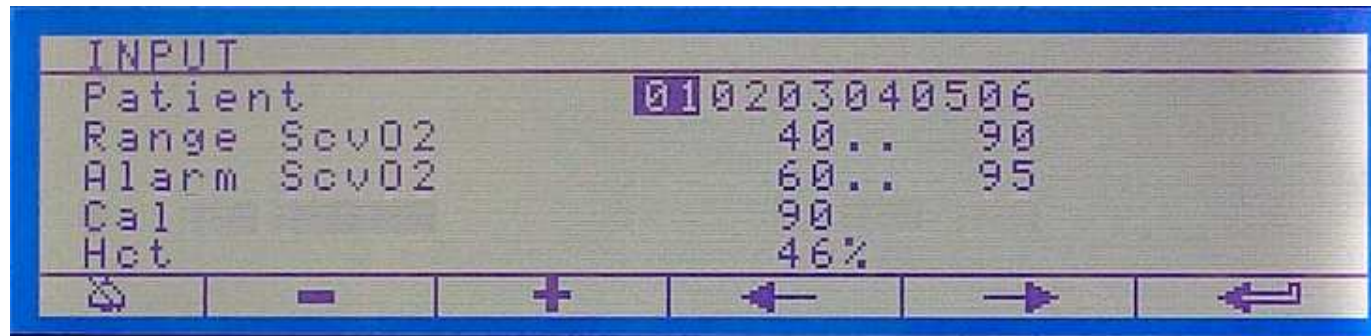
1. Insertion of the probe into the distal lumen of the central venous catheter
2. Probe is securely locked to the distal hub by Luer-Lock connection
3. Tip of the probe exceeds catheter tip by 2.5 ± 0.5 cm. Make sure that tip is not located in the right atrium
4. Probe connected to the optical module of the CeVOX: in-vivo calibration



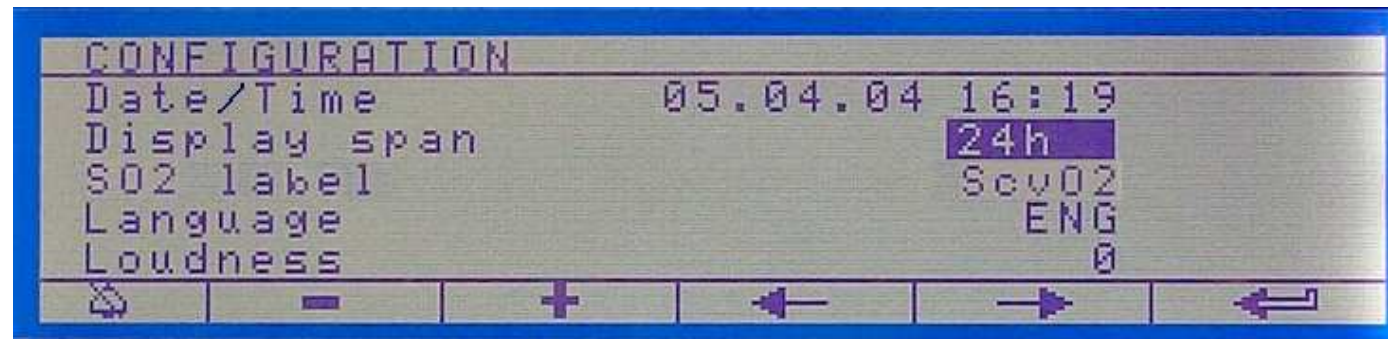


Startup Procedure II

Input screen



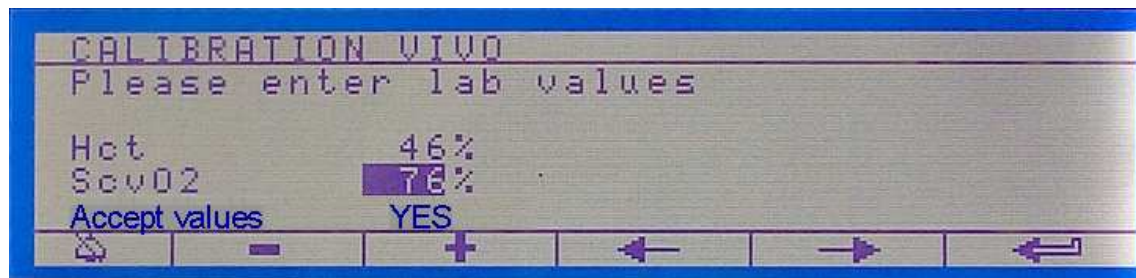
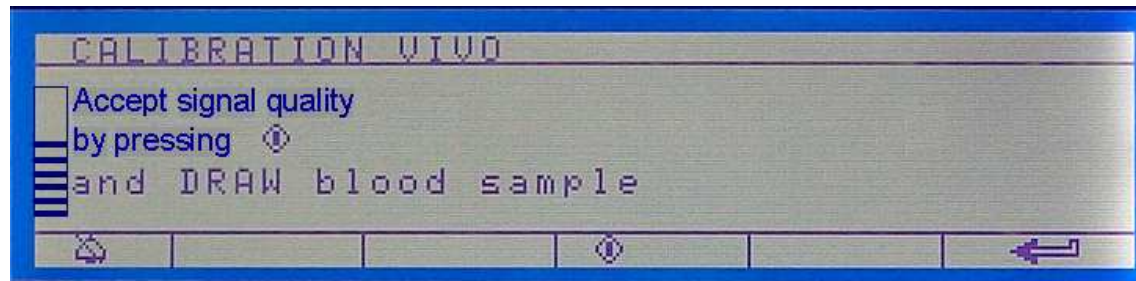
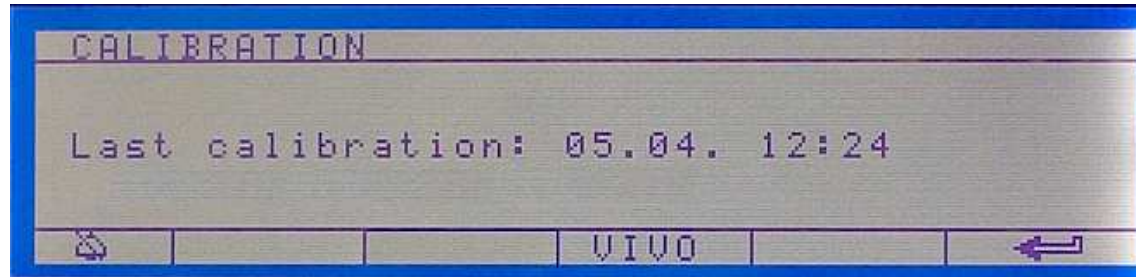
Configuration screen





Startup Procedure III

Calibration





Measurement Screen

Signal quality indicator

Current value



Graphical trend display

Trend indicator



CeVOX Disposables

CeVOX fiberoptic probe

PV2022-35 2F CeVOX fiberoptic probe (material: PU, Ø 0.67 mm, usable length: 35, total length: 95 cm)
for use with PULSION 8.5F PULSIOCATH central venous catheters

PULSIOCATH central venous catheter

PV2028L20CVC 8.5F PULSIOCATH central venous catheter; 2 lumen (distal 14 Ga, proximal 14 Ga)
PV2038L20CVC 8.5F PULSIOCATH central venous catheter; 3 lumen (distal 14 Ga, proximal 16 Ga, middle 16 Ga)
PV2048L20CVC 8.5F PULSIOCATH central venous catheter; 4 lumen (distal 16 Ga, proximal 18 Ga, middle dist
18 Ga, middle prox 18 Ga)

Indwelling PU catheter with blue flex tip, radiopaque, latex free, Ø 2.83 mm, usable length: 20 cm,
Extension Line Clamps, Injection Site Caps

Components: dilator; suture wing; syringe; 5cc guidewire: 0.035'' (0.89 mm), J, 70 cm; needle 18 Ga
(1.27 mm), 70 mm; mini scalpel; GW advancer; Y valve connector

specially suited for use with CeVOX fiberoptic probe PV2022-35



CeVOX Disposables

CeVOX fiberoptic probe for use with central venous catheters from various manufacturers

- PV2022-30** 2F CeVOX fiberoptic probe (useable length: 30 cm, extension line: 65 cm)
- ⋮
- PV2022-38** 2F CeVOX fiberoptic probe (useable length: 38 cm, extension line: 57 cm)

Probes designed for 16 cm and 20 cm central venous catheters

Distal lumen for $\geq 0.032''$ guide wires, remaining flow rate: 1/5 of original rate

Probe has to exceed distal tip of central venous catheter by 2.5 ± 0.5 cm

To determine correct length of probe:

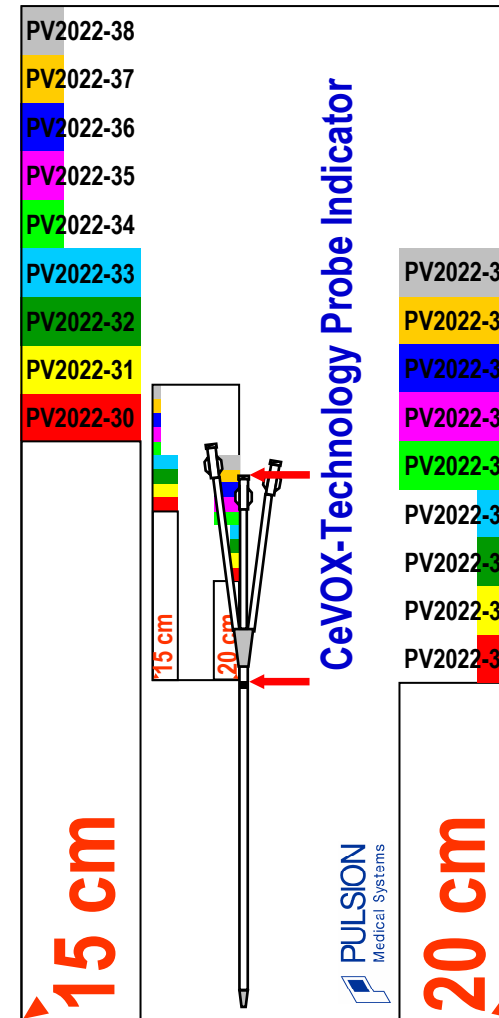
1. Distance of last length mark to Luer-Lock hub of distal lumen	12.5 cm
2. Value of length mark (catheter length)	20.0 cm
3. Add 2.0 cm	<u>2.0 cm</u>
4. Result	34.5 cm
5. Rounded up	<u>35.0 cm</u>
6. Appropriate probe	PV2022-35

Please also refer to CeVOX compatibility list and CevOX probe indicator (PC30607)



Probe Selection

CVC manufacturer and type	CeVOX probe								
	PV2022-30	PV2022-31	PV2022-32	PV2022-33	PV2022-34	PV2022-35	PV2022-36	PV2022-37	PV2022-38
PULSION									
8.5F, 2 lumen, 20 cm (PV2028L20CVC)						X			
8.5F, 3 lumen, 20 cm (PV2038L20CVC)						X			
8.5F, 4 lumen, 20 cm (PV2048L20CVC)						X			
MEDEX									
16G, 1 lumen, 20 cm					o	X	o		
7F, 2 lumen, 16 cm	o	X	o						
7F, 2 lumen, 20 cm					o	X	o		
7F, 3 lumen, 16 cm	X	X							
7F, 3 lumen, 20 cm					o	X			
8.5F, 2 lumen, 20 cm					o	X	o		
8.5F, 3 lumen, 20 cm					o	X	o		
8.5F, 4 lumen, 20 cm								X	o
8.5F, 5 lumen, 20 cm								X	o
12F, 2 lumen, 16 cm			X	X					
12F, 2 lumen, 20 cm							X	X	
12F, 3 lumen, 16 cm			X	X					
12F, 3 lumen, 20 cm							X	X	
B.BRAUN									
18G, 1 lumen, 15 cm		+	X	+			+	X	+
18G, 1 lumen, 20 cm									
16G, 1 lumen, 15 cm		+	X	+			+	X	+
16G, 1 lumen, 20 cm									
14G, 1 lumen, 15 cm		+	X	+			+	X	+
14G, 1 lumen, 20 cm									
7F, 2 lumen, 15 cm		+	X	+					
7F, 2 lumen, 20 cm							+	X	+
7F, 3 lumen, 15 cm		+	X	+					
7F, 3 lumen, 20 cm							+	X	+
8F, 4 lumen, 15 cm		+	X	+					
8F, 4 lumen, 20 cm							+	X	+
9F, 2 lumen, 15 cm		+	X	+					
9F, 2 lumen, 20 cm							+	X	+
12F, 2 lumen, 15 cm		+	X	+					
12F, 2 lumen, 20 cm							+	X	+
12F, 3 lumen, 15 cm		+	X	+					
12F, 3 lumen, 20 cm							+	X	+
12F, 5 lumen, 20 cm							+	X	+
ARROW									
Because of significant differences and partly contradictory details between data for ARROW CVCs, we received from ARROW and public data on ARROW's internet homepage, which also could not be clarified upon request, we are not able to provide compatibility information for ARROW products.									
X = compatibility most likely, + = compatibility in some cases, o = compatibility unlikely but possible									





Key Points

- ✦ CeVOX continuously monitors central venous oxygen saturation (ScvO₂).
- ✦ CeVOX can be inserted into an already placed central venous access.
- ✦ CeVOX provides information on oxygen delivery/consumption balance.
- ✦ CeVOX indicates any threat to the patient's tissue oxygenation early.

If you want to know if *something* is wrong *early*, use **CeVOX**,
if you want to know *what* is wrong and *why*, use **PiCCO!**