OPPORTUNITÀ TECNOLOGICHE NEL SETTORE DEI DISPOSITIVI BIOMEDICALI

Relatore

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Progetto: Tecniche innovative per la rimozione extracorporea di CO2

Extracorporeal CO_2 removal (ECCO2R)

- Role of ECCO2R?
- Why improving ECCO2R
- How to improve ECCO2R?

Role of ECCOR2R

- **Past:**
  - **ARDS** for protective ventilation
- **Present**
  - **ARDS** for ultra-protective ventilation
  - **COPD** to fasten extubation or avoid intubation
  - **ASTHMA** to fasten extubation or avoid intubation
  - as a bridge to **lung transplantation**
  - **immunocompromized** to fasten extubation or avoid intubation
- **Future**
  - ?, ALI, ambulatory

- prevent ventilator-induced acute lung injury (VILI)
- prevent ETT
- prevent nosocomial infections (VAP)
- minimize sedation

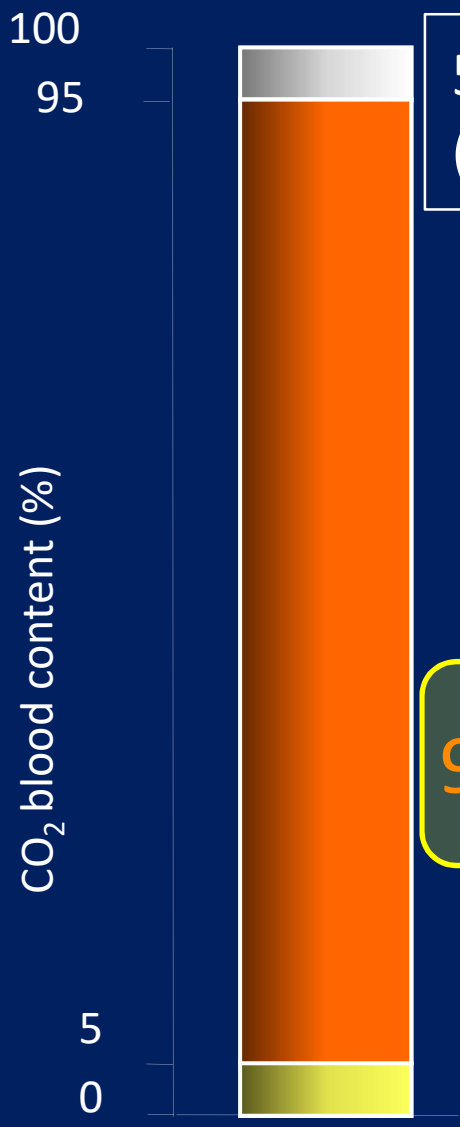
Why improving ECCO2R

Future

	Renal support (CVVH)	Partial extracorporeal support ($ECCO_2R$)			Total extracorporeal support (ECMO)	
	V–V	V–V	A–V	**V-V**	V–V	A–V
Blood flow (l/min)	0.2–0.3	0.3–0.5	1.0–2.5	0.5-2	2.0–5.0	5.0
Vascular access	V–V shunt	V–V shunt	A–V		V–V shunt	A–V shunt
			femoral shu			
Catheter's diameter	12 F	14 F	A: 13	>15 F	Inlet 19–24	A: 19–24
(F)	Double-lumen	Double-lume	V: 15		Outlet 15–21	V: 16
Priming volume (ml)	140–160	300	350		500	500
Needs for heparin (IU/min)	4–12	4–18	3.5–10		10–20	10–20
Membrane surface (m^2)	–	1.3	1.3		1.8	1.8
CO_2 extraction (% of baseline)	– **Future: >40**	25	50	>50	>50	>50
O_2 transfer (ml/min)	–	10	20–60		140–340	340

Curr Opin Crit Care 2012, 18:93–98

CO_2 blood content



5% dissolved CO_2
(pCO2 x 0.03)

Membrane lung works on ΔPCO2

How can we take advantage of bicarbonate form?

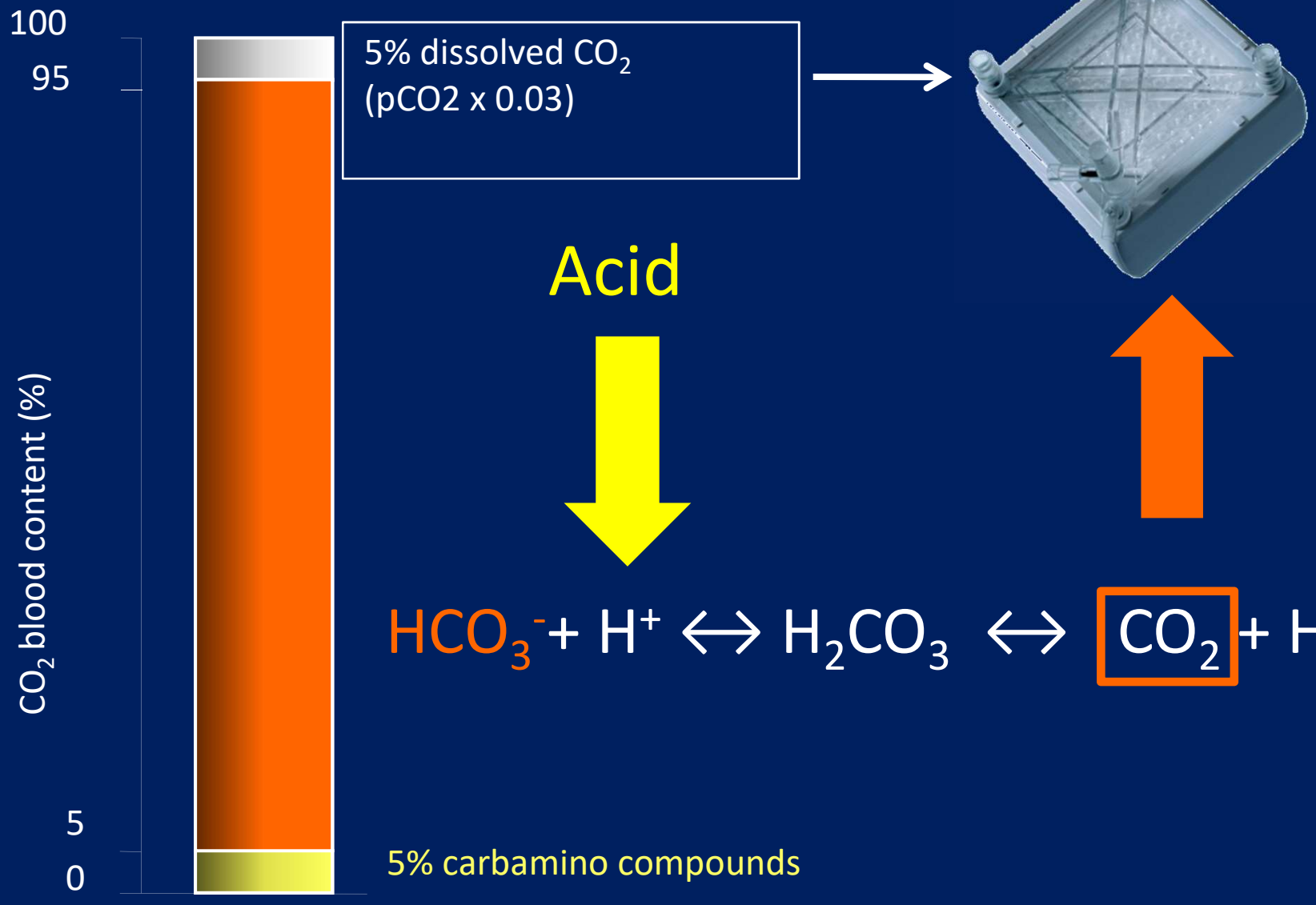
shift equilibrium towards dissolved CO2

90% HCO_3^- + H^+ $\leftrightarrow$ H_2CO_3 $\leftrightarrow$ $CO_2 + H_2O$

5% carbamino compounds

Venous blood
~650 ml CO_2/l blood

Blood acidification



Acid

$HCO_3^- + H^+ \leftrightarrow H_2CO_3 \leftrightarrow \boxed{CO_2} + H_2O$

Which ACID?

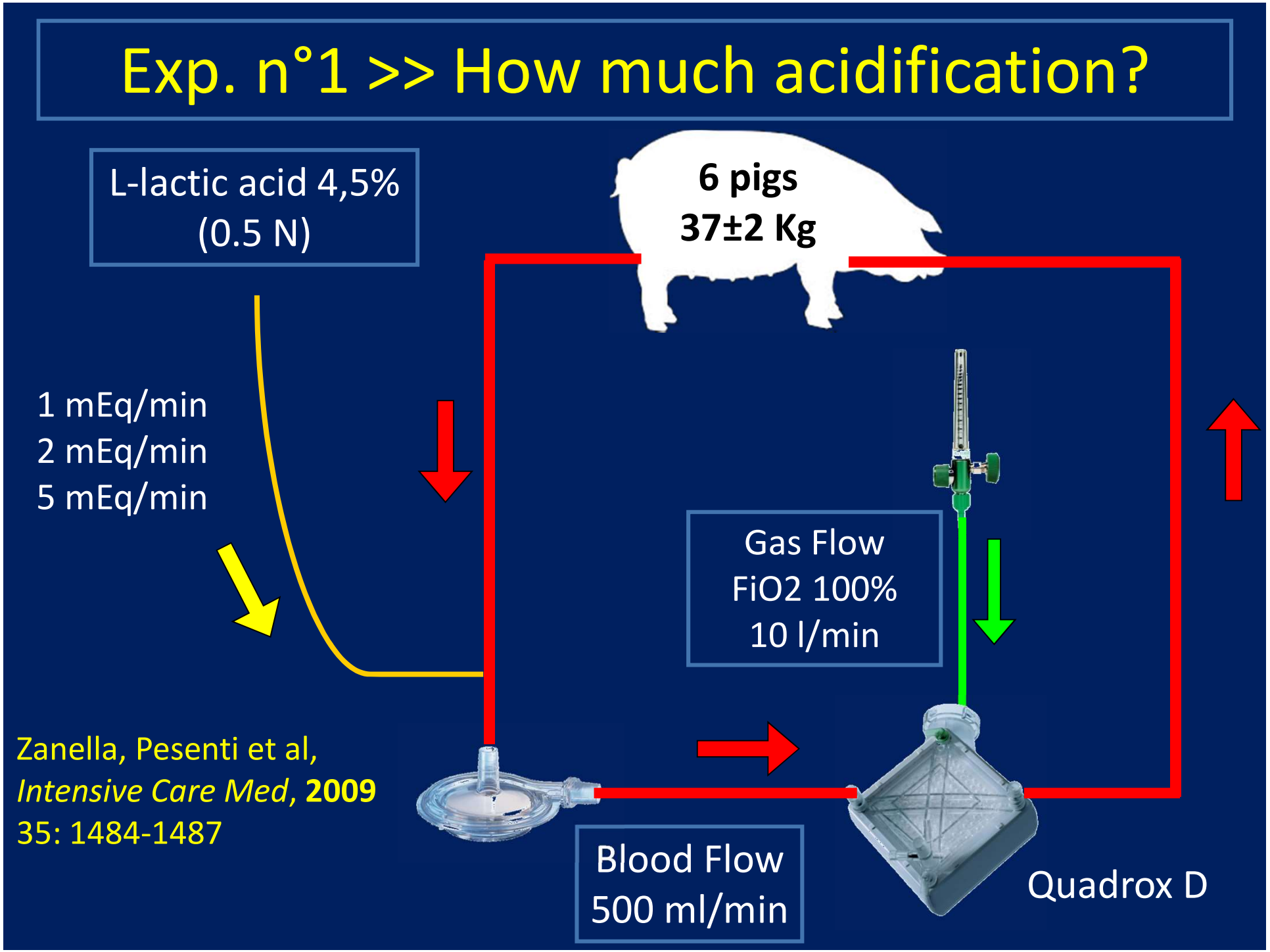
Non-metabolizable

- Hydrochloric acid

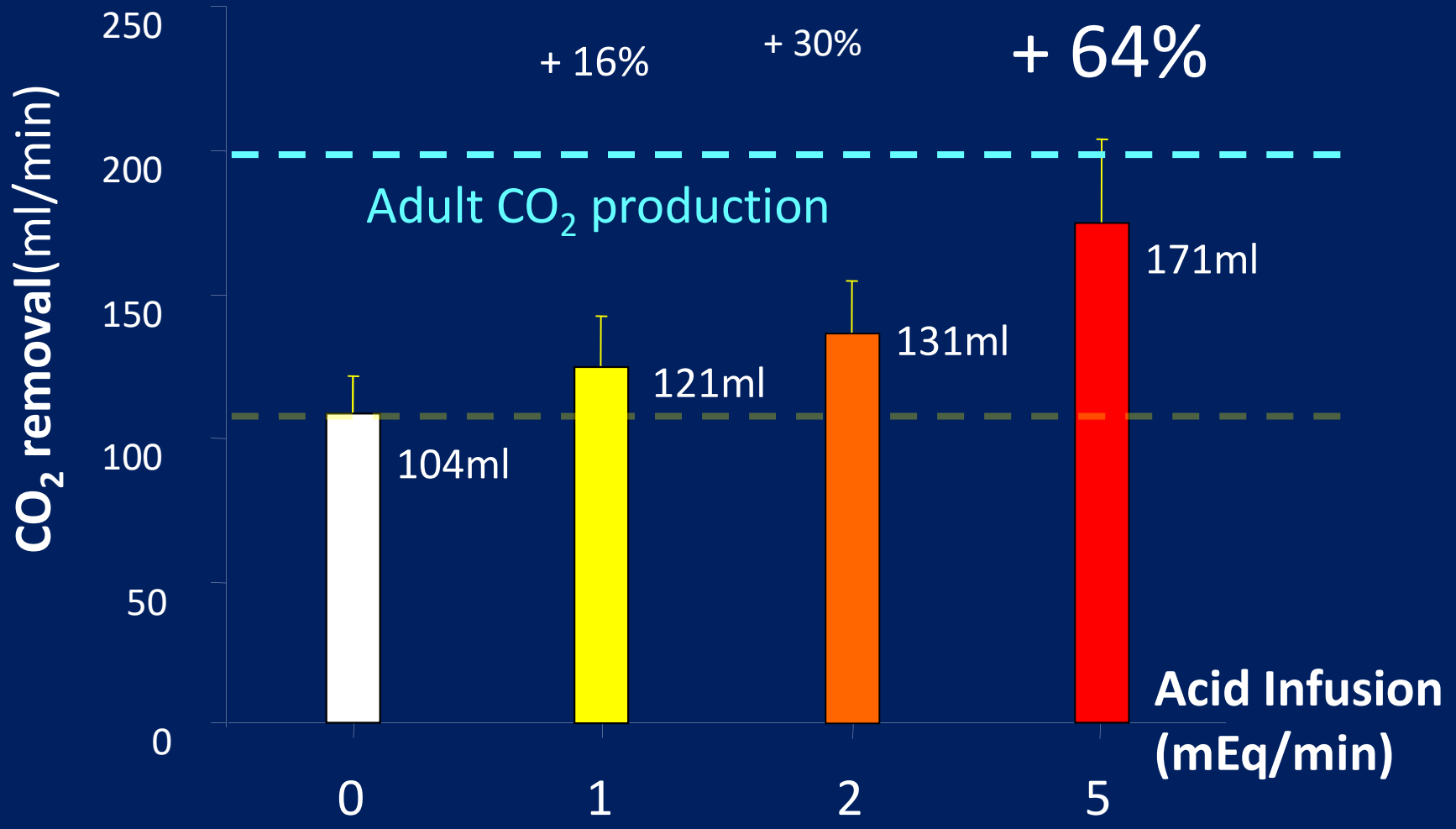
Metabolizable

- Lactic acid
- Citric acid

Exp. n°1 >> How much acidification?



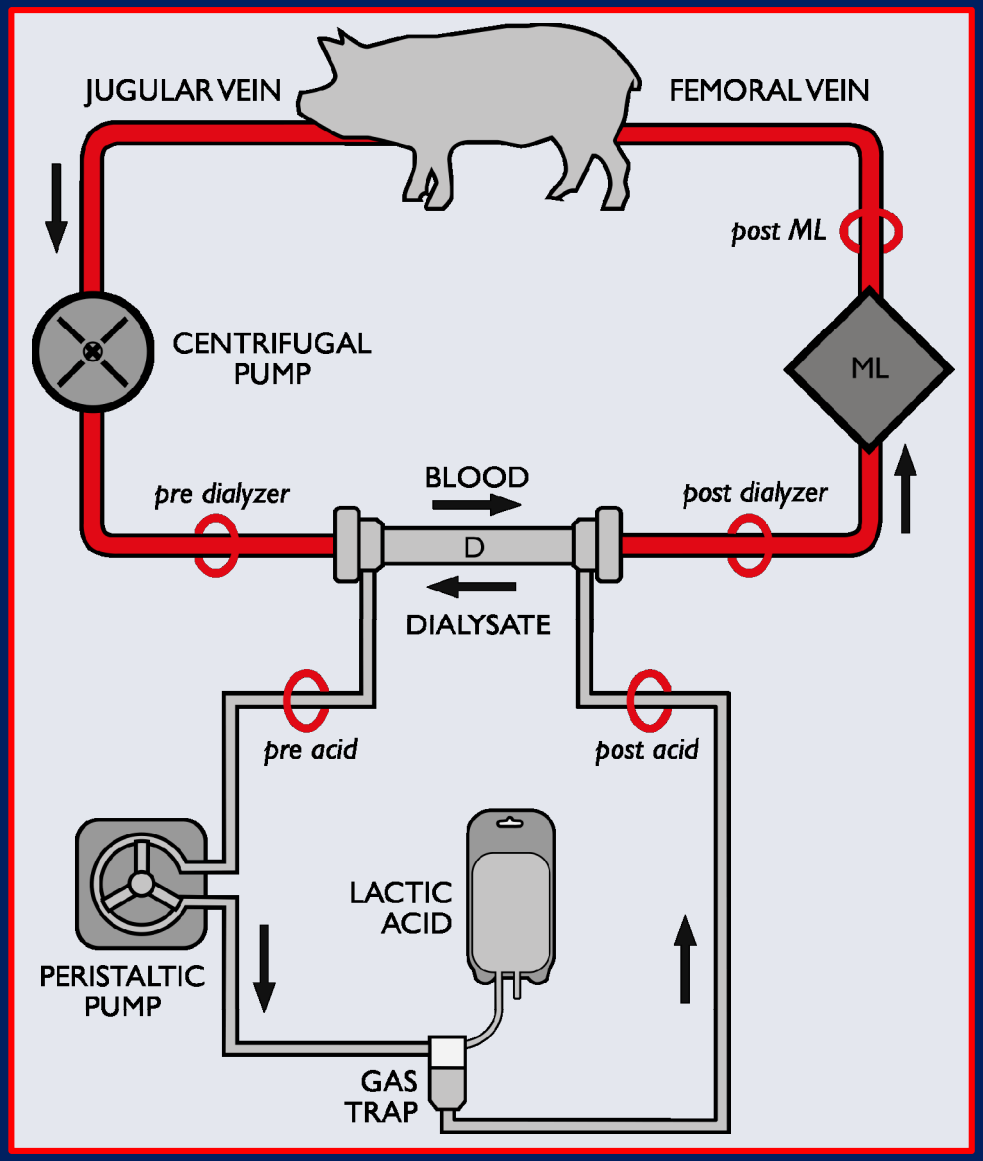
Exp. n°1 >> How much acidification?



Blood flow = **500 ml/min**

Zanella, Pesenti et al,
Intensive Care Med, 2009; 35: 1484-1487

Exp. n°2 >> Long term safety and efficacy

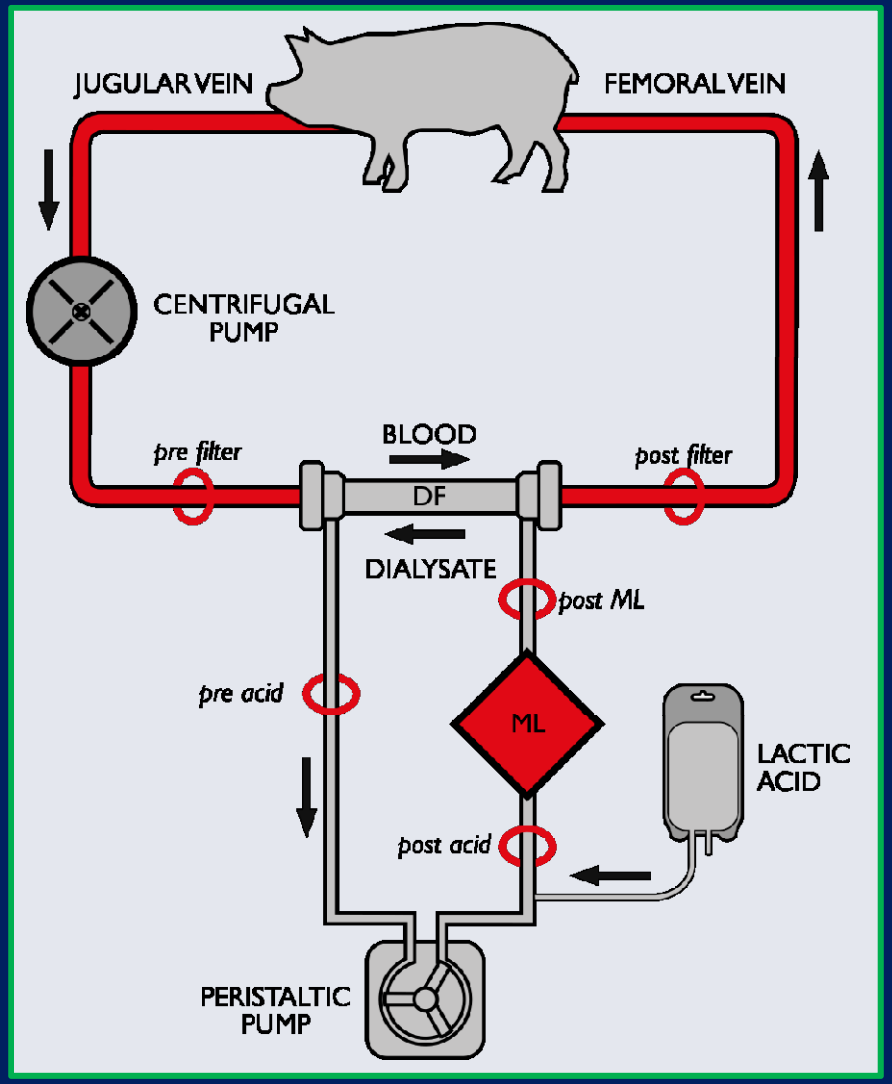


VCO2 + 70-80%

Sistema innovativo per infusione acido concentrato: 4.4N

No complicanze

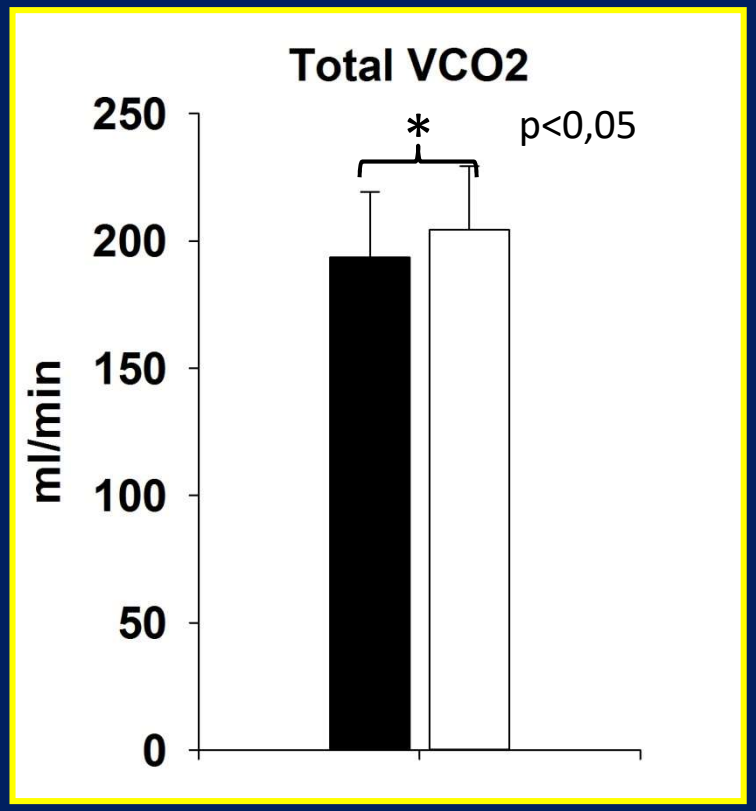
Exp. N°3 >> ML on dialysate circuit



VCO2ML = 85 ml/min

- Meno volume di sangue di priming
- Meno problemi coagulazione
- Meno shift di pH
- ML economico

Exp. n°4 >> CO_2 production during LA infusion



- Lactic acid is an energetic substrate and his metabolism produces CO_2. The impact of lactic acid infusion on total VCO_2 was unknown.

- Total VCO2 was about 5% higher during the *Lactic Acid* steps (204 ±25 vs 194 ±26 ml/min)

Future perspectives

- Development of ultra low-flow enhanced CO_2 removal techniques is feasible and may allow a widespread diffusion of this technique

- Blood acidification is an effective technique to increase ECCO2R efficiency

- We are testing different strategies to achieve the most effective and safe blood acidification:

- Confidential:
  - Acidification without injecting acids
  - Regional blood anticoagulation
  - Selectively remove acids from blood