

CONGRESSO NAZIONALE

NUOVE LINEE GUIDA 2021: RIANIMAZIONE CARDIOPOLMONARE POST-LOCKDOWN



Progetti IRC - Registro REBOA

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Conflict of interest

- Nothing to declare

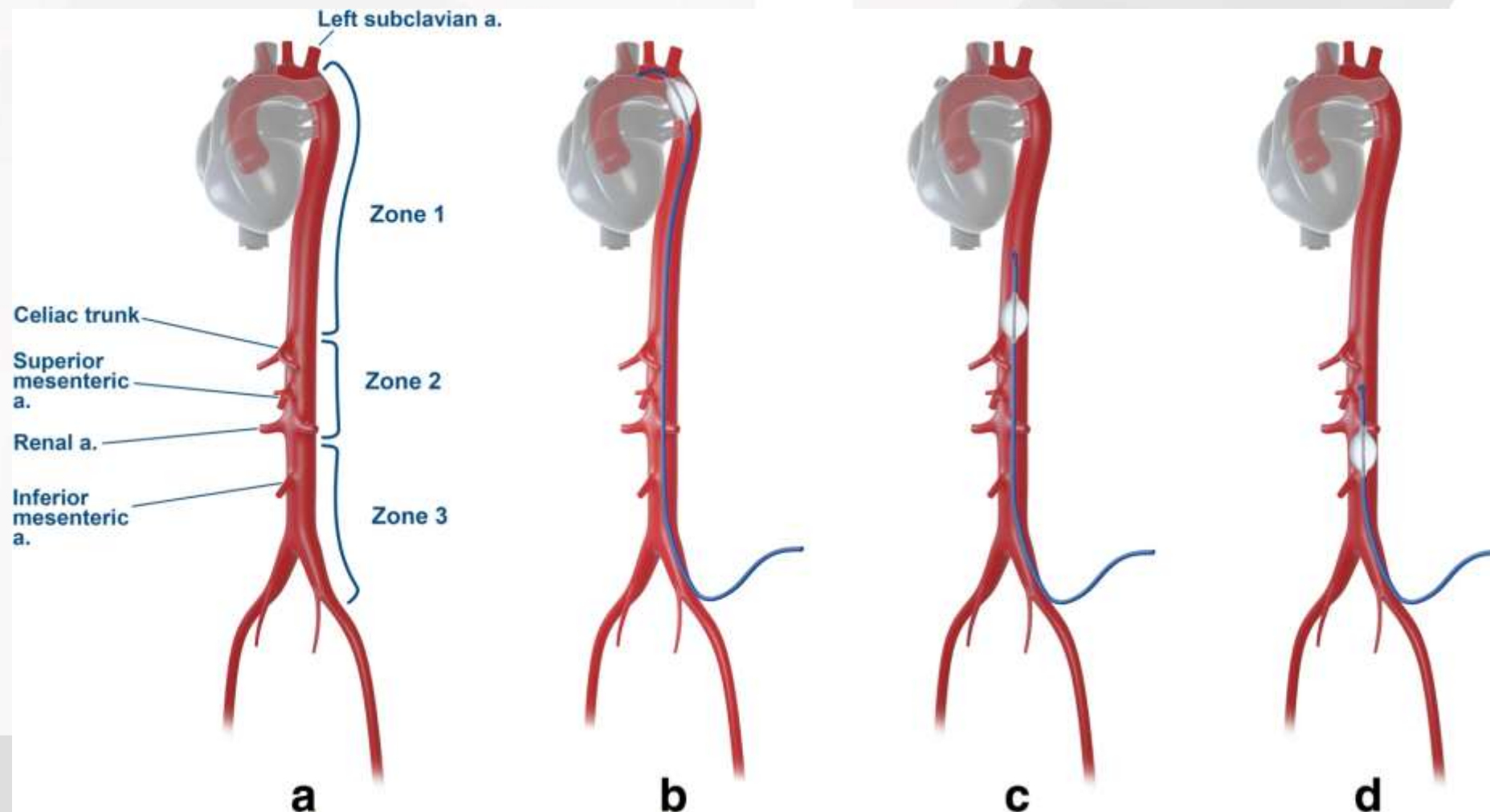
Objectives

- Pathophysiology and actual uses
- Animal data
- Human data
- The need for an international registry

RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA

- First description of the use of REBOA in patients with fatal bleeding was made by Colonel Hughes in 1954 during the Korean War
- Increasing employment for non-compressible pelvic and lower limbs haemorrhages
- Advantages: fast learning curve, portability (prehospital)

Zones

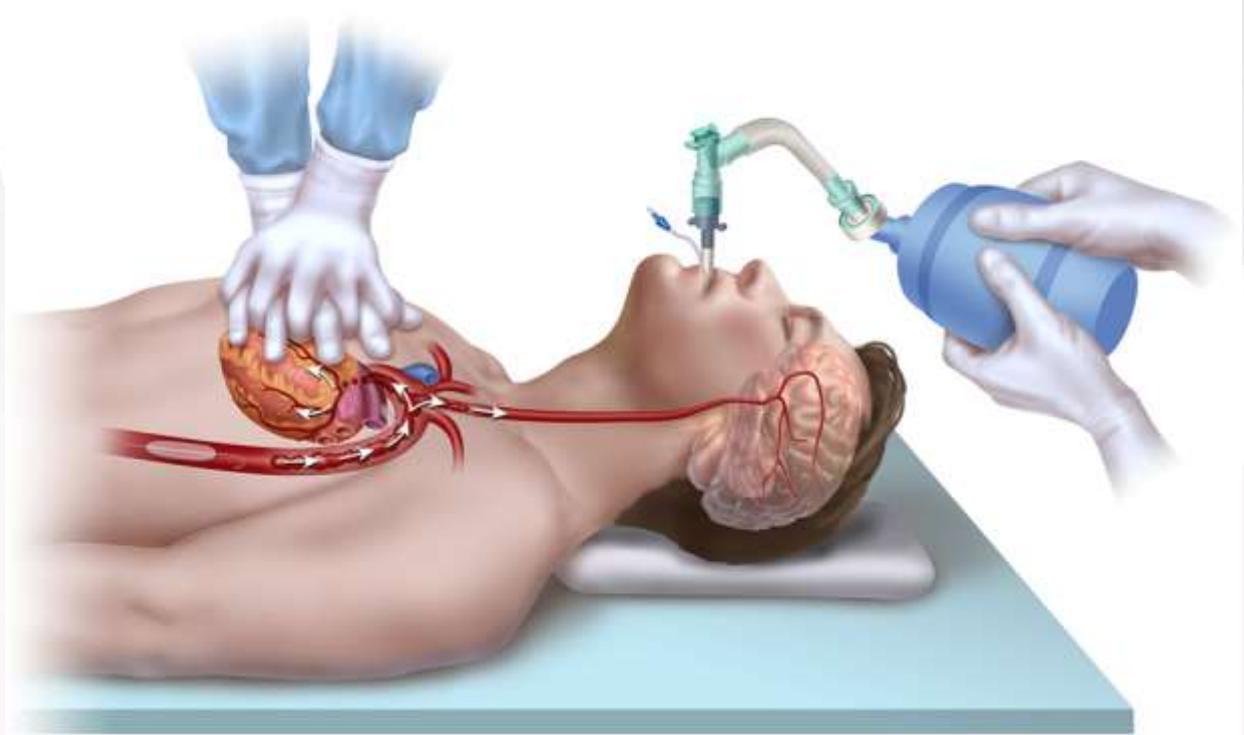
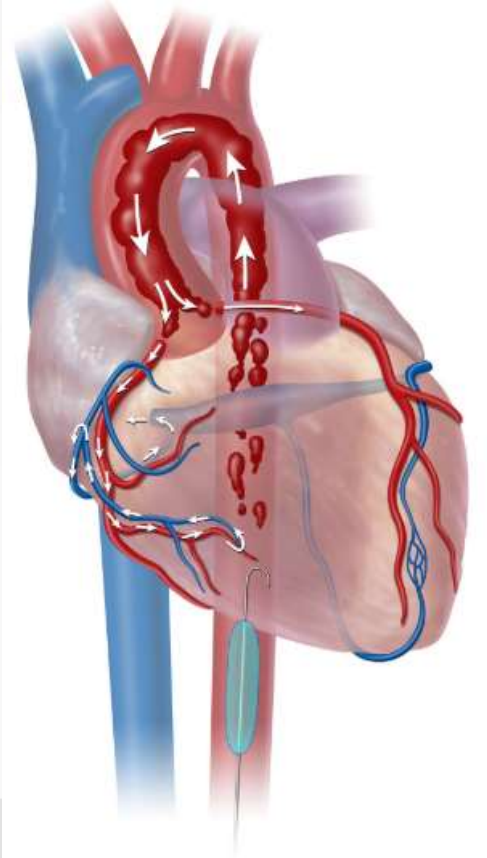


Actual uses

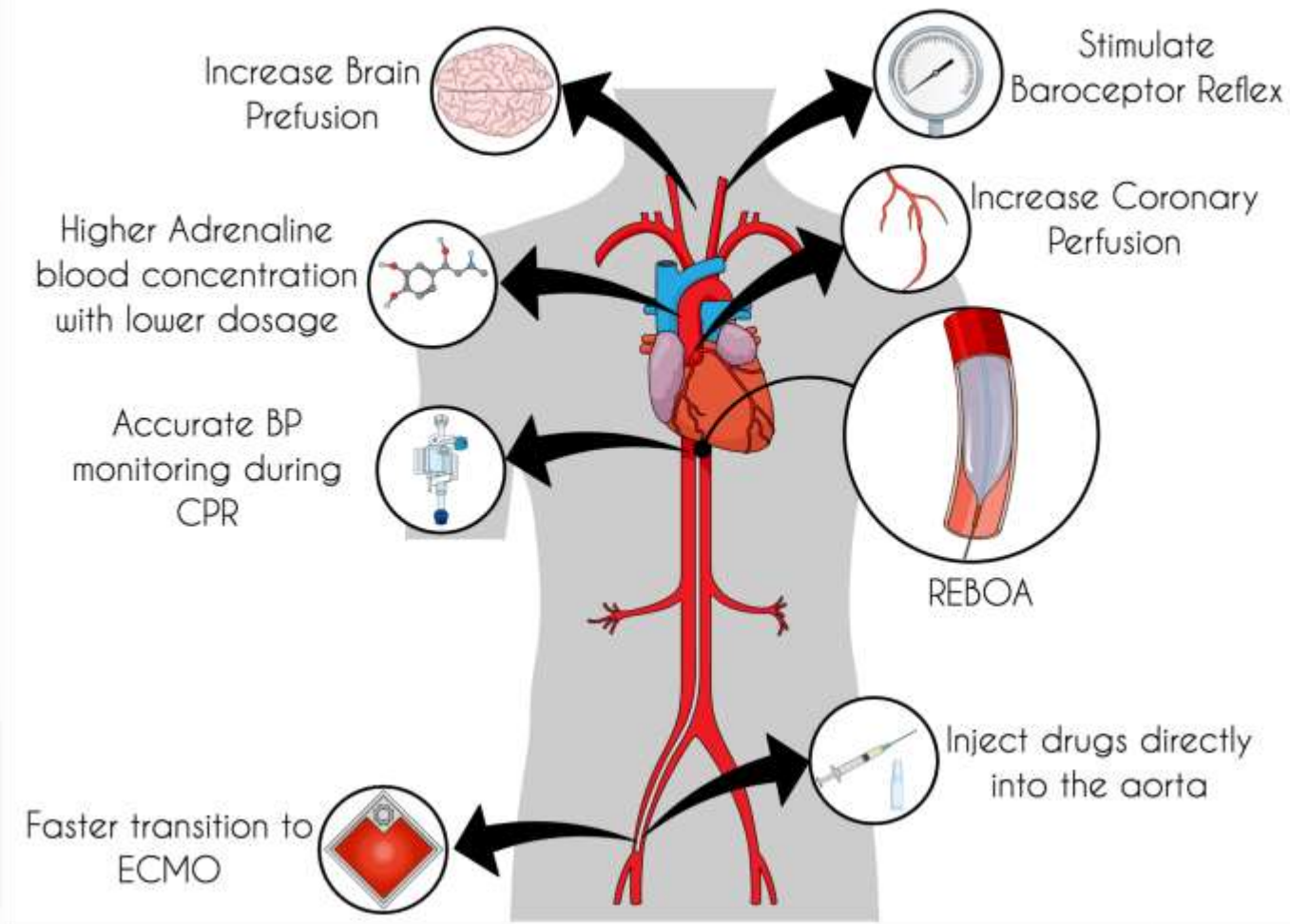
- Trauma
 - Non compressible haemorrhages of the pelvis and limbs – Zone 3
 - Traumatic cardiac arrest – Zone 1
- Obstetric haemorrhage



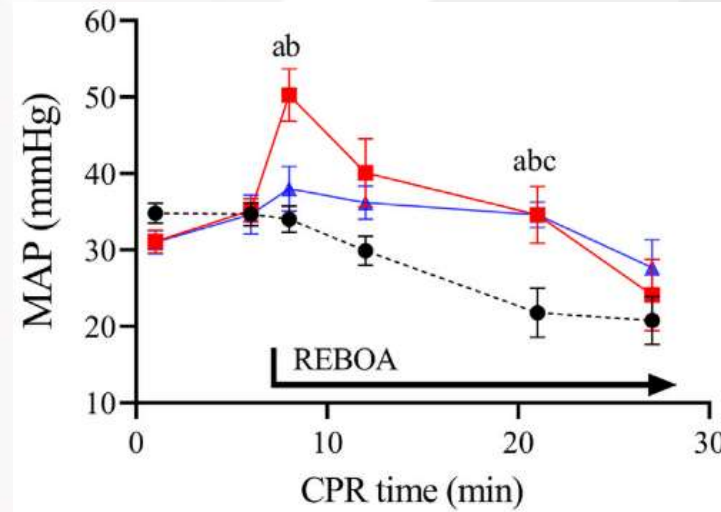
Pathophysiology of REBOA during CPR



Adjunctive potential aspects for NTCA



Animal data

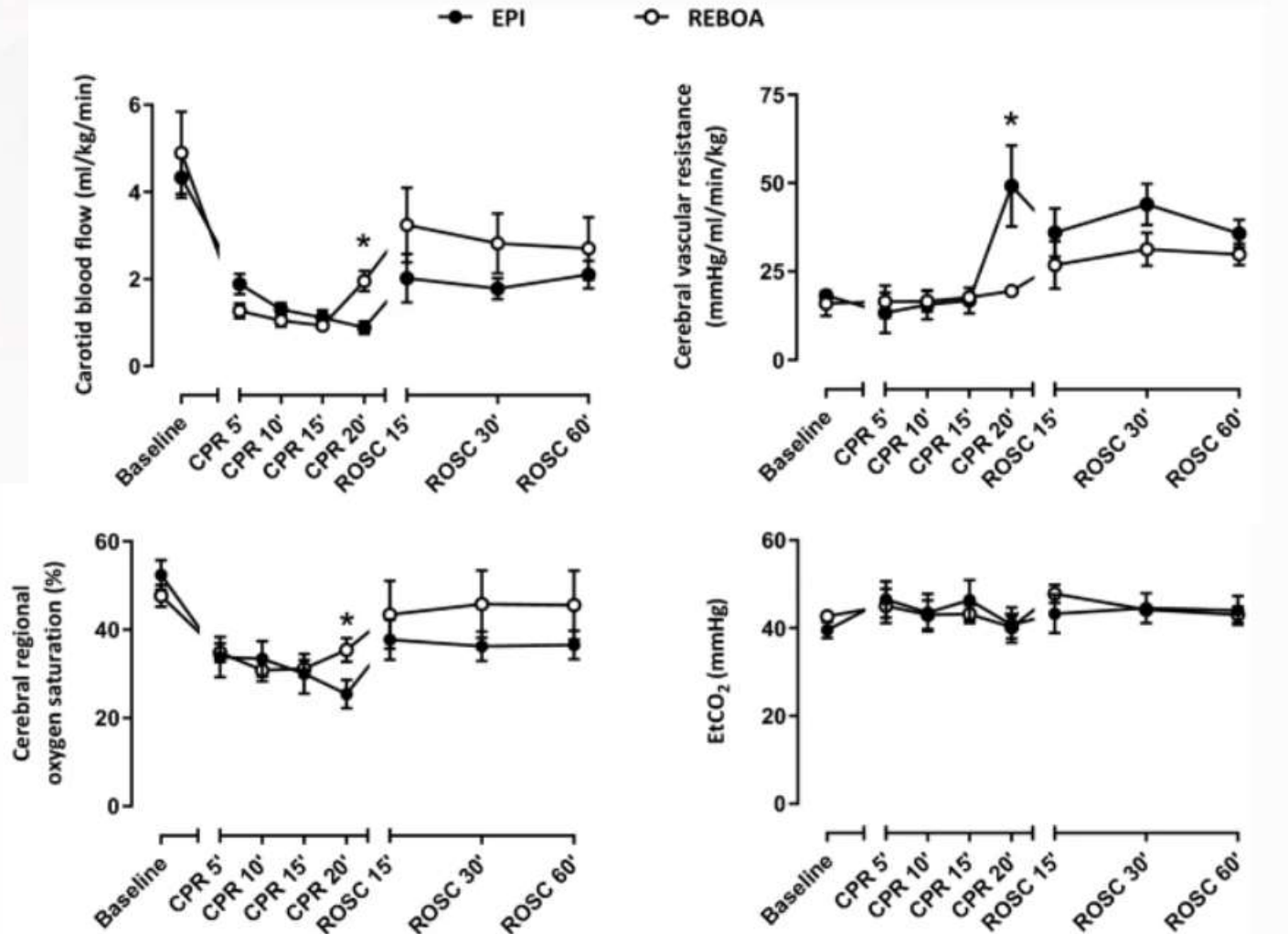


Dogan EM et al.
Resuscitative endovascular balloon occlusion of the aorta in zone I versus zone III in a porcine model of non-traumatic cardiac arrest and cardiopulmonary resuscitation: A randomized study.
Resuscitation. 2020 Jun

Table 1 – Arterial blood gas values in the hemodynamic study group in anesthetized pigs subjected to cardiopulmonary resuscitation (CPR) and randomized to resuscitative endovascular balloon occlusion of the aorta in zone I (REBOA-Ic, $n = 11$), zone III (REBOA-III, $n = 11$) or no aortic occlusion (control, $n = 10$). Values are displayed as means with a 95% confidence interval.

Variables	Groups	Baseline	Time (min after CPR)			
			6	12	21	27
pH	REBOA-Ic	7.57 (7.53–7.60)	7.31 (7.29–7.34)	7.45 (7.40–7.50)	7.44 (7.37–7.52)	7.44 (7.36–7.52)
	REBOA-III	7.55 (7.52–7.58)	7.31 (7.28–7.35)	7.21 (7.15–7.27)	7.22 (7.19–7.26)	7.21 (7.18–7.24)
	Control	7.58 (7.54–7.62)	7.34 (7.28–7.40)	7.30 (7.25–7.35)	7.24 (7.15–7.34)	7.19 (7.10–7.29)
PO ₂	REBOA-Ic	11.9 (11.4–12.4)	33.4 (24.8–42.1)	49.5 (43.6–55.4)	48.2 (37.0–59.5)	46.1 (33.7–58.5)
	REBOA-III	11.6 (11.2–12.0)	39.4 (28.9–49.8)	30.6 (19.1–42.1)	36.8 (24.3–49.3)	32.6 (20.1–45.1)
	Control	11.4 (10.8–12.0)	35.0 (21.8–48.2)	37.8 (23.7–52.0)	34.8 (19.5–50.0)	37.1 (19.7–54.4)
PCO ₂	REBOA-Ic	4.7 (4.6–4.9)	5.6 (5.0–6.1)	3.3 (2.9–3.8)	2.9 (2.5–3.4)	2.5 (2.0–3.0)
	REBOA-III	4.8 (4.6–5.0)	5.7 (5.3–6.1)	6.0 (5.0–7.0)	4.9 (4.4–5.4)	4.3 (3.9–4.8)
	Control	4.6 (4.3–5.0)	5.5 (4.9–6.2)	4.9 (4.4–5.4)	5.5 (3.5–7.4)	5.8 (3.7–7.9)
Lactate	REBOA-Ic	1.9 (1.6–2.2)	8.7 (7.9–9.6)	9.9 (9.0–10.8)	11.6 (10.6–12.7)	13.0 (11.9–14.0)
	REBOA-III	1.7 (1.4–1.9)	8.6 (8.1–9.2)	10.6 (10.2–11.0)	11.9 (11.2–12.6)	13.3 (12.4–14.1)
	Control	1.8 (1.5–2.0)	8.9 (8.2–9.6)	10.6 (9.9–11.4)	12.7 (11.9–13.5)	14.5 (13.4–15.6)

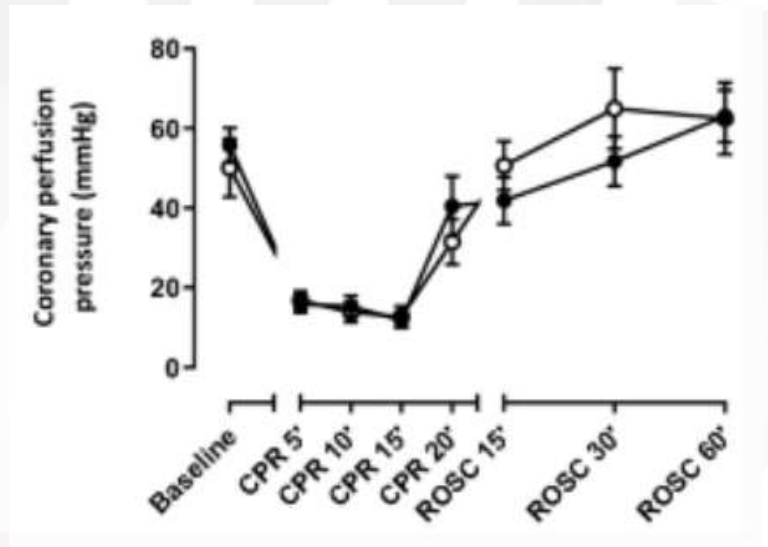
Animal data - 2



Hutin et al.

Resuscitative endovascular balloon occlusion of the aorta vs epinephrine in the treatment of non-traumatic cardiac arrest in swine.

Ann. Intensive Care 2021



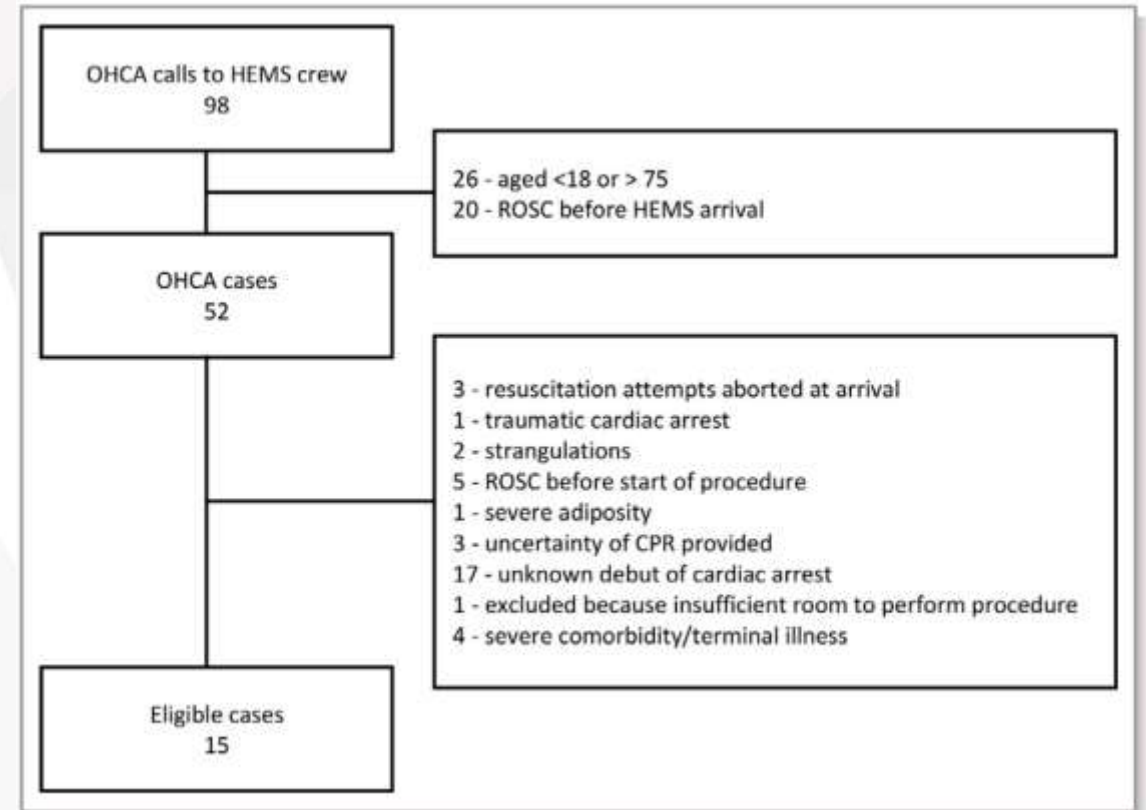
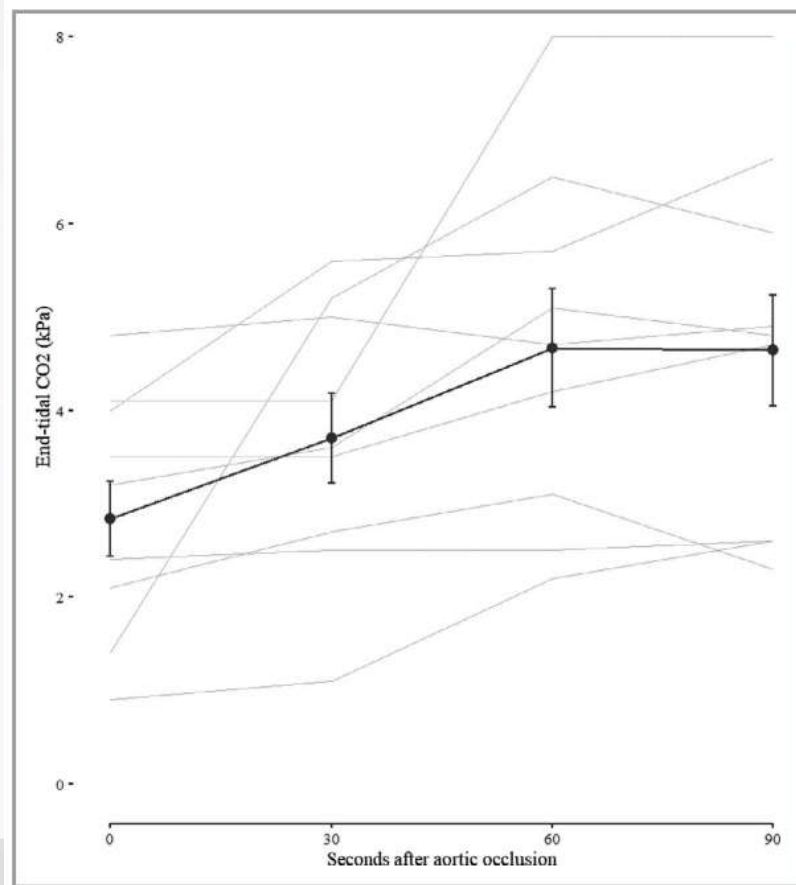
Human data – case series and ongoing studies



Case series - 1

Brede JR et al.
 Feasibility of Pre-Hospital Resuscitative
 Endovascular Balloon Occlusion of the Aorta
 in Non-Traumatic Out-of-Hospital Cardiac
 Arrest.

J Am Heart Assoc. 2019 Nov



Case series - 2

Levis A et al.
Resuscitative endovascular balloon occlusion
of the aorta (REBOA) during cardiopulmonary
resuscitation: A pilot study.
Resuscitation. 2020 Nov

Table 2 – Details of cardiac arrest circumstances.

Patient	Success	Interval dispatch time to start of procedure (min)	Witnessed cardiac arrest	First documented rhythm	Rhythm before start of procedure	Interval collapse to start of CPR (min)	Bystander CPR	ROSC
1	Yes	81	Yes	Shockable (AED)	PEA	0	Yes	No
2	Yes	60	Yes	VF	PEA	0	Yes	No
3	Yes	88	Yes	VF	PEA	<1	Yes	No
4	Yes	41	Yes	VF	Asystole	0	Yes	No
5	Yes	32	Yes	Asystole	PEA	1	Yes	No
6	No	No sooner than 44	No	VF	PEA	n/a	No	No
7	No (vein)	85	Yes	PEA	PEA	5	Yes	No
8	No	107	Yes	VF	PEA	5	Yes	No
9	Yes	26	Yes		PEA	0	EMS	Yes
10	No	No sooner than 52	No	VF	Asystole	n/a	No	No
11	Yes	58	Yes	VF	Asystole	<1	Yes	No
12	Yes	59	Yes	VT	PEA	7	Yes	No
13	No (sheath directed caudally)	30	Yes	VT	VT	7	Yes	No
14	No (vein)	128	Yes	VF	PEA	10	Yes	No
15	Yes	40	Yes	PEA	PEA	14	No	Yes

Note. ROSC: return of spontaneous circulation; AED: automatic external defibrillator; VF: ventricular fibrillation; VT: ventricular tachycardia (pulseless); PEA: pulseless electrical activity; EMS: emergency medical service.

Table 3 – Secondary outcomes: changes in cerebral oxygenation measured by NIRS, MAP proximal to the occlusion and end-tidal CO₂.

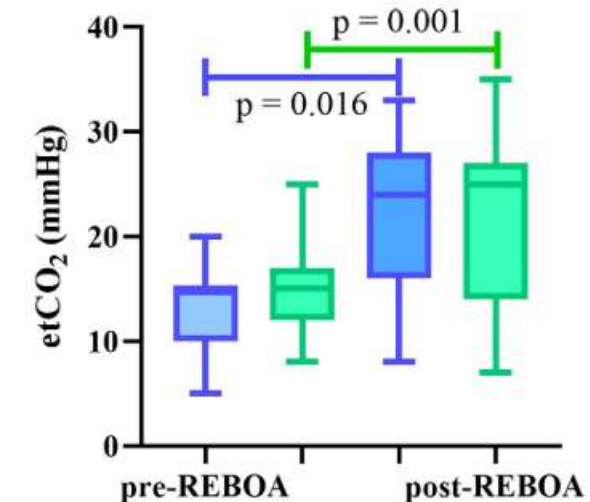
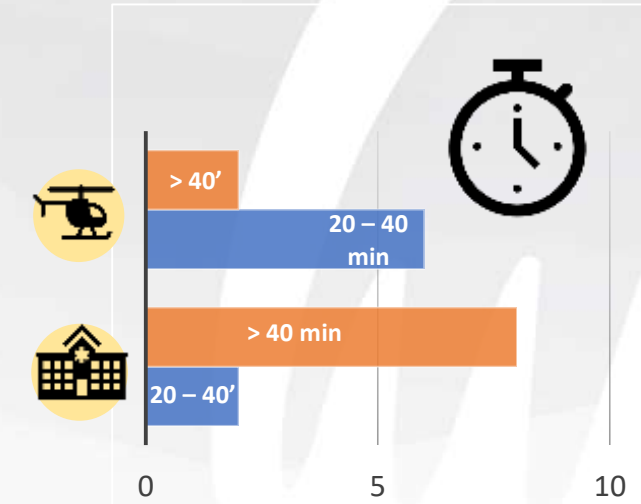
Outcome	Before occlusion	After occlusion	1 min	5 min	10 min	
NIRS (%)	41 (21–58)	41 (24–62)	41 (33–63)	41 (34–68)	42 (31–68)	$P < 0.001$
MAP (mmHg)	39 (22–55)	44 (19–76)	45 (21–81)	43 (21–60)	37 (17–67)	$P = 0.08$
End-tidal CO ₂ (mmHg)	22 (12–33)	20 (12–33)	19 (13–27)	17 (9–32)	14 (11–27)	$P = 0.17$

Note. All measurements are median and interquartile range (1–3). NIRS: near-infrared spectroscopy; MAP: mean arterial blood pressure; end-tidal CO₂: end-tidal carbon dioxide concentration.

Case series - 3

Gamberini L et al.
 Resuscitative endovascular occlusion of the aorta (REBOA) for refractory out of hospital cardiac arrest. An Utstein-based case series. Resuscitation. 2021 Aug

Non-traumatic OHCA (n = 11)	
HEMS attempted REBOA – n (%)	4 (36.4%)
Age – years – IQR	52 (34–63)
Sex – male – n (%)	6 (54.5%)
Initial shockable rhythm – n (%)	6 (54.5%)
Bystander CPR – n (%)	8 (72.7%)
Response time – minutes – IQR	7 (5–13)
Transported to hospital – n (%)	8 (72.7%)
Dispatch to hospital arrival – minutes – IQR	57 (44–102)
Any ROSC pre REBOA – n (%)	7 (63.6%)
Dispatch to procedure start – minutes – IQR	48 (34–63)
REBOA procedural time – minutes – IQR	9 (8–10)
Dispatch to balloon inflation – minutes – IQR	56 (46–72)
1-minute etCO ₂ increase ≥ 10 mmHg – n (%)	8 (72.7%)
Any ROSC after REBOA – n (%)	8 (72.7%)
Sustained ROSC – n (%)	4 (36.4%)
First arterial blood gas analysis available	
Initial arterial pH – IQR	Non-traumatic OHCA (n = 7) 7.03 (6.83–7.14)
Initial arterial lactate – mmol/L – IQR	18.8 (12.2–20)
Sustained ROSC details	
Dispatch to sustained ROSC – minutes – IQR	Non-traumatic OHCA (n = 4) 63.5 (51.25–81.75)
Total time of balloon occlusion – minutes – IQR	32 (29–38)
Hospital survival – n (%)	0 (0%)
Brain death – n (%)	3 (75%)
Organ donation – n (%)	2 (50%)





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REBOARREST Trial



Primary endpoint	Proportions of patients that achieve return of spontaneous circulation with a duration of at least 20 min
Secondary endpoints	The proportion of patients surviving to 30 days with good neurological status, defined as a modified Rankin scale score of 0–3
	Difference in end-tidal CO ₂ measurements in the control group and the intervention group after aortic occlusion
	Change in blood pressures after aortic occlusion
	Left ventricular ejection fraction (LVEF) measured by echocardiography
Exploratory endpoints	All-cause mortality 1 year after randomisation
	Difference in organ function, using the Acute Kidney Injury Network (AKIN) classification, liver function blood tests, and others
	Incidence of all adverse events

Inclusion criteria	Exclusion criteria
Estimated age 18–80 years	Traumatic cardiac arrest (including strangulation, electrocution, and patients rescued from avalanches)
Out-of-hospital cardiac arrest	Accidental hypothermia with temperature < 32 °C
Non-traumatic cardiac arrest	Suspected non-traumatic haemorrhage as aetiology of the arrest
Less than 10 min from debut of arrest to start of basic or advanced cardiac life support	Pregnancy (obvious or suspected)
ACLS is established and can be continued	Suspected cerebral haemorrhage as aetiology of the arrest
	Patient included to the study site's E-CPR protocol
	Other factors as decided by the treatment team (environmental factors, safety factors, and others)

Potential confounders

- Different etiologies underlying non traumatic OHCA could have different responses to aortic occlusion



- Timing of procedure initiation



- Setting



- Low recruitment rate



The need for an international registry

- More information is needed
- Phase 1 - Definition of a common set of variables to collect in addition to Utstein variables
- Phase 2 – Developement of a common interface to collect data

Red flags and Ethic concerns

- ECPR is a more established treatment supported by more evidence for non traumatic OHCA
- REBOA should not be applicated to patients eligible to ECMO if arrival time to the first ECMO centre is compatible with ECPR start
- REBOA is a time consuming task and should compete with the resolution of other reversible causes of OHCA
- REBOA carries adverse events:
 - Vascular damages: dissection, rupture, thromboembolism
 - Ischemia-reperfusion injury of the abdominal viscera and inferior limbs – compartment syndrome, necrosis and perforation

Italian Resuscitation Council

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