

Effect of lower body ischemia duration in aortic arch surgery under mild-to-moderate hypothermic circulatory arrest

**Murana G¹, Nocera C¹, Zanella L¹, Di Marco L^{1,2}, Snaidero S¹,
Castagnini S¹, Mariani C¹, Pacini D^{1,2}**

1. Division of Cardiac Surgery, Cardiac Surgery Department, IRCCS, Azienda Ospedaliero-Universitaria di Bologna
2. Department of Medical and Surgical Sciences, DIMEC, Alma Mater Studiorum-University of Bologna, Bologna

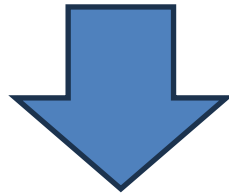
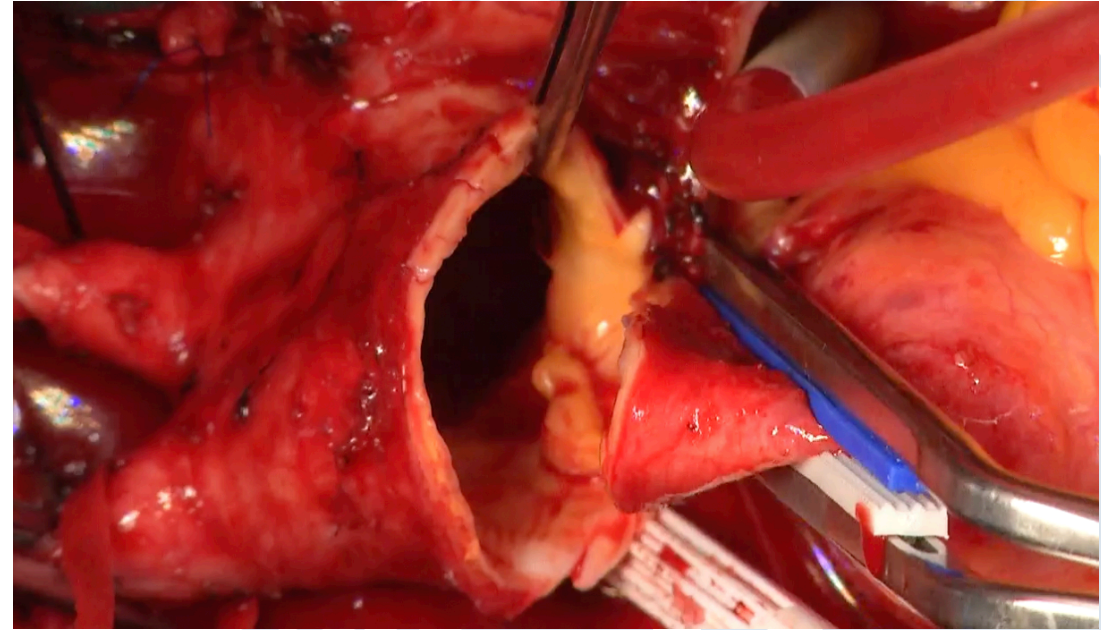


ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

POLICLINICO DI **SANT'ORSOLA**
Division of Cardiac Surgery

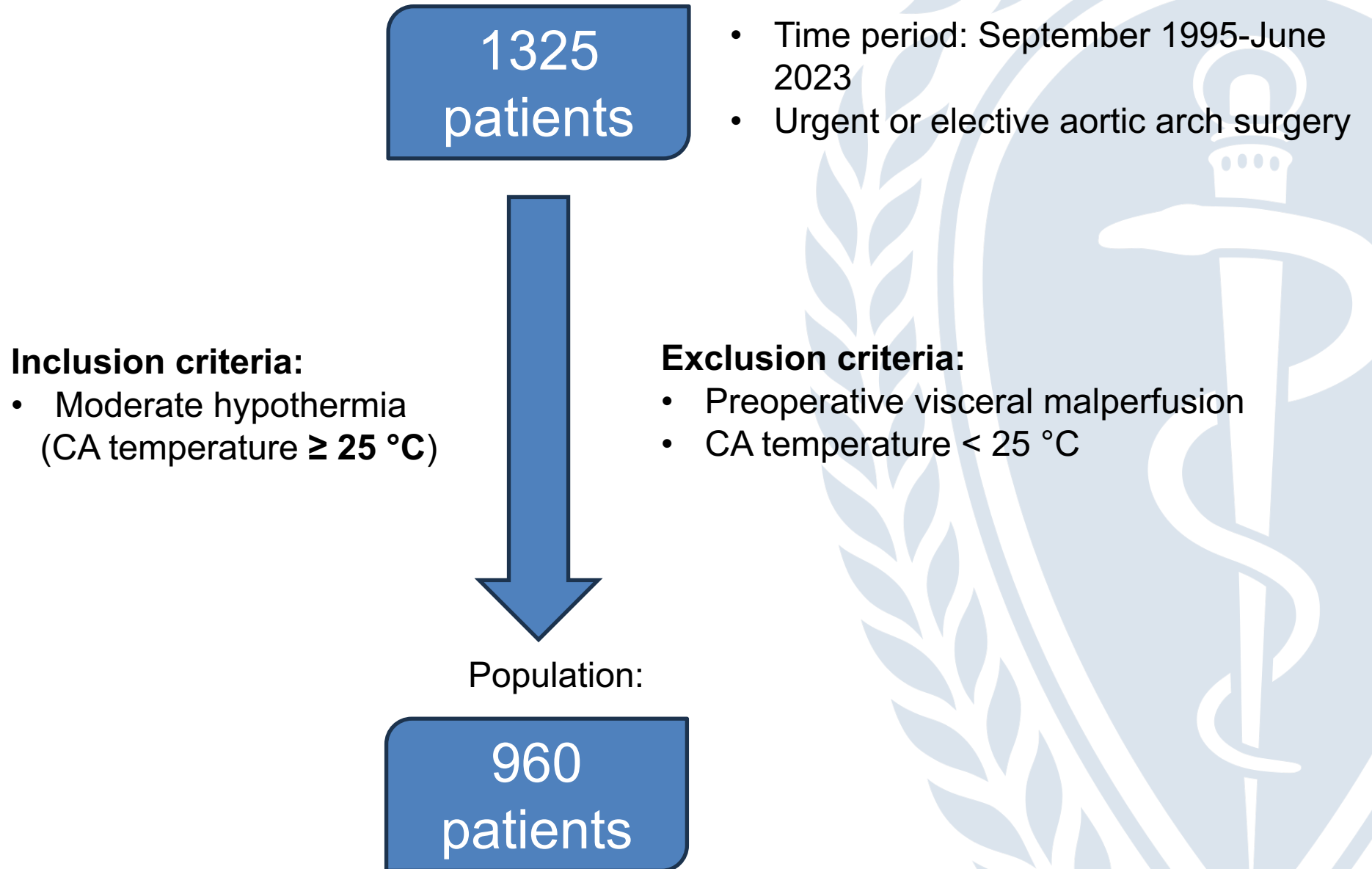
Background and objectives

- Selective cerebral perfusion (SCP) strategies allowed a shift towards higher circulatory arrest (CA) temperatures in aortic arch surgery
- Moderate hypothermia with nadir nasopharyngeal temperatures $\geq 25^{\circ}\text{C}$, combined with SCP, allows good outcomes in terms of mortality and neurological complications
- The effect of higher CA temperatures on visceral organ function has been poorly investigated, especially depending on the duration of the arrest



Primary objective: to assess the impact of **visceral ischemia time (VIT)** on organ function among patients undergoing arch surgery **under moderate hypothermia ($\geq 25^{\circ}\text{C}$)**

Methods (I)



Methods (II)

Mean nadir nasopharyngeal temperature: $25.4 \pm 0.8^\circ \text{C}$

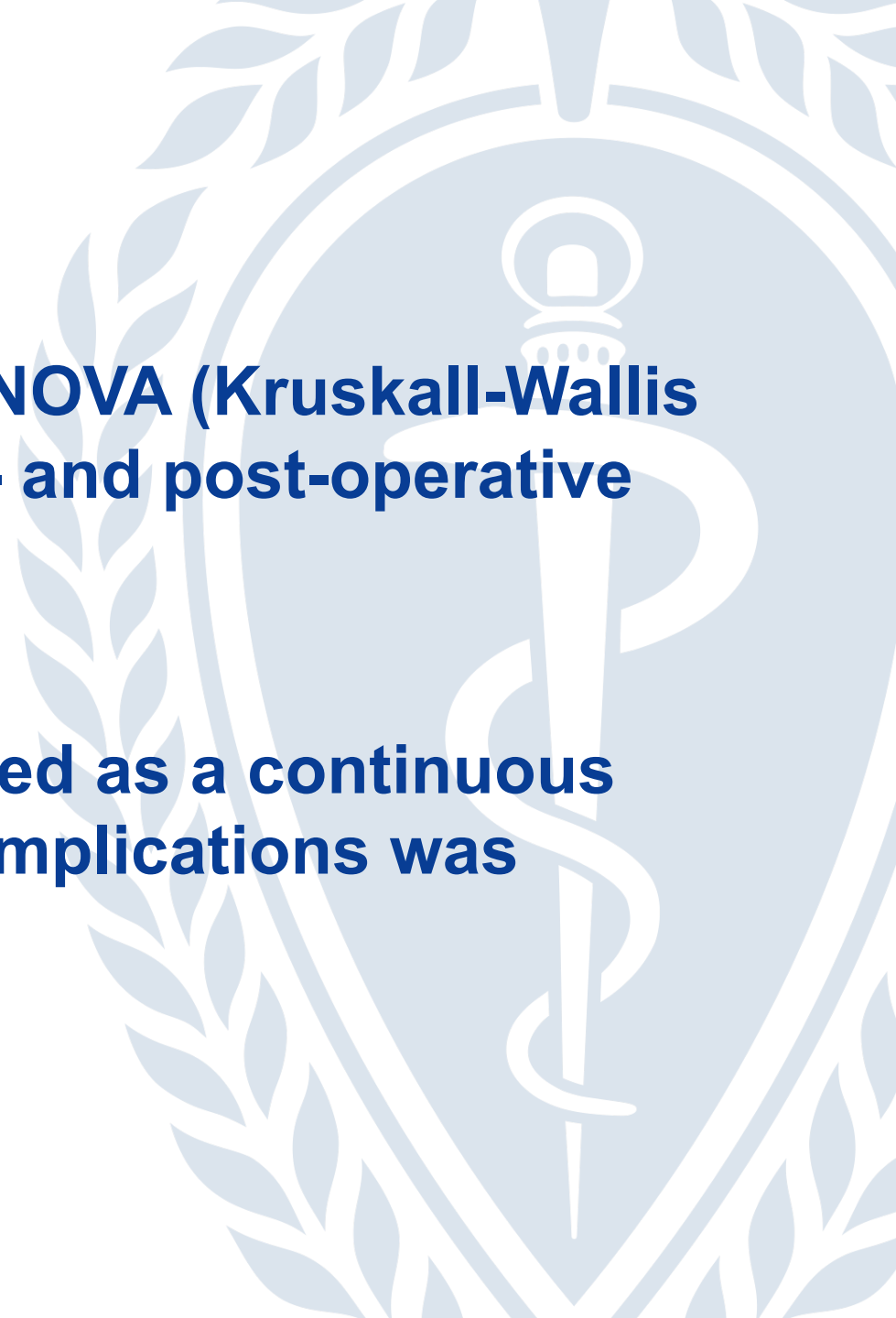
Mean visceral ischemia time (VIT): 46.3 ± 20 minutes

Classification into 3 groups:



Methods (III)

- **Chi-square test and non-parametric ANOVA (Kruskall-Wallis test) were used to compare pre-, intra- and post-operative data among the three groups**
- **The non-linear relationship of VITs, used as a continuous variable, with respiratory and renal complications was investigated with cubic splines**



Results (I): preoperative characteristics

	Overall (n=960)	VIT ≤ 30 mins (n=180)	VIT 30-60 mins (n=612)	VIT >60 mins (n=168)	p-Value
Mean age	63.4±12 years	62.6±12.3 years	64.1±11.4 years	61.5±13.6 years	0.021
Urgency	395	47 (26.1%)	282 (46%)	66 (39.3%)	<0.01
Indication:					
Type A aortic dissection	333 (34.7%)	47 (26.1%)	232 (37.9%)	54 (32.2%)	0.003
Intramural haematoma	49 (5.1%)	5 (2.8%)	36 (5.9%)	8 (4.8%)	0.248
Penetrating ulcer	20 (2.1%)	5 (2.8%)	13 (2.1%)	2 (1.2%)	0.582
Aneurysm	494 (51.4%)	119 (66.1%)	288 (47%)	87 (51.7%)	<0.01
Other	64 (6.7%)	4 (2.2%)	43 (7.1%)	17 (10.1%)	0.074
Preoperative renal failure	59 (6.1%)	13 (7.2%)	33 (5.4%)	13 (7.7%)	0.442
Preoperative dialysis	9 (0.9%)	1 (0.5%)	5 (0.8%)	3 (1.8%)	0.436
Diabetes	58 (6%)	14 (7.8%)	34 (5.6%)	10 (6%)	0.555
Smoking	372 (38.7%)	68 (37.8%)	234 (38.2%)	70 (41.7%)	0.702
Hypertension	692 (72.1%)	122 (67.8%)	452 (73.9%)	118 (70.3%)	0.205
Marfan syndrome	30 (3.1%)	2 (1%)	22 (3.6%)	6 (3.6%)	0.223
Previous cardiac surgery	279 (29.1%)	51 (28.3%)	182 (29.7%)	46 (27.4%)	0.814

- Group 2 included more urgent cases
 - Type A aortic dissection was significantly more frequent in groups with higher VIT, while aneurysm was more frequent in group 1

There was no significant difference in pre-operative risk factors or renal function between the 3 groups

Results (II): Operative strategy

	Overall (n=960)	VIT ≤ 30 mins (n=180)	VIT 30-60 mins (n=612)	VIT >60 mins (n=168)	p-Value
CPB times	210.2±64.5 mins	186.3±64.7 mins	210.6±60 mins	234.6±70.8 mins	<0.01
Cross-clamp times	135.4±49.2 mins	121.6±48.4 mins	133.6±46.6 mins	156.8±52.9 mins	<0.01
Surgical procedures					
Bentall	315 (32.8%)	71 (49.4%)	201 (32.8%)	43 (25.6%)	0.001
Hemiarch replacement	376 (39.2%)	92 (51.1%)	252 (41.2%)	32 (19.1%)	<0.01
Arch replacement	243 (25.3%)	53 (29.4%)	132 (21.6%)	58 (34.5%)	0.03
Frozen Elephant trunk	290 (30.2%)	27 (15%)	201 (32.8%)	62 (36.9%)	<0.01
Elephant trunk	51 (5.3%)	8 (4.5%)	27 (4.4%)	16 (9.5%)	<0.01
Cannulation site					
Aortic	145 (15.1%)	49 (27.2%)	77 (12.6%)	19 (11.3%)	<0.01
Axillary	254 (26.5%)	41 (22.8%)	156 (25.5%)	57 (33.9%)	0.04
Femoral	321 (33.4%)	38 (21.1%)	216 (35.3%)	67 (39.9%)	<0.01
Brachio-cephalic trunk	197 (20.5%)	46 (25.6%)	128 (20.9%)	23 (13.7%)	0.01
Carotid	43 (4.5%)	6 (3.3%)	35 (5.7%)	2 (1.2%)	0.097

More complex surgeries in groups 2 and 3

Results (III): short-term outcomes

	Overall (n=960)	VIT ≤ 30 mins (n=180)	VIT 30-60 mins (n=612)	VIT >60 mins (n=168)	p-Value
In-hospital death	114 (12.0%)	15 (8.5%)	80 (13.2%)	19 (11.3%)	0.224
Bleeding requiring reopening	71 (7.4%)	16 (8.9%)	43 (7%)	12 (7.1%)	0.662
Neurological complications	220 (22.9%)	35 (19.4%)	148 (24.2%)	37 (22%)	0.399
Permanent neurological deficits	75 (7.8%)	10 (5.5%)	55 (8.9%)	10 (6%)	0.188
Stroke	58 (6.1%)	6 (3.3%)	44 (7.2%)	8 (4.8%)	0.119
Transient neurological deficits	156 (16.2%)	27 (15%)	102 (16.7%)	27 (16%)	0.867
Spinal cord injury	24 (2.5%)	3 (1.7%)	15 (2.5%)	6 (3.6%)	0.537
Respiratory complications	243 (25.3%)	35 (19.4%)	172 (28.1%)	36 (21.4%)	0.027
Renal Complications	180 (18.9%)	23 (13.0%)	119 (19.7%)	38 (22.6%)	0.056
Permanent dialysis	64 (6.7%)	10 (5.6%)	44 (7.3%)	10 (6.0%)	0.679
Transient dialysis	71 (7.4%)	5 (2.8%)	47 (7.8%)	19 (11.3%)	0.011
Intestinal ischemia	21 (2.2%)	4 (2.2%)	15 (2.4%)	2 (1.2%)	0.610
Gastrointestinal complications	55 (5.7%)	9 (5%)	34 (5.5%)	12 (7.1%)	0.696

Groups with higher VIT presented:

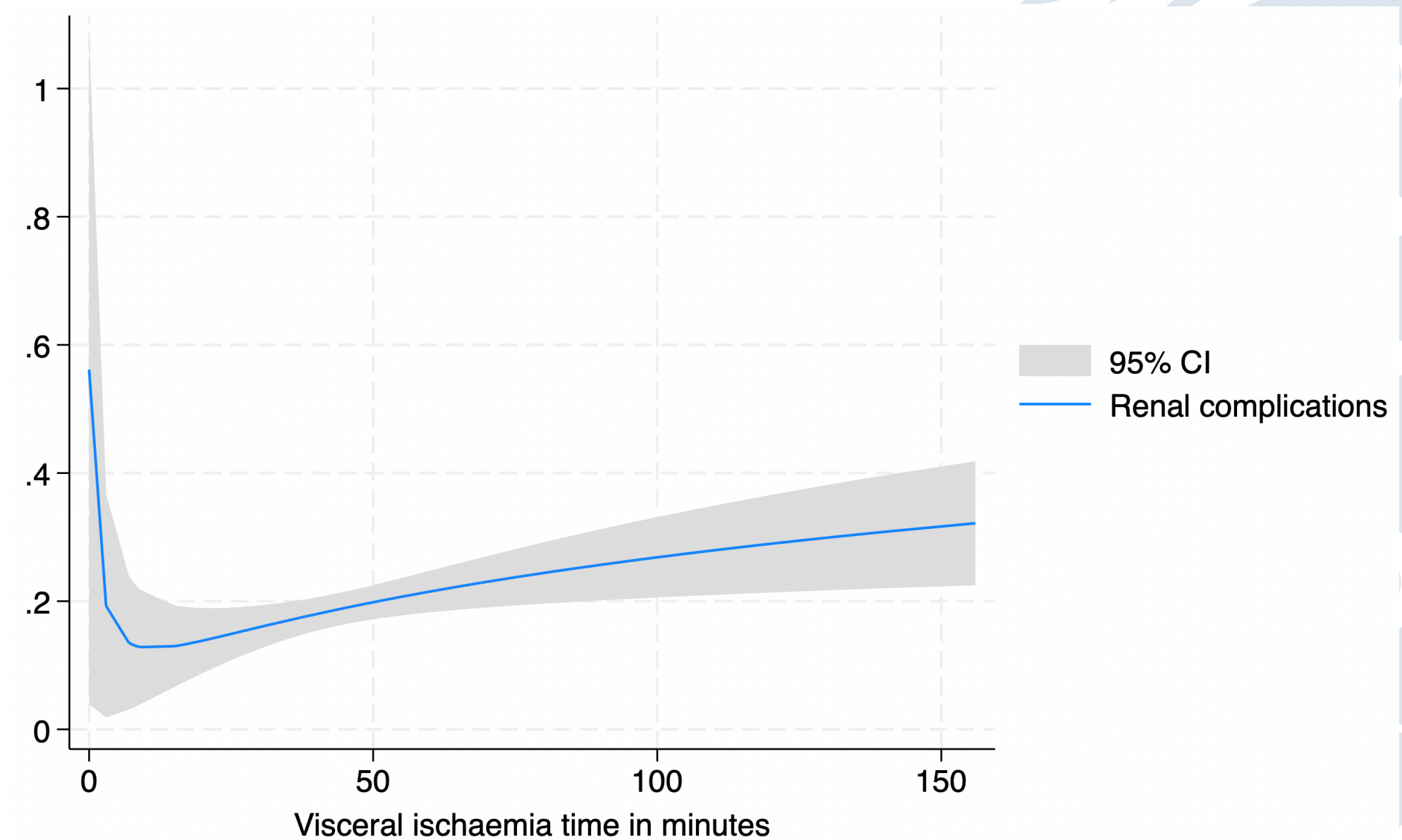
- **Higher incidence of respiratory complications** (defined as intubation time longer than 72 hours or post-operative respiratory failure)
- **Higher incidence of transient dialysis**
- **A (non-significant) increase in overall renal complications** (defined as Acute Kidney Injury of any stage)

Results (IV): Visceral ischemia bio-markers

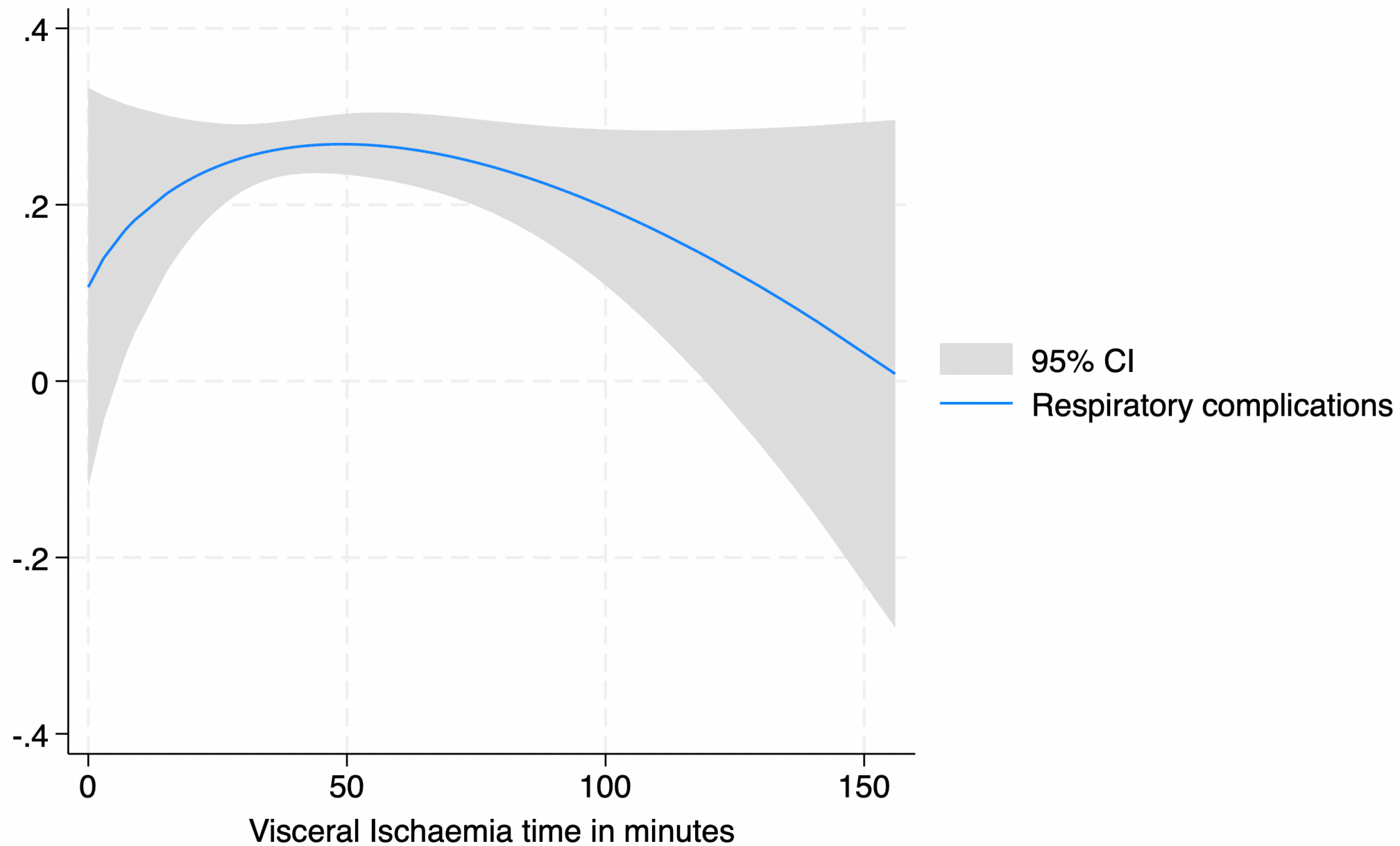
	Overall (n=960)	VIT ≤ 30 mins (n=180)	VIT 30-60 mins (n=612)	VIT >60 mins (n=168)	p-Value
Creatinine levels (mg/dL)					
At 24 hours	1.3±0.66	1.2±0.72	1.3±0.6	1.5±0.7	<0.001
At 48 hours	1.4±0.9	1.3±0.7	1.4±0.8	1.7±1.1	<0.001
Peak	2±1.6	1.6±1.4	2.0±1.7	2.2±1.6	<0.001
GOT levels (U/L)					
At 24 hours	120±252	99.1±186.7	127±292.9	117.6±131.1	<0.001
At 48 hours	125.3±292	94.2±228.7	137.6±331.4	115.7±184.7	<0.001
Peak	231±755.2	162.5±340.3	260±891.8	202.7±508.3	0.024
GPT levels (U/L)					
At 24 hours	57.6±156	42±83.6	60.8±174.1	62.7±146.4	<0.001
At 48 hours	73.9±530	36.4±79.9	91±665.6	53.5±88.2	<0.001
Peak	149.3±716.5	91.4±192.8	177.6±884.2	111.7±281.1	0.373
Bilirubin levels (mg/dL)					
At 24 hours	1,7±1.9	1.8±2.9	1.7±1.7	1.7±1.3	0.421
At 48 hours	1.8±4	2.1±7.7	1.7±2.6	1.5±2	0.143
Peak	2.5±3.2	2.3±2.4	2.6±3.5	2.2±2.3	0.430

Creatinine, GOT and GPT levels at 24 and 48 hours and peak creatinine and GOT levels increased significantly with VIT

Renal complications related to visceral ischaemia time in minutes



Respiratory complications related to visceral ischaemia time in minutes



Conclusions:

- **Visceral ischemic times (VIT) under moderate hypothermia (≥ 25 °C) had no impact** on in-hospital death, bleeding requiring reintervention, central neurological complications, intestinal ischemia, overall renal complications or permanent dialysis.
- **Longer VIT was linked to higher incidence of respiratory complications, and transient dialysis.**
- **Longer VIT was related to biomarkers** such as creatinine, GOT and GPT.
- **Renal complications incidence grew with VIT**, while **respiratory complications reached a peak at 50 minutes.**