

# Carboxyhemoglobin Levels in Smokers and Non-Smokers Undergoing Various Cardiac Surgical Procedures Using Cardiopulmonary Bypass

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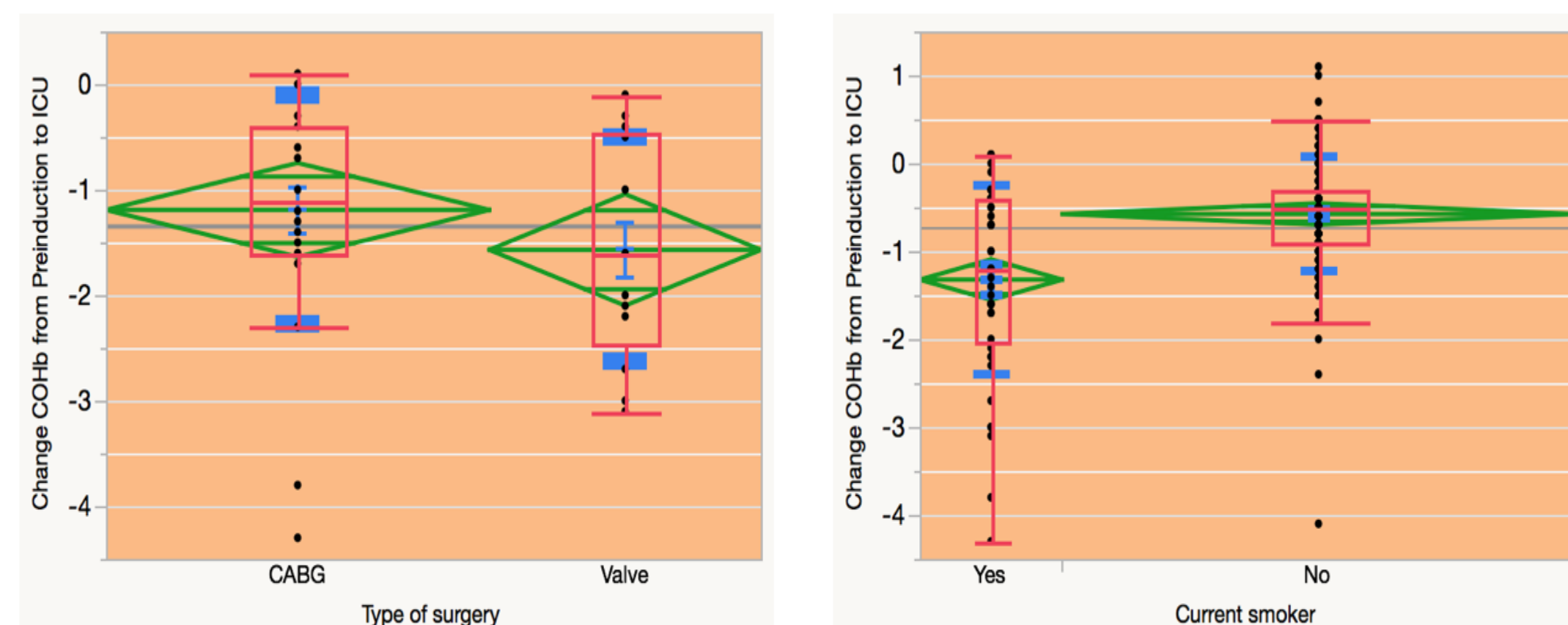
## INTRODUCTION

Low levels of endogenous and exogenous carbon monoxide has been shown to be cytoprotective in various pathophysiological conditions such as organ transplantation, ischemia/reperfusion, inflammation, sepsis, and shock states.<sup>1,3</sup> The inducible isoform of microsomal heme oxygenase-1 (HO-1) found in reticuloendothelial cells is the main producer of endogenous carbon monoxide. Known stressors and inducers of HO-1 gene expression include surgery, anesthesia and cardiopulmonary bypass (CPB).<sup>2</sup>

Cigarette smokers can have carboxy-hemoglobin (COHb) levels that are 2 to 10 times higher than that of non-smokers. It has been suggested that smoking may have a protective effect and could lead to favorable outcomes compared to non-smokers. The aim of this study was to examine COHb levels from pre-induction to arrival in the intensive care unit (ICU) as well as the clinical impact of COHb changes among smokers as compared to non-smokers undergoing CPB.

Comparison of the Change in COHb from Preinduction to ICU in Smokers based on the Type of Surgery

Comparison of the Change in COHb from Preinduction to ICU based on Smoking Status



## METHODS

In this retrospective cohort study, adult patients that were admitted to Augusta University Medical Center for coronary artery bypass graft (CABG) alone, CABG in combination with valve repair or replacement, or valve surgery alone, whether elective or emergent, from April 1, 2012, to January 1, 2016, were included in the study. Patients who died before an arterial blood gas sample could be obtained in the ICU were excluded.

## RESULTS

A total of 193 patients (42 smokers and 151 non-smokers) were identified. Two patients were excluded because of insufficient data. Other than age (smokers were significantly younger than non-smokers;  $p=0.004$ ) demographics such as sex and race as well as mean intraoperative variables such as CPB and aortic cross clamp times were comparable between the two groups (Table 1).

Smokers had significantly higher COHb levels at baseline ( $p<0.001$ ), just prior to CPB ( $p<0.001$ ), and immediately after weaning off CPB ( $p<0.001$ ). COHb levels on arrival to the ICU were similar in the two groups. Smokers had a more significant drop in COHb from baseline to the first ICU value compared to non-smokers ( $p<0.001$ ). There was no significant difference in the ICU or hospital length of stay between the two groups.

In a subgroup analysis comparing patients who underwent a CABG to those who underwent valve procedures showed a significantly higher COHb levels in non-smoking valve patients on arrival to ICU as well as change in COHb levels from preinduction to ICU as compared to CABG only patients, suggesting that a higher degree of systemic stress causes a higher production of endogenous COHb.

	Smokers (n=42)	Non-smokers (n=151)	P-value
Age, years	56.2 ± 9	62.4 ± 13	0.004
Sex, % male	54.8%	50.3%	NS
Race, %			
Caucasian	64.3%	62.9%	NS
African American	35.7%	33.8%	NS
Hispanic	—	1.0%	NS
Asian	—	1.0%	NS
Other	—	0.7%	NS
CPB time (min)	121.7 ± 81	129.8 ± 70	NS
ACC time (min)	81.1 ± 59	88.4 ± 49	NS
COHb, %			
Preinduction	2.2 ± 1.4	1.3 ± 0.6	<0.001
Pre-CPB	1.6 ± 0.9	1.1 ± 0.4	<0.001
Post-CPB	1.6 ± 0.6	1.2 ± 0.5	<0.001
First ICU arrival	0.9 ± 0.6	0.8 ± 0.4	NS
Overall COHb change	-1.3 ± 1.0	-0.6 ± 0.6	<0.001
ICU stay, days	7 ± 6	10 ± 16	NS
Hospital stay, days	12.5 ± 9	16 ± 17	NS

Mean COHb, %		CABG (n=81)	Valve (n=87)	P-value
Preinduction	Smokers	2.1	2.6	NS
	Non-Smokers	1.3	1.4	NS
Pre-CPB	Smokers	1.4	1.9	NS
	Non-Smokers	1.1	1.2	NS
Post-CPB	Smokers	1.6	1.8	NS
	Non-Smokers	1.1	1.3	NS
First ICU arrival	Smokers	0.9	1.0	NS
	Non-Smokers	0.6	0.9	0.002
Overall change	Smokers	-1.2	-1.6	NS
	Non-Smokers	-0.7	-0.5	0.04

## CONCLUSIONS

The more pronounced reduction in COHb levels following CPB in smokers as compared to non-smokers suggests that smokers have decreased endogenous production of CO in response to systemic stress. It is reasonable to conclude that exogenous CO in smokers has a “preconditioning effect” by reducing the overall systemic stress response.

## REFERENCES

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