Association of intraprocedural blood pressure and end tidal carbon dioxide with outcome after acute stroke intervention

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INTRODUCTION

- Prior retrospective studies have suggested that general anesthesia (GA) during acute endovascular stroke cases is associated with worse 90 day functional outcome compared to conscious sedation (CS)
- Two plausible mechanisms for this difference in outcomes are: 1. Drops in blood pressure with induction agents result in decreased cerebral perfusion pressure; 2. Hypocapnia results in cerebral vasoconstriction and decreased flow to the penumbra

METHODS

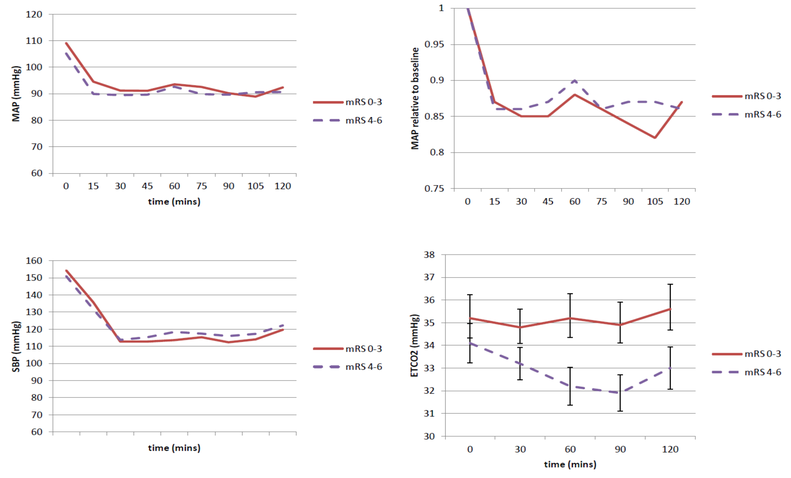
- Consecutive stroke patients who received endovascular intervention between 2007 and 2010 were enrolled in an OHSU database
- Due to institutional policies, all patients were intubated for their procedure
- Patient data from the chart was retrospectively reviewed for the present analysis
  - Blood pressures were recorded every 5 min in the anesthetic record and the mean blood pressure for each 15 minute period was used in the analysis
  - ETCO2 values were recorded every 30 min in the anesthetic record
- Patients were divided into two groups: Patients with "good" outcomes were defined as mRS 0-3 and those with "poor" outcomes were defined as mRS 4-6
- Demographic, clinical, and intraprocedural parameters were compared between and Univariate and multivariate analyses were performed to control for established factors that affect stroke outcome

Figure 1: Patient Demographic Data, stratified by outcome

	mRS 0-3	mRS 4-6	p
Age (mean)	61.8	69.4	**0.04**
NIHSSS (mean)	17	20	0.11
TICI ≥2a	65%	35%	**0.008**
TICI ≥2b	52%	25%	**0.014**
Clot location ICA-T or VB	38%	40%	0.846
Female	67%	59%	0.48
Hypertension	72%	70%	0.84
Diabetes	9%	32%	**0.02**
Atrial Fibrillation	31%	43%	0.266
Atrial fibrillation on monitor during case	16%	28%	0.182
Coronary artery disease	13%	30%	**0.063**
Admission glucose (mg/dL, mean)	134.2	142.3	0.42

Figure 2: Multivariate Analysis - Results of logistic regression controlling for age, NIHSSS, recanalization (TICI ≥ 2a), history of diabetes, and history of coronary artery disease..

	p	OR	95% CI	p	OR	95% CI	p	OR	95%CI
Age (/yr)	**0.02**	1.06	(1.01-1.11)	**0.02**	**1.09**	**(1.01-1.17)**	**0.02**	**1.09**	**(1.01-1.18)**
TICI ≥ 2a	**0.02**	3.70	(1.30-10.56)	**0.01**	**18.40**	**(2.35-143.91)**	**0.05**	**5.94**	**(1.00-35.14)**
Baseline NIHSSS	0.18	1.06	(0.97-1.15)	0.35	1.05	(0.95-1.17)	0.66	0.97	(0.84-1.11)
History of diabetes	**0.06**	**0.23**	**(0.05-1.08)**	**0.07**	**.16**	**(.02-1.12)**	**0.07**	**0.02**	**(0.02-1.19)**
History of coronary disease	0.55	0.65	(0.16-2.61)	0.90	.88	(0.12-6.31)	0.70	0.07	(0.07-5.79)
ETCO2 at 60 min				**0.004**	**.76**	**(0.63-0.92)**			
ETCO2 at 90 min							**0.01**	**0.76**	**(0.61-0.93)**



Figures 1 a-c depict changes in various measures of blood pressure over time stratified by outcome (red line represents favorable outcome (modified Rankin Scale (mRS) 0-3); broken blue line represents unfavorable outcome (mRS 4-6). The blood pressure at time 0 is the mean of all blood pressures measured prior to induction of general anesthesia. Subsequent blood pressures represent the mean of all blood pressures within each 15 minute epoch beginning with induction of general anesthesia. Mean arterial pressure (MAP) is shown in figure 1a. Relative MAP (defined as the mean MAP during each 15 minute epoch divided by the mean pre-induction MAP) is shown in figure 1b. Figure 1c depicts the change in systolic blood pressure over time.
Figure 1d depicts the change in end tidal carbon dioxide (ETCO2) over time. Time 0 represents the pre-induction ETC02 and subsequent ETC02 values reflect the mean of all measurements within each 30 minute epoch. The red line represents favorable outcome (modified Rankin Scale (mRS) 0-3); broken blue line represents unfavorable outcome (mRS 4-6).

RESULTS

- 106 received endovascular treatment for acute stroke during this time period; 86 had complete records for our analysis
- SBP, DBP, and MAP all had statistically significant drops after induction with anesthetic agents
- Average decrease in blood pressure, absolute drop in blood pressure, decrease by > 60%, SBP < 140 did **not** correlate with functional outcomes (i.e. 90 day mRS)
- EtCO2 was significantly higher in the group with a good versus a poor outcome at 60 min (35.2 mmHg vs. 32.2mmHg; p = 0.03) and 90 min (34.9 mmHg vs. 31.9 mmHg; p = 0.04); this relationship was preserved even after multivariate analysis controlling for other well-established predictors of outcome.

DISCUSSIONS / CONCLUSIONS

- Post induction, there is a statistically significant drop in blood pressure in all patients
- There is no association between decrease in blood pressure and final outcome, (i.e. mRS score) in either univariate or multivariate analysis
- End tidal carbon dioxide (ETCO2) at both 60 and 90 minutes, is significantly associated with patient outcomes
- Mechanistically, one physiological explanation for this finding is that relative hypocapnia results in cerebral vasocontriction. In stroke patients, this might cause compromised flow to the penumbra and increase stroke size and subsequent disability.
  - If CO2 levels do predict outcome, this could be clinically useful as well, since CO2 levels can be easily manipulated in the intubated patient
- The nature of this study, a retrospective study, can suggest correlation but it cannot establish causation; hence a prospective trial has been initiated to investigate the relationship between arterial pCO2 and post stroke outcomes

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