Title: DOES THE EEG PREDICT ANESTHETIC DEPTH BETTER THAN CARDIOVASCULAR VARIABLES?

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INTRODUCTION. Heart rate (HR) and blood pressure (BP) are often used for titrating the administration of anesthetic agents. How reliably do HR and BP predict anesthetic depth, and how well do they compare with the electroencephalogram (EEG)? We approached these questions by determining the probability that HR, BP, or EEG could correctly predict whether patients would move in response to surgical stimulation.
METHODS. The protocol was approved by the hospital IRB, and all patients gave written informed consent. Three hundred patients (Pts) undergoing routine laparoscopy received thiopental (4 mg/kg) and one of five maintenance anesthetic combinations: I (isoflurane/70% N_2O), II (isoflurane/70% N_2O/fentanyl 1 μg/kg), III (isoflurane/70% N_2O/fentanyl 2 μg/kg), IV (isoflurane/70% N_2O/fentanyl 4 μg/kg),and V (isoflurane/fentanyl 4 μg/kg). For each patient, move/ no move data were collected before insertion of a trocar and again during the less noxious closing phase. This gave a trocar (TR) and a closing (CL) group for each of the five anesthetic combinations, A CDC Cyber 960 Computer was used for offline scoring of EEG and for calculating the probability of correctly predicting movement or no movement. A probability of 0.50 means a 50/50 chance of being correct, that is, no better than chance alone, a random guess. A probability of 0.90 means a correct prediction 9 out of 10 times. A probability of 0.40 is worse than chance alone. The delta ratio is the power of the EEG power spectrum in the alpha plus beta bands divided by the power in the delta band. F50, F80, F90, and F95 are the frequencies below which reside 50%, 80%, 90%, and 95% of the power in the EEG power spectrum.
RESULTS. The table shows the probability of predicting patient movement, using HR, BP, or one of several EEG scoring methods. (The z-test comparison is shown only for F90.) The predicting ability of HR, BP, and the EEG may be compared by inspecting the probabilities within each row. Between-column comparisons are not valid, since each column contains a different clustering of deeply and lightly anesthetized patients.
DISCUSSION. The EEG showed significantly greater probability of predicting patient movement in these circumstances than did HR or BP and may be more useful than HR or BP for titrating the administration of anesthetic agents. Of the cardiovascular variables, systolic BP was most often the best. Of the EEG scoring methods, F80, F90, and F95 were the best, with about equal performance.

PROBABILITY OF PREDICTING PATIENT MOVEMENT

Variable	Comb I		Comb II		Comb III		Comb IV		Comb V	
	TR	CL	TR	CL	TR	CL	TR	CL	TR	CL
No. Pts	73	78	42	42	50	49	42	51	79	76
HR	.41	.59	.56	.62	.58	.71	.65	.69	.59	.56
Sys BP	.45	.58	.67	.71	.72	.58	.75	.64	.83	.64
Dias BP	.49	.56	.64	.67	.68	.41	.81	.55	.73	.58
F 50	.81	.91	.84	.56	.78	.74	.77	.55	.75	.52
F 80	.82	.92	.88	.64	.78	.87	.89	.58	.84	.73
F90	.77 #+	.92 #+	.89 #+	.69	.78	.88 #+	.89 #+	.57	.85 #	.78 #+
F 95	.74	.92	.89	.74	.79	.89	.89	.57	.84	.79
Mean freq	.81	.92	.86	.57	.78	.74	.85	.57	.79	.61
Peak freq	.75	.81	.78	.53	.68	.46	.67	.56	.58	.41
Delta ratio	.82	.88	.84	.44	.76	.52	.81	.61	.71	.49

Significantly different from HR (#) or systolic BP (+) ($p<0.05$)

TITLE: SIMULTANEOUS CARDIAC OUTPUT MEASUREMENTS BY TRANSTRACHEAL DOPPLER, ELECTROMAGNETIC FLOW PROBE AND THERMODILUTION DURING VARIOUS HEMODYNAMIC STATES IN PIGS

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Transtracheal Doppler (TTD) is a new method of measuring cardiac output (CO), in which a Doppler transducer mounted on the distal end of an endotracheal tube is placed in the trachea. An electronic unit drives the transducer and processes the Doppler information. CO is calculated from ascending aorta diameter and blood velocity.[1] Very limited comparisons between CO by TTD and established methods have been reported.[2] The aim of this study was to compare simultaneous TTD, electromagnetic flow probe (EMP) and thermodilution (TDL) CO obtained under various hemodynamic states.

Methods. Nine miniature pigs, anesthetized with pentobarbital 30 mg/kg I.V. and paralyzed with metocurine 0.25 mg/kg I.V., were endotracheally intubated with a Doppler probe-tipped endotracheal tube and mechanically ventilated. Optimal position of the Doppler probe was identified and maintained throughout the study. Doppler information was processed by an Applied Biometrics Inc. cardiac output computer. An electromagnetic probe was placed through a median sternotomy around the aortic root and flow measured with a model 701D Carolina Medical Electronics flowmeter. TDL CO was estimated using a Spectromed thermistor-tipped pulmonary artery catheter, ice-cold saline as injectate, and a Gould Companion computer. Hemodynamic status was modified in each pig by the following interventions: infusion of isoproterenol, esmolol, phenylephrine, and sodium nitroprusside; hemorrhage; normovolemic hemodilution; hypervolemia; cross-clamping of the thoracic aorta; partial occlusion of the inferior vena cava. Simultaneous TTD, TDL and EMP CO measurements were obtained before and during the interventions. Values from the three methods were compared by linear regression and correlation analysis.

Results. In each pig, the three methods correlated well ($p<0.001$). Combining measurements from all pigs (144 data points, CO range 1–3 l/min), correlation coefficients for TTD *vs* TD, TTD *vs* EMP, and TD *vs* EMP were 0.81, 0.80, and 0.93, respectively ($p<0.0001$). Regression analysis revealed a strong linear relationship for each pair of correlations, the relation TD–EMP being the strongest. The regression equations were as follows: TTD = 0.307 + 0.838 TD; TTD = 0.343 + 0.810 EMP; TD = 0.160 + 0.906 EMP.

Discussion. This study has shown that TTD CO correlated well with "gold standard" methods over a CO range of 1–3 l/min. TTD seems to be a promising non-invasive technology for CO measurements in endotracheally intubated patients. Further human investigations are warranted.

References:
1. Anesthesiology 70:134-138, 1989
2. Anesthesiology 71:11-15, 1989