TITLE: DETECTION OF ST SEGMENT ABNORMALITIES USING ARTIFICIAL NEURAL NETWORKS

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INTRODUCTION: Perioperative ST segment analysis can detect myocardial ischemia. Rule based ("Artificial Intelligence": AI) computer programs have been implemented in some ECG monitors to detect early ST segment changes. Artificial Neural Networks (ANN) are an alternative form of adaptive computer program. In ANN, data flows through layers of "nodes" interconnected by variable threshold "synapses." The network can be trained by entering known input to produce a specific output which is then used to adjust connection thresholds to facilitate that input/output match-up ("back propagation"). Consequently, subsequent inputs are classified to match previously recognized outputs. In this study, we used a multi-layered "perceptron" ANN with an 80 node input layer, a 6 node hidden layer, and a 3 node output layer. We used the ANN to recognize and classify 3 types of ST segment abnormalities.

METHODS: Normal ECG data from 6 healthy adults were digitized at 250 samples/sec and stored. The data were then used to create ECG waveforms simulating 3 different ST segment abnormalities. An ANN using a back propagation learning algorithm was implemented to detect abnormal ST segments and classify them into 3 groups: ST elevation, ST depression with zero slope, and ST depression with positive slope. The ANN was trained on 5 of the data sets and tested on the remaining set. This was repeated 6 times so that each data set was excluded and tested once. To determine the sensitivity of the ANN, 21 ECG patterns with ST segment shifts ranging from -.2 mV to +.2 mV at 0.02 mV increments were applied as input.

RESULTS: The system properly identified and classified the 3 different abnormalities. The sensitivity tests showed a recognition threshold of ±0.1 mV (Figure 1).

DISCUSSION: Obviously, there is no substitute for cognizance and vigilance on the part of the anesthesiologist. However, subtle and insidious changes may be overlooked and computer based enhancement of monitoring capabilities seems inevitable. Advanatages of an ANN compared to more traditional ("AI") rule based systems include robustness, adaptability, ease of implementation, and fast response time. Further, ANN may be "trained" on patients' individual baseline ECG during pre-oxygenation or early in the anesthetic to detect changes which may occur later. Multiple, parallel ANN may be simultaneously applied to recognize other ECG features such as QRS morphology, rhythm, axis, etc.

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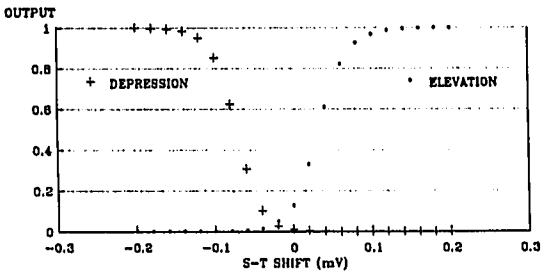

Figure 1. Output node values corresponding to depression and elevation as the ST segment shift varies from -0.2 mV to +0.2 mV in increments of 0.02 mV. An output value greater than 0.8 results in abnormality identification. This corresponds robustly with a depression or elevation of ±0.1 mV.

TITLE: LORAZEPAM UPTAKE BY DIFFERENT DESIGNS OF MEMBRANE OXYGENATORS

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Introduction Lorazepam is frequently added to a high dose narcotic anesthesia technique in order to prevent awareness and recall. Several studies have shown that certain anesthetic drugs may be taken up by the oxygenator membrane in the cardiopulmonary bypass (CPB) circuit. This uptake has been found to be specific to each of the membrane oxygenators because of their specific composition and design characteristics. The purpose of this study is to compare the uptake of lorazepam by the following oxygenator membranes: (1) Scimed (Dacron impregnated silicon, sheet), (2) Omnis (double-ply polypropylene, sheet), (3) Shiley (single-ply polypropylene, sheet), (4) Medtronix (polypropylene, fiber), and (5) Terumo (poylpropylene, fiber).

Methods Radiolabelled C^{14} lorazepam (Wyeth Labs, Phil., PA) was used. All membrane materials were supplied by the following companies:

SciMed (SciMed Systems)
LPM50 (Omnis)
M2000 (Shiley)
Maxima (Medtronic)
Capiox II (Terumo)

Two ml of C^{14} lorazepam in six different concentrations, ranging from 100 ng/ml to 6,000 ng/ml were placed in test tubes. The pH was adjusted to 7.4 at 37°C, and all experiments were carried out at 25°C. A piece of membrane material was cut, weighed (to determine surface area), and then incubated with agitation (to minimize boundary layer phenomenon) in each of the test tubes for 24 hours. The membrane was then washed with distilled water, dried, and assayed for C^{14} lorazepam using liquid scintillation technique. This procedure was repeated with each brand of membrane material.

Results The figure shows the comparison of lorazepam uptake by the different membrane oxygenators. The uptake of lorazepam by the LPM50 is 60% that of the SciMed membrane. The uptake of lorazepam by the M2000, Maxima, and Capiox II is 5%–15% that of the SciMed membrane.

Discussion This study compares the uptake of lorazepam by five different commercially available membrane oxygenators. Because of differences in membrane material and design, the uptake of lorazepam by these oxygenator membranes is expected to be different. Our experiments, utilizing isolated membrane squares, demonstrate that the uptake of lorazepam by the polypropylene oxygenators (sheet or fiber design) is significantly less than that of the SciMed silicon membrane. Lorazepam uptake by the SciMed membrane is small. We conclude that lorazepam levels should be easily maintained throughout the bypass period using the above polypropylene oxygenators, resulting in reliable sedation and amnesia.

Comparison of Lorazepam Uptake by Different Membrane Oxygenators