Title: MICROPROCESSOR AUTOMATION OF ANESTHESIA RECORDS

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Introduction. The purpose of this project was to devise a system for use during administration of an anesthetic which provides the following; automatic recording of vital signs and gas concentration, simplified keyboard input of drugs and maneuvers, in-O.R. visual display of all recorded information in graphic or listing format, magnetic storage of all data for future detailed review and analysis, legible hard copy of all recorded information to serve as an anesthesia record. The system had to be accurate, reduce the record keeping burden on the anesthetist, and require minimal capital investment. A microprocessor based system has been developed to meet this criteria.

Methods. An Imsai microprocessor based on an Intel 8080A chip is utilized. The processor is equipped with interval timer and interrupts (Imsai), analog to digital (Cromemco) and serial (Processor Technology) ports, video display module (Processor Technology) and cathode ray tube (Sanyo), forty four K RAM (Godbout, Processor Technology), 8 K EPROM (Cromemco), tape interface and operating system (Processor Technology), recorder (Panasonic), keyboard (Cherry) and printer (Teletype). Program development was facilitated by a Processor Technology ALS-8 assembler and text editor. Conventional monitors are interfaced to the computer. They provide non invasive arterial blood pressure (Dinamap), EKG derived pulse rate (Datascope), temperature (Gould with yellow springs thermistor), O_2, CO_2, N_2O, Halothane and Ethrane concentration (Perkin Elmer mass spectrometer). Analog variables are sampled every 100 msec. (gases and vapors) to 12 sec. (temperature). End tidal concentrations are extracted by the computer. Every Dinamap B.P. determination is input to the processor. Transduced blood pressure will soon be added to the system. Data concerning commonly used drugs is input via the keyboard in a code that requires ten or less key strokes to record drug, dose, route of administration and time given. Comments not related to drug administration can also be entered.

Results. The processor has now been used on more than 35 cases in less than two months of operation. It was developed for less than $6,000 and additional units could be obtained for less than $3,000 as some equipment purchased proved to be unnecessary due to design modifications and one printer could be used for multiple operation rooms. Each monitored variable and its rate of change are compared to pre set limits and if outside these limits an appropriate alarm message is displayed on the C.R.T. Graphic displays of each variable vs. time can be obtained with three key strokes. Any hour of the case may be the origin. Points on the graph represent the average value for one or five minutes depending on the time scale chosen. A list of drug information and comments can be obtained with a single key. At the end of each case a printed record is produced similar to conventional anesthesia records. The raw data is stored on tape and the processor is ready for the next case. Cases up to ten hours can be handled. The blood pressure temperature and pulse records are completely accurate when compared to conventionally collected data under non anesthesia conditions. Graphic PCO_2 proved to be within 2 TORR of A.B.G. in patients where blood gases were obtained during anesthesia. Studies to establish accuracy of all monitored variables during anesthesia will soon be undertaken.

Discussion. Most anesthetists learn how to use the processor during the course of one or two cases. Drug data is entered as fast as using pen and paper. The records provide more in depth information than conventional records. The system has already proven invaluable in the training of residents and the early detection of mishaps. For instance, a vaporizer fluid level falling below minimum effective level and a vaporizer inadvertently switched out of the fresh gas flow first came to the attention of the anesthetist due to alarms provided by the computer. An endotracheal tube that became endobronchial on positioning and draping the patient was accompanied by the alarm "CO_2 rising rapidly." Electromagnetic record storage will facilitate recall of previous cases and statistical analysis as well as remote real time monitoring of rooms run by nurses and residents.