Title : A PORTABLE AUTOMATED RECORD KEEPING SYSTEM, EMBEDDING ARTIFICIAL INTELLIGENCE.

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INTRODUCTION. There is an ever increasing need to use automated record keeping systems (ARKS) for anesthesia procedures (1). Apart from its benefit as a legal documentation, the vast amount of data precludes pure manual data entry, especially in unstable phases, where the anesthetist's attention is directed towards efficient decision-making (in a minimal delay), and appropriate medical action. An increased number of monitored parameters will not induce a parallel improvement of safety if it is not assimilated by the physician. We have developed a computer program to try to fulfil those needs, and above all evaluate several machine-to-man interfaces. Major initial requirements are (a) a turnkey system, or a minimal number of actions to reach a given function, and (b) minimal hardware requirements (generic computer, standard communication cards and links, standard video outputs) to achieve portability.

METHODS. The monitoring equipment is a series of Hewlett-Packard Minishot monitors, with EKG, temperature, invasive blood pressure (up to two), and non-invasive blood-pressure. All used a standard RS232 line to send data when requested by a computer. Any data available within a monitor (mean and extreme values, alarm status, transducer disconnection, real-time waveforms) could be sent to the computer. Computers. Four different ones were used: 1 IBM-XT, 2 IBM-AT3 and 1 Zenith Z183 battery operated laptop computer. Various types of graphic display were tested : Hercules (HRC), Color Graphic Adapter with a color screen (CGA), Color Graphic Adapter with a monochrome screen (CGM), and Enhanced Graphic Adapter (EGA). See Table 1. The laptop had a liquid cristal display (LCD) and used CGM. A Microsoft mouse was also tested.

Display	Resolution	Colors	Max number of curves (see text)
HRC	720 x 348	no	5
CGA	320 x 200	yes	5
CGM	640 x 200	no	3
EGA	640 x 350	yes	7

Table 1 : Tested displays.

The software was mostly written in C. Only the realtime segments were written in Assembler, with interrupts coming from the monitors. When the program starts, it screens all monitoring and hardware-related parameters, and configures accordingly. Data input comes from a monitor, keyboard entry, or mouse displacements and clicks. Softkeys allow to select menus and functions. Commands written in standard human language enter a natural-language processor (NLP), which uses artificial intelligence techniques and tries to derive simple commands. Data output. Trends and waveforms are displayed on the screen, and can be printed or plotted. Tests were carried under laboratory conditions, and in short surgical procedures (< 2 hours) with institutional approval.

RESULTS. Thirty tests were studied. Figure 1 shows a sample screen.

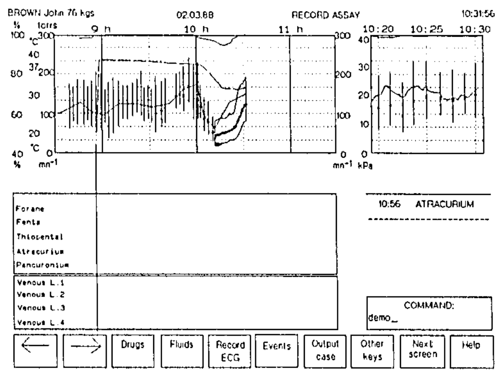

Figure 1 : a sample screen

DISCUSSION. Several guidelines were derived that should be shared with other developers. (a) The maximum number of data and curves that can be clearly displayed on a single screen increases with its definition and with the number of colors (see Table 1). (b) The CGM is somewhat below what the physician would expect from an ARKS. (c) Since the LCD is slow to refresh, the laptop was considered more as an automatic data recorder than as an interactive ARKS. (d) Screen-swapping provides access to more data, but was not much appreciated by the users (eyestrain), except for special tasks such as text-processing. (e) A two-screens system or a higher resolution color screen (i.e. 640 x 480) is therefore suggested. (f) Window style is well understood. (g) Manual data entry is mandatory for drug injections, fluids, events and minimal questions, until voice-recognition systems are available (2). (h) Although NLP can provide a front-end for the database, it still needs some typing, but proves to be very user-friendly since it bypasses menus. (i) Mouse operation is easy, provided its use is not mixed with typing. It needs a clean surface, which is somewhat difficult in non-laboratory conditions. (j) Execution time has to be fast : only sized-down programs can run non small computers.

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