TELEMEDICINE: PATIENT MONITORING IN UNUSUAL ENVIRONMENTS

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Introduction:

Of the several advantages telemetry systems have to offer the burgeoning field of patient monitoring, we have previously stressed recording from freely moving patients unencumbered by lengthy cables and unattached to conventional bulky machines. Paramount in the applications of systems designed and fabricated in our laboratory of Environmental Neurobiology have been the monitoring of patients afflicted with temporal lobe epilepsy in which the capture of unilateral or bilateral EEG seizure activity dictates the possibility or futility of neurosurgical intervention (1). Together with sophisticated computer analyses of neurophysiological data, telemetry has also made it possible to identify EEG correlates of bizarre schizophrenic ritualistic behavior virtually impossible to capture by conventional hard-wire techniques (2).

This presentation emphasizes another aspect of the utility of telemetry: the opportunity to record from patients in meaningful circumstances outside the sterile environs of the Neurophysiology Laboratory which sometimes involves freedom of movement and sometimes quiescence. The critical element in these situations is the unacceptability of bulky machinery and its attendant problems. Two such environments are the operating room and the sleep research and treatment laboratory or bedroom. Our current fairly extensive telemetry studies involve both of these surrounds. These activities will now be discussed.

1. Operating Room Studies

The goals of this investigation were:

a. Could EEG obtained on non-invasive, inobtrusive techniques reflect the arterial blood gas level as obtained by arterial puncture and conventional measurements?

b. Could different anesthetic gases by identified by EEG correlates?
The laboratory has in-house capability for employing both frequency and time domain devices (FDM and TDM). We chose to employ an FM/FM system previously more fully described (3) for a simple but cogent reason: the pure note of the 90 MHz carrier and the EEG transmitted as audio tones is easily heard and so is any interfering noise. Thus, the technician after application of the scalp disk electrodes and connection to the telemeter can quickly determine by the use of an inexpensive portable radio receiver presence of a clean EEG signal.

To date, more than 40 patients undergoing gas anesthesia for general surgical procedures which have included extensive orthopedic operations and gynecologic surgery. While the successful conduct of such monitoring requires coordinated performance, the data transmission itself was indeed unobtrusive and did not interfere with anesthesiologist or surgeon. It was not possible, however, to achieve useful transmission during electrocautery. This problem deserves continued attention.

Four channels of EEG and one channel of EKG were transmitted to a receiving antenna suitably positioned. The signals were written out by a conventional EEG machine and stored on FM analog magnetic tape for further computation at a central location. We have instrumented several operating rooms in the UCLA Hospital which can transmit to this location.

After demodulation, the EEG signals are digitized and submitted to spectral and discriminant analysis programs (4, 5, 6). Preliminary results do indicate that the EEG does permit estimation of the blood gas level with a high degree of accuracy and that the anesthetic gas can be identified.

2. Sleep Studies

The legal prescribing of some 800,000 pounds of barbiturates on an annual basis in the USA and the increasing interest in the sleep state attested by creation of clinics for the diagnosis and treatment of sleep disorders are but two indicators of the widespread nature of problems affecting this complex period of altered consciousness. In parallel, the requirement for obtaining the electro-physiological correlates of the varied states of consciousness in the sleep environment is essential. This environment may be the patient or subjects own home (7), or it may be a laboratory devoted to such studies somehow protected from the noisy EEG machines. In either circumstance, telemetry offers the convenience of remote recording with easily transportable transmitters and receivers, especially when the telemetry system is designed to take advantage of the voice-grade telephone (8). A further advantage of freedom from the hardwire approach is the ability to continue recording during movements which often dislodge the scalp electrode. These movements may include myoclonic jerks; actual arousal and rising from the bed - the most
frequent interruption of sleep is caused by nocturia; and somnambulism (9). Transmission of other signals of importance include the EKG and respiration: the latter is of significance in the sleep apneas - the so-called Ondines Curse. These apneas may also be documented by a cassette recording of the respiratory sounds. In the clinic locally here in Santa Monica for the diagnosis and treatment of sleep disorders we have used telemetry to monitor patients with sleep apnea, narcolepsy, hypersomnia and other problems.

In addition, in a study of task performance after interrupted sleep, telemetry has greatly facilitated the subjects transition from the bed to the task terminal. This study is still in progress and has not yet been reported.

Finally, no article on human telemetry, particularly when subject movement is involved, should ignore the enormous problems that beset the use of the non-invasive electrode. Virtually all of the advances in electronics which permitted increased stability, microminiaturization and micro powering, have been to no avail at the crucial electrode/electrolyte interface. With few exceptions, the sensing electrode is basically not different from the approach used by Hans Berger almost 50 years ago in the first recording of the human EEG. We have attempted to diminish the interface problem and have done so (10, 11). It is, however, far from solved.

There will be illustrations of this article at the presentation.

The anesthesia studies were supported by the National Institutes of Health. The interrupted sleep studies were supported by the Air Force Office of Scientific Research.

**BIBLIOGRAPHY**


