

right, less severe when she was supine. On the third postpartum day an epidural blood patch was performed at the L3-4 interspace using 8 ml autologous nonclotted fresh blood, with immediate and complete resolution of the headache. The patient was discharged without further complication.

Rapid drainage of at least 10 per cent of cerebrospinal fluid volume (approximately 20 ml) in standing human volunteers will produce immediate headaches.<sup>2</sup> This was clearly not the case in our patients. Abram and Cherwenka believe subarachnoid injection of air during attempted epidural cannulation was the etiology of the headaches they reported,<sup>1</sup> and this seems the most likely cause of the headaches we observed. Discussions with our colleagues suggest that the phenomenon of acute lumbar-puncture headache is probably more common in the obstetric population than previously recognized.

Anesthesiology  
52:101, 1980

JOHN R. AHLERING, M.D.  
*Chief Resident*  
JAY B. BRODSKY, M.D.  
*Assistant Professor*  
*Department of Anesthesia*  
*Stanford University School of Medicine*  
*Stanford, California 94305*

#### REFERENCES

1. Abram SE, Cherwenka RW: Transient headache immediately following epidural steroid injection. *ANESTHESIOLOGY* 50:461-462, 1979
2. Kunkle, EC, Ray BS, Wolff HG: Experimental studies on headache. Analysis of the headache associated with changes in intracranial pressure. *Arch Neurol Psychiatr* 49:323-358, 1943

(Accepted for publication July 31, 1979.)

### Enflurane Antiarrhythmic Effect Documented

*To the Editor:*—Williams and Sone<sup>1</sup> initiated their study on the premise that no one had demonstrated any difference in the incidences of arrhythmias in man anesthetized with halothane and enflurane and undergoing surgical procedures. Such is not the case. Dr. Reisner and I determined the incidences of ventricular arrhythmias with and without exogenous epinephrine administration in a group of patients anesthetized with halothane or enflurane and undergoing gynecologic, oral, otolaryngologic or neurologic operations.<sup>2,3</sup> There were 100 patients in each of the four groups. We found the incidences of ventricular arrhythmias to be 3 per cent in the halothane control group, 7 per cent in the halothane-epinephrine group, 0 per cent in the enflurane control group, and 1 per cent in the enflurane-epinephrine group. Like Williams and Sone, we concluded that the incidence of cardiac arrhythmias is significantly less when enflurane is used.

Anesthesiology  
52:101-102, 1980

MAURICE LIPPMANN, M.D.  
*Chief, Cardiovascular Anesthesia*  
*Associate Professor*  
*Department of Anesthesiology*  
*University of California, Los Angeles,*  
*Torrance, California 90509*

#### REFERENCES

1. Williams HD, Sone L Jr: Cardiac arrhythmias during coronary-artery operations with halothane or enflurane anesthesia. *ANESTHESIOLOGY* 50:551-553, 1979
2. Lippmann M, Reisner LS: Epinephrine injection with enflurane anesthesia: Incidence of cardiac arrhythmias. *Anesth Analg (Cleve)* 53:886-889, 1974
3. Reisner LS, Lippmann M: Ventricular arrhythmias after epinephrine injection in enflurane and in halothane anesthesia. *Anesth Analg (Cleve)* 54:468-470, 1975

(Accepted for publication August 20, 1979.)

### DSA System Misleading

*To the Editor:*—The device that Fleming and Smith<sup>1</sup> have called the density-modulated spectral array (DSA) is essentially a slow-speed on-line recorder of frequency analyses. Automatic gain control of the input signal is both a feature and a limitation of that system, with its inherent loss of all information on the overall amplitude of the electroencephalogram (EEG). Therefore, this device displays proportional amounts of EEG

frequencies but not the total amount of electrical cortical activity. Frequency analysis alone gives a limited view of cerebral activity<sup>2-4</sup> because of the possibility of fast activity remaining even at deep levels of anesthesia<sup>2</sup> or, in some cases, brain damage (*e.g.*, "alpha" coma). Consequently, the DSA is not sufficiently reliable for routine clinical use, a limitation admitted by the authors. An alternate, simplified EEG mon-

itoring device—the cerebral function monitor—which processes both the frequency and the amplitude of the EEG, has been used with success during general anesthesia<sup>5</sup> and cardiopulmonary bypass,<sup>6</sup> and in intensive care units.<sup>7</sup> These studies have all emphasized the clinical importance of total cerebral energy.

Other problems make interpretation of the article by Fleming and Smith difficult. Critical information regarding the frequency characteristics of the input low-pass filter is missing. Specifications as to which frequencies are retained or rejected are not given. It is also important to know what type of electrodes were used, their maximum impedance, and whether there was a system for either eliminating or detecting artifacts. In addition, when arbitrarily choosing to ignore frequencies above 16 Hz when testing general anesthetics, an inaccurate picture of cerebral electrical activity may occur, particularly under conditions such as light barbiturate anesthesia, where higher frequencies may predominate. Finally, the use of the word inexpensive in the title is misleading. The acknowledged cost of the components (\$400) is merely the tip of the iceberg, and does not reflect the cost of other requisite equipment (*i.e.*, isolated preamplifier, recording device), nor the substantial cost of engineering support to build the whole system.

MICHEL DUBOIS, M.D.  
*Department of Anesthesia*

*Georgetown University School of Medicine  
Clinical Center  
The National Institutes of Health  
Bethesda, Maryland 20205*

## REFERENCES

1. Fleming RA, Smith NT: An inexpensive device for analyzing and monitoring the electroencephalogram. *ANESTHESIOLOGY* 50:456–460, 1979
2. Prior PF, Maynard DE, Brierley JB: EEG monitoring for the control of anaesthesia produced by the infusion of Althesin in primates. *Br J Anaesth* 50:993–1001, 1978
3. Dubois M: Improved monitoring of the brain during anesthesia: The cerebral function analyzing monitor (abstr). Fifth European Congress of Anaesthesiology, Excerpta Medica, 1978, pp 215–216
4. Prior PF: Special purpose technical developments, Monitoring Cerebral Function: Long-term recordings of cerebral electrical activity. Elsevier/North-Holland Biomedical Press (Lippincott, USA distributor), 1979 p366
5. Dubois M, Savege TM, O'Carroll TM, et al: General anaesthesia and changes on the cerebral function monitor. *Anaesthesia* 33:154–164, 1978
6. Schwartz MS, Colvin MP, Prior PF, et al: The cerebral function monitor: Its value in predicting the neurological outcome in patients undergoing cardiopulmonary by-pass. *Anaesthesia* 28:611–618, 1978
7. Prior PF, Maynard DE, Sheaff PC, et al: Monitoring cerebral function: Clinical experience with new device for continuous recording of electrical activity of brain. *Br Med J* 2:736–738, 1971

(Accepted for publication August 22, 1979.)

Anesthesiology  
52:102–103, 1980

*In reply:*—Although Dr. Dubois has had considerable experience monitoring the EEG in the operating room, we cannot agree with most of his statements. An exception to this is the second and third sentences of his letter. We said essentially the same thing in the last two sentences of our penultimate paragraph.<sup>1</sup> We also stated, "This absolute intensity information can be displayed on the end-track, however, by varying the end-track width according to the total EEG." We would only change *can be* to *is*. Amplitude information is now a routine part of our DSA.

While frequency analysis alone does not give a complete picture, it is more complete than amplitude analysis alone, because it eliminates less of the original information. Lumped frequency analysis (that is, where all frequencies are combined) has the problem Dr. Dubois describes, but frequency analysis where

separate components are displayed, such as the DSA, reacts to the remaining past activity as part of the "signature." Furthermore, all amplitude information is not lost in the DSA, only absolute information.

The DSA is reliable for routine clinical use. We and others have used the DSA on a routine basis in operating rooms in four different institutions. It has been easy for students with minimal training, nurses, residents, and staff to use. The rapidity of response, the large amounts of information, and the ability to display it alongside other variables, such as arterial pressure and heart rate, have also helped make the DSA popular. In fact, it is the ability to display the analyzed EEG next to circulatory variables that has made the DSA especially useful in postoperative assessment and in teaching.

Dr. Dubois points out that information is missing