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[5] and cardiopulmonary bypass,[6] and in intensive care units.[7] 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.

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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.[1] 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

regarding the characteristics of our filtering system. The requirements for describing filtering for a digital system are different from those for describing an analog system, such as the cerebral function monitor (CFM). By cutting off a spectral display at, say 16 or 24 Hz, one has effectively done the filtering. We did say that the frequencies are solely dependent on the A-D converter sampling rate and the total epoch time, and we did define each of these precisely. Because of our extremely high sampling rate, filtering is not important. An antialiasing filter, described in our report, however, is essential. In addition, we use a sharp filter that cuts off at 32 Hz and is down to less than 0.4 per cent by 96 Hz (128–32 Hz). This, then, allows us to analyze and display at any frequency up to 32 Hz simply by altering the analysis frequencies internal to the device, with no aliasing error present between 0 and 32 Hz. Dr. Dubois suggests that one loses vital information by filtering above 16 Hz; however, the CFM apparently cuts off at 15 Hz.[2] We agree that 16 Hz is an unrealistic upper limit for many cases, but not for the examples we showed. The user should be given the option of selecting the frequency band, as we have done. However, what one gains in frequency range, one loses in resolution.

We did not describe the electrodes used (silver–silver chloride) or their maximum impedance, mainly because the factors are not nearly so important in frequency analysis as they are in amplitude analysis. Amplitude of any type is highly dependent on variables such as lead placement, skin resistance, impedances, cable length, noise sources (electrocautery, cable movement, etc.), and electrode gels.

Dr. Dubois objects to the use of the word inexpensive. We did not include the CFM in the cost analysis, since it did not seem germane to compare a commercially available, mass-produced device with a one-of-a-kind device. The engineering support is our cost, not that of the subsequent users, and should not be taken into consideration. The cost of computer parts continues to decrease rapidly, as everyone knows. A revised estimate of parts cost, including the isolated front end, in lots of 100, is about $50–75. This would permit a selling price of $400–500. A thermal recorder already sits in each of our operating rooms. In a cost comparison with the DSA, we had in mind other monitors, such as the ECG, arterial pressure, or temperature. One can, for example, pay as much as $7,000 for the privilege of monitoring "cuff" arterial pressure. For brevity's sake, we neither described a complete EEG system nor compared the various available devices. Those interested in such a comparison are invited to read two chapters written by the junior author.[3,4]

Not everyone agrees that the CFM gives the complete picture[5,6] (Warren Levy, personal communication*). In the only simultaneous and direct comparison of the CFM with other techniques, the CFM has not fared well. Specifically, there were several cases where the CFM showed no change, but the DSA indicated serious impairment of cerebral oxygenation, which reflected simultaneous circulatory events. However, this information, that which we describe above, and most published accounts of use of the CFM are anecdotal. We therefore suggest that a large-scale, direct comparison of EEG analytic and display techniques be performed using EEG tracings from the same patients. To that end, we invite Dr. Dubois to share our extensive set of tape-recorded EEG tracings to play back into the CFM. In turn, we would be glad to analyze any of his recorded information on the DSA.

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