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In Reply:—In response to the letter of Kleinman *et al.*, we would like to reemphasize our conclusion that with a wide variety of blood pressure monitoring systems, errors in and the variability of systolic pressure measurement can be reliably reduced if those systems include the Rose® resonance eliminator and/or an electronic filter such as the one in the Hewlett Packard® (HP) patient monitor. This conclusion is based on the direct comparison of pressures simultaneously measured with catheter-tip pressure transducers and catheter-manometer monitoring systems. The multiple regression analyses show that when the Rose® is included in a monitoring system, the errors in systolic pressure measurement are independent of heart rate, extension tubing length, or the type of recorder used. As such, the Rose® represents a simple solution to a complex problem and obviates the need for dynamic testing. We did not seek to determine the robustness of the Rose® in reducing errors due to poor technique; care should still be taken in setting up pressure monitoring systems.

Having established which systems recorded pressure accurately *in vivo*, we sought to determine whether classical manometer theory would also predict that those systems would behave satisfactorily. The calculation of working heart rate (f_{wh}) was undertaken to solve a particular problem in analyzing the dynamics of resonating single-degree-of-freedom catheter-manometer systems: since the resonant frequency (f_0) and damping coefficient (α) of a given system can change independently, we sought to define a single term that relates f_0 and α , and expresses it in physiologic units. The choice of ten harmonics is somewhat conservative but there is still no real agreement as to what bandwidth is needed to record accurately different blood pressures. While Patel *et al.*¹ report that the modulus of the fifth harmonic of left ventricular pressure is only 4% of that of the first harmonic, they also showed that the "less demanding" right and left atrial pressure curves had flatter frequency responses, with the fifth harmonics 25 and 20% of the fundamental, respectively. Attinger *et al.*² report that while the modulus of the fourth harmonic of the mesenteric arterial pressure (dog) is 9.5% of the modulus of the fundamental, the sixth harmonic is 11% of the fundamental. Similar findings are reported by Gersh *et al.*³ From these reports it is clear that if the definition of f_{wh} is to be made less conservative, five harmonics would be the minimum allowable value. Gardner⁴ suggests that systems with a "natural" frequency (presumably damped resonant frequency) of less than 10 Hz (\approx seven harmonics at 90 beats per min) will be marginal even with resonance elimination using the Accudynamic®. The choice of five harmonics would effectively double the f_{wh} values we have reported; for example, the f_{wh} of system 1 with HP would rise from 35 to only 70 beats per min, and the f_{wh} of system 1 with Rose® would rise from 54 to 108 beats per min; both these systems gave excellent recordings at heart rates up to 160 beats per min.

The calculation of f_{wh} is simply a manipulation of the accepted equations for the characterization of catheter-manometer systems and relies on those systems being of a single degree of freedom ("lumped" sys-

tems). The low values for f_{wh} are surprising and indicate that, based on theory, most of the systems studied would be unsuitable for arterial pressure recording. This is in stark contrast to the more than adequate performance of those systems *in vivo*. For example, the f_{wh} of system 1 with EMT was 32 beats per min and that of system 1 HP was 35 beats per min, and yet the error pressures recorded with the EMT were much greater and more variable than those recorded, at the same time, with the HP. Furthermore, the differences between the f_{wh} calculated *in vitro* (sine wave) and *in vivo* (fast-flush) cast doubt on the validity of the fast-flush test (especially if one is attempting to "tune" the Accudynamic®). In the case of the *in vitro* tests there was no evidence of the multiple resonances that characterize systems of many degrees of freedom ("distributed" systems), but the bulk-flow nature of the fast-flush test is such that it is almost certain that we are dealing with distributed systems, during the test itself. Rothe and Kim⁵ report similar disagreement between the fast-flush test and other methods of dynamic testing. Billiet and Colardyn* show that the dynamic characteristics of a given catheter-manometer system are influenced by the position at which the pressure is applied, and they conclude that the fast-flush method may not be used in testing catheter-manometer systems.

The major thrust of the study, stated in the last sentence of the Discussion, is that satisfactory recordings can be made despite the theoretical predictions. While modification of the theory to take into account only five harmonics will go some way toward reconciliation of theory and practice, it will explain neither the differences between the fast-flush and sine-wave tests nor the different *in vivo* performances of systems with similar f_0 and α .

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Safety of Anesthesia for Patients with Anterior Mediastinal Masses: I.

To the Editor:—We read with interest the recent presentation by Ferrari and Bedford¹ of their large series of patients with anterior mediastinal masses. The care provided these patients at Sloan-Kettering Cancer Center is laudable in that 44 high-risk patients underwent general anesthesia without a single death or permanent injury. However, we believe that a rate of life-threatening complications of 20%, does not substantiate the conclusion "that the benefits of obtaining an accurate tissue diagnosis and initiating an appropriate therapeutic regimen outweigh the possible risks inherent in anesthetizing children with anterior mediastinal masses."

This statement may be apropos in an institution where care of such high-risk patients is not uncommon. But if a complication rate of 20% occurs in an institution where skills are polished because of regular application, to what level would morbidity and mortality increase if anesthesiologists who care for these high-risk patients only infrequently began to assume their care?

We heartily agree with Ferrari's and Bedford's belief that "the ability to rapidly alter both the patient's position and the anesthetic technique are the most important factors in preventing anesthetic complications whenever this high-risk situation is encountered." In this regard, we have used a technique that has allowed us to obtain diagnostic tissue specimens that directed appropriate therapy without submitting the patient to the risks of general endotracheal anesthesia.

Recently, we were consulted regarding the management of a 13-year-old boy with a large anterior mediastinal mass who refused local anesthesia for diagnostic biopsies. Because previous reports in the anesthesia literature verify that these patients are at increased risk for either cardiac or pulmonary catastrophe when they undergo induction of general anesthesia,²⁻⁹ we used intravenous ketamine, local infiltration anesthesia, and supplemental nitrous oxide/oxygen in a 50% mixture for the scheduled biopsies.

Preoperatively, the child received intravenous glycopyrrolate (0.2 mg) and diazepam (2.5 mg). During the procedure, with the patient in reverse Trendelenburg (15-20°), intravenous ketamine was titrated (2 mg/kg total dose) to maintain spontaneous ventilation and to provide adequate sedation and analgesia for excision of a left supraclavicular lymph node and right anterior iliac crest bone marrow biopsy. The patient quietly maintained spontaneous ventilation while pulse oximetry confirmed excellent oxygenation; hemodynamic parameters remained stable throughout the procedure. His postoperative recovery was unremarkable.

In this scenario, knowledge of the anesthetic concerns unique to this high-risk population remains paramount, as does the necessity of taking precautions to handle potential complications. Likewise, the capability to rapidly change the anesthetic technique if airway or cardiac compromise occurs must be readily available. However, alternatives are implemented only if the need to secure the airway becomes unavoidable. If ketamine is titrated judiciously and spontaneous ventilation

is maintained, accurate tissue diagnoses can be made in these high-risk patients without subjecting them to the risks of general endotracheal anesthesia.

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