man subjects in research and all patients in the study[1] were informed specifically that the technique of radial-artery cannulation used often resulted in vascular occlusion, and that there were ways to prevent this from occurring (*i.e.*, small catheters, short duration of cannulation). The patients also knew that they could choose one of these options if they so desired. In fact, however, since we began documenting ulnar artery blood supply to the hand by the presence of retrograde pulsatile Doppler signals in the radial artery to be cannulated,[2] we have not seen any instance of distal ischemic complications resulting from 338 elective cannulations performed with Teflon® 18-gauge catheters.[1–4] In addition, despite the difference between incidence of asymptomatic radial-artery thrombosis with 18- and 20-gauge catheters, we have found no difference in the incidences of symptomatic complications (*i.e.*, necrosis of skin over the catheter).[3]

From the patients' point of view, the advantage of using 18-gauge catheters is that they do not kink *in situ* and become dysfunctional during major operative procedures, as do 20 per cent of 20-gauge catheters.[5] When 18-gauge catheters become dysfunctional due to accumulation of thrombotic material, it usually occurs hours after the completion of the surgical procedure.

We felt that the greatest risk to the patients in this study was not related to radial-artery cannulation, but rather was the 1.7 per cent incidence of anaphylactoid reactions associated with injection of radiographic contrast medium.[6] If we had pursued Dr. Cohen's suggested experimental design using 20-gauge catheters, approximately three times as many patients would have been exposed to arteriography to achieve the same result.

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Anesthetic Mortality

To the Editor:—I read with great interest the article of Dr. Arthur Keats,[1] and the editorial of Dr. William Hamilton.[2] Dr. Keats supported the case for "unavoidable" adverse actions of drugs as an important cause of anesthetic mortality, while Dr. Hamilton believes that 90 per cent of anesthetic deaths may be attributed to management errors.

Is management error a bias or a fact? In a trial to answer this important question, 36 cases of cardiac arrest in our hospital attributable to general anesthesia were analyzed (table 1). The analysis revealed three groups of patients: in Group I (14 cases), management error was considered the primary cause of cardiac arrest; in Group II (12 cases), an adverse reaction to a drug or a technique was a contributing factor, although we could not entirely exclude management error; in Group III (ten cases), cardiac arrest was attributed to the patient's poor condition, and we believed that both management errors and adverse reactions could be excluded as causes.

TABLE 1. Causes of Cardiac Arrest in 36 Cases

Group I, management errors (14 cases)
1. Technical failure, *e.g.*, esophageal intubation
2. Machine failure, *e.g.*, N_2O instead of O_2, leaking flowmeters
3. Drug overdosage (anesthetic and nonanesthetic)
Group II, adverse reaction to a drug or a technique with or without management errors (12 cases)
1. Adverse reaction to a drug
e.g., hypersensitivity reactions, interaction of a drug with the disease of the patient
2. Complications of a technique
e.g., regurgitation and aspiration during crash induction, hypotensive technique
Group III, poor condition of the patient (10 cases)
Exsanguination, amniotic fluid embolism, uncontrolled heart failure, etc.

From this analysis I agree with Dr. Keats that we must rid ourselves of the "error bias," but unfortunately, a management error is still a common and preventable cause of anesthetic cardiac arrest.

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Valve Simplifies Pressure Monitoring from Triple-lumen Pulmonary-artery Catheters

To the Editor:—The triple-lumen, flow-directed pulmonary-artery catheter permits the simultaneous monitoring of pressures in the right atrium and pulmonary artery (PA). In addition, by inflation of the balloon, the distal lumen can be used to measure pulmonary capillary wedge (PCW) pressure. However, it is often unnecessary or impractical to monitor the two pressures continuously with a transducer and its associated electronic amplification/processing/display system. If the PA/PCW pressure information is considered to be of greater significance than the central venous pressure (CVP), the distal lumen will normally be connected to the transducer with provisions for intermittently switching to the proximal lumen. The switching system usually consists of some stopcock or manifold arrangement that selects the pressure to be seen by the transducer and ensures that both lumens will be kept patent by the slow or intermittent flush of a suitable solution. The system must also provide for the withdrawal of blood samples and the venting of the transducer to atmosphere for zero or calibration adjustments.

Any arrangement comprised solely of conventional stopcocks, either individually or in a manifold, necessitates that several stopcock handles be turned in the correct direction to monitor a different lumen while insuring that the other is kept patent. Errors of omission or commission may result in mishaps such as inaccurate calibration, mistaken waveform identification, clot formation, air embolism, blood back-up, or sampling and flushing of an undesired lumen.

To decrease the probability of error, we have employed a special four-way valve that simplifies the process for selecting the lumen to be monitored. This valve, when combined with two Intraflo®*-type flush-

* Sorenson Research Company, P.O. Box 15588, Salt Lake City, Utah 84115.

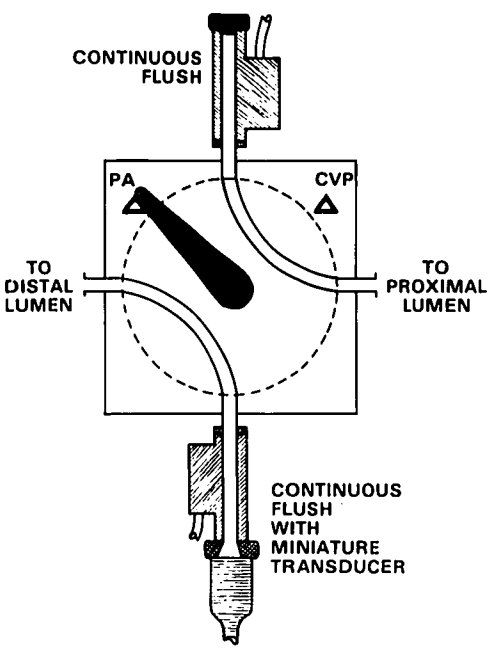

FIG. 1. Fluid pathways of the special four-way valve in position to monitor PA/PCW pressure.

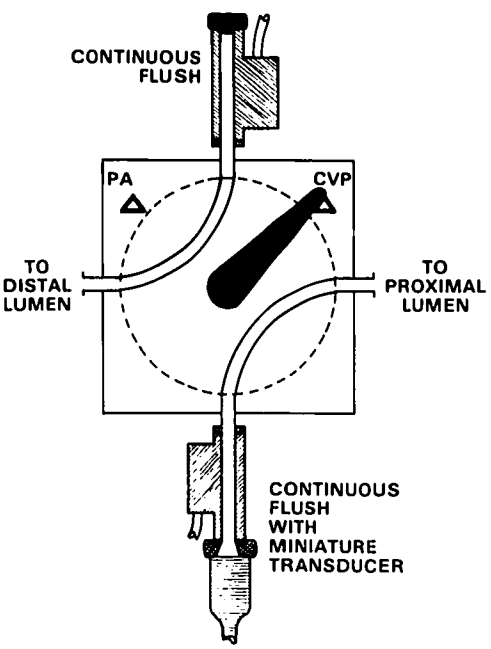

FIG. 2. CVP monitoring position requires only 90-degree rotation of the valve handle but assures patency of the distal lumen.