flurane (but not isoflurane). Interpolation to lower, clinically relevant concentrations suggests that enflurane and halothane only minimally affect intracellular free calcium.

E. I. EGER, II, M.D.
Professor and Vice Chairman for Research
Department of Anesthesia
University of California, San Francisco
513 Parnassus Avenue
San Francisco, California 94143

REFERENCES

1. Nakagawara M, Takeshige K, Takamatsu J, Takahashi S, Yoshitake J, Minakami S: Inhibition of superoxide production and Ca^{2+} mobilization in human neutrophils by halothane, enflurane, and isoflurane. ANESTHESIOLOGY 64:4–12, 1986
2. Welch WD: Inhibition of neutrophil cidal activity by volatile anesthetics. ANESTHESIOLOGY 64:1–3, 1986
3. Renzi R, Waud BE: Partition coefficients of volatile anesthetics in Krebs' solution. ANESTHESIOLOGY 47:62–63, 1977

(Accepted for publication March 13, 1986.)

Anesthesiology
65:123, 1986

In reply:—It has been known that oxygen radicals produced by phagocytes play a crucial role in the host–defense mechanism. The inhibitory effects of volatile anesthetics on the oxidative metabolism in human neutrophils were reported by Welch *et al.*[1,2] They have shown that the anesthetics inhibited oxidative metabolism of human neutrophils reversibly at clinically relevant concentrations.

Our intent was to study the mechanism of the inhibitory effects of the anesthetics on the superoxide-releasing activity of human neutrophils.[3] We used the relatively high concentrations of the anesthetics to obtain distinct evidence of the inhibitory effects of the anesthetics on the superoxide release and Ca^{2+} mobilization. The concentrations we used were not lethal to the neutrophils as shown by the trypan blue exclusion test, wherein more than 90% of the cells were viable and that functional recovery of 65–85% was observed after removal of the anesthetics. This may be due to a short anesthetic exposure time of only 10 min. In clinical usage, the volatile anesthetics might not so strongly affect oxidative metabolism and the mobilization of Ca^{2+}, but we believe that the same mechanism may work with a longer exposure time even at lower anesthetic concentrations. Further study by using a more sensitive method for determination of intracellular free Ca^{2+} concentration, such as aequorin,[4] would be necessary.

MIWAKO NAKAGAWARA, M.D.
Instructor of Anesthesiology

JUNNICHI YOSHITAKE, M.D., PH.D.
Professor of Anesthesiology

SHIGEKI MINAKAMI, M.D., PH.D.
Professor of Biochemistry

Kyushu University School of Medicine
3-1-1, Maidashi, Higashi-ku
Fukuoka City, Japan

REFERENCES

1. Welch WD, Zaccari J: Effect of halothane and N_2O on the oxidative activity of human neutrophils. ANESTHESIOLOGY 57:172–176, 1982
2. Welch WD: Effect of enflurane, isoflurane, and nitrous oxide on the microbicidal activity of human neutrophils. ANESTHESIOLOGY 61:188–192, 1984
3. Nakagawara M, Takeshige K, Takamatsu J, Takahashi S, Yoshitake J, Minakami S: Inhibition of superoxide production and Ca^{2+} mobilization in human neutrophils by halothane, enflurane, and isoflurane. ANESTHESIOLOGY 64:4–12, 1986
4. Ware JA, Johnson PC, Smith M, Salzman EW: Aequorin detects increased cytoplasmic calcium in platelets stimulated with phorbol ester or diacylglycerol. Biochem Biophys Res Commun 133:98–104, 1985

(Accepted for publication March 13, 1986.)

Anesthesiology
65:123–124, 1986

In reply:—Dr. Eger suggests that the findings of Nakagawara *et al.* are interesting, but may have limited clinical relevance because of the very high partial pressures of anesthetics required to achieve the reported effects. I have always found "anesthetic concentrations" *in vitro* to be a controversial topic, perhaps due to the ambiguity of what constitutes a clinically relevant anesthetic concentration in an *in vitro* system.

The partition coefficient of Hanks' buffer at 37° C for halothane is ~0.8[2] and for whole blood at 37° C, 2.4. If

a 1% halothane concentration is given to a tube containing Hanks' buffer and blood both at 37° C, the respective volume/volume % concentration of halothane in the two tubes would be ~0.8 and 2.4. To achieve a higher concentration of halothane in Hanks' buffer, one that would be comparable to blood levels seen *in vivo* in patients given a therapeutic exposure of halothane, a higher concentration of vaporized halothane would have to be used. The blood thus serves as a "carrier" of the anesthetic. The solubility of the "carrier" for the particular anesthetic will profoundly effect the concentration of the anesthetic in the "carrier".

Dr. Eger states that the "increase in temperature decreased the solubility of the anesthetic and thereby increased the partial pressure of anesthetic." Thus, if the solubility of the anesthetic is less at higher temperatures (an increase from 4° C to 37° C in the experiments of Nakagawara *et al.*[1]), there would be *less* of the anesthetic (because of a decreased solubility at the elevated temperature) in the liquid reaction mixture (containing neutrophils and Hanks' buffer) and more in the atmosphere above the reaction mixture, resulting in a higher partial pressure of the anesthetic. What is more important, the concentration (partial pressure) of the anesthetic used to treat or expose the reaction mixture, or the actual concentration of the anesthetic *in the* reaction mixture? If one is trying to assess the effect of an anesthetic on neutrophil function in a liquid medium, it would appear that the concentration of the anesthetic in the particular experimental liquid medium is critical for such an evaluation.

WILLIAM D. WELCH, PH.D.
Director
Microbiology and Immunology Division
Endocrine Sciences
18418 Oxnard Street
Tarzana, California 91356

REFERENCES

1. Nakagawara M, Takeshige K, Takamatsu J, Takahashi S, Moshitake J, Minakami S: Inhibition of superoxide production and CA mobilization in human neutrophils by halothane, enflurane, and isoflurane. ANESTHESIOLOGY 64:4–12, 1986
2. Welch WD, Zazzari J: Effect of Halothane and N_2O on the oxidative activity of human neutrophils. ANESTHESIOLOGY 57: 172–176, 1982

(Accepted for publication March 13, 1986.)

Anesthesiology
65:124–125, 1986

More Problems with the Arrow-Racz Epidural Catheter

To the Editor:—We have noted a number of problems with the Arrow-Racz Spring Wire reinforced Continuous Epidural Catheter, product no. EC-02220. We placed the catheter in three patients for administration of epidural local anesthetics and narcotics. We used 17-gauge Touhy needles to place the catheters, and we took care to follow the instructions contained in the package insert for placement and removal of the catheters. Two of our patients developed leaks at the catheter–skin interface, requiring replacement of the catheter after 3 days of use. At least one of these catheters appeared to have minute cracks in the fluoropolymer coat, which developed some time after catheter insertion.

In our third patient, the catheter worked well for 5 days. When we removed the catheter, a large amount of resistance was noted, and as we pulled with more force, the catheter began to unravel and the fluoropolymer coat fractured into pieces of various sizes (fig. 1). The metal portions of the catheter were retrieved intact, but we were unable to determine with certainty that we retrieved all of the fluoropolymer coat. Lingenfelter[1] described unraveling of the Racz epidural catheter, but his report was attributed to use of the lateral flexed position for removal. We used the lateral neutral position and grasped the catheter at skin level several times without any success in preventing or halting the unraveling process. One possible explanation for this phenomenon is that the open-spring coils of the catheter tip could allow tissue adherence or permit the catheter actually to "corkscrew" its way into soft tissues. Figure 2 shows the tip of our catheter. At the time of removal, a small amount of tissue was adherent to the catheter, but this tissue fell from the catheter prior to the taking of these photographs.

Other investigators have also reported similar problems with the Racz catheter concerning leakage at the catheter–skin interface.[2,*] We feel that nylon catheters, with good care, give good results for administration of epidural narcotics with less chance of catheter leakage and breakage and much less expense.

* Reigler R, Hammerle AF, Albright GA, Neumark J: The Racz epidural catheter: first clinical experiences. Regional Anesthesie 7:109–111, 1984.