a 20-gauge, 100-cm long catheter is not easy because the length and the diameter of the catheter offer significant resistance.

The feasibility of blood injected into the epidural space entering the subarachnoid compartment through the previous dural sac puncture remains unproven. In this particular case, it seems that the autologous blood was injected through the catheter, which was located intrathecally rather than epidurally. Administration of blood into a catheter under these circumstances may be ill advised; for one, it may not be necessary because not all the patients who have dural punctures develop postdural puncture headache (PDPH) (5,6). Second, because the location of the distal tip of the catheter is not exactly known, it is best not to use it as a vehicle for EBP injection (7). In this case, when the blood was injected, it resulted in an intrathecal hematoma that was present even two weeks after the catheter insertion. Clinically, the patient has continued to experience typical symptoms of ARC, including burning on both feet, low back pain, and low-grade fever with headaches and frequent diaphoresis.

The most common causes of noninfectious ARC are chemical irritation produced by oil-based dyes previously used for myelograms (8,9), the intrathecal injection of blood, which has been also shown to produce neurological deficit in dogs (10), and entry of blood into the intrathecal space during spinal surgical interventions (11). Arachnoiditis has also been found after subarachnoid hemorrhage (12) but is even more likely to occur when blood is also found after administration of pantopaque, a dye used to perform myelograms (13,14). For decades, pantopaque was used as contrast medium to obtain myelograms, and it was considered safe. Ironically, in the past, the only way to diagnose arachnoiditis was with a myelogram. Recently, thousands of patients with arachnoiditis caused by this procedure have been diagnosed by MRI; central clumping of spinal nerve roots as described in this patient has been identified as one of the radiological signs of this disease (15,16). Adherence of roots to the dural sac is more likely to happen after dural entry during surgery.

Although no warning has been given about the possibility of this occurrence when EBPs are administered prophylactically, either through the same catheter or in a separate injection, the feasibility of arachnoiditis, a life-long serious complication, is factual.

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Relationship Between Complications of Pediatric Anesthesia and Volume of Pediatric Anesthetics

To the Editor:

Excessive anesthesia-related morbidity and mortality in children has been explained in part by a lack of competency in pediatric anesthesiology (1). As a result, precise guidelines defining competency by a minimum volume of pediatric anesthetics in this subspecialty have been established in the United Kingdom. We have studied the occurrence of complications in pediatric anesthesia and its relationship to pediatric practice in France through an anonymous retrospective postal survey. A survey packet consisting of a questionnaire requesting information about the anesthesiologists (age, sex, year of board certified), their practice (type of institution), their training, and the number of major complications experienced in 1993, a cover letter to explain the survey, and a prestamped envelope was sent to 5200 French anesthesiologists board-certified with a uniform standard in May of 1994. To characterize the anesthesiologists who did not respond to the first questionnaire, a second questionnaire requesting information regarding the anesthesiologists (age, sex, year of board certified) and the reasons for nonresponse was sent to 300 random nonrespondents. The responding anesthesiologists had a significantly lower age (mean ± SD, 45 ± 7 years versus 47 ± 9 years) and had a significantly ($P < 0.05$) higher percentage of their practice in pediatric anesthesia (90% vs 63%) than the nonresponding anesthesiologists. The other characteristics were similar in both groups. Of the 173,700 pediatric anesthesics, respondents reported 351 complications: inadequate endotracheal intubation or ventilation ($n = 161$), anesthetic drug overdose ($n = 105$), cardiac arrest ($n = 33$), pulmonary aspiration ($n = 27$), complications due to regional anesthesia ($n = 17$; regional anesthesia was performed in 10% of the patients), and acute pulmonary edema ($n = 8$). Outcomes included death in five of the 33 cardiac arrest patients and serious neurologic sequelae due to hypoxia in one patient. A significantly ($P < 0.05$) higher incidence of complications was found in the groups that performed 1 to 100 (7.0 ± 24.8 per 1000 anesthetics) and 100 to 200 pediatric anesthetics (2.8 ± 10.1 per 1000 anesthetics) than in the group that administered more than 200 pediatric anesthetics/year (1.3 ± 4.3 per 1000 anesthetics).

Although interpretation of data reported herein must take into account clinical practice in France with Certified Registered Nurse Anesthetists and residents, they represent the first examination of the relationship between the number of complications and the volume of pediatric anesthetics administered per year. The potential biases in this study include self-report bias, which depends mostly on physician recall of events and nonresponse bias. In this study, self-report bias could manifest as a desire on the part of the anesthesiologists to appear cooperative. Indeed, the response rate in our study (904 of 4992 [18.4%], 208 undelivered) was closely similar to that of a recent retrospective postal study concerning anesthesia for infants requiring a pyloromyotomy (19%) (2). However, the anonymous nature of the questionnaire makes it less likely that an individual intentionally reported untrue behaviors or perceptions. In addition, the data received could not be influenced in any way by fear of medical-legal consequences. In a report of complications, there are many confounding factors such as medical severity, operating room staffing, the ratio of nonspecialists, anesthetic drug used, and ratio of elective and emergency cases. However, the rate of cardiac arrests in our study (0.19 per 1000) was similar to a previous French report (3) and to a recent American report (4). A recent French retrospective study based on a questionnaire showed an incidence of anaphylactic shock in France of 1/10,000 pediatric

anesthetics (5), which was comparable to the incidence in our study (0.9/10,000).

Despite the limitations of our study that we have outlined above, we recommend that a minimum case load of 200 pediatric anesthetics per year is necessary to reduce the incidence of complications and improve the level of safety in pediatric practice.

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Continuous Intramucosal Pco_2 Measurement: Is It Actually Necessary?

To the Editor:

Knichwitz et al. (1) demonstrated the applicability of the fiberoptic Pco_2 sensor for the continuous measurement of intramucosal Pco_2 ($Pico_2$). The excellent precision and reliability of continuous measurement of $Pico_2$ using the method was promising, but its clinical significance is questioned. $Pico_2$ reflecting perfusion and/or metabolism in the mucosa changes rather slowly in the time course of hours or days even in critically ill patients (2). This makes the continuous measurement of $Pico_2$ actually *unnecessary*. Indeed, conventional tonometry requires 90 minutes for the equilibration of CO_2, but it does not become a serious problem because of the slow changes of $Pico_2$. Another problem the authors raised is the instability of CO_2 in the tonometric solution. It must be carefully assessed in evaluating intramucosal pH, but it can be almost overcome by the use of a phosphate-buffered solution instead of a saline tonometric solution (3).

Another issue of the method is the imbalance of its cost and benefit. The fiberoptic device as well as its disposable sensor are expensive, which renders its widespread use difficult. Gastric tonometry, which is quite simple and requires only a blood gas analyzer, can be performed everywhere with a low cost.

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In Response:

Tatara states that the continuous determination of $Pico_2$ is unnecessary and takes as basis for his opinion a review article by Fiddian-Green (1). In this review, Fiddian-Green describes the results of the important work on the physiology of intestinal ischemia by Haglund and colleagues (2) that observed: "the progression to transmural infarction occurs over a period of many hours or even days in patients who are critically ill."

However, Tatara's assumption that an increase in $Pico_2$ occurs parallel to the development of irreversible histologic damage that develops over hours to days is inappropriate. $Pico_2$ changes can actually happen long before the occurrence of irreversible tissue damage.

In recent experimental work (unpublished data), we saw that the reduction of mesenteric blood flow by 60% causes a sudden and rapid increase to 300%–400% of baseline of the continuously measured $Pico_2$. This $Pico_2$ increase was completely reversible when inadequate perfusion was restored in due time and did not result in permanent tissue damage. However, after three hours of reduced mesenteric perfusion, the $Pico_2$ remained increased, indicating a permanent tissue injury. These results are in agreement with the reports of other authors, which demonstrate in animal models that changes in $Pico_2$ and the calculated pHi occur immediately with the onset of mesenteric ischemia and not only after the occurrence of irreversible intestinal ischemic injury (3–5).

Therefore, it is this early increase in $Pico_2$ that allows the detection of inadequate tissue perfusion and, thus, the early therapy before irreversible damage. In conclusion, we cannot understand the denial of a new method for the continuous determination of $Pico_2$ before its clinical value has been tested and sufficient experience and data are available.

Apart from the advantage of a continuous determination, there are several other reasons underlining the importance of the fiberoptic CO_2 sensor. The conventional intermittent method via the nasogastric tonometer is a indirect method that has been associated with a number of methodological errors. Each blood gas analyzer has its own instrumental bias when measuring CO_2 in aqueous solutions. Therefore, every user has to establish individual correction factors according to the blood gas analyzer, the tonometric solution, and the equilibration time used. Only this will allow the comparison of collected data. A phosphate-buffered solution will, indeed, attenuate the enormous errors; however, it will not totally abolish the instrumental bias (6). Furthermore, the equilibration of CO_2 in the tonometric balloon is very slow and takes at least 60 minutes. In the clinical routine, $Pico_2$ and pHi will not be determined every 60–90 minutes. As a result, the measured $Pico_2$ value can only be regarded as the average of a certain time period that does not pick up short time variations. Unintendent $Pico_2$ alterations, due to hypoventilation or administration of bicarbonate, for example, will not be observed and, thus, not corrected for.

Finally, the conventional tonometry bears other causes for error, such as difficult handling with airfree instillation and aspiration of the tonometric fluid, the storage and processing of samples, and the calculation of $Pico_2$ data. As the continuous $Pico_2$ measurement determines the $Pico_2$ directly in the gastrointestinal lumen, these errors are eliminated, and the collected data can be directly compared with those of other patients in different critical care units. Only this will allow the introduction of normal $Pico_2$ range for the first time.

The gastrointestinal tract is thought to play a major role in the development of sepsis and multiorgan failure. Multiorgan failure is the most common cause of death in critical care patients. Its therapy is considered to be the foremost challenge of intensive care of this century's last decade. The ability to detect gastrointestinal malperfusion in its early stages by continuous $Pico_2$ measurement will allow appropriate therapy and offer an interesting tool to eventually reduce mortality from multiorgan failure. This would clearly outweigh the costs of this new device.

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