state nursing authorities will respond by developing favorable policies in the future. We completely agree with the need for strict guidelines and immediate medical support when epidural opiates are used.

Continuous infusion of epidural opiates is a reasonable alternative to bolus injections. We have initiated a randomized blinded study to determine whether quality of analgesia or incidence of side effects differ with these two modes of drug delivery. Most of our patients, however, still receive epidural morphine by nurse-administered bolus injection. In our hospital, continuous infusions of epidural opiates increase patient costs. The hospital assigns charges for the use of an infusion pump, and the hospital pharmacy charges a professional fee for dispensing the infusion solutions.

Our experience with respiratory depression has not materially changed as our experience continues to grow. We do not see life-threatening events—perhaps, since milder forms of the problem are detected with the monitoring protocols we use. We are interested to note somnolence preceded respiratory depression in all cases seen by Drs. Hammonds and Hord. This reinforces our belief in the importance and utility of level of consciousness as a monitoring tool. We urge other practitioners to consider its routine use. The bedside sedation scale we use is as follows: 0 = None (alert); 1 = Mild (occasionally drowsy; easy to arouse); 2 = Moderate (frequently drowsy; easy to arouse); 3 = Severe (somnolent; difficult to arouse); and S = Sleep (normal sleep; easy to arouse).

Ward nurses rate level of consciousness hourly during the first 24 h of epidural opiate analgesia. We remain convinced that trained vigilant nurses are essential for safe practice with epidural narcotics.

As our experience with PCA has increased, we, too, in selected cases, have offered this device to patients with histories of inappropriate opiate use and drug-seeking behavior. We have found it useful to discuss PCA with these patients preoperatively, including its expected duration of use and the transition to oral methadone. Physicians already experienced in managing this difficult group of patients may find PCA very useful. Physicians without this experience may wish to seek consultation or use more conventional means for pain management.

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*(Accepted for publication March 15, 1988.)*

Anesthesiology
69:140-141, 1988

## Arrow Brachial CVP Air Aspirating Catheter Placement with the IVECG Technique

*To the Editor:*—Using a single-orificed catheter as an ECG lead, Martin correlated the resultant ECG trace with the catheter's intra-atrial position as confirmed by chest x-ray.[1] Termed intravascular electrocardiography (IVECG), this technique has been used to successfully insert single-orificed catheters into the right atrium. Catheters designed to aspirate air from the right atrium, however, have multiple orifices to maximize their effectiveness. Previous work has shown that the IVECG technique can be used to accurately locate the multiorificed catheter, knowing that the IVECG is conducted from the proximal orifice,[2,3] and not the catheter tip. Recently, Colley and Artru found that the IVECG was conducted from a middle orifice using the commercially available Cook Bunegin-Albin multiorificed catheter.[4] It seems, therefore, that each multiorificed catheter design should be tested for the site of IVECG conduction before accuracy of this technique can be insured. For this reason, a study was undertaken to determine the site of the IVECG conduction of the commercially available Arrow Brachial CVP multiorificed catheter.

This study was approved by our institution's Human Investigation Review Board and informed consent was obtained. A custom-made, double-lumen catheter was used as the test catheter (Arrow International, Inc., Reading, PA). One lumen had a single orifice at its tip, while the second lumen was identical in design to the Arrow brachial CVP multiorificed catheter. This catheter has four side orifices (1 mm diameter) with the proximal orifice either 2.5 or 2.75 cm from the catheter tip.

Prior to pulmonary artery catheterization, this test catheter was inserted through a sheath in the right internal jugular vein in seven patients prior to their coronary artery bypass grafting. The catheter was advanced in 1-cm increments into the right atrium and IVECGs from both lumens using the catheter-F (intracardiac-left leg) lead,[5] were simultaneously recorded as previously described.[2] The results showed that the distance be-

TABLE 1. P Wave to R Wave Ratios of IVECG Traces of the Single- and Multiorificed Lumens *versus* Distance the Catheter was Advanced

| Distance Catheter was Advanced (cm) | Patients | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| Single-orificed lumen | | | | | | | |
| 1 | 0.32 | 0.41 | 0.26 | 0.40 | 0.36 | 0.50 | 0.20 |
| 2 | 0.42 | 0.88 | 0.49 | 0.68* | 0.52 | 0.80* | 0.25 |
| 3 | 0.59 | 1.43 | 0.63 | 0.48 | 1.00* | 0.61 | 0.35* |
| 4 | 0.75* | 1.50* | 0.74* | 0.30 | 0.78 | 0.50 | 0.21 |
| 5 | 0.60 | 1.33 | 0.29 | 0.00 | 0.60 | 0.00 | 0.00 |
| 6 | 0.35 | 0.00 | 0.24 | 0.00 | 0.52 | 0.00 | 0.00 |
| 7 | 0.00 | 0.00 | 0.23 | 0.00 | 0.40 | 0.00 | 0.00 |
| 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Multiorificed lumen | | | | | | | |
| 1 | 0.30 | 0.28 | 0.23 | 0.40 | 0.26 | 0.42 | 0.07 |
| 2 | 0.35 | 0.35 | 0.29 | 0.37 | 0.28 | 0.52 | 0.07 |
| 3 | 0.40 | 0.43 | 0.29 | 0.38 | 0.31 | 0.60 | 0.19 |
| 4 | 0.52 | 0.70 | 0.44 | 0.68* | 0.45 | 0.70 | 0.25 |
| 5 | 0.64 | 0.86 | 0.52 | 0.40 | 0.69 | 0.88* | 0.35* |
| 6 | 0.80* | 1.20 | 0.66* | 0.30 | 1.00* | 0.66 | 0.24 |
| 7 | 0.54 | 1.30* | 0.44 | 0.00 | 0.75 | 0.53 | 0.16 |
| 8 | 0.00 | 1.04 | 0.30 | 0.00 | 0.56 | 0.00 | 0.00 |
| 9 | 0.00 | 0.00 | 0.30 | 0.00 | 0.29 | 0.00 | 0.00 |
| 10 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Distance between maximal P wave | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| Proximal orifice-to-tip distance | 2.5 | 2.75 | 2.5 | 2.5 | 2.75 | 2.75 | 2.5 |

* Maximal P wave deflection or highest P/R wave ratio.

tween the maximal P wave deflection of both lumens was 2 cm and 3 cm for proximal orifice-to-catheter tip distances of 2.5 and 2.75 cm, respectively (table 1). These data suggest that the IVECG trace of the Arrow brachial CVP multiorificed catheter is conducted from the proximal orifice. Proper placement of this catheter using the IVECG technique is possible, knowing that the catheter tip is 2.5 cm deeper into the right atrium than the IVECG suggests.

It is important to know which orifice the IVECG is conducted in order to place the catheter close to the optimal air aspirating position. The 1.25-cm difference between proximal and middle orifice conduction seems of little clinical consequence since catheter tips have been reported to move distances in excess of 3–4 cm with arm adduction, neck flexion, and diaphragmatic movement.[5,6] Considering this, it may also be important to have the ability to move the catheter in a sterile fashion to maintain this critical position.

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## REFERENCES

1. Martin JT: Neuroanesthetic adjuncts for surgery in the sitting position. III. Intravascular electrocardiography. Anesth Analg 49:793–808, 1970
2. Johans TG: Multiorificed catheter placement with an intravascular electrocardiographic technique. ANESTHESIOLOGY 64:411–413, 1986
3. Warner DO, Cucchiara RF: Position of proximal orifice determines electrocardiogram recorded from multiorificed catheter. ANESTHESIOLOGY 65:235–236, 1986
4. Colley PS, Artru AA: Bunegin-Albin catheter improves air retrieval and resuscitation from lethal venous air embolism in dogs. Anesth Analg 66:991–994, 1987
5. Lee DS, Kuhn J, Shaffer MJ, Weintraub HD: Migration of tips of central venous catheters in seated patients. Anesth Analg 63:949–952, 1984
6. Kasten GW, Owens E, Kennedy D: Ventricular tachycardia resulting from central venous catheter tip migration due to arm position changes; Report of two cases. ANESTHESIOLOGY 62:185–187, 1986

*(Accepted for publication March 15, 1988.)*