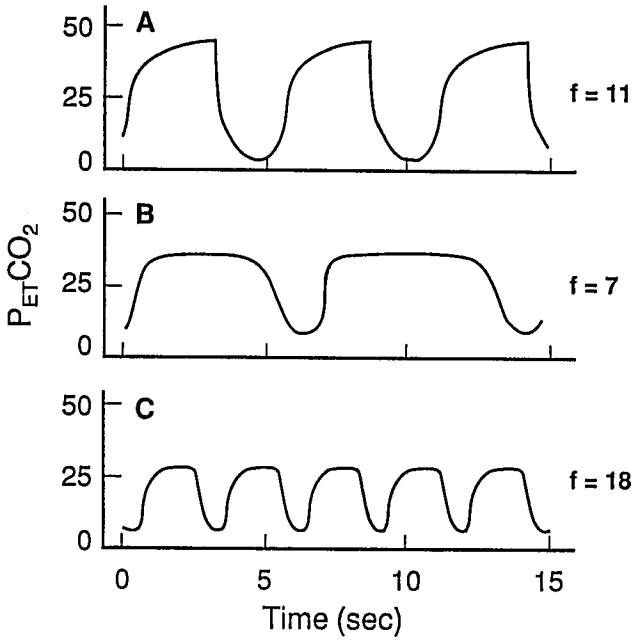

Fig. 2. Waveforms from carbon dioxide analyzer output during controlled ventilation with an endotracheal tube (*A*) and during jet ventilation at two respiratory frequencies (*B* and *C*).

tracheal tube was inserted in the trachea, and the capnographic tracing shown in figure 2A was recorded during controlled ventilation with 100% O_2 at f = 11 breaths/min, V_T = 800 ml, and PIP = 21 mmHg. Five minutes later, the end-tidal P_{CO_2} was 32 mmHg while arterial blood analysis revealed pH = 7.37, Pa_{CO_2} = 42 mmHg, and Pa_{O_2} = 270 mmHg. The surgeon inserted the suspension laryngoscope with the injector of figure 1 attached to its base, the endotracheal tube was removed, and the patient's lungs were ventilated with intermittent jets of 100% O_2 using a hand-controlled apparatus (Anesthesia Associates, Philadelphia, PA) at a supply pressure of 20 psi. After 15 min of jet ventilation with f = 7 breaths/min, the capnographic tracing in figure 2B was obtained, the $P_{ET}CO_2$ was 33 mmHg, and arterial blood analysis revealed *p*H = 7.33, Pa_{CO_2} = 46 mmHg, and Pa_{O_2} = 102 mmHg. The rate and depth of ventilation was varied. Seven minutes later with f = 18 breaths/min, $P_{ET}CO_2$ was 32 mmHg, and the capnographic trace of figure 2C was obtained along with an arterial blood gas analysis, which revealed pH = 7.35, Pa_{CO_2} = 43 mmHg, and Pa_{O_2} = 108 mmHg.

The data of figure 2 indicate that capnographic tracings with well defined plateaus can be obtained using side-stream sampling during jet ventilation for laryngoscopy. The end-tidal to arterial P_{CO_2} differences during controlled ventilation through an endotracheal tube and during jet ventilation are comparable. Therefore, we conclude that reliable capnographic data can be obtained readily with side-stream sampling when jet ventilation is used during laryngoscopy.

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Epidural *Versus* Intravenous Fentanyl Following Thoracotomy

To the Editor:—Although the evidence continues to mount against the clinical application of fentanyl for postoperative epidural analgesia, I still find myself reluctant to abandon fentanyl in favor of morphine. Based on theory and my clinical experience, I had hoped that by delivering fentanyl into the thoracic epidural space, closer to the proposed site of action in the spinal cord, it would provide a more selective spinal analgesic effect and avoid the systemic levels produced with lumbar epidural fentanyl analgesia. Unfortunately, Guinard and his associates, in a carefully designed and well executed study, have effectively proved that even thoracic epidural fentanyl infusions do not appear to offer a substantial reduction in fentanyl requirement and systemic exposure.[1] Although they did offer a glim-

mer of hope by demonstrating a significantly shorter hospital stay in the thoracic epidural group *versus* the intravenous fentanyl group, it is difficult to place much emphasis on outcomes based on a small sample.

During the initial 48 h, Guinard *et al.* were able to demonstrate better preservation of pulmonary function in the patients treated with thoracic epidural fentanyl *versus* those treated with intravenous fentanyl. Unfortunately, their findings, although significant, were small in magnitude and did not appear to result in detectable improvements in radiologic or physiologic outcomes. It is difficult to interpret the value of postoperative pulmonary function studies in postoperative thoracotomy patients. The degree of surgical trauma to the remaining lung, the extent of the resection, a perioperative pattern of tobacco abuse or disuse, the presence and severity of reactive airways disease, and the quality of one-lung ventilation (separation) all affect the amount of lung function retained or lost in the early postoperative period. Much of this information was not available, and even if it were documented, it would be difficult to factor into an interpretable format. Thus, the relative preservation of pulmonary function, as indicated by the forced vital capacity, forced expiratory volume in 1s, and peak expiratory flow rate in the thoracic epidural fentanyl group, might be attributed to the presence of two lobectomy patients in the thoracic epidural group and the absence of any lobectomy patients in the intravenous fentanyl group. The greater number of pneumonectomy patients in the intravenous fentanyl group may explain the greater loss of pulmonary function witnessed in this group. Pulmonary function studies in the early postoperative period may be useful in patients undergoing nonpulmonary surgery but must be regarded cautiously in intrathoracic surgery patients.

The findings reported by Guinard *et al.* are not the overwhelming endorsement for thoracic epidural fentanyl analgesia that I hoped for. Nevertheless, I will continue employ fentanyl for thoracic epidural analgesia. Perhaps patient-controlled epidural analgesia, with or without a local anesthetic, will provide the means to a more selective central neuraxis effect from epidural fentanyl.

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In Reply:—We appreciate the interest of Burgess for our study.[1] Based on our everyday practice, we also believe that our patients do better with thoracic epidural fentanyl analgesia after thoracotomy. More objectively, we have shown that their hospital stay may be reduced and that they need fewer rescue boluses. However, we can not escape from our results: when used alone, fentanyl consumption will not significantly be reduced by epidural infusion, even at the thoracic level.

We agree that pulmonary function may be influenced by numerous factors after thoracotomy, but we do not expect that a bias in randomization can explain the results of our study for the following reasons: (1) the type of surgery did not vary between groups, and (2) the best pulmonary function was observed in patients receiving thoracic epidural fentanyl despite the greatest number of pneumonectomies in this group (the incidence of pneumonectomies was not greater in patients receiving intravenous fentanyl as suggested by Burgess).

How can we reconcile our expectations and observations about epidural fentanyl use? Based on our data, a sample size of 833 patients will be required to detect a difference between intravenous and lumbar epidural fentanyl requirements (power of 0.8, $P = 0.05$, with a 33% difference between those two groups only). However, inclusion of such a large number of patients in this type of clinical study is impractical. Use of patient-controlled analgesia may reduce fentanyl consumption, but it is more expensive, is potentially more dangerous, and would not be expected to improve the quality of analgesia.[2,3] The glimmer of hope concerning epidural fentanyl analgesia may rather come from: (1) concomitant epidural infusion of dilute local anesthetic solutions[4]; (2) addition of intravenous or oral nonsteroidal antiflammatory drugs[5]; and/or (3) intraoperative use of epidural analgesia.[6]

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