algesia for at least 4–6 h postoperatively, resulting in "up regulation of spinal cord analgesic pathways" and persistently greater opioid requirements thereafter. We believe that other differences in experimental design also may have been important. First, all patients in our study received fentanyl either through the lumbar epidural route or intravenously on a double-blind, patient-controlled basis, thereby avoiding observer bias in determining when fentanyl boluses were administered. Once our patients were comfortable, we sought to find the lowest infusion rate that maintained good analgesia by lowering infusion rates whenever visual analog pain scores were less than 2 of 10. A similar approach was used by Salomaki *et al.* in their study of thoracic epidural fentanyl *versus* intravenous fentanyl for thoracotomy pain.[3] Sandler *et al.*, on the other hand, reduced infusion rates only when their patients became excessively drowsy or developed significant carbon dioxide retention. As a result, fewer than half their patients had any reduction in fentanyl infusion rates once good analgesia was achieved. It is therefore not surprising that drug requirements were similar in their groups.

Second, Sandler *et al.'s* results concerning the respiratory effects of lumbar epidural fentanyl and intravenous fentanyl are consistent with a direct central nervous system effect of the former. They found that epidural patients had significantly higher rates of episodes of apnea and slow respiratory rates even though there were no differences in plasma fentanyl levels at any measurement time.

We agree with Sandler *et al.*, Salomaki *et al.*, and Welchew and Breen[4] that, to minimize epidural fentanyl requirements, the catheter should be placed at or near the level of the dermatomes involved with postoperative pain. We believe, however, that fentanyl requirements post-thoracotomy are significantly reduced even with lumbar epidural administration as compared to intravenous and suggest that thoracic epidural fentanyl infusion should be reserved for those patients in whom systemic opioid effects must be kept to a minimum.

Raymer P. Grant, M.D., F.R.C.P.C.
Jon A. Harper, M.D., F.R.C.P.C.
David G. Parsons, M.D., F.R.C.P.C.
Department of Anaesthesia
The University of British Columbia Faculty of Medicine
910 West 10th Avenue
Vancouver, British Columbia
Canada V5Z 4E3

References

1. Sandler AN, Stringer D, Panos L, Badner N, Friedlander M, Koren G, Katz J, Klein J: A randomized, double-blind comparison of lumbar epidural and intravenous fentanyl infusions for post-thoracotomy pain relief. ANESTHESIOLOGY 77:626–634, 1992
2. Grant RP, Dolman JF, Harper JA, White SA, Parsons DG, Evans KG, Merrick CP: Patient-controlled lumbar epidural fentanyl compared with patient-controlled intravenous fentanyl for post thoracotomy pain. Can J Anaesth 39:214–219, 1992
3. Salomaki TE, Laitinen JO, Nuutinen LS: A randomized double-blind comparison of epidural *versus* intravenous fentanyl infusion for analgesia after thoracotomy. ANESTHESIOLOGY 75:790–795, 1992
4. Welchew EA, Breen DP: Patient controlled on-demand epidural fentanyl. Anaesthesia 46:438–441, 1991

(Accepted for publication February 8, 1993.)

Anesthesiology
78:990, 1993

In Reply:—Grant *et al.* have unfortunately misread and misinterpreted some of our findings. 1) We clearly demonstrated, as shown in figure 5 of our paper, that *significantly larger* quantities of fentanyl were required *via* the lumbar epidural catheter to produce equianalgesia in the epidural and intravenous groups. 2) Rigid parameters were required to increase fentanyl dosing, which are clearly outlined in the study, therefore minimizing observer bias.[1] Similarly, stepwise decrease of the infusions was controlled by similar criteria at regular intervals when data collection occurred. In a regular clinical setting, we believe that somnolence and carbon dioxide retention are the most useful criteria for decreasing infusions if they are observer-controlled.

Similarly, the results obtained from continuous respiratory monitoring may have been misinterpreted. Although the number of episodes of apnea and slow respiratory rates were significantly higher at a small number of time periods later in the 24-h postoperative observation period, this was related to a very small number of patients with a relatively high incidence of respiratory disturbances in both groups. For example, only four patients in the epidural group and five in the intravenous group had apnea rates greater than 10/h.[1] This may represent marginally increased respiratory disturbance in the epidural group but requires cerebrospinal fluid sampling for fentanyl to validate the theory. We do not dispute that a portion of the fentanyl dose given epidurally (or perhaps systemically) may be acting at the spinal level, but we believe that, under the conditions of our study, much of the analgesic effect was produced by systemic reabsorption.

Alan N. Sandler, M.B., Ch.B., F.R.C.P.C.
Anaesthetist-in-Chief

Joel Katz, Ph.D.
Department of Psychology

The Toronto Hospital
Toronto General Division
200 Elizabeth Street
Toronto, Ontario
Canada M5G 2C4

Reference

1. Sandler AN, Stringer D, Panos L, Badner N, Friedlander M, Koren G, Katz J, Klein J: A randomized, double-blind comparison of lumbar epidural and intravenous fentanyl infusions for post-thoractomy pain relief. ANESTHESIOLOGY 77:626–634, 1992

(Accepted for publication February 8, 1993.)