the thenar eminence, thumb and index fingers,[3] as well as the pads of the third, fourth and fifth digits.[4] In fact, angiographic studies by Hasse et al.[5] demonstrated that the radial artery is frequently an end artery to the thenar area. Thus, it is possible that a pulse oximeter applied to the tip of a digit may indicate adequate collateral flow to the tip when in fact the thenar area is at risk of ischaemia should radial occlusion be permanent.

During our studies with the PORCH test we observed that some hands with a normal Allen's test exhibited signs of thenar ischaemia with the PORCH test (see Figures 1 and 2). Such patients would probably not have been identified using pulse oximetry as described by Dr. Wong. What appeals to us about the PORCH test is its ability to assess the end-point of interest to anaesthetists – the response of the collateral circulation in the hand to temporary but intense ischaemia. If the collateral circulation is adequate during performance of the PORCH test, it is probably safe to conclude that it will also be adequate in the event of permanent ischaemia. We would emphasize that the attributes of the PORCH test are based on 14 hands with an abnormal collateral circulation. Further assessments will be necessary before these attributes can be stated with precision.

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REFERENCES

1 *Nowak GS, Moorthy SS, McNiece WL.* Use of pulse oximetry for assessment of collateral arterial flow. Anesthesiology 1986; 64: 527.
2 *Kurki TS, Sanford TJ, TySmith N, Dec-Silver D, Head N.* Effects of radial artery cannulation on the function of finger blood pressure and pulse oximeter monitors. Anesthesiology 1988; 69: 778–82.
3 *Mangano DT, Hickey RF.* Ischemic injury following uncomplicated radial artery catheterization. Anesth Analg 1979; 58: 55–7.
4 *Baker RJ, Chunprapaph B, Nyhus LM.* Severe ischemia of the hand following radial artery catheterization. Surgery 1976; 80, 449–57.
5 *Hasse J, Pusterla C, Cloeren S.* Angiographische untersuchungen nach dauer kanulierung der arteria radialis. Schweiz Med Wochenschr 1971; 101, 1057–61.

Pharmacokinetics of sufentanil

To the Editor:

The recent report by Fyman *et al.*, "Pharmacokinetics of sufentanil in patients undergoing renal transplantation"[1] deserves comment. Several inconsistencies are present in the report. There is disagreement between the pharmacokinetic variables reported in the table, the pharmacokinetic equation and description contained in the legend of the Figure, and the appearance of the Figure itself:

1 The legend states that the Figure is a "sufentanil plasma decay curve fitted to a two-compartment model." However, the data in the Figure appear to be mean data (the authors stated that they only fitted individual data), and do not appear "fitted" at all; the data points are merely connected by lines and demonstrate no scatter about a line of best-fit, which should appear as a smooth curve.
2 The equation in the legend suggests that the values of α and β (the exponents in the two terms) are 0.621 min^{-1} and 0.025 min^{-1}, respectively. If the values of α and β half-life from the Table are converted to the corresponding exponents by the transformation $0.693/t_{1/2}$, the results are 0.239 min^{-1} and 0.00394 min^{-1}, respectively. This discrepancy may have arisen from taking the arithmetic mean of the half-lives, when the harmonic mean may have been more appropriate.[2] However, the gross disagreement between the two estimates of β suggests a more serious error. Conversely, if the parameter values for k_{10}, k_{12}, and k_{21} (from the Table) are applied to standard equations[3] to calculate the exponents α and β, above, the results are 0.626 min^{-1} and 0.024 min^{-1} respectively. These compare well with the values of the equation in the Figure legend. However, a β value of 0.024, when converted to half-life, yields a value of approximately 30 min, in complete disagreement with the reported mean half-life of 176 min.
3 The terminal (β) half-life (stated in the Table) of 176 min, or about 3 hr, does not correspond to the appearance of the concentration versus time plot. The concentration of sufentanil at 120 min is approximately 0.35 to 0.4 $ng \cdot ml^{-1}$; at 360 min, 4 hr later, the concentration appears virtually unchanged as do the concentrations at intervening time points. Yet, the half-life stated in the table would predict a concentration of less than 0.2 $ng \cdot ml^{-1}$ at 360 min.

The authors concluded that sufentanil disposition in their population of renal transplant patients were not different from that observed in "healthy" patients, offering the data of Bovill *et al.*[4] as an appropriate comparison. If one compares the plot of mean sufentanil concentration versus time published by Bovill's group with that of Fyman *et al.*[1] striking differences are evident. The scales of the two graphs are very similar, yet the data of Bovill show a clear, linear decrease in concentration with time after 2 hr, corresponding to a half-life of 164 min, while that of Fyman shows little or no decrease in concentration, with a half-life reported to be 176 min. Also, the mean sufentanil concentrations at 6 hr appear

higher in Fyman's report, despite the fact that the sufentanil dose was 2½-fold higher in Bovill's study!

It is difficult to understand how the authors reached the conclusion they did. The gross appearance of the graph in their report suggests that sufentanil elimination is impaired in these patients. The parameter estimates provided in the table appear unrealiable, as they do not interconvert accurately (or even approximately), nor do they agree with the appearance of the graph. It would be desirable for the authors to publish a clarification, perhaps including more data and a more detailed description of their pharmacokinetic anlysis.

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REFERENCES

1 *Fyman PN, Reynolds JR, Moser F, Avitable M, Casthely PA, Butt K.* Pharmacokinetics of sufentanil in patients undergoing renal transplantation. Can J Anaesth 1988; 35: 312–5.
2 *Lam FC, Hung CT, Perrier DG.* Estimation of variance for harmonic mean half-lives. J Pharm Sci 1985; 74: 229–31.
3 *Gibaldi M, Perrier D.* Pharmacokinetics. 2nd Ed. New York, Marcel Dekker, Inc., 1982.
4 *Bovill JG, Sebel PS, Blackburn CL, Oei-Lim V, Heykants JJ.* The pharmacokinetics of sufentanil in surgical patients. Anesthesiology 1984; 61: 502–6.

REPLY

We appreciate the comments of Kramer et al. *and would like to address them by clarifying the statistical analysis methods employed in the study. The sufentanil plasma decay curve illustrated in the Figure represents mean ± SEM of patient data at specified blood sampling times. Data were indeed collectively fitted using a two compartment model; however, the corresponding smooth curve does not appear in the article. Instead, data were illustrated as in the Figure to provide the reader with an idea of the high variability observed in the study. While we agree that an illustration of the curvilinear decay plot would have been valuable, and that the figure legend should not indicate a two compartment fit, the decay profile does suggest a two compartmental character.*

The apparent discrepancy between the α and β half-lives reported in the table and those derived by transforming the α and β rate constants from the line of best fit can be explained by examining the way data were collected and reported. Initially, each patient data set was individually fitted to a two compartment model using the NONLIN procedure in the Statistical Analysis System (SAS) program. The variables A, α, B and β were then computed for each patient. The values reported in the Table represent the arithmetic mean ± SEM of the individually derived variables. In presenting the data in this manner, the reader is made aware of the inherent variability observed in the study. By deriving the half-lives of the two compartment model, one reports the half-lives of the average data and not average of the half-lives as observed in the individual patients (as reported in the Table). The importance of reporting averages of the individual data is clearly evident in the case of the β half life (176 minutes) with an SEM of 86 minutes. As seen in all values listed in the Table, the data were highly variable. Although an illustration of scatter around the line of best fit would have also showed this variability, to have simply reported the average A, α, B and β, and derived half-lives from the averaged variables would have unduly masked the variability. Finally, the inconsistency between the minimal decay observed from 120 to 360 minutes and the values predicted using the equation in the legend is again attributable to high variability about average values and the way data were plotted in the figure.

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The Montando laryngectomy tube

To the Editor:

Anaesthesia for laryngectomy and surgical procedures around a pre-existing tracheostomy is complicated by the need to ensure secure control of the airway whilst still allowing adequate surgical access.[1–4] Airway control is hampered by difficult fixation, inadvertent extubation and bronchial advancement.[5,6] Numerous techniques have been advocated in an attempt to satisfy these requirements. Chester[3] described intraoperative division of the tracheal tube and reconnection of the two sections through the tracheostomy. Lees[7] also divided the tracheal tube intraoperatively, but then discarded both fragments and inserted a tracheostomy tube for the remainder of the procedure. Geffin[6] and Coffin[1] used conventional tracheal tubes inserted through the stoma and both found bronchial advancement to be a problem. Campkin[8] and Condon[2] used a right-angled James tube which is inserted intraoperatively following withdrawal of the orotracheal