CORRESPONDENCE

Anesthesiology
1999; 91:589

Prediction Bounds for Case Scheduling: Interpret with Caution

To the Editor:—We read with interest the article by Zhou and Dexter on the use of prediction bounds to assist scheduling of add-on cases.[1] We acknowledge that the authors have addressed an important topic in operating-room efficiency; however, we have certain concerns as to the practical utility of the current version of this approach.

Table 1 in their article supplies data on the quality of 50%, 80%, and 90% prediction bounds for the distribution-free and log-normal methods, where quality refers to the amount of bias existing in these estimates. We accept the conclusion of the authors that bias is adequately controlled by the log-normal method, although perhaps not by the distribution-free approach. Strum *et al.*[2] have claimed that surgical durations may well follow the log-normal distribution. Nevertheless, large numbers of observations are needed to verify independently the log-normal goodness of fit, as Zhou and Dexter acknowledge.

However, although unbiased estimators traditionally have been considered desirable, this property is not sufficient to ensure the usefulness of this statistical procedure. Similarly, the authors' statement that "such prediction bounds can be calculated from only two previous cases," while technically correct, does not guarantee this approach to be clinically useful. We examined this issue using case duration data obtained at our own institution and computed log-normal prediction bounds for knee arthroscopies performed by six surgeons, using the same formula as in the authors' appendix. Table 1 contains computed prediction bounds with durations expressed in hours and minutes. The last column provides the SD of the logarithm of surgical duration.

Surgeon #4, associated with the smallest s value, seems to perform this procedure very consistently, with a mere 21-min difference between his 50% and 90% prediction bounds. On the other hand, surgeon #6's predicted durations at 80% and 90% are extremely long because of the combination of an elevated 50% value, a small sample size, and a large s value. Although these bounds are mathematically correct, the combination of these three factors produce prediction bounds that are clinically not useful. Small sample size is problematic not only because the t distribution is used, but also because of the $(1+1/n)$ factor in the prediction formula. To illustrate the effect of sample size, when we compute prediction bounds for surgeon #2 using only his last two cases instead of his previous 12 cases (#2b in table 1), the prediction bounds revert to a much wider distribution. Furthermore, we observe that the prediction quantiles for surgeon #4 ($n = 4$) are tighter than those for surgeon #1 ($n = 25$) and that the value of the SD is also a very important consideration. Although one might be tempted to interpret the SD as a measure of a particular surgeon's ability to work at a consistent rate, differences in SDs are far more likely to arise from random variability. In this context, such variability is known among statisticians to be substantial and must be considered dominant for smaller sample sizes.

Although the authors are to be commended for advancing our understanding of efficient operating-room scheduling, we believe additional investigation is required before a practical implementation of log-normally distributed case durations can be recommended.

Frank Overdyk, M.S.E.E., M.D.
Associate Professor of Anesthesiology
Philip Rust, Ph.D.
Associate Professor of Biometry and Biostatistics
Department of Anesthesia and Perioperative Medicine
Children's Hospital
Charleston, South Carolina 29425

References

1. Zhou J, Dexter F: Method to assist in the scheduling of add-on surgical cases—Upper prediction bounds for surgical case durations based on the log-normal distribution. ANESTHESIOLOGY 1998; 89:1228-32

2. Strum DP, May JH, Vargas LG: Surgical procedure times are well modeled by the log normal distribution (abstract). Anesth Analg 1998; 86(suppl):S47

(Accepted for publication April 7, 1999.)

Table 1. Prediction Bounds for Six Surgeons Performing Knee Arthroscopy

Surgeon	Sample Size	50%	80%	90%	s
1	25	1:59	2:38	3:04	0.3221
2	12	1:36	1:58	2:12	0.2267
3	10	2:01	2:46	3:18	0.3370
4	4	1:52	2:04	2:13	0.0930
5	4	2:18	3:11	3:57	0.2966
6	2	2:20	5:10	13:48*	0.4722
2b	2	1:47	3:06	6:08	0.3271

* Ninety percent prediction bound exceeds 13 h, based on two cases (100 min and 195 min duration).