are too high, approximately 500 per quarter estimated during 1990. On the other hand, the "random sample" model predicts a very dramatic peak in infections for the last two quarters of 1980. Qualitatively these results do not depend on the use of a parametric formulation for new HIV infections, or on constraining the new infection rate.

It is interesting that approximately half of the lack of fit occurs in five distinct quarters. For the "treatment model" (and actually any model based on the Weibull distribution, with or without treatment effects), the lack of fit occurs in Q1, 1984, and Q4, 1985, both with too few observed cases, and in Q3, 1988, Q4, 1988, and Q2, 1990, all with too many observed cases. However, for the "Hepatitis B Vaccine Trial" model, the overfit occurs as just described, but now there is underfitting in the second quarters of 1985 and 1989, as well as 1990. The monthly observed data in each of these quarters are (8, 21, 9), (29, 44, 51) and (50, 44, 44). Also, three of the nine second quarters are overfitted by the model, indicating little evidence for any seasonal variation. It is interesting that part of the lack of fit appears to be driven by the incubation-period distribution. There are apparent outliers in the data too, but no explanation has been found for them.

DISCUSSION

Backcalculation is widely held by statisticians to be the most statistically respectable approach to both estimating the past HIV-infection curve and predicting the future course of the AIDS epidemic, but other methods should also be considered. In mathematical complexity and requisite assumptions, backcalculation lies between empirical curve fitting to observed AIDS-incidence data and models for the transmission dynamics of HIV infection. We reiterate that resources need to be devoted to considerable sensitivity analyses for backcalculation; experimental-design considerations may play a useful role here. On a related point, it seems essential to analyze the data in relatively homogeneous groups and to give predictions separately for geographical regions and transmission categories within regions.

There is considerable heterogeneity between individuals concerning the incubation distribution and the availability and effect of a variety of treatment regimes which have been evolving continuously over the recent past. It may be that the underreporting rate is decreasing as treatment becomes more readily available to those in earlier stages of HIV disease (at least in Australia) and HIV-infected individuals are more actively seeking treatment both at an earlier stage and because it is more efficacious. It is also possible that reporting delays are shortening because these individuals will then be monitored fairly closely.

An alternative way of modelling seasonal effects to that suggested by the authors would be to fit the first four terms of a Fourier series. That is, ignoring trend, replace the $S(j)$ or the $e^{S(j)}$ by

$$\alpha \cos\left(\frac{2\pi j}{12}\right) + \beta \sin\left(\frac{2\pi j}{12}\right) + \gamma \cos\left(\frac{4\pi j}{12}\right) + \delta \sin\left(\frac{4\pi j}{12}\right).$$

This model has the advantage of reducing the number of parameters to be estimated to four, or two if only the first two terms are fitted, but this is likely to be too restrictive. Serial correlation can also be incorporated, although it may be difficult to distinguish such correlation from trend. This model might also help to distinguish "true" seasonal effects from artifacts of the data-collection process.

It is not possible to remove all the uncertainty surrounding the epidemic, but statisticians can help provide information on which consensus decisions can be made together with social and medical scientists and others. As part of this process, it is important to incorporate external information, both objectively and subjectively, especially regarding the recent past. The available data on HIV disease, incubation and so on, represent an incomplete description of phenomena which are, on the whole, relatively poorly understood, and we should be aiming to bring as much knowledge as possible to bear on the problem.

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Rejoinder

Peter Bacchetti, Mark R. Segal and Nicholas P. Jewell

We thank the discussants for a number of insightful comments, as well as some useful additional background and discussion. Here, we respond to a number of the issues raised and provide some additional comments on a few points.

Although we emphasized in the paper some draw-