Reply
To the Editor:

Our study tested three methods of sternal closure applied to polyurethane foam sternal models using a common stress-until-failure technique. The figure-of-eight wire closure that we tested is the method which we employ clinically. As noted, our tests demonstrated the superiority of a cable closure technique as well as the superiority of Pectofix Dynamic Sternal Plates over our standard wire closure. The use of standardized polyurethane foam sternal models allows reproducible and repetitive testing of these closure techniques. We appreciate the fact that static testing does not necessarily provide the same information as fatigue or other dynamic tests, since different material classes behave differently under fatigue loading. The viscoelastic nature of bone and polymeric materials has been demonstrated to have profound effects on the response to static, dynamic, and fatigue loading. Fatigue testing will provide very important information about the longevity of the device, and how the device may interact with the host. This type of testing utilizing our model system is the basis of our current follow-on study. The use of polyurethane models of bone allows inexpensive and simple testing of a wide variety of closure techniques under many different conditions which is its advantage over the use of cadaver or animal specimens.

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The Use of Z Scores in Assessing Neuropsychological Change After Cardiac Operations
To the Editor:

I read with considerable interest the recent review by Collie and associates [1] concerning statistical analysis of cognitive change after coronary artery surgical procedures. It is agreed that the percent change and standard deviation "cutoff" methods of deficit analysis are arbitrary, do not take practice effects into account, and are relatively insensitive, especially as the incidence of cognitive decline has decreased. The main alternative advocated [2], group mean analysis has the flaw of allowing patients who show improvement to mask those whose cognitive status deteriorates even if there is a group to control for regression toward the mean. Further alternatives are clearly required.

It is therefore disappointing that although many *potentially* superior statistical methods from the neuropsychological and psychiatric literature were illustrated in Table 1 of the review and discussed, little mention was made of the *z* change score, which was used in a randomized, controlled trial by Arrowsmith and coauthors [3] and an observational study by Steed and colleagues [4] involving patients undergoing coronary artery bypass grafting. Table 1 describes Kneebone and associates [5] as using a "standard deviation index" [$(X_2 - X_1)/\mu SD_1$]. However, they actually used the traditional binary standard deviation method, as they converted a score of $(X_2 - X_1)/\mu SD_1$ greater

than 1 to a deficit and compared this with a reliable change index, which was their main outcome measure.

In contrast, the *z* score, which is also calculated as $(X_2 - X_1)/\mu SD_1$, is not then converted to a deficit or no deficit depending on whether it is greater or less than 1. These scores are left as raw numbers and can then be used to give a mean for each test or the sum of a battery of tests for different groups of patients. This method has the advantage of increased sensitivity because it is a continuous measure without absolute cutoffs, thus giving each individual a score. An additional benefit is that it allows group comparisons, which take into account potential learning effects. Z scores are a recommended way of analyzing cognitive change that should be considered for future studies of cardiac surgical patients.

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Reply
To the Editor:

We thank Dr Whitaker for his comments on our recent review of the statistical methods used in studies of postoperative cognitive decline (POCD) in patients who have undergone coronary artery surgical procedures [1]. He highlights the important point that the interpretation of statistical tests used to investigate POCD is constrained by both the design and the objectives of the study. Most of the studies cited in our review reduced the standard deviation (SD) index to a binary impairment/no impairment outcome. Importantly, these studies were mostly observational in nature and were designed primarily to determine the incidence of POCD. The use of a binary outcome measure is therefore understandable, although as suggested, alternative approaches exist. As Whitaker states, the SD index can also be treated as a continuous variable, more commonly known as a *z* score. Such an interpretation of the SD index is more appropriate when the study objective is not to determine incidence of POCD, but rather to test a specific hypothesis such as the effects of a putative neuroprotective agent on the severity of POCD [2]