**Transcripts for Benchmarking through Data Balancing**

Alemi: These slides provide a brief introduction to benchmarking clinicians using data balancing. This brief presentation was organized by Dr. Alemi. Data balancing enables the analysts to compare the performance of clinicians to their peer groups on the same set of patients.

We're going to use the terminology of benchmarking clinicians to facilitate the discussion. Data balancing uses a different set of terminology. It's important to understand how these different terms are the same, so you can understand how benchmarking uses data balancing.

Sample is replaced with patient groups. The concept of covariates in data balancing is replaced with patient comorbidities. A stratum, or a unique combination of covariates, is replaced with patient types, which is the unique combination of comorbidities.

In context of benchmarking, the clinician is treatment variable. Treatment effect is replaced with clinician's impact on outcomes. Cases are clinician's patients.

Cases are matched to controls. Controls are peer group's patients. When cases are matched to controls, clinician's patients are matched to peer group's patients.

It's a very interesting fact that data balancing often relies on a set of weights, sometimes called propensity weights. In benchmarking, this concept is replaced with switching distributions. In essence, we do not use propensity weights at all but accomplish the same goals of balancing the data without estimating the weights. So let's go through the steps.

First, the patients are described in terms of combination of their features or comorbidities. We refer to these combinations as different patient types. Here, we see an example with two diseases previous MI and congestive heart failure.

A patient type is a combination of these two diseases, so when a patient has congestive heart failure but no previous MI, this is one type of patient. And when the patient has both of these diseases, then that's another type. Second, these patient types are used to calculate distributions of clinicians and peer group's patients. Naturally, these two groups will differ in who is taking care of sicker patients.

The probability of different patient types is referred to as distribution of patients. Here, we see that 85% of patients seen by the clinician have previous MI. Among those who have previous MI, 65% have congestive heart failure. So the probability of the patient type that has previous MI and congestive heart failure is 85% times 65%.

The equivalent probability for peer group is 50% times 83%. These probabilities show the distribution of patient types under clinician and peer group's care. Obviously, the clinician and the peer group see different types of patients. In calculating the expected outcomes for this peer group and the distribution of peer group's patient is switched with the distribution of the clinician's patients. In this fashion, the analyst simulates the performance of peer group on the same patients that are seen by the clinician.

The switching of distribution is done by replacing the peer group's probabilities with the probabilities from the clinician's patients. So we switch 0.50 in the peer group with the clinician's probability of 0.85. We replace 0.83 with 0.65 and so on, with all other probabilities in the two distributions. Now the peer group sees the same patient at the same frequency of the patient types as the clinician.

The expected outcome for the clinician is calculated as the sum of the product of the probability of observing a patient type times the outcome for these patient types. The expected outcome for the peer group is simulated on the patients of the clinician by replacing the peer group's probabilities for different patient types with the clinician's probabilities. In this way, the clinician and the peer group are evaluated on the same patient types. This is, in essence, the distribution switch. The probabilities are switched, while the outcomes are not.

Finally, in reporting the outcomes of peer group and clinician's patients, a problem arises when the peer group does not see the patients seen by the clinician. To compensate, the peer group's outcomes for these situations are constructed using synthetic cases. These synthetic cases replace missing cases and allow all clinician's patients to have at least one match among the peer group's patients.

Let's take a look at a little bit more complicated situation. Here, we are looking at a hierarchical conditional categories in a measure that CMS uses for severity of the patients. And then we are also looking at three DRGs, acute myocardial infarction, congestive heart failure, and angioplasty.

We have outcomes for these DRGs and HCC scores, and we have the probabilities of these events. But notice that the peer group sees no patients with high HCC and AP-DRG. The clinician sees these types of patients, but the peer group does not. The peer group's expected outcomes are calculated with the clinician's frequency, so we are not missing the frequencies. But the outcome for the peer group for these types of patients is not known and should be estimated.

We do not know the outcome for angina pectoris with the high HCC category. To estimate this outcome, we calculate the marginal outcomes. The marginal outcome for angina pectoris is 5.5 days, the average of the values in the row. And the marginal outcome for the high HCC category is 4.5 days, the average of the vertical column. Under assumption of independence, the joint outcome for a person with both angina pectoris and high HCC is calculated as the product of the marginal values divided by the average outcome for the entire set of data.

You can also estimate the missing control by regressing outcomes on patient comorbidities and imputing the missing value. Some analysts have a much easier time using regression. And therefore they can easily estimate the missing value for peer group.

Now that the synthetic case calculations allows to match every patient's type seen by the clinician with at least one patient type seen by the peer group, we can switch the distributions and calculate the expected outcomes. The synthetic estimation process allows us to anticipate 6.2 days for peer group taking care of angina pectoris with high HCC levels. We can now switch the probabilities and calculate the expected outcome. To highlight how these probability calculations are made, we have kept the probabilities in green and the outcomes in red. The expected outcome for the clinician is calculated to be 4.62 days.

Now let us look at the performance of the peer group. As before, the probabilities are shown in green. These are the same probabilities for the clinician as, by definition, they see the same types of patients. The peer group's outcomes are shown in red. Note that 6.2 was missing and estimated for a synthetic case composed of marginal components of the missing value.

This data showed that the peer group keeps patients more in the hospital than the clinician. On an average patient, the peer group keeps the same patient 0.19 days more in the hospital. So in 100 patients, the clinician saves the cost of care by 19 days. The take-home lesson is that distribution switch and synthetic case calculations allow us to balance data and compare clinicians and peer group on the same types of patients.