

Release Notes:	Target Analysis (core measures only)
Version: 2009	Initial Date: 1/16/2009 Modification Date: n/a

Target Analysis (core measures only)

Introduction

The objective of target analysis is to compare a health care organization's data against a comparative norm for the purpose of evaluating performance improvement opportunities. When an organization's performance level is statistically significantly different from a comparative norm, it is called a statistical deviation. A statistical deviation may be desirable or undesirable depending on the "direction of improvement" of the measure. An organization that has neither a desirable or undesirable result is called neutral, i.e. the result is not statistically different from the comparative norm.

At the start of public reporting of performance data by The Joint Commission, the national average has been used as the comparison value through which it was determined whether the reporting organization received a plus rating (indicating that performance was significantly better than the comparison value), a check rating (indicating that performance was not significantly different from the comparison value), or a minus rating (indicating that performance was significantly worse than the comparison value) on Quality Check, the Joint Commission's ORYX reporting web site. Organizations have had experience with the aligned CMS/Joint Commission performance measures for a number of years and the performance on these measures has been improving over time. However, using the national average as a benchmark has a number of disadvantages. It is not the most effective benchmark to use if the goal is to move performance to a given (absolute) level. If performance is very high or very low, statistical differences from the national average would give a misleading impression of the organization's desired performance. For these reasons, The Joint Commission is moving to a target measure range approach (target analysis) as a basis to evaluate an organizations' rating.

The use of target analysis in addition to the control chart is a key feature of the Joint Commission's analytic methods in the ORYX[®] initiative. The two analyses are alike in that an organization's actual (or observed) performance level is evaluated against a comparative norm, but are fundamentally different as to how such a norm is established. In control chart analysis, the norm is determined from an organization's own historic data so that one may assess the organization's internal process stability. In target analysis, the norm is obtained based on multiple organizations' performance data to evaluate an organization's relative performance level. Therefore, the two analyses evaluate an organization's performance in two distinct perspectives and, as a result, can provide a more comprehensive framework to assess an organization's overall performance level.

In evaluating a process, a control chart analysis is completed before the target analysis to determine the stability of the process before forming any conclusions on the organizations' observed performance and performance capability. Unless a process is in statistical control, target analysis cannot come to any meaningful conclusions about the quality of care at an organization.

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Elements of Target Analysis

There are two components to the new target analysis methodology. Given the national average for a performance measure, a target range will be constructed as detailed below. Using generalized linear mixed models methodology (also known as hierarchical models), predicted estimates of an organization's performance with a corresponding 95% confidence interval will be generated and this confidence interval will be compared to the target range to determine the organizations' rating. This estimate of the organization's true performance is based on both the data from that organization and on data from the entire set of reporting organizations. These estimates are known as "shrinkage" estimators since the estimate is "shrunk" toward the overall performance level based on data from all organizations. Organizations whose observed performance has low reliability, determined mainly by the sample size and how far the organizations' observed performance is from the performance level of all organizations, are shrunken closer to the overall performance level compared to organizations whose observed performance reliability is high. Previously, methods for estimating an organization's performance were based only on the individual organization's data.

Statistical assumptions about data

Statistical analyses differ depending on the assumptions that are made about the data. In ORYX, different assumptions are made depending on the type of measures (e.g., proportion, ratio, or continuous variable) as described below:

- **Proportion measures:** It is assumed that the proportion measures follow a binomial distribution. This is the probability distribution of the number of "successes", or, "occurrences" (e.g., numerator) in a series of independent trials (e.g., denominator), each of which can result in either a "success" or a "failure" with a constant probability.
- **Ratio Measures:** The ratio measures are similar to the proportion measures in that both are based on count (or attribute) data, but differ in that the numerator and the denominator address different attributes. For ratio measures, a Poisson distribution is assumed.
- **Continuous Variable Measures:** The continuous variable measures are based on data that can be represented by a range of values, without any gaps, on a continuous scale. The ORYX continuous variable measures to date have been measures of time until a given process is performed. These types of measures typically have a lower limit of zero and a large upper limit. Since the distribution of these types of measures is typically skewed, a log-normal distribution is assumed.

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What data are compared?

The target range in the target analysis for core measures is calculated as follows depending on the type of measure:

Proportion Measures

For each core proportion measure, a target range is calculated based on the national rate.

The target range consists of an upper target limit and a lower target limit and is computed as follows for measures where the direction of desired improvement is an increase:

1. If the national rate is greater than or equal to 0.95 then the upper target limit and lower target limit will both be set to 0.95.
2. If the national rate is less than 0.95 and greater than or equal to 0.90, then the upper target limit is set to 0.95 and the lower target limit is set to the national rate.
3. If the national rate is less than 0.90 then the lower target limit is set to the national rate and the upper target limit is the average of (the national rate and 100%).

Examples

National Rate	Lower Target Limit	Upper Target Limit
0.98	0.95	0.95
0.92	0.92	0.95
0.84	0.84	0.92

The target range consists of an upper target limit and a lower target limit and is computed as follows for measures where the direction of desired improvement is a decrease:

1. If the national rate is less than or equal to 0.05 then the upper target limit and lower target limit will both be set to 0.05.
2. If the national rate is greater than 0.05 and less than or equal to 0.10, then the lower target limit is set to 0.05 and the upper target limit is set to the national rate.
3. If the national rate is greater than 0.10 then the upper target limit is set to the average of (the national rate and 0%), and the lower target limit is set to 0.05).

Examples

National Rate	Lower Target Limit	Upper Target Limit
0.04	0.05	0.05
0.08	0.05	0.08
0.28	0.05	0.14

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Ratio Measures

For ratio measures, the target range is a single value based on the national rate.

Continuous Variable Measures

The target range for ORYX continuous variable measures are based on the national average (weighted median rate) and a cut-off value specific to the measure. For example, the Pneumonia antibiotic timing measure would use the national average and six hours as the target range since receiving an antibiotic within six hours of hospital arrival is the current standard of care.

Outcome Proportion Measures

Each outcome measures uses a target range that consists of a single value based on the national observed rate.

The comparative norm (e.g., expected rate) in the target analysis for core measures is the:

- “weighted median predicted rate” if the measure is risk-adjusted;
- “weighted median rate” if the measure is continuous and not risk adjusted;
- “weighted group mean” if the measure is a proportion or ratio measure.

How to determine when the observed performance is a statistically significant deviation from the comparative norm

In target analysis, the null hypothesis about an organization’s performance is that the observed performance is no different from the comparative norm (target range). This null hypothesis can be tested by using a statistical model to calculate a confidence interval for an organization’s predicted measure value and then compare this confidence interval to the target range. A confidence interval is an interval having upper and lower limits that represents the set of values for which the null hypothesis is accepted. If the null hypothesis is rejected by the statistical test, the observed measure value is statistically significantly different from the target range.

Joint Commission's Target Analysis for the Accreditation Survey Process

Under the analytical framework described in the earlier sections, the Joint Commission has established a set of initial analytical methods for use in the accreditation survey process. Because ORYX data are dynamic (for instance, new performance measures are added; and ORYX participation requirements expand to other settings over time), it is anticipated that the analytical methods will be dynamic (that is, updated over time) as well.

The target analysis for the accreditation survey process will be based on quarterly summary-level data that are aggregated from the monthly data submitted by the measurement systems. All statistical tests in the target analysis are performed at the 5% level of significance. Statistical formulas used in the analysis are described below.

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Joint Commission's Target Analysis for Quality Check

Under the analytical framework described in the earlier sections, the Joint Commission has established a set of initial analytical methods for use in the Quality Report. The target analysis for the Quality Report is based on a rolling year summary-level data that are aggregated from the monthly data submitted by the measurement systems. Statistical formulas used in the analysis are described below.

Target Analysis Chart Construction

A target analysis chart is a graphical summary of the target analysis. It displays tabular information from the target analysis into a standardized graphical format so that a visually intuitive assessment may be made about an organization's performance. A target analysis chart consists of actual (or observed) values, target range values (comparative norm), and confidence intervals for given quarterly/yearly timeframes. The confidence interval describes the degree of certainty that a given point is different from the comparative norm. The Joint Commission has chosen to use 95% confidence limits to minimize the type II error rate.

To create a target analysis chart, the confidence interval for each data point is calculated from all reporting organizations' observed quarterly/yearly values using the statistical methodology outlined below. The observed rate is considered a random variable, while the target range is assumed to be a constant value. If the confidence interval includes values outside the allowable range, the interval must be truncated to correspond to the allowable range. By definition, a proportion measure must be between 0 and 1 because the numerator for the measure is a subset of the denominator. For ratio measures, the values must be zero or any positive numbers. Continuous variable measures may include both positive and negative numbers, but must correspond to the allowable range of the measure.

Target Chart Interpretation

A statistically significant deviation interpretation depends on the direction of improvement of a measure. The direction of improvement can be positive, negative, or neutral. Directions of improvement are defined as follows:

- Positive measures: An observed value that increases signals improvement. In other words, a larger observed value is more desirable than a smaller observed value.
- Negative measures: An observed value that decreases signals improvement. In other words, a smaller observed value is more desirable than a larger observed value.
- Neutral measures: Either an increase or decrease in the observed value could be a signal of improvement. In other words, there is no clear direction of improvement for these measures.

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The target analysis will result in one of the following scenarios regardless of the type of measures.

- No statistical deviation - Actual performance is not statistically different from the target range;
- Statistically desirable - Actual performance is better than the target range;
- Statistically undesirable - Actual performance is worse than the target range.

It is important to know that the length of the expected range is inversely proportional to the organization's number of cases for a given measure. For a given measure value, an organization with a small population will have a wider expected range compared to an organization with a large population.

Small Sample Size Issues for Target Chart Use

When an organization's measure's population for the analysis time period (statistically referred to as *sample size* or simply "*n*") is very small, a warning message will be printed on the *ORYX Performance Measure Report*. This warning message will notify surveyors that the target data analysis may not be valid due to a small sample size **and that such data should be interpreted and used with caution.**

The very small sample size warning message will be issued when:

- For proportion and ratio measures, the quarter's sample size is less than 30 (i.e., $n < 30$)
- For continuous measures, the quarter's sample size is less than 10 (i.e., $n < 10$)
- The number of organizations participating in the measure's target group is less than 10 for non-risk adjusted measures

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Aggregation Formulas

The target analysis is developed with quarterly/yearly data points instead of monthly data points. Although monthly data points are transmitted to the Joint Commission, the data are pooled or rolled-up into quarterly/yearly points for analysis and target chart presentation. These quarterly/yearly pooled data points are calculated as a weighted mean (using the sample size as weights) of the statistic being evaluated (proportion, ratio, median) or the overall proportion, ratio, or median for all data within the quarter. (Note: these values should be identical).

The pooled or weighted quarterly/yearly values \overline{Q}_j are calculated as follows:

Let

$$\overline{Q}_j = \frac{\sum_{i=1}^m n_i * \overline{q}_i}{\sum_{i=1}^m n_i}$$

Where \overline{q}_i is the value of the statistic (proportion, ratio, or median) being pooled for the i^{th} month and n_i is the number of cases for the i^{th} month. Yearly values are calculated in the same manner.

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Target Analysis Implementation Details **Proportion Measures**

Once the data is aggregated by measure at the yearly/quarterly level for each healthcare organization, the aggregated data is analyzed using a logistic mixed effects model. Statistically, the number of numerator events conditional on a healthcare organization's random effect is modeled as a binomial distribution based on each organization's number of denominator cases and observed rate. The random effect of the healthcare organization is assumed to be normally distributed with mean 0 and variance specific to each healthcare organization. The model is as follows:

Let

- x_i = number of numerator events for the i th healthcare organization
- n_i = number of denominator events for the i th healthcare organization
- p_i = expected rate for the i th healthcare organization
- u_i = random effect for the i th healthcare organization
- σ_i^2 = variance for the i th healthcare organization

$$x_i | u_i \sim \text{Binomial}(n_i, p_i)$$

$$u_i \sim N(0, \sigma_i^2)$$

$$\text{model: } \log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + u_i$$

A 95% confidence interval around the predicted rates is computed using the model for each measure for each healthcare organization. At The Joint Commission, this is implemented in the SAS statistical programming language using the NLMIXED procedure. If a healthcare organization has less than 30 denominator cases for any measure, a 95% confidence interval will not be computed.

The confidence interval will be compared to a measure's target limit to test differences between a healthcare organizations predicted rate and the target range interval. If the confidence interval overlaps the target interval for a measure, then the healthcare organization is not considered statistically different from the target range and receives a check rating. If the healthcare organization's confidence interval does not overlap the target interval, the healthcare organizations will either receive a favorable or unfavorable rating depending on the direction of improvement.

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Example – Direction of Improvement is Increase

N	Observed Rate	Lower Target Limit	Upper Target Limit	Lower Confidence Interval	Upper Confidence Interval	Rating (Plus, Check, Minus)
56	0.91	0.95	0.95	0.76	0.98	Check
19	0.74	0.95	0.95	0.46	0.93	Minus
141	0.99	0.78	0.89	0.93	0.97	Plus

Note that observed rates do not need to be contained in the confidence interval as the interval is based on the predicted estimate from the model. This predicted value is based on both the organization's observed rate and the overall national rate and will be a value somewhere between these two rates. The larger the organization's sample size, the closer the organization's predicted rate will be to their observed rate.

Note: When the sample size (n) for proportion measures is less than 30 or when the number of organization in the comparison group is less than 10 for the non-risk adjusted measures or for the risk adjusted measures whose risk adjusted data are not available, an appropriate warning message is issued to indicate that the data may not be valid due to a small sample size and that such data should be interpreted and used with caution.

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Ratio Measures

For ratio measures, the aggregated data is analyzed using a Poisson mixed effects model. Statistically, the number of numerator events conditional on a healthcare organization's denominator size and the random effect is modeled as a Poisson distribution based on each organization's number of denominator cases and the observed rate. The random effect of the healthcare organization is assumed to be normally distributed with mean 0 and variance specific to each healthcare organization. The model is as follows:

Let

- x_i = number of numerator events for the i th healthcare organization
- n_i = number of denominator events for the i th healthcare organization
- λ_i = expected rate for the i th healthcare organization
- u_i = random effect for the i th healthcare organization
- σ_i^2 = variance for the i th healthcare organization

$$x_i | u_i, n_i \sim \text{Poisson}(\lambda_i)$$

$$u_i \sim N(0, \sigma_i^2)$$

$$\text{model: } \log(\lambda_i) = \beta_0 + u_i$$

A 95% confidence interval around the predicted rates is computed using the model for each measure for each healthcare organization. At The Joint Commission, this is implemented in the SAS statistical programming language using the GLIMMIX procedure. If a healthcare organization has less than 30 denominator cases for any measure, a 95% confidence interval will not be computed.

Using the target chart, one can determine statistical significance by comparing the confidence interval for the predicted rate of λ_i with the target value. If the confidence interval contains the target value, it is not a statistically significant deviation at the 5% significance level. If the confidence interval does not contain the target value, the observed rate is a statistically significant deviation.

Note: When the sample size is very small, an appropriate warning message is issued to indicate that the data may not be valid due to a small sample size and that such data should be interpreted and used with caution. Specifically, a warning message is issued when the number of expected denominator cases is smaller than 30 for ratio measures (i.e. $n < 30$).

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Outcome Measures

For outcome measures, the aggregated data is analyzed using a Poisson mixed effects model with an offset based on the risk-adjusted rate and the sample size. Statistically, the number of numerator events conditional on a healthcare organization's expected number of events and the random effect is modeled as a Poisson distribution based on each organization's expected number of cases and the observed rate. The random effect of the healthcare organization is assumed to be normally distributed with mean 0 and variance specific to each healthcare organization. The model is as follows:

Let

x_i = number of numerator events for the i th healthcare organization

n_i = number of denominator events for the i th healthcare organization

p_i = the risk-adjusted rate for the i th healthcare organization

e_i = expected number of numerator events for the i th healthcare organization based on the risk-adjusted rate = $n_i * p_i$

λ_i = expected rate for the i th healthcare organization

u_i = random effect for the i th healthcare organization

σ_i^2 = variance for the i th healthcare organization

$x_i | u_i, e_i \sim \text{Poisson}(\lambda_i)$

$u_i \sim N(0, \sigma_i^2)$

model: $\log(\lambda_i) = \beta_0 + u_i$

A 95% confidence interval around the predicted rates is computed using the model for each measure for each healthcare organization. At The Joint Commission, this is implemented in the SAS statistical programming language using the GLIMMIX procedure. If a healthcare organization has less than 30 denominator cases for any measure, a 95% confidence interval will not be computed.

Using the target chart, one can determine statistical significance by comparing the confidence interval for the predicted rate of λ_i with the target value. If the confidence interval contains the target value, it is not a statistically significant deviation at the 5% significance level. If the confidence interval does not contain the target value, the observed rate is a statistically significant deviation.

Note: When the sample size is very small, an appropriate warning message is issued to indicate that the data may not be valid due to a small sample size and that such data should be interpreted and used with caution. Specifically, a warning message is issued when the number of expected denominator cases is smaller than 30 for ratio measures (i.e. $n < 30$).

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Continuous Variable Measures

For continuous variable measures, the aggregated data is analyzed using a lognormal mixed effects model. Statistically, the measure value conditional on the random effect is modeled as a lognormal distribution based on each organization's observed value weighted by the standard deviation. The random effect of the healthcare organization is assumed to be normally distributed with mean 0 and variance specific to each healthcare organization. The model is as follows:

Let

- m_i = the measure value for the i th healthcare organization
- s_i = observed standard deviation for the i th healthcare organization
- μ_i = expected value for the i th healthcare organization
- u_i = random effect for the i th healthcare organization
- σ_i^2 = variance for the i th healthcare organization

$$m_i | u_i, n_i \sim \text{Lognormal}(\mu_i)$$

$$u_i \sim N(0, \sigma_i^2)$$

$$\text{model: } \log(\mu_i) = \beta_0 + u_i$$

A 95% confidence interval around the predicted value is computed using the model for each measure for each healthcare organization. At The Joint Commission, this is implemented in the SAS statistical programming language using the GLIMMIX procedure and the standard deviations as weights. If a healthcare organization has less than 10 denominator cases for any measure, a 95% confidence interval will not be computed.

Using the target chart, one can determine statistical significance by comparing the confidence interval for the predicted rate of μ_i with the target range. If the confidence interval overlaps the target range, it is not a statistically significant deviation at the 5% significance level. If the confidence interval does not overlap the target range, the observed rate is a statistically significant deviation.

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2009 Release Notes

This is a new section.

These release notes detail the changes that have been made to this document since its initial version was provided to vendors on 1/16/2009. Items that have been modified or added are highlighted in blue.

Date of Modification	Original Information	Modified Information	Reason