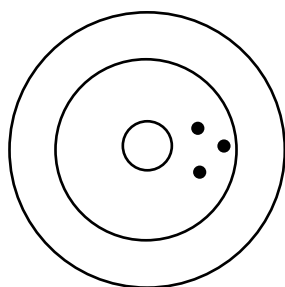


# Performance Evaluations on the Cholestech LDX<sup>®</sup> System

The purpose of this technical bulletin is to discuss some of the important points in running a performance evaluation between the Cholestech LDX and your current method and interpreting the results. The goal of a performance evaluation should be to give you confidence in the accuracy and precision of your Cholestech LDX. The quality of the results also depends on a number of pre-analytical factors, which will be discussed in this bulletin. If you would like help with an evaluation, call Cholestech Technical Service, 800-733-0404 or 510-732-7200, or send a Fax to Cholestech Technical Service, 510-732-7227. Cholestech has an evaluation protocol that can be used to evaluate the performance of your LDX.

## What is Accuracy?

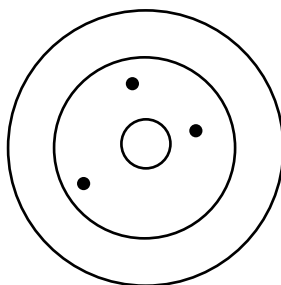
Accuracy is how close a result is to the "true" value.



Using a target as an example, accuracy is how close your shot is to the center of the bull's eye. The three shots on the target are close to the center but a little biased to the right. "Bias" is a word used to describe or indicate how far you are from the "true" value or the bull's eye. For comparison purposes the "true" value may be a well-standardized reference method or the result you get from the method you currently use.

## What is Precision?

Precision is reproducibility or how closely several results analyzed on the same sample agree. Using the example of the bull's eye, the first target has three shots that are close together, or very precise.



The second target has three shots that are scattered around the center. These are not precise. If you average all of the shots, the accuracy would be right on the bull's eye. But if you are only going to make one measurement you want that one measurement to be accurate. Without good precision you will not always have accurate results.

See the Technical Bulletin on Accuracy and Precision for a further discussion of accuracy and precision.

## Factors to Consider Before Running an Evaluation

### Sample Type

Whenever possible it is best to compare the same sample type on the LDX and your current method, i.e. serum vs serum or whole blood vs whole blood. This will eliminate the variability caused by collection methods and sample types. Acceptable sample types for the LDX System are fingerstick whole blood, lithium or sodium heparin whole blood (green top tube), and serum.

**Note:** Any sample type may be used for evaluating the Cholestech LDX. However, for routine use, the Cholestech LDX System is CLIA waived for fingerstick or venous whole blood unprocessed samples only.

### Blood Collection Technique

Consult your Cholestech LDX User Manual for the proper fingerstick technique. Excessive squeezing of the finger will affect all test results. Leaving the tourniquet on too long during the venipuncture has been shown to elevate lipids as much as 5%.

### Timing

The samples to be run on the LDX and the comparison method should be drawn at the same time and in the same location.

### Sample Handling

Venous samples should be well mixed, inverted gently 7-8 times and tested on the LDX within 30 minutes of collection. Fingerstick samples for lipids and glucose should be run within 5 minutes after collection. Fingerstick samples for ALT should be run immediately after collection. Samples should be run on the reference or comparison method on the same day they are collected. Delay in running the samples will add more variability to the results.

### Glucose

When evaluating glucose results on fingerstick samples, keep in mind that capillary blood glucose levels on non-fasting individuals may be 20 to 70 mg/dL greater than venous levels drawn at the same time.

**After the sample is placed into the cassette well,** *immediately* place the cassette into the drawer and push the RUN button.

## Training

Read the Cholestech LDX User Manual and watch the Cholestech LDX System Training Video before running your evaluation. Cholestech Technical Service can answer any questions you have before you begin your evaluation.

## Quality Control

Run the optics check cassette and quality control material before running patient samples. Ensure that all results are within established ranges before running patient samples.

## How Many Samples Should Be Tested in an Evaluation?

Your confidence in the results will increase with the number of samples you run. Cholestech recommends that you run at least 20 samples. With an  $n = 20$  samples you will have a good degree of confidence that the results of the evaluation are an accurate indication of the true performance of the LDX. You can run fewer samples but your confidence in the results will not be as high. The samples should also cover the measuring range for each analyte.

## How Do We Look At the Results?

The quality of a result from any test method depends on the accuracy and precision of the method. The difference between two methods may be expressed in terms of total error, which takes into account both accuracy and precision. The National Cholesterol Education Program (NCEP) through the Centers for Disease Control and Prevention (CDC) has established total error guidelines for lipid tests that can be used to determine whether any differences between a routine lipid method and the CDC reference method are acceptable. These total error guidelines are as follows:

Analyte	Total Error
Total Cholesterol	$\leq 8.9\%$
HDL Cholesterol	$\leq 13\%$
Triglycerides	$\leq 15\%$
LDL Cholesterol	$\leq 12\%$

This means that you can expect 95% (95 out of 100) of the test results in normal individuals to be within these total error guidelines when you compare the results from a routine lipid method to the CDC reference method for that analyte. The NCEP guidelines apply to all testing methods regardless of instrument size or location.

There are challenges in interpreting method comparison data when neither method is a CDC reference method. For example, consider two methods, A (your current method) and B (the Cholestech LDX). Assume that total precision is identical between the two. Method A is compared with a CDC reference method and found to have a negative bias, but overall an acceptable total error. Method B is compared with a CDC reference method and found to have a positive bias, but overall an acceptable total error. However, it is possible that when A and B are compared with each other, and method A is considered the "reference, the total error for method B will exceed total error limits because Method A has a negative bias and Method B has a positive bias compared to the CDC reference method.

When interpreting results between methods it is also important to remember that the NCEP guidelines apply to comparisons of the same sample by different methods, for example serum on the LDX and serum on your current method. There will be additional variability when different sample types are compared, for example fingerstick or venous whole blood on the LDX and serum on your current method, even when the samples are drawn at the same time.

Although there are no nationally accepted guidelines for glucose total error, the Cholestech LDX System provides results that are consistent with good patient care:

Analyte	Total Error
Glucose	$< 11\%$

## Looking at a Typical Set of Results

(See the following chart for an example.)

Place the results in a spreadsheet and calculate the % Bias between the two results as follows:

- Is there the same number of results for both methods? If not, delete the missing results from both data sets.
- Are all results within the testing range of both methods? If not eliminate those results from both data sets.
- Are the results acceptable? Look at the % Bias column. For total cholesterol (TC) 19 of the 20 results are within the total error guidelines,  $\leq 8.9\%$ . 95% of the results should be  $\leq 8.9\%$ , or 1 in 20 may be  $> 8.9\%$ . The total cholesterol results fulfill these criteria and the mean bias of  $-0.9\%$  is also acceptable.

For HDL cholesterol (HDL) 19 of the 20 results are within the total error guidelines,  $< 13\%$ . The 1 result out of 20 that is  $> 13\%$  is acceptable. The mean bias of  $5.2\%$  is also acceptable.

**Conclusion:** This evaluation is acceptable for both total cholesterol and HDL cholesterol

## Standardization of Lipid Tests

Calibration or standardization differences between methods can also play a role in the agreement in results between the LDX and your current method. To increase the accuracy and precision of lipid measurements the NCEP established the Laboratory Standardization Panel (LSP).

Through the LSP and the Centers for Disease Control and Prevention (CDC), reference methods have been developed for total cholesterol and an effort has been made to standardize total cholesterol measurement

### Looking at a Typical Set of Results — Sample

TC Sample	TC LDX - FS	TC REF - Ser	HDL % Bias	HDL LDX - FS	HDL REF - Ser	% Bias
1	200	196	2.0	75	75	0.0
2	250	240	4.2	77	72	6.9
3	285	300	-5.0	66	65	1.5
4	171	165	3.6	39	35	11.4
5	119	120	-0.8	54	49	10.2
6	218	227	-4.0	64	61	4.9
7	204	208	-1.9	27	27	0.0
8	184	174	5.7	50	45	11.1
9	180	196	-8.2	28	26	7.7
10	200	217	-7.8	33	32	3.1
11	231	240	-3.8	85	80	6.3
12	199	206	-3.4	45	44	2.3
13	167	183	-8.7	36	38	-5.3
14	290	285	1.8	22	21	4.8
15	225	246	-8.5	62	56	10.7
16	218	195	11.8	35	30	16.7
17	162	152	6.6	43	41	4.9
18	210	218	-3.7	54	55	-1.8
19	289	274	5.5	49	49	0.0
20	254	261	-2.7	36	33	9.1
<b>Mean</b>	<b>212.8</b>	<b>215.2</b>	<b>-0.9</b>	<b>49.0</b>	<b>46.7</b>	<b>5.2</b>

FS = Fingerstick, Ser = Serum, TC = Total Cholesterol, HDL = HDL Cholesterol  
Ref= Reference or Comparison Method

throughout the United States. Similar standardization has been developed for HDL cholesterol. Because of the complicated nature of the HDL cholesterol reference method, the CDC has developed and evaluated a designated comparison method (DCM) that is now available to assist manufacturers in standardization of HDL methods. The CDC has also developed a reference method for Triglycerides. There may still be more variability when comparing the LDX triglyceride test with other triglyceride methods because other methods may not be standardized to this reference method.

The Cholestech LDX total cholesterol, HDL cholesterol and triglyceride methods are traceable to the CDC reference methods through the

Cholesterol Reference Method Laboratory Network.

### Other Statistical Methods

A common statistical test used to evaluate agreement between methods is linear regression. This test utilizes additional statistical parameters such as calculation of the slope, intercept and correlation coefficient. This test is useful but only under certain conditions:

- The number of samples must be large, ideally 40 or more.
- The range of results for each analyte should be over a wide range, i.e. 150-400 mg/dL for total cholesterol or 15-90 mg/dL for HDL. This requirement is often difficult to meet.

- Linear regression may be invalid if there are outlying points at the upper or lower end of the sample range that do not agree.

If you are interested in performing linear regression on your data, call Cholestech Technical Service, 800-733-0404 or 510-732-7200, or FAX 510-732-7227, and we will be glad to help you with the calculation and interpretation of the results.

### References

1. National Cholesterol Education Program, U.S. Department of Health and Human Services: Recommendations for Improving Cholesterol Measurement. NIH Publication No. 93-2964, 1993.
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4. Bachorik PS, Ross JW, National Cholesterol Education Program Recommendations for Measurement of Low-Density Lipoprotein Cholesterol: Executive Summary, Clin Chem 1995; 41: 1414 – 1420.

**To assist you with any  
further questions, please call  
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