

Laboratory Procedure Manual

Analyte: **Total Triiodothyronine, Total T3**

Matrix: **Serum**

Method: **Access 2 (Beckman Coulter)**

Method No.:

Revised:

as performed by:

Collaborative Laboratory Services
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contact:

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Important Information for Users

Collaborative Laboratory Services periodically refines these laboratory methods. It is the responsibility of the user to contact the person listed on the title page of each write-up before using the analytical method to find out whether any changes have been made and what revisions, if any, have been incorporated.

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Public Release Data Set Information

This document details the Lab Protocol for testing the items listed in the following table:

| File Name | Variable Name | SAS Label |
|------------------|----------------------|--------------------------------|
| THYROD_G | LBXTT3 | Total Triiodothyronine (ng/dL) |

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1. SUMMARY OF TEST PRINCIPLE AND CLINICAL RELEVANCE

The Access Total T3 Assay is a paramagnetic particle, chemiluminescent immunoassay for the quantitative determination of triiodothyronine levels in human serum and plasma using the Access Immunoassay Systems. The Total T3 Assay is a competitive binding immunoenzymatic assay. Sample is added to reaction vessels with a stripping agent to dissociate T3 from the binding proteins. T3 in the sample competes with the T3 analogue coupled to biotin for anti-T3 alkaline phosphatase conjugate. Of the resulting antigen: antibody complexes, the T3 analogue: antibody complexes are bound to the streptavidin coated solid phase. Separation in a magnetic field and washing removes the sample T3; antibody complexes and other materials not bound to the solid phase. A chemiluminescent substrate, Lumi-Phos® 530, is added to the reaction vessel and light generated by the reaction is measured with a luminometer. The light production is proportional to the amount of enzyme conjugate bound to the solid support. The amount of analyte in the sample is determined by means of a stored, multi-point calibration curve.

Total T3 measurements are used in the diagnosis of thyroid disorders. Elevated concentrations of T3 can be found in Grave's disease, and most other classical causes of hyperthyroidism. Decreased concentrations occur in primary hypothyroid diseases such as Hashimoto's thyroiditis and neonatal hypothyroidism or secondary hypothyroidism due to defects at the hypothalamo-hypophyseal level.

2. SAFETY PRECAUTIONS

Consider all plasma or serum specimens potentially positive for infectious agents including HIV and the hepatitis B virus. We recommend the hepatitis B vaccination series for all analysts working with whole blood and/or plasma. Observe universal precautions; wear protective gloves, laboratory coats. Place disposable plastic, glass, and paper (pipette tips, gloves, etc.) that contact plasma and any residual sample material in a biohazard bag and keep these bags in appropriate containers until disposal by maceration chlorination. Wipe down all work surfaces with Germicidal Disposable Wipe when work is finished.

Handle acids and bases with extreme care; they are caustic and toxic. Handle organic solvents only in a well-ventilated area or, as required, under a chemical fume hood.

Reagents and solvents used in this study include those listed in Section 6. Material safety data sheets (MSDSs) for these chemicals are readily accessible as hard copies in the lab.

3. COMPUTERIZATION; DATA SYSTEM MANAGEMENT

- a. Microsoft Excel software on a PC and our Laboratory Information Systems (L.I.S.) are used to manage the data. The test is analyzed on a Beckman Coulter Access2 Immunoassay System. The Access2 is interfaced to the Laboratory Information Systems (L.I.S.) with a bi-directional interface. After tests are completed, the results will go to the L.I.S. Host Computer Interface to be verified by qualified analyst.
- b. Reflex testing is set up in the L.I.S. to order a repeat of any critical result, to verify abnormal values.
- c. Statistical evaluation of the runs is accomplished with Microsoft Excel software on a PC.
- d. A result file is generated in the L.I.S. database. The file is opened and copied to an Excel spreadsheet for evaluation. The run numbers, and date specimens were received are entered into the Excel file. The Excel spreadsheet results file data are copied to the shipment Excel file and sent using Internet FTP transfer of files or e-mailed to Westat within 21 days of sample receipt.
- e. The Excel files containing all raw data and results are backed up once a week using a CD writer or External drive for storage. Files stored on the L.I.S. network are automatically backed up nightly to tape.
- f. Documentation for data system maintenance is contained in printed copies of data records, as well as in "system log" files on the local hard drives used for the archival of data.

4. SPECIMEN COLLECTION, STORAGE, AND HANDLING PROCEDURES; CRITERIA FOR SPECIMEN REJECTION

- a. Interferences:
- 1) No interference from <10 mg/dL bilirubin.
 - 2) No interference from <1800 mg/dL triglycerides, or <400 mg/dL cholesterol.
 - 3) No interference for <1.0 g/dL hemoglobin. Grossly hemolyzed should not be used.
 - 4) No interference from total protein concentrations ranging from 5.0-9.0 g/dL
- b. Separated serum or plasma should not remain at +15°C to +30°C longer than 8 hours. If assays are not completed within 8 hours, serum or plasma should be stored at +2°C to +8°C. If assays are not completed within 48 hours, or the separated sample is to be stored beyond 48 hours, samples should be frozen at -15°C to -20°C. Frozen samples should be thawed only once. Analyte deterioration may occur in samples that are repeatedly frozen and thawed.
- c. Fasting is not required.
- d. A minimum of 0.5 mL serum is needed for the Total T3.
- e. Sample volume for individual test is 55 µL.
- f. Sample is run singly.

5. PROCEDURES FOR MICROSCOPIC EXAMINATIONS; CRITERIA FOR REJECTION OF INADEQUATELY PREPARED SLIDES

Not applicable for this procedure

6. EQUIPMENT AND INSTRUMENTATION, MATERIALS, REAGENT PREPARATION, CALIBRATORS (STANDARDS), AND CONTROLS

- a. Instrumentation: Beckman Access2 Immunoassay System
- b. Materials:
- 1) Access Immunoassay 1.0 mL Insert Cups (*Cat. #81915*)
 - 2) Access Immunoassay 3.0 mL Sample Container (*Cat. #81914*)
 - 3) Access Immunoassay Reaction Vessels (*Cat. #81901*)
 - 4) Stockwell Scientific Tubes, 13x100mm, polystyrene, (Prod #8570)
 - 5) S/P Plastic Transfer Pipette (*Cat. #P5214-10*)
- c. Reagent Preparation:
- 1) Access Total T3 Reagent Pack (*Cat. #33830*): 100 determinations, 50 tests/pack. Contains the following components:
 - R1a: Mouse monoclonal anti-T3 alkaline phosphatase (bovine) conjugate and Dynabeads[®] paramagnetic particles coated with streptavidin in a TRIS buffer with protein (aves and murine), surfactant, <0.1% sodium azide, and 0.1% ProClin[™]300.
 - R1b: T3 analogue coupled to biotin in a TRIS buffer with protein (aves), surfactant, <0.1% sodium azide, and 0.1% ProClin[™]300.
 - R1c: 0.4N Sodium hydroxide (NaOH) solution with 8-Anilino-1-Napthalenesulfonic Acid (ANS).
 - R1d: 0.4N Hydrochloric acid (HCl) solution.
 - a) Provided ready to use.
 - b) Store upright at 2-10°C.
 - c) Packs must be refrigerated at 2-10°C for two hours before loading on instrument.
 - d) Unopened packs are stable until expiration date when stored as directed.
 - e) After initial use, pack is stable for 28 days at 2-10°C.
 - f) CAUTION: Sodium azide may react with lead and copper plumbing. On disposal of liquid, flush drain with large volume of water. ProClin is a potential skin sensitizer, in case of contact with reagent, thoroughly flush with water.
 - g. CAUTION: 0.4N NaOH is an Irritant. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable gloves and eye/face protection.
 - 2) Access Substrate (*Cat. #81906*)

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- a) Lumi-Phos 530 (buffered solution containing dioxetane Lumigen PPD, fluorescer, and surfactant).
 - b) Allow substrate to equilibrate, unopened at room temperature for a minimum of 18 hours (maximum 14 days) prior to use.
 - c) Unopened substrate is stable until expiration date when stored at 2-10°C
 - d) Opened substrate on board in external fluids tray is stable for 14 days.
 - e) Substrate is sensitive to air exposure. Keep tightly closed at all times. Do not pool bottles of substrate.
- 3) Access Wash Buffer (*Cat. #81907*).
- a) Tris buffered saline, surfactant, 0.1% sodium azide and 0.1% ProClin 300.
 - b) Stable until expiration date when stored at room temperature.
- d. Standards Preparation: No preparation required.
- 1) Beckman Access Total T3 Calibrators (*Cat. #33835*).
- e. Control Material:
- 1) Bio-Rad Immunoassay Plus Controls (Levels 1, 2, and 3) (*Cat. #371, 372, 373*).
- a) Reconstitute each vial with 5 mL deionized water using a volumetric pipette. Replace the stopper and let control stand for 15 minutes. Before using, invert vial several times to mix.
 - b) Reconstituted control is stable for 7 days when stored at 2-8°C.
 - c) At least two levels of control should be analyzed in a 24 hour time period.
 - d) Ensure that assay control values are within the concentration ranges stated in the package insert or calculated from cumulative data at CLS.
 - e) Refer to Quality Control Flow Chart for action decision guidelines.

7. CALIBRATION AND CALIBRATION VERIFICATION PROCEDURES

- a. Calibrators: Beckman Access Total T3 Calibrators (*Cat. #33835*).
- 1) Six levels of calibrator.
 - 2) Provided ready to use.
 - 3) Mix contents by gently inverting prior to use.
 - 4) Stable until expiration date when stored at 2-10°C.
 - 5) Refer to calibration card enclosed with each set of calibrators for actual concentrations.
- b. Calibration:
- 1) Calibration is required when a new lot of Total T3 reagent is loaded, when the calibration curve expires (curve stability is 14 days), or when controls are out of range.
 - 2) Refer to Access2 Quick Reference Guide or Access2 "help" icon for detailed instructions on programming a calibration.

8. PROCEDURE OPERATING INSTRUCTIONS; CALCULATIONS; INTERPRETATION OF RESULTS

- a. Preliminaries
- 1) Enter test in L.I.S. as a part of a panel according to procedure listed in this document.
- b. Sample Preparation
- 1) Thaw samples and vortex, mixing well.
 - 2) Specimen handling, labeling and transferring serum.
- c. Operation
- 1) For detailed instructions on operating the Access, refer to the Access2 Quick Reference Guide, or use the "help" icon on the instrument screen.
- d. Recording of Data
- 1) Operator will review and verify results in the L.I.S.
 - 2) The L.I.S. reorders tests to verify any critical results. These results are stored in the L.I.S. along with the original results. Original values are used when repeat results match the original within 3 CV.
 - 3) Project supervisor will export data from the L.I.S. into an Excel file. The data is copied in into another Excel file for further evaluation.
 - 4) An Excel spreadsheet printout of the results for each container ID is made and comments noted.
 - 5) Project supervisor reviews the results. If problems noted with results or QC, Project Supervisor investigates and discusses issues if necessary with Laboratory Director. Repeat samples if necessary.
 - 6) Daily log sheets are completed and any problems or issues noted.

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- e. Replacement and Periodic Maintenance of Key Components
- f. Calculations:
 - 1) The Access Immunoassay System performs all calculations internally to produce the final reported result. Patient test results are determined automatically by the system software using a smoothing spline math model with no inflection points. The amount of analyte in the sample is determined from the measured light production by means of the stored calibration data.

9. REPORTABLE RANGE OF RESULTS

- a. Analytical Range:
 - 1) The analytical range for Total T3 is 10 - the value of the highest calibrator (~800) ng/dL.
 - 2) A result over range high should be reported as ">800". To obtain a numerical answer, the specimen may be diluted one volume of sample to one volume of 0.0 Calibrator. After assaying the diluted sample, multiply the printed value by 2 to obtain the reportable answer.
 - 3) Limits of detection (LOD) are established by Beckman Coulter and linearity data verifies the reportable range. Detection of results below the reportable range is not relevant and formal limit of detection study is unnecessary.
 - 4) Sensitivity is defined as the lowest measurable concentration which can be distinguished from zero with 95% confidence. Sensitivity for the Total T3 determination is 10 ng/dL.
 - 5) 0 is not a reportable value. Report results below 10 as <10.

10. QUALITY CONTROL (QC) PROCEDURES

- a. Blind QC Specimens are included in the samples received from NHANES.
- b. Bio-Rad Immunoassay Plus Controls levels 1, 2, 3 are assayed prior to running CDC-NHANES samples and after running CDC-NHANES samples.
- c. Acceptable Answer:
 - 1) Controls must be within ± 2 S.D.
 - 2) Refer to Quality Control Flow Chart for action decisions guidelines.

11. REMEDIAL ACTION IF CALIBRATION OR QC SYSTEMS FAIL TO MEET ACCEPTABLE CRITERIA

Remedial action for out of control conditions includes examination of the pipetting and detection equipment and examination of reagent materials. The QC parameters are compared to the patient means to look for confirmatory or disconfirmatory evidence. When the 2 2s and/or 1 3s rules are violated, samples are repeated following corrective maintenance or reagent changes.

12. LIMITATIONS OF METHOD; INTERFERING SUBSTANCES AND CONDITIONS

- a. Hemolyzed samples with up to 1.0 g/dL hemoglobin have no significant interference.
- b. <10 mg/dL bilirubin has no significant interference.
- c. Lipemia has no significant interference in samples containing equivalent of 1000 mg/dL triglycerides or Cholesterol of <400 mg/dL.
- d. In addition, total protein concentrations ranging from 5.0-9.0 g/dL (50 to 90 g/dL) do not affect the concentration of the total T3 assay.
- e. For assays employing mouse antibodies, the possibility exists for interference by human anti-mouse antibodies (HAMA) in the sample. Human anti-mouse antibodies may be present in samples from patients who have received immunotherapy or diagnostic procedures utilizing monoclonal antibodies or individual who have been regularly exposed to animals. Additionally, other heterophile antibodies, such as human anti-goat antibodies, may be present in patient samples.
- f. Total T3 results should be interpreted in light of the total clinical presentation of the patient, including: symptoms, clinical history, data from additional tests and other appropriate information.

13. REFERENCE RANGES (NORMAL VALUES)

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Total T3

| <i>Serum</i> | <i>ng/dL</i> |
|--------------|--------------|
| Serum | 80 - 200 |

Adult reference Range values were established from wellness participants with an age mix similar to our patients. These data were analyzed using non-parametric techniques described by Reed (Clin Chem 1971;17:275) and Herrera (J Lab Clin Med 1958;52:34-42) which are summarized in recent editions of Tietz' textbook. Descriptions appear in Clin Chem 1988; 34:1447 and Clinics in Laboratory Medicine June 1993; 13:481.

14. CRITICAL CALL RESULTS ("PANIC VALUES")

There are no critical call back values.

15. SPECIMEN STORAGE AND HANDLING DURING TESTING

Specimens arrive frozen with dry ice. Specimens are kept frozen at -70°C until ready to analyze. Sample is thawed, mixed well by vortexing, and then transferred to sample cup or sample insert cup on the Access.

Specimen vials are returned to container and refrigerated after transfer of aliquot and double checking of Sample I.D. Specimen vial container is placed in -70°C freezer after testing is complete.

16. ALTERNATE METHODS FOR PERFORMING TEST OR STORING SPECIMENS IF TEST SYSTEM FAILS

Samples will remain in -70°C freezer until instrument is back in operation.

17. TEST RESULT REPORTING SYSTEM; PROTOCOL FOR REPORTING CRITICAL CALLS (IF APPLICABLE)

The collaborating agency with access to patient identifiers or the responsible medical officer receives an Excel file with all results for a specimen with any critical values. These files with critical values are sent in advance of results that are not abnormal, unless all results are ready to send at the same time. The earliest reporting of results would be the day after arrival of specimens. More frequently two to three days after receiving specimens.

Test results that are not abnormal are reported to the collaborating agency at a frequency and by a method determined by the study coordinator. Generally, data from this analysis are compiled with results from other analyses and sent to the responsible person at the collaborating agency as an Excel file, either through Internet FTP transfer of files or electronic mail or other electronic means.

All data are reported electronically to Westat within 21 days of receipt of specimens.

Internet FTP transfer of files is available and is preferred for data transfer.

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18. TRANSFER OR REFERRAL OF SPECIMENS; PROCEDURES FOR SPECIMEN ACCOUNTABILITY AND TRACKING

In general, when specimens are received, the specimen ID number, and a name identifying the container ID and slot number is entered into the Laboratory Information System (L.I.S.) database. New barcodes are printed and the specimens stored in a refrigerator. Samples are aliquoted to a sample cup or sample insert cup with the new barcodes. The specimen ID is read off of the tube by a barcode reader. Tracked in the database are the date and time of entry into the L.I.S., date and time analysis completed, and who certified the results.

Microsoft Excel spreadsheets are used to keep records and track specimens with the data taken from the Laboratory Information System. Logs are kept including information of when samples arrive, are processed and tested, when frozen after testing, and when returned to NHANES for long term storage.

The Project supervisor is responsible for keeping a logbook containing the ID numbers of specimens prepared incorrectly, those with labeling problems, and those with abnormal results, together with information about these discrepancies. It is recommended that records, including related QA/QC data, be maintained for 10 years after completion of the NHANES study.

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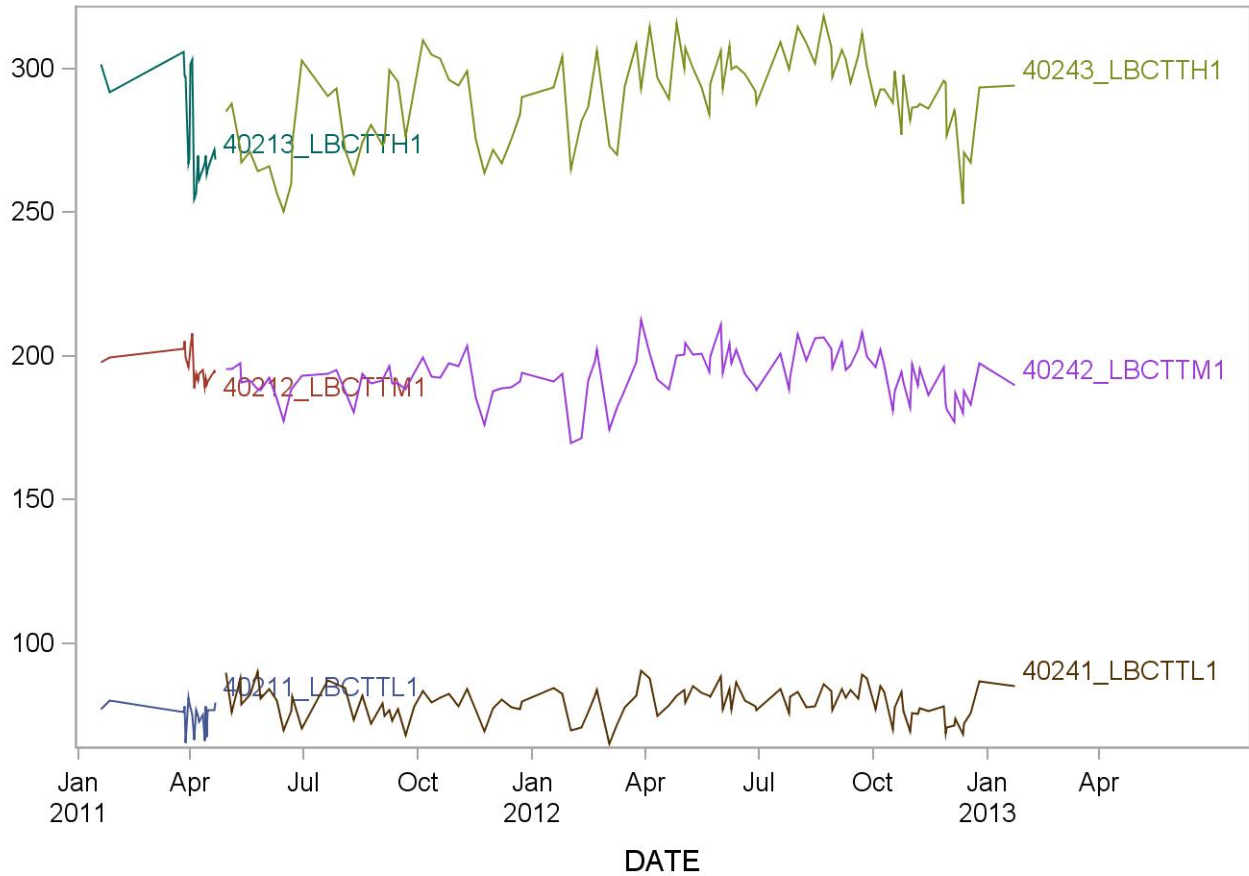
19. SUMMARY STATISTICS AND QC GRAPHS

See next page.

Summary Statistics for T3 (ng/dL)

| Lot | N | Start Date | End Date | Mean | Standard Deviation | Coefficient of Variation |
|---------------|-----|------------|----------|-------|--------------------|--------------------------|
| 40213_LBCTTH1 | 20 | 19JAN11 | 21APR11 | 277.4 | 17.6 | 6.3 |
| 40211_LBCTTL1 | 20 | 19JAN11 | 21APR11 | 75.2 | 4.9 | 6.5 |
| 40212_LBCTTM1 | 20 | 19JAN11 | 21APR11 | 196.3 | 5.5 | 2.8 |
| 40243_LBCTTH1 | 106 | 29APR11 | 23JAN13 | 289.3 | 15.3 | 5.3 |
| 40241_LBCTTL1 | 106 | 29APR11 | 23JAN13 | 79.4 | 5.6 | 7.0 |
| 40242_LBCTTM1 | 106 | 29APR11 | 23JAN13 | 193.1 | 8.1 | 4.2 |

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