



Manual 7

Biospecimen Collection and Processing

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1. BIOSPECIMEN COLLECTION AND PROCESSING

The Hispanic Community Health Study – Study of Latinos (HCHS/SOL) is a multi-site, interdisciplinary epidemiologic study in Hispanic populations in the U.S. sponsored by the National Heart, Lung, and Blood Institute (NHLBI) and six other institutes, centers, and offices of the National Institutes of Health (NIH). Its goals include studying the prevalence and development of disease in Hispanics, the role of acculturation, and to identify risk factors that play protective or harmful roles in Hispanics. Blood and urine samples are collected to study these factors through specialized, state-of-the-art laboratory assays. More routine laboratory tests will also be performed and reported to study participants and their physicians, as described in Section 3.6 of Manual 1. Study Protocol, General Description and Study Management.

The target population of 16,000 persons of Hispanic origin, specifically Cuban, Puerto Rican, Mexican, and Central American, to be recruited through four Field Centers affiliated with San Diego State University, Northwestern University in Chicago, Einstein College of Medicine in New York, and the University of Miami. Seven additional academic centers will serve as scientific and logistical support centers.

The Central Laboratory performs the tests on the blood and urine specimens donated by the study participants who have been asked to fast for 12 hours. DNA is prepared from the packed cells of EDTA blood, and aliquots of serum, plasma, and urine prepared at the field centers will be stored at the Central Laboratory. The Central Laboratory is located at the University of Minnesota Medical Center, Fairview in Minneapolis MN. A complete list of the tests performed is located in Appendix 1.

Laboratory tests are performed on specimen samples that are collected and processed by the technicians at each of the four HCHS/SOL field centers. Probably the most important step in this process (and potentially the most difficult to standardize) is the collection and field center processing of the blood samples. Laboratory tests can be repeated, but if the blood sample itself is not correctly drawn, labeled, and processed, the laboratory results may not be accurate even if the laboratory assays are precise. For the study to succeed, it is important that variation in measurement values reflect true differences between the study participants rather than differences in blood drawing or processing procedures. Thus, it is important that all field center technicians are well-trained, certified, fully compliant with the protocol for drawing and processing the specimens in the field, and also willing to take pride and responsibility in their work.

2. PREPARATION

Since participation in this study is voluntary, every effort must be made to make the entire procedure as easy and painless as possible for participants. Technicians must remain calm and project an attitude of competence even when faced with the most nervous or inquiring participant. The best way to achieve this is for the technicians to be thoroughly knowledgeable about all aspects of the procedures. The HCHS/SOL study collects approximately 58 - 76 mL of blood from each participant. Eight tubes of blood are collected, with a possible ninth tube as described below for the 2 hr post glucose load collection. The technician should reassure any participant who is concerned about the volume of blood collected that the total amount drawn is only about 4 – 5 tablespoons, although it may look like more to them. The technician may also assure participants that they donate almost 10 times as much blood (450 mL) when they donate a pint of blood.

2.1. Staff Certification Requirements

Blood drawing and processing are performed by a certified HCHS/SOL technician(s) at each field center. The technicians complete a training course taught by certified laboratory staff. Each technician must complete the training and pass both written and practical exams before becoming HCHS/SOL certified. Recertification takes place annually and is authorized by the supervisory personnel.

2.2. Blood Collection Trays and Tubes

One day prior to a scheduled participant visit, the technician prepares two trays: one to hold the blood collection tubes, another to hold the plastic vials which will hold the final packed cells, serum, plasma, and urine aliquots until they are frozen and ultimately transferred to the Central Laboratories for analysis. Label these sets of tubes with the appropriate code numbers for the participant. A list of equipment, suppliers, and vendors is provided in Appendix 2.

2.2.1 Blood Collection Tray

First, the technician organizes and prepares the blood collection tray. The blood collection tray is made of hard unbreakable plastic that can be easily cleaned. The tray has individual compartments that are filled with the following supplies:

- test tube rack that holds at least to 10 blood collection tubes (described in the next section)
- sterile, disposable 21 gauge butterfly needles
- plastic vacutainer tube guides
- vacutainer Luer adapters
- sterile alcohol swabs
- gauze sponges
- tourniquet
- bandages ("Band Aids")

Smelling salts, ice packs, and wash cloths should be readily available in the blood collection area for participants who become faint during the blood collection.

2.2.2 Blood Collection Tubes

Technicians must be familiar with: the arrangement of blood collection tubes, the order in which the tubes are to be filled, the type of anticoagulant in each tube, and the possible sources of error in handling each tube. These tubes are organized in the test tube rack in the following sequence:

Tubes #1 and #2 are 9 mL red stoppered tubes. Although these tubes do not contain anticoagulant, they do have a clot activator and therefore require mixing following collection. The serum from these tubes will be used for testing lipids (fats) and other biochemical markers.

Tube #3 is a 4 mL lavender-stoppered tube containing EDTA anticoagulant. This tube will be used for CBC, differential and platelet count, and glycosylated hemoglobin.

Tubes #4 and #5 are 10 mL lavender-stoppered tubes containing EDTA anticoagulant. (These tubes are labeled as 10 mL tubes, but because they are plastic, a volume as low as 8 - 9 mL of blood is collected.) The plasma from these tubes is used for several analytical tests including glucose (sugar). The cells will be used to isolate DNA.

Tubes #6 and #7 are 4.5 mL blue-stoppered tubes containing liquid sodium citrate anticoagulant. The plasma from these tubes is used for coagulation studies. These tubes must be filled completely in order to standardize the blood to liquid anticoagulant ratio. Partially filled tubes will result in erroneous test results.

Tube #8 and #9 are 2.5 mL red-stoppered Paxgene tubes containing anticoagulant and lymphocyte stabilizers. (The Paxgene tube is the size of a 10 mL collection tube, but because of the liquid stabilizers, only 2.5 mL of blood is collected.) These tubes must be filled completely in order to standardize the blood to liquid anticoagulant ratio. Partially filled tubes will result in erroneous test results. RNA will be isolated from the lymphocytes and used for gene expression studies. Because there is a large volume of liquid in this tube, be sure to hold the tube below the participant's arm during collection. (There is a risk, although extremely small, that the liquid in the tube could flow into the participant's vein if the tube is not held below the arm during collection.)

Tube #10 is a 4 mL lavender-stoppered tube containing EDTA anticoagulant. This tube will only be collected from participants who have the oral glucose tolerance test (OGTT). The plasma from this tube will be used for post OGTT glucose test and other analytical tests.

2.2.3 Blood Collection Tubes: Labeling and Set-Up

Blood collection tubes can be set up in advance of the participant visit.

1. Apply pre-numbered barcode laboratory ID labels to each blood collection tube. Place the labels on the tubes vertically, with the bar-code oriented from the bottom of the tube to the top of the tube. Handle only one participant's specimens at a time so the chance of mislabeling is minimized.

2. Arrange the blood collection tubes in the test tube rack in the same order in which they are to be collected. The nine tubes are collected in the following order:

Tube #1: 9 mL red stoppered tube (Serum)
Tube #2: 9 mL red stoppered tube (Serum)
Tube #3: 4 mL lavender stoppered tube (EDTA)
Tube #4: 10 mL lavender stoppered tube (EDTA)
Tube #5: 10 mL lavender stoppered tube (EDTA)
Tube #6: 4.5 mL blue stoppered tube (Citrate)
Tube #7: 4.5 mL blue stoppered tube (Citrate)
Tube #8: 2.5 mL red stoppered Paxgene tube
Tube #9: 2.5 mL red stoppered Paxgene tube
Tube #10: 4 mL lavender stoppered tube (EDTA) (Collected 2 hr after glucocorticoid administration.)

3. Additional laboratory ID number labels will be used when the participant arrives to provide a documented match between their HCHS/SOL participant ID number and the laboratory specimen ID number on the Biospecimen Collection form (BIO).

A number of HCHS/SOL participants will be asked to donate one to two additional tube(s) of blood for quality control purposes. The duplicate sample will be assigned a different laboratory ID number, called a Phantom ID, and shipped to the Central Laboratory one week later. This quality control procedure is described more completely below, in Sections 6.1 – 6.4.

2.2.4 Sample Aliquot Trays

The technician prepares a tray of the plastic freezer microvials, which will contain the aliquots to be shipped to the Central Lab for each participant. Each type of serum/plasma storage tube has a corresponding color-coded screw cap that fits onto it. The technicians are trained to organize the tray for the sample processing and aliquotting as follows:

The tray itself should be a flexible sponge test tube rack, which will fit tubes from 10-16 mm in diameter. The tray has 5 rows and 10 columns. The columns are numbered 1-10 from left to right. The rows are lettered A-E from top to bottom. See Appendix 11 for cleaning instructions for these trays.

2.2.5 Organization

The technicians need the following supplies for each sample tray. Supplies are organized in the order of centrifugation and processing.

- 15 – 2 mL polypropylene tubes (purple top)
- 1 – 2 mL amber polypropylene tube (purple top)
- 2 – 5 mL polypropylene tubes (blue top)
- 7 – 2 mL polypropylene tubes (blue top)
- 14 – 2 mL polypropylene tubes (red top)
- 1 – 2 mL amber polypropylene tube (red top)
- 3 – 2 mL polypropylene tubes (clear top)
- 3 – 2 mL polypropylene tubes (yellow top)
- 1 – 2 mL polypropylene tubes (green top)
- 1 – 2 mL polypropylene tubes (orange top)

2.2.6 Labeling

Vertically label the plastic sample aliquot tubes with the laboratory ID number and arrange in the sample aliquot trays in the following order (see Figure 1. Aliquot Tray Layout):

Tray 1 (for stages 1 – 3 processing):

- Col 1: 2 mL purple top *amber* tube; row B
- Col 1: 2 mL purple top clear tubes; rows A, C, D
- Col 2: 2 mL purple top clear tubes; rows A – D
- Col 3: 2 mL purple top clear tubes; rows A – D
- Col 4: 2 mL purple top clear tubes; rows A - D
- Col 5: 5 mL blue top clear tubes; rows A– B
- Col 6: 2 mL blue top clear tubes; rows A – D
- Col 7: 2 mL blue top clear tubes; rows A - C
- Col 8: 2 mL red top *amber* tube; rows B
- Col 8: 2 mL red top clear tubes; rows A, C, D, E
- Col 9: 2 mL red top clear tubes; rows A - E
- Col 10: 2 mL red top clear tubes; rows A – E

Tray 2 (for stage 4 and urine processing):

- Col 1: 2 mL clear top, clear tubes, rows A – C
- Col 2: EMPTY
- Col 3: 2 mL yellow top clear tubes, row A - C
- Col 4: 2 mL green top clear tube, row A
- Col 5: 2 mL orange top clear tube, row A
- Col 6 – 10: EMPTY

All extra labels are returned to the Central Laboratory with the daily specimen shipment.

Figure 1. Aliquot Tray Layout

Aliquot Tray 1 Layout (Stages 1 - 3 Processing)

Col Row	1	2	3	4	5	6	7	8	9	10
A	0.2 mL plasma, Tube #4	minimum 0.5 mL plasma, Tube #4	minimum 0.5 mL plasma, Tube #5	minimum 0.5 mL plasma, Tube #5	packed cells, Tube #4	minimum 0.5 mL plasma, Tube #6	minimum 0.5 mL plasma, Tube #7	1.0 mL serum, Tube #1	minimum 0.3 mL serum, Tube #1	minimum 0.3 mL serum, Tube #2
B	minimum 0.5 mL plasma, amber vial, Tube #4	minimum 0.5 mL plasma, Tube #4	minimum 0.5 mL plasma, Tube #5	minimum 0.5 mL plasma, Tube #5	packed cells, Tube #5	minimum 0.5 mL plasma, Tube #6	minimum 0.5 mL plasma, Tube #7	minimum 0.3 mL serum, amber vial, Tube #1	minimum 0.3 mL serum, Tube #1	minimum 0.3 mL serum, Tube #2
C	minimum 0.5 mL plasma, Tube #4	minimum 0.5 mL plasma, Tube #4	minimum 0.5 mL plasma, Tube #5	minimum 0.5 mL plasma, Tube #5	Empty	minimum 0.5 mL plasma, Tube #6	minimum 0.5 mL plasma, Tube #7	minimum 0.3 mL serum, Tube #1	minimum 0.3 mL serum, Tube #1	minimum 0.3 mL serum, Tube #2
D	minimum 0.5 mL plasma, Tube #4	minimum 0.5 mL plasma, Tube #4	minimum 0.5 mL plasma, Tube #5	minimum 0.5 mL plasma, Tube #5	Empty	minimum 0.5 mL plasma, Tube #6	Empty	minimum 0.3 mL serum, Tube #1	minimum 0.3 mL serum, Tube #2	minimum 0.3 mL serum, Tube #2
E	Empty	Empty	Empty	Empty	Empty	Empty	Empty	minimum 0.3 mL serum, Tube #1	minimum 0.3 mL serum, Tube #2	minimum 0.3 mL serum, Tube #2

Aliquot Tray 2 Layout (Stage 4 and Urine Processing)

Col Row	1	2	3	4	5	6	7	8	9	10
A	0.2 mL plasma, Tube #10	Empty	1.0 mL urine, neutral	1.5 mL urine, acid	1.5 mL urine, alkaline	Empty	Empty	Empty	Empty	Empty
B	minimum 0.5 mL plasma, Tube #10	Empty	1.5 mL urine, neutral	Empty	Empty	Empty	Empty	Empty	Empty	Empty
C	minimum 0.5 mL plasma, Tube #10	Empty	1.5 mL urine, neutral	Empty	Empty	Empty	Empty	Empty	Empty	Empty
D	Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
E	Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty

2.2.7 Preparation for Specimen Collection

In the morning, prior to drawing blood from the participants:

1. Check to make sure the blood collection tray is properly equipped. Every item on the checklist must be ready before proceeding.
2. Check that each Vacutainer tube is properly labeled with the correct laboratory barcode ID label.
3. Check that the sample aliquot trays are properly equipped. Every item on the checklist must be ready and in its proper position.
4. Check that each aliquot storage container is labeled with the correct laboratory barcode ID label.
5. Perform and record quality control (QC) check on centrifuge temperature ($15^{\circ}\text{C} \pm 2^{\circ}\text{C}$).
6. Perform and record QC check on refrigerator temperature ($4^{\circ}\text{C} \pm 2^{\circ}\text{C}$).
7. Perform and record QC check on freezer temperature ($-70^{\circ}\text{C} \pm 5^{\circ}\text{C}$) and ($-20^{\circ}\text{C} \pm 2^{\circ}\text{C}$).
8. Perform and record QC check on room temperature.
9. Perform and record QC checks for glucometer reagents and controls.

2.2.8 At Participant Arrival

1. Check that the participant's HCHS/SOL Participant ID number on the Biospecimen Collection form (BIO) is correct. Place the laboratory ID label that matches the label on the collection tubes and aliquot containers onto the Biospecimen Collection form (see Appendix 3).
2. Confirm the match between the participant name, the HCHS/SOL participant ID number, and the laboratory ID number on the blood collection tubes, aliquot containers, and the Biospecimen Collection form.
3. Check that duplicate Quality Control tubes are prepared and labeled, if needed.

2.3. Biospecimen Collection form

Complete the safety questions (section A1 – A6) and the fasting question (section B) of the Biospecimen Collection form (see Appendix 3). The remaining sections can be completed after the venipuncture. Any deviations from the routine collection or processing protocol are recorded in the section on venipuncture / processing incidents of the Biospecimen Collection form.

3. VENIPUNCTURE PROCEDURE

Handle all specimens as potentially infectious for laboratory workers. Blood borne pathogens such as hepatitis B and human immunodeficiency virus (HIV) can be transmitted following contact of a tainted blood sample through "broken skin" or intact mucous membrane (mouth, eyes, or nose) or as a result of an inadvertent needle stick. Examples of "broken skin" include open cuts, nicks and abrasions, dermatitis, and acne. OSHA rules mandate that technicians always wear disposable protective gloves when collecting and processing specimens. When performing a venipuncture, the protective gloves worn by the phlebotomist must be intact (e.g., a fingertip cannot be torn off of the glove in order to locate a venipuncture site). If the phlebotomist accidentally sustains a stick with a contaminated needle, clean the wound

thoroughly with disinfectant soap and water, notify a supervisor, and consult the HCHS/SOL physician. Never take lab coats worn during the collection and processing of samples outside of the laboratory area except for laundering. Before leaving the laboratory, the technician will remove the lab coat and disposable gloves and wash hands with a disinfectant soap.

Use OSHA-approved cleaning solution to clean up any spills of blood, plasma, serum, or urine. Use this solution to clean all laboratory work surfaces at the completion of work activities. OSHA regulations require that all needles and sharp instruments be discarded into puncture resistant containers. Do not attempt to bend, break, or recap any needle before discarding it. Discard the butterfly set following each specimen collection. Do not perform any pipetting by mouth; especially of any blood, plasma, serum, or urine.

Avoid formation of potentially infectious aerosols when removing the rubber stoppers from Vacutainer tubes. In addition to wearing protective gloves, hold a piece of gauze over the stopper while slowly removing it from the tube. Creation of aerosols can also be diminished by careful pipetting and centrifugation techniques. Further steps to minimize infection risk while processing samples are described in the OSHA regulations stated in the Federal Register of December 6, 1991 (Vol. 56, No. 235, page 64177). Wear a mask in combination with an eye protection device, such as goggles or glasses with solid side shields or a chin-length face shield when working with potentially infectious materials that have the potential for splashing, spraying, or spattering. An alternative to these devices would be a desk-mounted or under-shelf-mounted clear plastic shield, which would offer similar protection from possible infectious splashes or sprays.

Place all used Vacutainer tubes and blood-contaminated products in biohazard bags for proper disposal.

3.1. Phlebotomy Room

The blood drawing takes place in an isolated room or in a room with dividers. The room is equipped with all of the necessary blood drawing supplies. A separate work area is equipped with all of the supplies that are used in the blood processing. The centrifuge, refrigerator, and freezers should be nearby.

3.2. Participant Preparation

Informed consent must be obtained before drawing any blood, to ensure that the participants understand the purpose and possible complications of the venipuncture procedure. A standard informed consent has been prepared for this study. The consent statement informs study participants that although there may be some minor discomfort, their blood (about 4-5 tablespoons) will be drawn by trained technicians. The consent also states that a copy of clinically important test results will be sent to them (and their physician if they authorized it) and that they will be contacted if clinically important tests are abnormal.

Complete the Biospecimen Collection form (BIO) sections A and B with the participant (Appendix 3). Before blood is collected, the participant is asked the following safety questions (section A, 1-5):

1. ...if they have had a radical mastectomy or other surgery where lymph nodes were removed from their armpits. If they have, blood should not be collected from the arm where this has occurred.
2. ...whether he/she has a bleeding disorder. If such a disorder is present, ask the participant whether he/she has had blood drawn previously and if so, whether he/she had any problems with excessive bleeding or bruising at the venipuncture site. When the participant reports a bleeding disorder, specify the type of bleeding disorder(s) as briefly as possible in Item 15 of the Biospecimen Collection form. In general, a bleeding disorder is not a reason for participant deferral. A gauze and tape bandage is applied. The participant is instructed to maintain pressure on the venipuncture site for 2 minutes and to keep the bandage on the site for the remainder of the examination visit.
3. ...if they have ever had a graft or shunt for kidney dialysis. If they have, blood should not be collected from the arm where this has occurred. Also, this participant is excluded from the OGTT.
4. ...if they have diabetes. If they have been diagnosed with diabetes, they are excluded from the OGTT.
5. ...if they have ever had part of their stomach or intestines removed. If yes, they are excluded from the OGTT.

If blood is to be drawn, complete the fasting blood collection information with the participant (section B, 7-8). Fill in date, time, and if the blood will be collected prior to glucola administration (section C, 9-11).

The participant should be seated during the blood draw. It is difficult to standardize the length of time that a person is in the sitting position prior to venipuncture, but to the extent possible attempt to have the participant be sitting for a minimum of five minutes. This allows the participant to relax before the venipuncture takes place.

Perform venipuncture with a 21-gauge butterfly needle and 12 inches of plastic tubing between the venipuncture site and the blood collection tubes. The butterfly has a small thin-walled needle that minimizes trauma to the skin and vein. The use of 12 inches of tubing allows tubes to be changed without any movement of the needle in the vein. Give the participant enough time to feel comfortable both before and after the blood collection. In many cases the most memorable part of the experience for participants will be the contact with the technicians who draw the blood and their general attitude and competence.

If the participant is nervous or excited, the technician briefly describes the procedure, e.g., "I am going to be drawing about 4 tablespoons of blood. This blood will be used in tests for lipids (fats), glucose (sugar), and other biochemistry tests. We hope to be able to use the results of these tests to better understand the health issues of the Hispanic community." **HANDLING PARTICIPANTS WHO ARE EXTREMELY APPREHENSIVE ABOUT HAVING BLOOD DRAWN:** Do not under any circumstances force the participant to have blood drawn. It may help to explain to the participant that the blood drawing is designed to be as nearly painless as possible. It is sometimes best to let the participant go on with another part of the visit. It may also be helpful to have the participant relax in the blood drawing chair just so the phlebotomist

can check the veins in the participant's arms, without actually drawing blood. If the participant is very anxious, he/she may lie down during the blood collection. A reclining individual will undergo an extravascular water shift, resulting in a dilutional effect on lipid values. If this option is taken, note it on the Biospecimen Collection form by placing an "X" in the appropriate boxes. (Appendix 3, Item 14).

3.3. Venipuncture

With jacket or sweater removed, have the participant sit upright with the sleeves rolled up to expose the antecubital fossa (elbow). Use a tourniquet to increase venous filling. This makes the veins more prominent and easier to enter. The preferred arm to draw from is the left arm. Use the right arm only if blood collection is not possible from the left arm. This does not mean you must stick the left arm. Only do so if an adequate vein is apparent.

PRECAUTIONS WHEN USING A TOURNIQUET: The tourniquet should be on the arm for the shortest time possible. Never leave the tourniquet on for longer than two minutes. To do so may result in hemoconcentration or a variation in blood test values. If a tourniquet must be applied for preliminary vein selection, and it remains on the arm for longer than two minutes, it should be released and reapplied after a wait of two minutes. Instruct the participant that he/she should not clench their fist prior to the venipuncture. Doing so could cause fluctuations in the results in several of the analytes being measured. If the participant has a skin problem, put the tourniquet over the participant's shirt or use a piece of gauze or paper tissue so as not to pinch the skin.

A. Apply tourniquet.

1. Wrap the tourniquet around the arm 3 to 4 inches (7.5 to 10.0 cm) above the venipuncture site.
2. Tuck the end of the tourniquet under the last round.
3. If a Velcro tourniquet is used, adhere the ends to each other.

B. Identify vein: Palpate and trace the path of veins several times with the index finger. Unlike veins, arteries pulsate, are more elastic, and have a thick wall. Thrombosed veins lack resilience, feel cord-like, and roll easily. If superficial veins are not readily apparent, lowering the extremity over the arm of the chair will allow the veins to fill to capacity. Identify the best available vein.

C. Assemble the butterfly-Vacutainer set.

1. Attach the Luer adapter to the Vacutainer holder.
2. Attach the Luer end of the butterfly needle set to the Luer adapter.

D. Cleanse the venipuncture site.

1. Remove alcohol prep from its sterile package.
2. Cleanse the vein site with the alcohol prep using a circular motion from the center to the periphery.
3. Allow the area to dry to prevent possible hemolysis of the specimen and a burning sensation to the patient when the venipuncture is performed.

4. If venipuncture becomes difficult, the vein may need to be touched again with a gloved hand. If this happens, cleanse the site again with alcohol.
- E. Perform venipuncture.
1. Grasp the participant's arm firmly, using your thumb to draw the skin taut. This anchors the vein. The thumb should be 1 or 2 inches (2.5 or 5.0 cm) below the venipuncture site.
 2. With the needle bevel upward, enter the vein in a smooth continuous motion.
 3. Once blood appears in the butterfly tubing, place tube #1 (9 mL red top) into the Vacutainer holder. Grasp the flange of the needle holder and push the tube forward until the butt end of the needle punctures the stopper, exposing the full lumen of the needle.
 4. Make sure the participant's arm is in a flat or downward position while maintaining the tube below the site when the needle is in the vein. It may be helpful to have the participant make a fist with the opposite hand and place it under the elbow for support. **DO NOT HAVE THE PARTICIPANT MAKE A FIST IN THE HAND OF THE ARM FROM WHICH BLOOD IS TO BE DRAWN.**
 5. Remove the tourniquet after tube #3 fills. Once the draw has started, do not change the position of a tube until it is withdrawn from the needle. The tourniquet may be reapplied if blood flow is slow without it. If the color of the arm turns red or blue, the tourniquet is applied too tightly. Loosen it and continue. If the tourniquet is loosened or reapplied, note this on the Biospecimen Collection form.
 6. Keep a constant, slight forward pressure (in the direction of the adapter) on the end of the tube. This prevents release of the shutoff valve and stopping of blood flow. Do not vary pressure nor reintroduce pressure after completion of the draw.
 7. Fill each Vacutainer tube as completely as possible; i.e., until the vacuum is exhausted and blood flow ceases. If a Vacutainer tube fills only partially, remove the tube and attach another without removing needle from vein.
 8. When the blood flow into the collection tube ceases, remove the tube from the holder. The shutoff valve covers the point, stopping blood flow until the next tube is inserted (if necessary). Gently invert each tube eight times immediately following removal of the tube from the adapter while the next tube is filling. (See section 7.3.5 for mixing instructions.)
 9. When collecting the Paxgene tubes #8 and #9, be sure to keep the tube upright and below the participant's arm.
 10. To remove the needle, lightly place clean gauze over venipuncture site. Remove the needle quickly and immediately apply pressure to the site with a gauze pad. Discard needle with its cap into needle box. **DO NOT ATTEMPT TO RECAP NEEDLES!** Have the participant hold the gauze pad firmly for one to two minutes to prevent bruising.
 11. If the blood flow stops before collecting all of the tubes, repeat the venipuncture on the participant beginning with the first unfilled tube. Because of the ratio of anticoagulant to blood, tubes #6 and #7 must be completely filled in order to perform the analyses. As always, the tourniquet must never be on for longer than two minutes.
 12. If phlebotomy is interrupted on tube #6 or #7 (Citrate tubes) collect 2mL of blood into a red SST tube before collecting tubes #6 and #7. (The SST tube blood is discarded.)

- F. If a blood sample is not forthcoming, the following manipulations may be helpful.
1. If there is a sucking sound, turn needle slightly or lift the holder in an effort to move the bevel away from the wall of the vein.
 2. If no blood appears, move needle slightly in hope of entering vein. Do not probe. If not successful, release tourniquet and remove needle. A second attempt can be made on the other arm. The same technician should not attempt a venipuncture more than twice (once in each arm). If a third attempt is necessary, a different phlebotomist should attempt the venipuncture.
 3. Loosen the tourniquet. It may have been applied too tightly, thereby stopping the blood flow. Reapply the tourniquet loosely. If the tourniquet is a Velcro type, quickly release and press back together. Be sure, however, that the tourniquet remains on for no longer than two minutes at a time.
- G. Bandaging the arm.
1. Under normal conditions:
 - a. Slip the gauze pad down over the site, continuing mild pressure.
 - b. Apply an adhesive or gauze bandage over the venipuncture site after making sure that blood flow has stopped.
 2. If the participant continues to bleed:
 - a. Apply pressure to the site with a gauze pad. Keep the arm elevated until the bleeding stops.
 - b. Wrap a gauze bandage tightly around the arm over the pad.
 - c. Tell the participant to leave the bandage on for at least 15 minutes.
- H. PRECAUTIONS - When a Participant Feels/Looks Faint Following the Blood Drawing:
1. Have the person remain in the chair. If necessary, have him/her lie on the floor with legs elevated. Use of a transfer belt may be indicated in this situation.
 2. Take an ampule of smelling salts, crush it, and wave it under the person's nose for a few seconds.
 3. Provide the person with a basin if he/she feels nauseous.
 4. Have the person stay seated until the color returns and he/she feels better.
 5. Have someone stay with the person to prevent them from falling and injuring themselves if he/she should faint.
 6. Place a cold wet cloth on the back of the person's neck or on their forehead.
 7. Once the episode has passed, some fruit juice may be given to the participant in order to counteract any possible hypoglycemia due to their pre-clinic visit fast.
 8. If the person continues to feel sick, take a blood pressure and pulse reading. Contact a medical staff member for further direction.
- I. Venipuncture for OGTT (Tube #10): If an OGTT test is administered, a separate venipuncture is performed 2 hours after the glucola was administered to collect Tube #10. (See section 3.6 OGTT.)

3.4. Blood Tube Mixing and Storage During Venipuncture

All tubes must be mixed with the anticoagulant to prevent clotting. Even tubes #1 and #2 that do not contain an anticoagulant, have a clot activator that needs to be mixed with the blood. Begin by holding the tube horizontal to the floor. Gently tip the stopper end down while watching the air bubble rise to the butt (1st inversion). Now, lower the butt end slightly while watching the bubble float to the stopper (2nd inversion). Lower the stopper end again when the bubble reaches the stopper. This is the third inversion. Invert each tube eight times unless otherwise specified (Tubes #8 and #9). Eight inversions should take 6 to 8 seconds.

Tube #1 and #2: 9 mL red stoppered tube containing no anticoagulant. Invert tube gently 8 times immediately after collection. Place tubes in room temperature rack and allow the blood to clot for 30 minutes after collection. Protect tubes from light by placing a box over the rack until centrifugation.

Tube #3: 4 mL lavender-stoppered tube contains EDTA anticoagulant. Invert gently 8 times immediately after collection. Store this tube in the refrigerator until same-day shipment to the Central Laboratory on frozen gel pack.

Tube #4 and #5: 10 mL lavender-stoppered tube contains EDTA anticoagulant. Invert gently 8 times immediately after collection. Place the tubes #4 and #5 in a cup with ice slush and protect them from light by placing a box over the cup of ice slush until centrifugation.

Tube #6 and #7: 4.5 mL blue-stoppered tube contains sodium citrate anticoagulant. Invert gently 8 times immediately after collection. Place the tubes in room temperature rack until centrifugation at 15° C. (These tubes can be placed under the box, but do not require protection from light.)

Tube #8 and #9: 2.5 mL red-stoppered Paxgene tubes contain anticoagulant and lymphocyte stabilizer. Immediately after blood is drawn, gently invert 12 times and place in room temperature rack for at least 4 hr. At the end of the day or after at least 4 hours at room temperature, place this tube upright in a wire rack (to allow for adequate air circulation during freezing) in the -20° C freezer for 24 hr. (NOTE: This must be manual defrost model – not a frost-free model.) After 24 hours at -20° C, place this tube in the aliquot sample tray in the -70° C freezer with the other aliquots on the same participant. (These tubes may be kept at -20° C over a weekend if necessary and placed at -70° C on Monday morning. These tubes can be placed under the box, but do not require protection from light.)

Tube #10: 4 mL lavender-stoppered tube contains EDTA anticoagulant. Immediately after collection gently invert tube 8 times. Place the tube in room temperature rack until centrifugation. (This tube does not require protection from light.)

3.5. Glucose Screening

If the participant is eligible for the OGTT based on answers to safety questions A3-A5 and fasting status B7-B8 on the Biospecimen Collection form, then a glucose screen test must be performed and recorded in A6 in order to insure that the OGTT is administered only to

participants with a glucose equal to or less than 150 mg/dL,. For detailed instructions on use, maintenance, and quality control of the glucometer, see Appendix 9.

1. Use Tube #4 (10 mL EDTA tube) for the glucose screening test. Make sure that tube #4 is mixed well by gently inverting it 12 times; then remove the stopper.
2. Using a disposable transfer pipet, remove a small amount of blood and place a drop onto the pink target area of the test strip. A confirmation dot on the back of the test strip turns blue when adequate blood has been added.
3. Insert the test strip into the meter with the pink side up. The black tip completes an electrical circuit, thereby insuring that the strip is inserted properly and remains inserted.
4. Record the glucose reading from the meter on the Biospecimen Collection form (Appendix 3) under item A.6. If the meter reading is “HI”, enter 500 on the Biospecimen Collection form.
5. Remove the strip and discard in the biohazard waste container. Replace the cap onto the collection tube for centrifugation.
6. If the reading is equal to or less than 150 mg/dL, and the participant has not been excluded from the OGTT based on safety questions A3- A5 and fasting status based on item 11a, then glucoala can be administered. Skip to section 3.6.
7. If the reading is greater than 150 mg/dL, the participant will not be allowed to do the OGTT procedure. Explain according to the script and enter result on the form.
8. If the reading is 200-399 mg/dL, proceed as follows:
 - a. Ascertain symptoms of hyperglycemia (follow script on thirst, frequent urination, dizziness, active infection, or blurred vision). If symptoms(s) are present, contact the clinic manager to refer participant to the emergency room.
 - b. Measure urine for ketones (see Appendix 10 for a detailed procedure). If the urine dipstick is positive for ketones, contact the clinic manager to refer participant to the emergency room. If the urine dipstick is negative for ketones, make a note on the Clinic Check off Sheet so that during the exit interview the participant can be referred to a health care provider or a referral physician to be evaluated within one week.
9. If the reading is greater than 400 mg/dL, STOP the examination and contact the clinic manager to refer the participant to the emergency room (regardless of the presence of symptoms).

3.6. OGTT

3.6.1 Glucola Administration

The preferred means of serving the glucola drink to the participant is to remove the cap and serve the bottle with a straw. If requested by the participant, the contents can also be poured into a paper cup and served with or without a straw. Participants are instructed to consume the contents of the container in less than 5 minutes. Most individuals consume the full amount in 3 to 5 minutes quite easily.

The timing for the 2 hour post load venipuncture begins as soon as the participant starts to drink the glucose solution. The time the participant began drinking the glucola is recorded in Item 24 of the Biospecimen Collection form (Appendix 3). The time the participant should have the 2 hour post load venipuncture is then recorded on the Clinic Check List.

Study participants are encouraged to drink the full amount of glucola; otherwise they will not get the full benefit of the test. If the individual does not consume the full amount of glucola, the technician measures the residual amount and records it in Item 23 of the Biospecimen Collection form. The measurement of the residual glucola is not necessary if only a few drops are left. If the residual amount is 145 mL or more, the 2 hour blood draw is NOT performed, and Item 24 of the Biospecimen Collection form is completed accordingly. Based on the experience in many epidemiologic studies in the U.S. and elsewhere, this should be a very uncommon event.

3.6.2 Two Hour Post Glucose Load Venipuncture

The two hour blood sample is obtained for measurement of glucose two hours after the start of the test. The blood sample is drawn as close to the two hour time as possible. The phlebotomist records that the post-load blood glucose sample was drawn, and the actual time it was drawn (items 24 and 25 of the Biospecimen Collection form).

Every scheduling effort is made to allow participants to go to the venipuncture work station for the 2 hour blood sample. The Clinic Check List needs to be checked frequently as a guide to scheduling interviews and procedures, especially towards the end of the examination. In a complex field center examination such as the HCHS/SOL, it is likely that some participants will be busy with other parts of the examination. If the participant is available within a 10 minute window of the scheduled 2 hour post-load venipuncture, the overlapping interview or procedure does not need to be rescheduled or interrupted. However if the 2 hour blood sample is due and the participant cannot come to the venipuncture work station within the 10 minute window, the phlebotomist, if possible, goes to the participant to obtain the sample at the examination or interview station.

3.6.3 Snack

OGTT study participants should neither drink nor eat anything in the period between the glucose administration and the 2-hour blood draw. After the post-load venipuncture, participants are given the regular snack. Study participants will have been asked at the reception station whether on advice of their physician they can postpone taking the medications they usually take first

thing in the morning until they have their 2 hour post-load Venipuncture. If that is the case, this will be noted on the Clinic Visit Check List and participants are then assisted in retrieving their medications during the snack break.

3.6.4 Documentation of Side Effects

If participants complain of any problems during the test, they should be reported to the Study Coordinator or the Study Nurse and documented on the field center's Incident Log. Based on many previous studies similar to HCHS, side effects are quite infrequent, and vomiting was reported only on 0.1 percent of tests (diarrhea is not a side effect of the OGTT). However, if vomiting has occurred, the 2-hour blood draw should not be done. In this case, Item 24 of the Biospecimen Collection form is completed accordingly and the reason for the incomplete test recorded in Item 23 of the Biospecimen Collection form.

3.6.5 Readiness for Emergencies

Field centers keep on hand orange juice or equivalent, sugar-containing beverages at all times.

Participants with known or undiagnosed diabetes may develop low blood sugar or an "insulin reaction". If recognized promptly by clinic staff, it should be mild and easily treated with orange juice or a similar sugar containing beverage.

Hypoglycemia, or an abnormally low blood glucose level, occurs when there is an imbalance between the dose of hypoglycemic medications (in the treated diabetic) or the blood sugar level (in any person) and the person's food intake and activity level. However, treated diabetics are excluded from the OGTT. Classic symptoms include anxiety, tremor, palpitations, sweating, faintness, and hunger. If untreated, a further decrease in blood glucose may lead to confusion followed by loss of consciousness. Prolonged hypoglycemia may precipitate angina pectoris or seizures.

It is important to remember that symptoms of hypoglycemia are variable and may be partially masked in older participants.

If a person displays any of these symptoms after ingesting the glucola and is able to take food orally, orange juice containing additional sugar should be given immediately and the clinic physician notified as soon as possible. If orange juice or other forms of sugar has been administered a two-hour blood specimen should not be drawn. This is communicated to the participant and recorded on the itinerary form / checklist, and the reason for the incomplete procedure is recorded in Item 23 of the Biospecimen Collection form and Item 24 is completed accordingly. When a hypoglycemic reaction occurs, the person is evaluated by medical staff prior to leaving the field center.

If an OGTT participant loses consciousness, hypoglycemia should be presumed until ruled out. Severe hypoglycemic reactions are a medical emergency and the person should be transported immediately to an emergency care facility.

4. BLOOD AND URINE PROCESSING

4.1 Stage One: Immediate Processing

After completion of venipuncture:

1. Tubes #1 and #2 remain at room temperature for 30-45 minutes to allow the blood to clot (blood at 4°C clots extremely slowly). Keep these covered with a box to protect them from light. Set a timer for 30 minutes as a reminder to centrifuge these tubes.
2. Within 15 minutes of collection, place tubes, #4, #5, #6, and #7 in the centrifuge trunions. Place tubes in the centrifuge buckets in a balanced manner (see description of balancing the centrifuge in 4.2 “Operating the Centrifuge”). Spin these tubes at 3,000 x g for 30 minutes at 15° C. Record on the Biospecimen Collection form the time at which these tubes began to spin.
3. Place tube #3 in refrigerator until daily shipment on frozen gel pack to the Central Laboratory.
4. Leave tube #8 in an upright position at room temperature for at least 4 hours, after which the tube is placed in an upright position in the -20° C freezer for 24 hours. Finally, this tube is placed with its corresponding aliquots in the -70° C freezer.

4.1.1 Operating the Centrifuge

Refer to Centrifuge Operating Manual for specific operating and balancing instructions. In order to achieve a 3000 x g centrifugal force (rcf) within the centrifuge, the corresponding revolutions per minute (RPM) may vary from centrifuge to centrifuge depending on radius of the centrifuge's rotor. Consult the centrifuge's operating manual for the appropriate RPM for each centrifuge. If the field center's centrifuge is not capable of creating a 3000 rcf, increase the centrifugation time until the rcf-minutes total 90,000. If, for example, the maximum force is 2000 rcf, then increase the time from 30 to 45 minutes. To balance the centrifuge, place tubes of the same size and with equal volume of blood as determined visually in opposite positions in the bucket adaptors. For tubes of blood that do not have another tube of equivalent blood volume, use a “balance tube” of the same size containing an equivalent volume of water. Wait for centrifuge to come to a complete stop before opening the lid. Proceed to stage 2 processing.

4.2. Stage Two: Processing of Plasma

Stage two begins approximately 30 minutes after venipuncture. Eye protection, gloves and lab coat must be used for all blood processing. All other rules regarding the safe blood specimen handling must also be observed.

When removing the plasma after centrifugation do not disturb the white blood cells layer, also called the buffy coat, which forms a thin layer between the upper plasma layer and the lower layer of packed red blood cells. This is especially true in tube #6 and #7 because the platelets which are found near the top of the buffy coat contain some of the analytes which are to be

measured and could cause erroneous result if aspirated with the plasma. If some of the buffy coat is accidentally aspirated while removing the plasma, re-centrifuge the tube using the initial processing conditions. Indicate on Item 22 of the Biospecimen Collection form (Appendix 3) that the tube was re-centrifuged.

Aspiration of the lipid layer that may float to the surface after centrifugation could also adversely affect the test results. Thus, it is critical that only the clear plasma or serum between the buffy coat and the upper lipid layer be aspirated when preparing these sample aliquots. If lipids floated to the top of the plasma, indicate on Item 23 of the Biospecimen Collection form (Appendix 3) "lipids present on top of plasma/serum were not pipetted".

Unless otherwise specified, place at least 0.5 mL and up to, but not more than approximately 1.5 mL of serum or plasma into the 2 mL vials.

1. Remove tubes #4, #5, #6, and #7 from the centrifuge and place them in a wire rack in front of the sample aliquot tray 1. Remove the stoppers. Be careful not to disturb the cell layers.
2. Tubes # 4, and #5: Using a plastic transfer pipet and being careful not to disturb the red or white blood cell layers, remove the clear plasma supernatant from tube #4. Aspirate slowly starting at the top of the plasma (or just below the lipid layer if one is present on the top). The pipet tip does not get any closer than ¼ inch from the cell layer. Leave ¼ to ½ inch layer of plasma above the buffy coat/red blood cells. Place approximately 0.2 mL of plasma into the first clear 2 mL vial in position A1 of the sample aliquot tray 1. (Use the "0.2 mL template" vial as a guide for an approximate 0.2 mL volume.) Distribute the remaining plasma equally into one amber vial in position B1 and six clear 2 mL vials in positions C1 through D1 and A2 through D2 of the sample aliquot tray. Process tube #5 similarly, distributing the plasma equally into eight 2 mL clear vials in positions A3 through D3 and A4 through D4.
3. Fasten the lavender screw caps onto the vials in columns 1, 2, 3, and 4 and place them in the cup with ice slush.
4. Using the same plastic transfer pipette, slowly aspirate the remaining plasma, buffy coat layer, and some of the red cells from tube #4. (Do not let the buffy coat aspirate into the bulb of the disposable pipette.) Transfer this to the 5 mL vial in position A5. Now transfer the remaining red blood cells from tube #4 to this same vial. (This ensures that the buffy coat is adequately rinsed from the transfer pipet.) Repeat these steps for tube #5 and place the liquid into the 5 mL vial in position B5. Fasten the blue screw caps onto these vials.
5. Re-stopper tubes #4, and #5 and discard them in a biohazard waste container.
6. Tubes #6 and #7: Using a plastic transfer pipet and being careful not to disturb the red or white blood cell layers, remove the clear plasma supernatant from tube #6. Aspirate slowly starting at the top of the plasma (or just below the lipid layer if one is present on

the top). The pipet tip does not get any closer than ¼ inch from the cell layer. Leave ¼ to ½ inch layer of plasma above the buffy coat/red blood cells. Place 0.5 mL of plasma into the vial in position A6 and distribute the remaining plasma equally into each of three 2 mL vials in positions B6 through D6 of the sample aliquot tray 1. (Use the “0.5 mL template” vial as a guide for an approximate 0.5 mL volume.) For tube #7, distribute the plasma equally into the three 2 mL vials in positions A7 through C7 of the aliquot tray 1. Place the blue screw cap on each vial. Replace the blue stopper on both of the collection tubes and discard them in a biohazard waste container.

4.3. Stage Three: Processing of Serum

Stage three begins approximately 30 minutes after venipuncture.

1. As close to 30 minutes after venipuncture as possible, and no longer than 45 minutes after venipuncture, spin the red stoppered tubes #1 and #2 at 3,000 x g for 10 minutes. Record the time when centrifugation begins on the Biospecimen Collection form. (Stage 2 processing can be done while these tubes are centrifuging.)
2. When the centrifuge has come to a complete stop, remove tubes and place them in a wire rack in front of the sample aliquot tray 1. Remove the stopper.
3. Using a plastic transfer pipet, withdraw serum from tube #1. Place approximately 1.0 mL of serum into the 2 mL vial in position A8 of the sample aliquot tray. (Use the “1.0 mL template” vial as a guide.) Distribute the remaining serum equally into one amber vial in position B8 and six 2 mL clear vials in positions C8, D8, E8, A9, B9, and C9 of the sample aliquot tray. Remember to withdraw only the clear serum; if lipids are present on top begin aspirating from below that layer. For tube #2, distribute the serum equally into the seven 2 mL vials in positions D9, E9, A10, B10, C10, D10, and E10 of the sample aliquot tray. (Use the “0.3 mL template” vial as a guide.) Fasten the red screw caps onto these vials.
4. Re-stopper tubes #1 and #2 and discard them in a biohazard waste container.

Remove the purple-capped vials from the cup with ice slush, dry them with a paper towel, and place them into positions in columns 1, 2, 3, and 4 of the sample aliquot tray. Immediately place the aliquot tray in the -70° C freezer. The aliquots should freeze in an upright position so that the material does not freeze in the cap. Record the time these aliquots are placed in the freezer on the Biospecimen Collection form.

4.4. Stage Four: Processing of OGTT Plasma

Stage four will only be needed for participants who qualify and agree to take an OGTT. In this case, tube #9 is collected 2 hours after glucola was administered.

1. Within 15 minutes of collection, place tube #9 in the centrifuge. Balance the tube as described in 4.3 “Operating the Centrifuge”; then spin this tube at 3,000 x g for 10

minutes at 15° C. Remove the tube from the centrifuge and place in position 1A of aliquot tray 2.

2. Using a plastic transfer pipet and being careful not to disturb the red or white blood cell layers, remove the clear plasma supernatant from tube #9. Aspirate slowly starting at the top of the plasma (or just below the lipid layer if one is present on the top). The pipet tip does not get any closer than ¼ inch from the cell layer. Leave ¼ to ½ inch layer of plasma above the buffy coat/red blood cells. Place 0.2 mL of plasma into the 2 mL clear vial in positions A1 and distribute the remaining plasma equally into each of two 2 mL clear vials in positions B1 and C1 of sample aliquot tray 2. Fasten the clear screw caps onto these vials and place them in the freezer in an upright position in aliquot tray 1, row A with the other aliquots from this participant.
3. Re-stopper tube #9 and discard in a biohazard waste container.

4.5. Urine Collection and Processing

4.5.1 Urine Collection

A urine sample is collected from each participant (preferably) at the beginning of the clinical exam. After participants complete the Reception work station activities and are taken to change clothes, they are informed about the urine collection. The urine specimen is collected whenever the participant needs to void. If the participant has not voided by the time of the exit interview, the participant is asked to void at that time.

A specimen cup (labeled with the participant's ID), cup lid, and a TIME VOIDED label are provided by the staff member working with the participant at that time. The participant is instructed to:

1. void in the cup, filling it if possible, and place the lid securely on top of the container,
2. record the time of voiding on the label, and
3. bring the specimen cup back to the staff member, OR
4. place the sample container in a refrigerator designated for urine samples, and report to a staff member that the specimen has been collected, depending on locally approved OSHA regulations.

Bathrooms are equipped with a wall clock and pencils for participants to use in recording the time of voiding on the label. The staff member verifies the participant has written the "time voided" on the label, and assesses the adequacy of the sample for processing. At least 6 mL of urine is required for processing. If insufficient, the participant is requested to void again in a clean container prior to leaving the field center. A note is made on the participant's Itinerary Sheet that a second sample is needed by the staff person who observes the placement of the participant's urine specimen in the refrigerator. A note can also be made on the participant's first sample that a second sample is needed. The optimal time for the collection of the second specimen is after the snack when the participant is changing back in to street clothes. The instructions for providing the urine sample are repeated to the participant at that time.

Prior to processing, the laboratory staff records whether a urine sample was obtained and transcribes the collection time of the urine void from the ID label onto each participant's Biospecimen Collection form (Appendix 3, Items 27, 28, and 29).

Labeled urine samples should be placed in the designated specimen refrigerator for storage prior to processing and as soon as possible after the specimen has been voided. This can be done either by the participant or a staff member, as determined by local option. However, procedures need to be set up at each field center to verify that urine samples are not inadvertently left out at room temperature. Urine may be left at room temperature for a maximum of 4 hours.

Refrigerated urine samples need to be processed and frozen as soon as possible, and within 12 hours of collection. A comment is placed in Item 23 of the Biospecimen Collection form if a urine “sample has remained at room temperature for more than 4 hours”, or “is not processed and placed in the freezer within 12 hours of collection”.

4.5.1 Urine Processing

The technician prepares the work area by laying out a plastic transfer pipet and four 2 mL vials in the second aliquot tray. A Lab ID label is affixed to each specimen vial. ID labels are placed vertically on the vials, as on the blood vials.

Eye protection, gloves and lab coat must be used for all urine processing. All other rules regarding the safe blood specimen handling must be observed when processing urines.

1. Mix the urine container by inverting eight times.
2. Record the date and time of collection, the time of processing, and the processing technician's code on the Biospecimen Collection form (Appendix 3, items 28, 29, 30, and 31).
3. Prepare three different types of urine aliquots (5 total vials) as follows:
 - a. Neutral urine aliquots (3): Using the plastic transfer pipet, place 1.0 mL of urine in the vial in position A3 and 1.5 mL in the vials in position B3 through C3 of the second sample aliquot tray. (Use the “1.0 mL template” vial as a guide.) Fasten the yellow screw caps to these vials.
 - b. Acidified urine aliquot (1): Using the plastic transfer pipet, place 1.5 mL of urine in the vial in column 4 of the second sample aliquot tray. Using the MLA D-Tipper Pipetter, add 30 uL of 6 N hydrochloric acid into the vial. Fasten the green screw cap to the vial and gently mix by inverting 8 times. Place it back in the aliquot tray 2.

CAUTION: HCl is a corrosive poison. **WEAR GOGGLES WHEN PIPETTING.** Do not get in eyes, on skin, or on clothing. Wash thoroughly after handling. In case of contact: Immediately flush eyes and skin with water for at least 15 minutes. Remove the contaminated clothing. If inhaled: Remove to fresh air. Assist breathing if

needed. If swallowed: Wash out mouth with water. IN ALL CASES GET MEDICAL ATTENTION IMMEDIATELY. Follow your institution's policy for storage and disposal of this chemical.

- c. Alkaline urine aliquot (1): Using the plastic transfer pipet, place 1.5 mL of urine in the vial in column 5 of the second sample aliquot tray. Using the MLA D-Tipper Pipetter, add 30 uL of 1 N sodium carbonate into the vial. Fasten the orange screw cap to the vial and gently mix by inverting 8 times. Place it back in the tray. Some precipitate may form, which is normal.

CAUTION: Sodium carbonate is a corrosive poison. WEAR GOGGLES WHEN PIPETTING. Do not get in eyes, on skin, or on clothing. Wash thoroughly after handling. In case of contact: Immediately flush eyes and skin with water for at least 15 minutes. Remove the contaminated clothing. If inhaled: Remove to fresh air. Assist breathing if needed. If swallowed: Wash out mouth with water. IN ALL CASES GET MEDICAL ATTENTION IMMEDIATELY. Follow your institution's policy for storage and disposal of this chemical.

4. Immediately after processing, transfer the five urine aliquot vials to aliquot tray 1, row A in the -70° C freezer with the other aliquots from this participant.
5. Once the specimens are safely stored in the freezer, the urine remaining in the collection container may be discarded. The urine can be poured down a sink with copious amounts of water, or it can be flushed down a toilet. The empty collection container is discarded in accordance with local biosafety guidelines.

4.5.2 Procedures for Small Urine Samples

If the volume of urine sample is inadequate to process the four sample aliquots, check to see if a second sample was provided. If there is a second sample and it (in and of itself) is adequate for processing, use the second sample (record the time voided on the Biospecimen Collection form based on that sample) and discard the first sample. If neither is adequate, combine the specimens, and transcribe the latest voiding time on the Biospecimen Collection form. If there appears to be adequate urine for the neutral aliquots, split the sample into these two vials and comment in item 23 of the Biospecimen Collection form that the volume was insufficient for acid and alkaline aliquots.

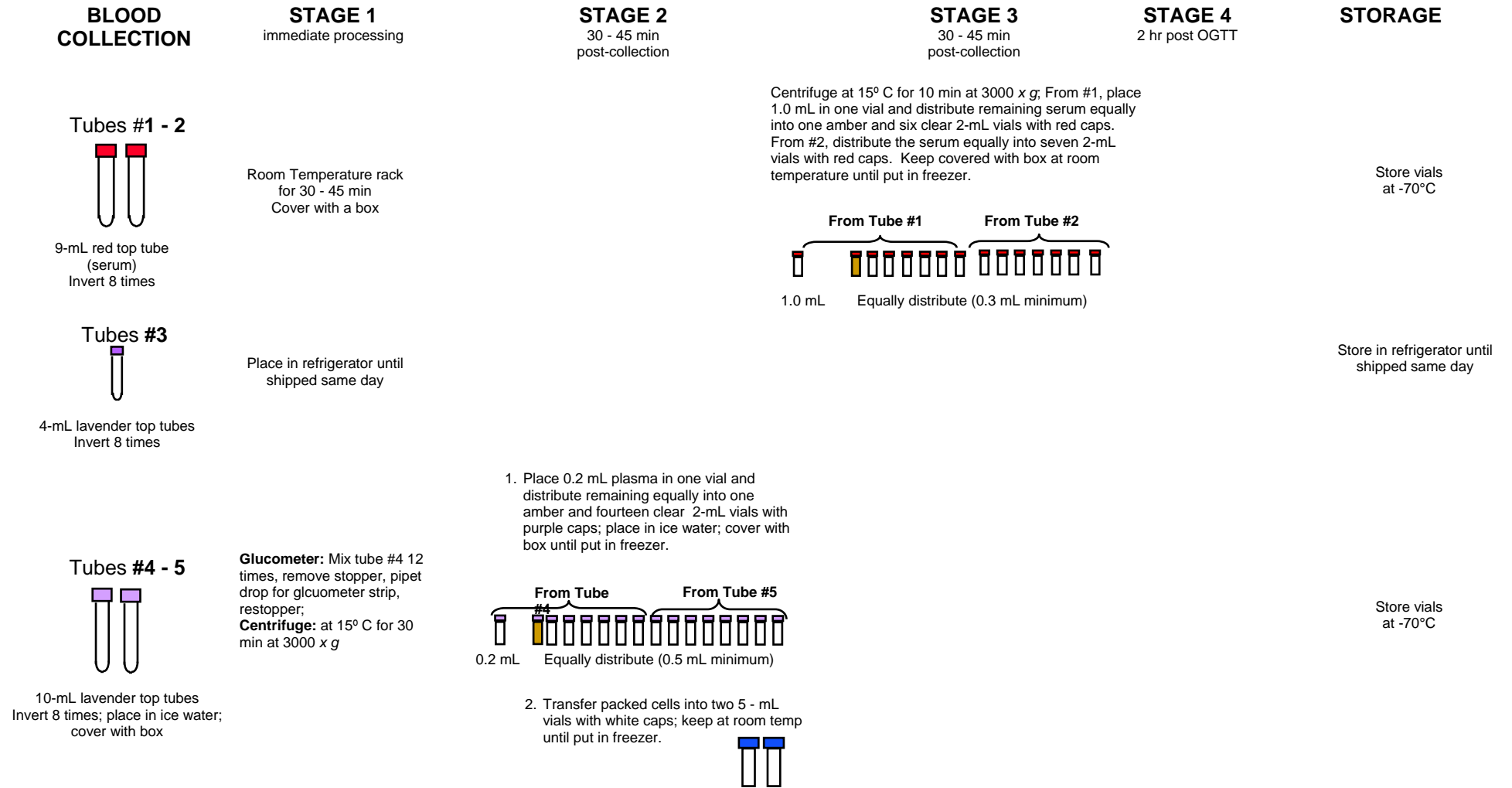
4.5.3 Procedures for Urine Samples Contaminated with Blood

Although urine samples contaminated with blood will affect the measurement of albumin, these specimens should not be thrown out. All urine samples collected from participants that have adequate volume for processing are kept, including those that are (appear to be) contaminated with blood. If a urine sample is contaminated with blood, ask the participant to provide a second urine sample at the end of the examination. Use the second sample if it has adequate volume and is less contaminated. Document urine blood contamination by entering the comment, "sample contaminated with blood" in Item 23 on the Biospecimen Collection form.

4.6. Overview of Specimen Collection

A summary overview of the protocol steps for the collection and processing of blood and urine specimens is presented in Figure 2. (Specimen Processing Flow Diagram)

Figure 2. HCHS - SOL Blood & Urine Processing Work Flow



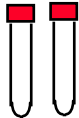
BLOOD COLLECTION

Tubes #6 - #7



4.5-mL blue top tube
invert 8 times

Tube #8 - #9



2.5-mL red top Paxgene tube
Invert 12 times

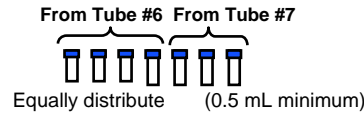
STAGE 1
immediate processing

Room temp rack; centrifuge at 15° C for 30 min at 3000 x g

Room temp rack for at least 4 hr; place tube in -20° C freezer for 24 hr; then transfer to -70° C freezer.

STAGE 2
30 min
post-collection

Equally distribute plasma into seven 2-mL vials with blue caps; keep at room temp until put in freezer.



STAGE 3
30 min
post-collection

STAGE 4
2 hr post OGTT

STORAGE

Store tube at -70° C

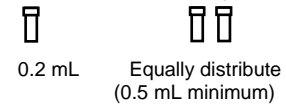
Store tube at -70° C after at least 4 hr at room temp plus 24 hr at -20° C

Tube #10



4-mL lavender top tubes
Invert 8 times
Draw 2 hr post OGTT

Centrifuge at 15° C for 10 min at 3000 x g; Place 0.2 mL plasma in one vial and distribute remaining equally into two 2-mL vials with clear caps.

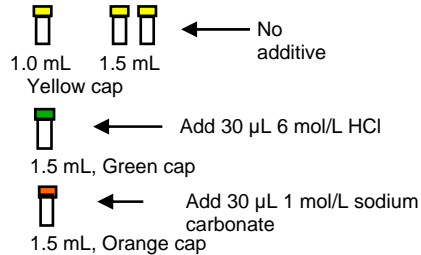


Store vials at -70° C

Grab urine collection



Refrigerate within 4 hr; Process within 12 hr; Invert container 8 times; transfer ~ 1.0 mL urine into one vial and 1.5 mL into four 2-mL vials.



Freeze within 12 hr of collection

Store vials at -70° C

Shipping to the Central Laboratory: **Vials and tube stored at -70° C → weekly on dry ice; Tube # 3 → daily, refrigerated**
(Complete HCHS Shipping Forms, Face sheet and Contents sheet, and include in dry ice shipment.)

Questions regarding this protocol can be answered by contacting the Central Laboratory at 612-273-3645

4.6.1 Freezing

When all of the blood and urine specimens have been aliquotted into their respective vials and the vials have been replaced in the sponge rack, the entire rack is placed upright in the -70° C freezer for a minimum of 30 minutes. Samples must be placed into the freezer within 90 minutes from venipuncture time. Samples must be thoroughly frozen before packaging them for storage and shipping. Record the time that the aliquots are placed in the freezer on the Biospecimen Collection form. Package the samples for each participant after tubes #8 and #9 have been placed at -70° C.

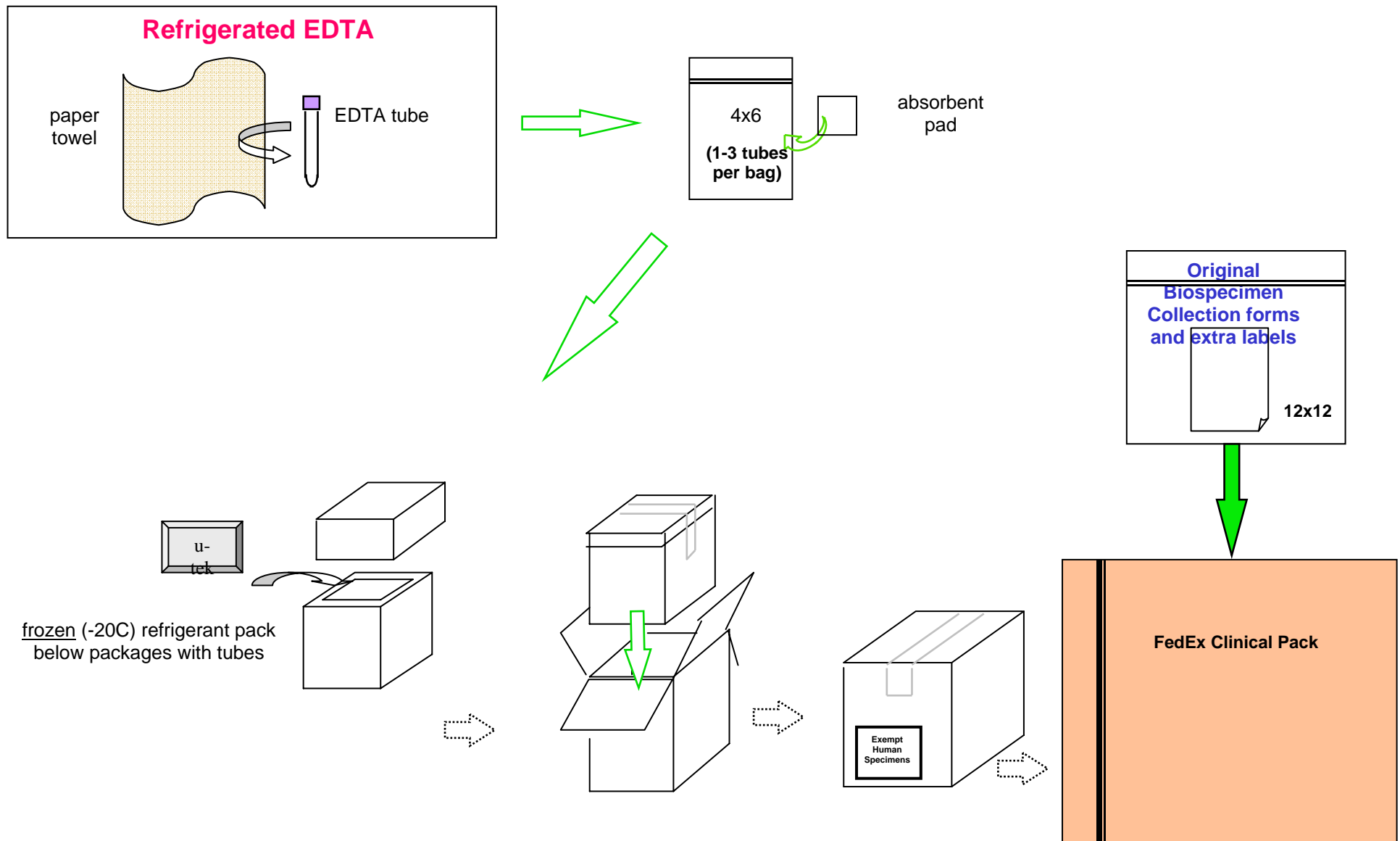
5. PACKAGING AND SHIPPING

Packaging and shipping instructions for refrigerated tube #3 (4 mL fasting EDTA) shipped daily (See Figure 3.)

5.1. Instructions

1. Check to be sure that each tube is properly labeled. Wrap each tube in paper toweling to cushion it and place in a 4" x 6" storage bag. (One to three patients per bag.) Include an absorbent square in each bag.
2. Place bags into a small Styrofoam cooler with a frozen gel pack (frozen at -20° C in the Styrofoam cooler) to keep the samples cold (not frozen) during shipment. Place bags with samples on top of frozen gel pack. If necessary, place packing material on top of the bags to fill the Styrofoam cooler. Place the Styrofoam cooler into its cardboard sleeve, and seal with tape to make sure the box does not come open.
3. Affix "Exempt Human Specimens" label to outside of box.
4. Place box in orange, plastic "FedEx Clinical Pack" mailing bag.
5. Insert the original Biospecimen Collection form for all participants collected this day, (even if tube #3 was not collected) into a 12" x 12" plastic bag and place it inside the "FedEx Clinical Pack" mailing bag. (Keep a copy for your files.) Also, place all extra labels for participants collected this day into this bag. (Remember to keep two labels, one for the 12" x 12" plastic bag used for the frozen aliquot shipment and one for the frozen shipment log.)
6. Peel off the right side of the FedEx billable stamp and affix it to the outside of the "FedEx Clinical Pack" mailing bag. Record the site address and telephone number in section 1. The left side of the form may be kept for your records. Contact Federal Express (1-800-GO-FEDEX) for pickup.
7. Send an e-mail message containing the tracking number and date of shipment to Annie Lukkari (alukkar1@Fairview.org), Naomi Hanson (nhanson1@Fairview.org), Mary VanHale (mvanhall@fairview.org) and Amanda Soyring (asoyrin1@fairview.org).

Figure 3. Refrigerated Sample Packaging



5.2. Storage, Packaging and Shipping (For Frozen Specimens)

Remove the sample aliquot tray from the -70° C freezer. Package quickly after this point to avoid thawing of the specimens and exposure to light. Each participant's serum, plasma, packed cells, urine samples, and Paxgene tubes are packaged in freezer storage bags according to their specimen type.

5.2.1 Packaging Frozen Specimens

Place the red-capped serum vials into one 4" x 6" storage bag, the purple-capped plasma vials into another 4" x 6" storage bag, the blue-capped plasma vials into a third 4" x 6" storage bag, and the clear-capped plasma vials into a fourth 4" x 6" storage bag. Place the blue-capped packed cells (5 mL vials) into a fifth 4" x 6" storage bag. Place all of the urine vials (regardless of cap color) into a sixth 4" x 6" storage bag. Wrap the Paxgene tubes #8 and #9 each in paper toweling to cushion them and place them in a seventh 4" x 6" storage bag. Check again to make sure all vials/tubes are labeled as they are placed into the storage bags. Add an absorbent pad to each bag of samples. Press the air out of each bag and seal. Place all seven of the sealed 4" x 6" bags into one 12" x 12" bag. Place the Lab ID# label for that set of aliquots on a piece of paper and insert it into the 12 x 12 bag so that it shows through. Expel the air from the bag and seal it. Place this bag in the Central Laboratory Styrofoam box in the -70° C freezer and do not remove it until the time of shipment. Complete the shipping log with appropriate information for these samples.

The bags of frozen sera, plasma, packed cells, urine samples, and Paxgene tubes are packed and shipped in Styrofoam boxes. Packaging instructions (See Figure 4) are as follows:

1. Place a layer of dry ice on the bottom of the Styrofoam box.
2. Put one-half of the 12" x 12" bags of sample vial/tubes into the Styrofoam box on top of the dry ice.
3. Layer more dry ice on top of and around the sample bags.
4. Put the remaining sample bags into the Styrofoam box on top of the dry ice.
5. Layer more dry ice on top of and around the sample bags. The amount of dry ice in the shipping should total at least 5 pounds.
6. Place packing material on top of the dry ice to fill the box.
7. Insert the paper shipping forms into a 12" x 12" bag and place on top of the packing material. The shipping forms with instructions are shown in Appendix 4.
8. Seal the box tightly with strapping tape. Affix "Exempt Human Specimens" label and a Fed-Ex dry ice label to outside of box. These labels are provided by the Central Laboratory.

9. Affix the FedEx airbill to the outside of the box. Record the site address and telephone number in section 1. (Do NOT use the billable stamp on dry ice shipments.) Contact Federal Express (1-800-GO-FEDEX) for pickup.

10. If necessary, more than one box may have to be shipped per week.

Send an e-mail message containing the tracking number and date of shipment to Annie Lukkari (alukkar1@Fairview.org), Naomi Hanson (nhanson1@Fairview.org), Mary VanHale (mvanhall@fairview.org) and Amanda Soyring (asoyrin1@fairview.org).

5.2.2 Shipping

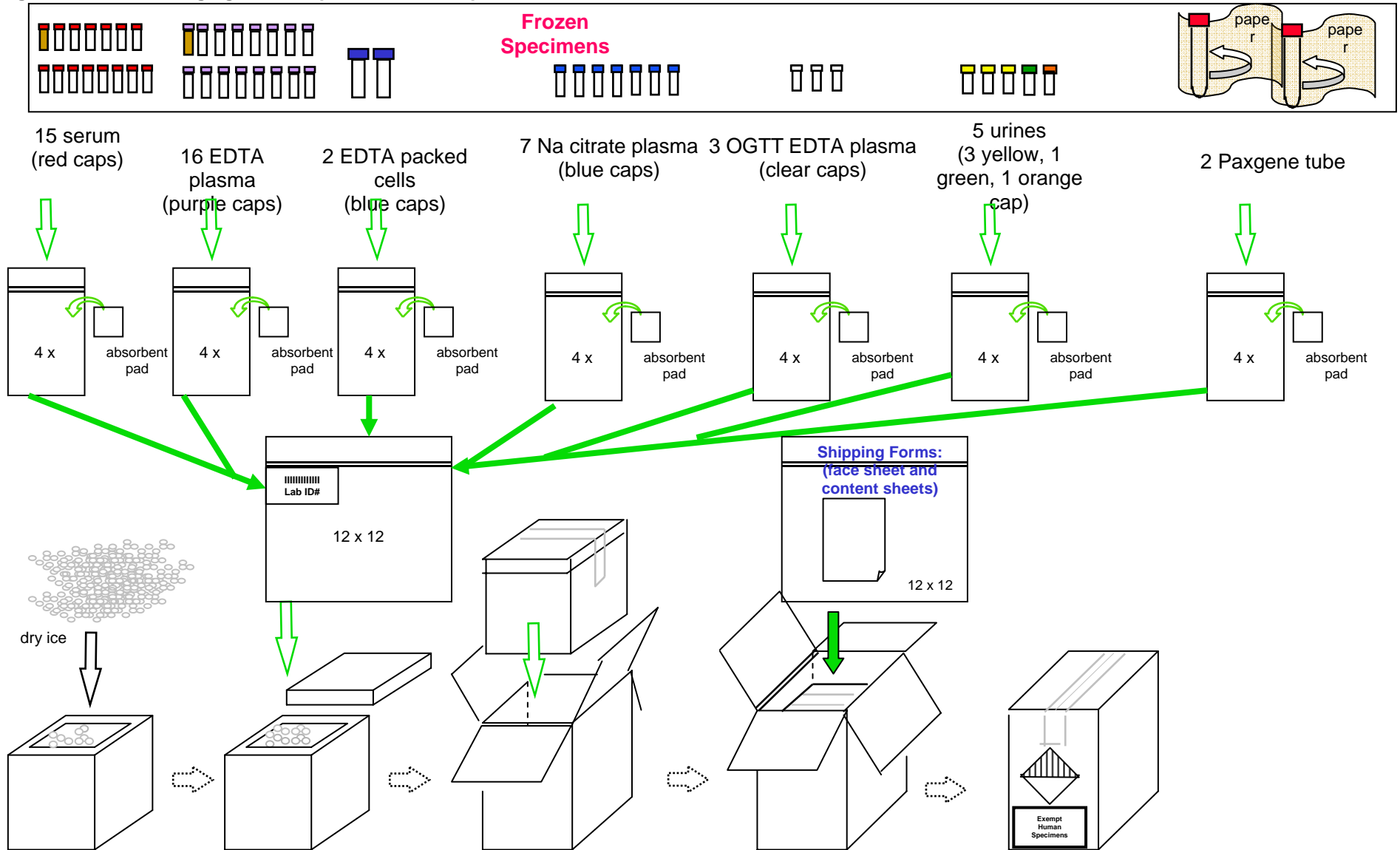
The samples remain in their Styrofoam box at -70° C until they are shipped. All frozen plasma, sera, packed cells, urine, and Paxgene tubes collected and stored within the last work week are shipped to the Central Laboratory on Monday with the exception of Quality Control aliquots, as discussed in the Quality Control section below. Samples can be shipped on Tuesday if the Field Center is closed on Monday, but the contact person at the Central Laboratory must be notified that the shipment will arrive one day later than usual. If very few participants were seen in the field center during a week, two or three weeks of specimens can be combined into one shipment. Notify the Central Laboratory if the weekly shipment is being held. Weigh all packages before shipping, if possible. It is important to record an accurate weight on the Federal Express airbill. Do not over-estimate the package weight.

Whenever a package is shipped to the Central Laboratory, Send an e-mail message containing the tracking number and date of shipment to Annie Lukkari (alukkar1@Fairview.org), Naomi Hanson (nhanson1@Fairview.org), Mary VanHale (mvanhall@fairview.org) and Amanda Soyring (asoyrin1@fairview.org).

All shipping containers are sent to the HCHS/SOL Central Laboratory by overnight courier to ensure receipt within 24 hours. The empty Styrofoam containers are recycled by returning them to the Field Centers via ground transportation. Shipping containers to the Central Laboratory are addressed as follows:

HCHS/SOL Central Laboratory
University of Minnesota Medical Center, Fairview
Room L275 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, MN 55455
Telephone: (612) 273-3645
Fax: (612) 273-3489

Figure 4. Packaging Frozen Specimens for Shipment



6. QUALITY CONTROL

There are two different aspects of quality control. One is the daily or monthly record of the performance of the refrigeration equipment, glucometer, and centrifuge. Daily and monthly measurements (e.g., temperatures) are recorded on a log, as described below. The other aspect of quality control is documentation of problems with blood collection and processing which is part of each participant's record. (See Appendix 3, Items 11, 12, 19, and 20, Biospecimen Collection form.)

- all or some blood samples not drawn
- tourniquet reapplied
- fist clenching
- needle movement
- incomplete blood collection causing missing tubes
- broken tubes
- clotted tubes
- hemolyzed serum or plasma
- lipemic serum or plasma
- other processing problems

This record provides documentation that blood was drawn in a standardized manner and that the equipment was functioning properly. This quality control documentation is the best evidence that samples in each of the four Field Centers are being drawn and processed identically. Differences in the way the samples are collected or processed could potentially create a significant difference in assay results, which could seriously compromise the laboratory test data. It is very important that the quality control records of the procedures and the equipment be properly maintained.

Daily, log the temperatures of the laboratory, all refrigerators, freezers, and refrigerated centrifuges (Appendix 5), and run the glucometer controls (Appendix 9). In addition, check and record the actual speed of the centrifuge annually with a tachometer. (This is usually performed by a biomedical engineer.)

6.1. Quality Control Duplicate Blood Samples

As part of the overall quality control program for laboratory determinations from blood and urine samples, duplicate specimens are sent to the laboratory, with one half of each specimen pair sent under the participant's regular HSHC-SOL laboratory ID number, and the other half under a Quality Control Phantom Participant (QC) laboratory ID number. The QC laboratory ID numbers are not distinguishable from other laboratory ID numbers so that this forms a blinded external quality control program monitoring measurement variability.

To reduce the burden on any single participant, extra blood is drawn from several participants and sent out under the same QC ID number. For data analysis, results on each laboratory measurement are matched to the appropriate participant results at the Coordinating Center from the QC Phantom ID Form (Appendix 6) that is completed by Field Center technicians.

If extra QC blood is drawn for a tube that is processed for weekly shipment (Tubes #1, 2, 4, 5, 6, 7, 8, or 10), the aliquots are stored at the Field Center for an extra week and then sent to the Central Laboratory with a regular shipment. (Note that a duplicate Paxgene tube #9 is not collected.) If extra QC blood is drawn for a tube that is processed for daily shipment (Tube #3), the tube is sent to the Central Laboratory with the regular daily shipment.

The QC blood samples are collected in sequential order (cycling back to Tube #1 after QC Tube #10 has been collected). Each Field Center will collect a QC samples from approximately 25% of the participants. QC samples are drawn daily. Initially, we will try to collect a QC sample from every participant to have more QC data available at the start of the study. After a period of time (to be determined by the QC Committee), we will ask each Field Center to collect QC samples on fewer participants.

An example plan for collecting the QC samples each day: From the first participant of the day, draw tubes #1 and #2; from the second participant of the day draw tube #3; from the third participant, draw tubes #4, and #5; from the fourth participant draw tubes #6 and #7; from the fifth participant draw tube #8; from the sixth participant draw tube #10; use a urine sample with sufficient volume to provide 2 sets of aliquots (one for the QC duplicate) from one participant each day. (This could be a urine from a participant who has also volunteered to donate additional blood.)

6.2. Blood and Urine QC Sample Checklist

The venipuncture technicians maintain a daily checklist posted in their work area of the QC samples to be drawn. As each sample is drawn and processing completed, it is checked off. An example of the checklist is given below.

Blood and Urine QC Sample Checklist

Date: _____

<u>Participant</u>	<u>Tubes</u>	<u>Aliquot Type</u>	<u>Sample collected? (Y/N)</u>
Participant 1	1 & 2	Serum	_____
Participant 2	3	Whole Blood	_____
Participant 3	4, & 5	Plasma, EDTA	_____
Participant 4	6 & 7	Plasma, sodium citrate	_____
Participant 5	8	Paxgene	_____
Participant 6	10	pOGTT plasma, EDTA	_____
Participant 7	Urine	Urine	_____

6.3. Preparation for Drawing and Processing QC Samples

Blood Drawing Tubes: Each morning (or the afternoon before) the blood drawing technician(s) prepares the extra blood collection tube(s) for the QC sample(s) to be drawn that day. Each tube is labeled with the QC ID number to be used that day. In addition, the technicians may wish to mark QC blood drawing tubes "QC" in a clearly visible fashion, to reduce the chance that these tubes might be mixed up with the regular blood collection tubes during processing. However, this should not be done for tubes #3 or #8 which are sent to the Central Laboratory in the

collection tube. The QC tubes are set in the same rack used to hold the regular blood collection tubes, in a separate row from the other tubes.

Sample Aliquot Tubes: Each morning (or the afternoon before) a separate sample aliquot tray is prepared for the QC blood vials that the technician will process that day. The tray contains all the aliquot vials needed to process the day's quality control sample. The tubes in each block are labeled in advance with the QC ID number being used that day. Care must be taken during processing that the labels on the sample aliquot tubes match the label on the QC blood collection tubes.

For the duplicate urine sample, four extra tubes for the urine QC duplicates are set out and labeled with the urine QC ID number. A participant's sample with adequate urine volume to provide duplicate aliquots is chosen for the QC sample.

6.4. Collecting and Processing QC Blood and Urine

Selecting Participants for QC Blood Draw: Initially, a QC sample will be collected from the first 6-7 participants of the day. Based upon the size of their veins, the difficulty of drawing the blood, and the apprehension a participant shows about the blood draw, the venipuncture technician may forego the drawing of the QC tube from certain participants. (After a specific number of QC sample sets are collected from each field center as determined by the Coordinating Center, the frequency of participant QC collections will decrease.)

Order of QC Tubes in Relation to Regular Blood Collection: Draw the QC tubes after the other tubes have been collected. This procedure is followed to cause the least disruption of the collection of the regular blood samples. If the blood flow falls off at the end of the draw, so that it would be difficult to obtain the extra QC tubes, a different participant is used to get this blood. **DO NOT PERFORM A NEW NEEDLE STICK JUST TO GET MORE BLOOD FOR A QC SPECIMEN. DO NOT REAPPLY THE TOURNIQUET AFTER INITIAL RELEASE.**

Processing and Freezing QC Blood: Process the QC blood samples along with the regular blood samples. After processing is completed for each QC blood collection tube, the sample aliquot tubes are put into the -70° C freezer (for a minimum of 30 minutes) with the exception of QC tubes #3 and #8. QC tube #3 is placed in the refrigerator and shipped the same day with its matched participant pair. QC tube #8 is stored identically to the regular Paxgene tubes, i.e. keep at room temperature for at least 4 hr, then at -20° C for 24 hr and finally, at -70° C. After the samples are thoroughly frozen, they are put into a freezer storage bag and put into the freezer box. Keep the QC specimens separate from the other specimens collected during the week so they are not shipped along with them.

The four urine QC samples are placed into the freezer at the same time as their matched participant pair. As with the blood specimens, the urine samples are kept away from the other urines collected during the week so they are not included with that week's shipment.

Biospecimen Collection form: This form is completed for the QC phantom set of samples. However, it is not possible to complete this form truthfully since the set is collected from

multiple participants. It is suggested that the information from the participant to donate tube #3 is used to complete the form for the QC set.

Logging the Match between QC and Regular HCHS/SOL ID's and Reporting these to the Coordinating Center: The QC Phantom Participant's folder is kept in the blood drawing area. In the folder is the HCHS/SOL Quality Control Phantom Participant Form (see example in Appendix 6), which is used to keep track of the match between the QC and regular HCHS/SOL specimens. At the top of the log sheet is a space for the QC Phantom Participant's laboratory ID number. As participants donate blood to make up a QC set, labels with their participant ID numbers (not their Lab ID#) are added to the line corresponding to the tubes donated. This step must be done immediately after completion of drawing blood for that participant, to minimize the chance of recording the wrong ID number. One such form is recorded for each QC ID number used. As soon as the full set of tubes is completed for each phantom participant, the QC phantom participants' folder with this form is given to the receptionist (or other person designated by the Study Coordinator). The folder is processed like other participants' folders, with the QC phantom participant form transferred to the Coordinating Center by keying the Phantom form (PHT) into the data management system. Do not send a hardcopy of the Phantom form (PHT) to the Central Laboratory because it will unblind the masked QC analysis of the samples. A Biospecimen Collection form is also completed for the phantom duplicate.

6.5. Internal Laboratory Control

Internal quality control procedures monitor analytical performance of the test relative to medical goals and alert analysts to unsatisfactory analytical performance. Quality control statistics are used to make judgments about the quality of analytical results, whether system correction is necessary, whether patient data should be accepted or rejected, and for estimating performance parameters which can be compared to analytical and medical goals. Testing is monitored by two control samples analyzed daily in each batch of samples. A permanent standard deviation (SD) and coefficient of variation (CV) is determined by analyzing the material on 50 – 100 separate days. The mean for new lots of material is established by analyzing the material on 20 separate days. The SD and CV from the data collected over 20 days is used to monitor the permanently established SD. Quality control results are plotted on Levy-Jennings plots and acceptability (i.e. in statistical control) is determined using three Westgard rules (1-2s, 1-3s, and 2-2s).

Documentation is made on the control charts when there is a change in reagent lot numbers, any action is taken due to unacceptable control results, and when other pertinent information is observed.

6.6. Reporting Results

The Central Laboratory has the responsibility for reporting results to the Coordinating Center. All test results are transmitted to the Coordinating Center through file transfer protocol (FTP) or use of a Coordinating Center upload facility that is accessed through the web based DMS. This transmission will occur daily, Monday through Friday. In order to see if the Coordinating Center has received and processed the lab results for a participant, the field center can run the “End of Study Availability Report” using the HCHS/SOL data management system. The availability report summarizes the receipt of information from the Central Laboratory and reading centers. Tests reported to the participants will be available to the field centers via a report in the DMS

called the “End of Study Report”. Any tests included in this report whose results exceed their alert range will be flagged appropriately. In addition, any alert result on a test not normally reported to the participants will be included in a separate upload. Reference ranges and alert values can be found in Appendix 1. Note that CBC, differential, and platelet count results will be available in 4-5 days and all other test results will be available in approximately 3-4 weeks after the sample is collected.

7. TRAINING PROCEDURES

Technicians will be trained in actual procedure of phlebotomy by their respective institutions. The study does not provide phlebotomy training.

A check list of the venipuncture and processing procedures that HCHS/SOL technicians must know and be prepared to demonstrate is listed in Appendix 7. The technician must study the HCHS/SOL Specimen Collection and Processing Manual and watch a few participant samples being processed. Then the technician may proceed to a mock drawing and mock processing of samples, without performing any actual venipuncture. Mock venipuncture is performed with the Vacutainer system. A piece of latex tubing with a knot in one end leading to a glass of water is used as a target vein. Practice tubes are collected in the correct order, and then placed at their proper positions. The sample is processed from start to finish exactly as if real blood were being used. Each technician performs a minimum of two mock draws from beginning to end.

Although the mock draws take time, they provide hands-on experience and allow the technician to become comfortable with the procedures before proceeding to live participants.

At this point the technicians are ready to practice on live volunteers. The technicians practice at least once with just one volunteer at a time and again process the blood entirely by themselves from start to finish. If the technicians do not feel comfortable, they can always go back and repeat the process with dummy tubes. If volunteers are available, it may be beneficial to repeat this several times. Any questions or problems that the technicians have must be solved before the technicians actually proceed to drawing the HCHS/SOL participants. Before the technicians draw blood from any HCHS/SOL participant, they must take and pass the practical and written tests included at the end of this manual (Appendix 8). After passing the test and depending on the written evaluation of their instructor, they may proceed either to drawing blood from the HCHS/SOL participants as part of a team, or do more practice on live volunteers.

8. SNACK

A light snack for the participant is scheduled as soon as possible after venipuncture. Make sure that this is provided only after the 2 hour OGTT blood collection (tube #10) has been collected. Menus are locally determined.

Appendices

Appendix 1 Laboratory Tests, Reference Ranges, and Alert Values

<u>Test Name</u>	<u>Reference Range</u>	<u>Units</u>	<u>Alert Value</u>
*Hemogram (CBC):			
White Blood Count (WBC)	4.0-11.0	x 10 ⁹ /L	<2 and >25
Red Blood Count (RBC) – male	4.4-5.9	x 10 ¹² /L	
Red Blood Count (RBC) – female	3.8-5.2	x 10 ¹² /L	
Hemoglobin - male	13.3-17.7	g/dL	<8 and >20
Hemoglobin - female	11.7-15.7	g/dL	<8 and >20
Hematocrit – male	40.0-53.0	%	
Hematocrit – female	35.0-47.0	%	
Mean Corpuscular Volume (MCV)	78-100	fL	
Mean Corpuscular Hemoglobin (MCH)	26.5-33.0	pg	
Mean Corpuscular Hemoglobin Concentration (MCHC)	32-36	g/dL	
Red Cell Distribution Width (RDW)	10.0-15.0	%	
*Platelet Count	150-450	x 10 ⁹ /L	<50 and >1000
WBC Differential:			
Neutrophils	40-75	%	
Lymphocytes	20-48	%	
Monocytes	0-12	%	
Eosinophils	0-6	%	
Basophils	0-2	%	
Absolute Neutrophils	0.6-8.3	x 10 ⁹ /L	
Absolute Lymphocytes	0.8-5.3	x 10 ⁹ /L	
Absolute Monocytes	0-1.3	x 10 ⁹ /L	
Absolute Eosinophils	0-0.7	x 10 ⁹ /L	
Absolute Basophils	0-0.2	x 10 ⁹ /L	
*Total cholesterol	<200	mg/dL	>360
*Triglycerides	<150	mg/dL	>1000
*HDL-cholesterol	#	mg/dL	<20
*LDL-cholesterol, calculated	#	mg/dL	>260
*Glucose, fasting	60-99	mg/dL	<50 and >400
Glucose, post OGTT	0-139	mg/dL	
*Glycosylated Hemoglobin	4.3-6.0	%	
Insulin, fasting	2-25	mU/L	
Insulin, post OGTT	NA	NA	
Alanine aminotransferase (ALT), male	0-66	U/L	
Alanine aminotransferase (ALT), female	0-44	U/L	
Aspartate aminotransferase (AST), male	0-52	U/L	
Aspartate aminotransferase (AST), female	0-42	U/L	
hsCRP	0-5	mg/L	
*Creatinine, male	0.5-1.2	mg/dL	>2.0
*Creatinine, female	0.4-1.1	mg/dL	>2.0
*eGFR	>60	mL/min/1.73m ²	
*Albumin/creatinine ratio	0-20	mg/g creatinine	
*Iron, male	45-160	ug/dL	
*Iron, female	30-160	ug/dL	
*Total Iron Binding Capacity (TIBC)	228-428	ug/dL	
*Transferrin saturation	15-50	%	
* Hepatitis A total antibody	negative	NA	
*Hepatitis B surface antibody	negative	NA	positive is reported to Dept of Health
*Hepatitis B core antibody	negative	NA	positive is reported to Dept of Health
*Hepatitis B surface antigen	negative	NA	positive is reported to Dept of Health
*Hepatitis C antibody	negative	NA	positive is reported to Dept of Health
*Hepatitis C RNA	<25	IU/mL	
*Hepatitis C RNA	<1.4	Log IU/mL	

#Reference ranges for these tests are given in the form of a comment accompanying all result reports: National Cholesterol Education Program guidelines suggest that : 1) LDL-cholesterol values less than 100 mg/dL are optimal, 100-129 mg/dL are near or above optimal, 130-159 mg/dL are borderline high, 160-189 mg/dL are high. 190 mg/dL and above are very high; and 2) HDL-cholesterol values below 40 mg/dL are undesirable. (JAMA 2001; 285:2486-2497).

*These tests will be reported to the participants.

Appendix 2 Equipment and Supplies

Supplies to be supplied by the Central Laboratory:

Description

Microvials, clear (2 mL) 500/pk
Microvials, amber (2 mL) 500/pk
Red Screw Caps 1000/pk
Yellow Screw Caps 1000/pk
Purple Screw Caps 1000/pk
Blue Screw Caps 1000/pk
Clear Screw Caps 1000/pk
Green Screw Caps 1000/pk
Black Screw Caps 1000/pk
Screw Top Vials (5 mL) 1000/pk
White Screw Caps for 5 mL Vial 1000/pk
Vacutainer Tubes 100/pk
Serum, red top, 9 mL
EDTA, lavender top, 10 mL
EDTA, lavender top, 4 mL
Sodium citrate blue top, 4.5 mL
Paxgene Tube, 2.5 mL

FedEx mailing bags

FedEX pre-printed shipping labels

Dry ice shipping labels

Exempt Human Specimens label

Glucose strips and controls for screening

Supplies to be obtained by the Field Center:

Supplier	Catalogue No	Description
Cardinal Health	B3036-4	Butterfly Needles, 21G x 3/4", #367250
Cardinal Health	B3035-12	Luer Adapters, #367290
Cardinal Health	40000-110	Alcohol Swabs 2,000/cs
Cardinal Health	KC913A	Gauze Sponges 200/pk
Cardinal Health	JJ5644	Band Aids 100/pk
Cardinal Health	367203	Tourniquets, Latex free, 50/pk
Cardinal Health	364815	Vacutainer Tube Holders 1000/cs BD #364815
Cardinal Health	P5214-12	Transfer Pipettes 500/pk
Cardinal Health	SBE2R46	Ziplock Freezer Bags 4" x 6" 1000/pk, 5000/cs
Cardinal Health	SBE2R1212	Ziplock Freezer Bags 12" x 12" 5000/cs
Heathrow Scientific	HS21645A	Polyester Foam Tube Rack, 50 wells, 6/pk
Cardinal Health	C3521-01	Polyester Foam Tube Rack, 50 wells, 6/pk, #0010
Cardinal Health	B3062-40	PDI Ammonia Inhalant
Cardinal Health	C8827-24	Grab Urine Collection Container
Cardinal Health	B2922-1A	Blood Collection Trays
Cardinal Health	T2050-1	Thermometers -20 C-+110 C
Cardinal Health	M1050-7	50 mL Absorbent Pads for shipping
Cardinal Health	B1900-18	Harvard Trip Balance (Ohaus 1550SD)
Cardinal Health	C6510-1	Timer- 3 channel digital
Polyfoam Packers/ ThermoSafe	398	Styrofoam shipping box, (Est. 25-30 frozen samples sets)
Polyfoam Packers/	352	Styrofoam shipping box, (Est. 28-30 frozen samples sets)

ThermoSafe Polyfoam Packers/ ThermoSafe Polyfoam Packers/ ThermoSafe Polyfoam Packers/ ThermoSafe Cardinal Health	601 602 429 M1067-6	Styro specimen mailer (6 x 3 x 2.5 in.) (daily refrigerated shipments) Cardboard sleeve for specimen mailer UTEK gel pack, 8 oz. UTEK gel pack, 8 oz. Dry Ice (approximately 5-10 lbs. per shipment) Packing Material
Cardinal Health	P5065-30 (30uL), #1143C	MLA D-Tipper Pipetter, Fixed Volume pipetter
Cardinal Health	P5064-902	MLA pipette tips, #9025 3M, Scotch brand 3750 clear packaging tape
Fisher Scientific	SA56-500	6.0 N HCL, 500 mL
Fisher Scientific	SS148-1	1.0 N sodium carbonate, 1L
Fisher Scientific	BC00515	Chemstrip K (ketone strip), 100/vial
Fisher Scientific	02-675-275	Diascreen 1k (ketone strip), 50/vial
Fisher Scientific	23-029-375	Sentry Urinalysis Control, 2 levels x 25 mL each
Fisher Scientific	02-675-289	Diascreen Liquid Urine Control, 2 x 12 mL each

Equipment purchased and maintained by Field Centers:

Table-top centrifuge with swinging buckets, refrigerated, and capable of producing 3,000 x g

Freezer capable of maintaining -70° C with a minimum of 5 cu ft storage

Freezer capable of maintaining -20° C for storing Paxgene (16 x 100 mm) tube upright. (NOTE: This must be a manual defrost model – not a frost-free model.)

Refrigerator 4° C for storing urine containers and 4 mL EDTA tubes prior to shipping.

Appendix 3 Partial Biospecimen Collection Procedure

Participant Sample Set

1. If a full set of biospecimen collection tubes/urine can not be obtained after 2-3 attempts, determine if the HCHS participant is willing to return for a (fasting) re-collection appointment. Insert a comment on item #15 of the Biospecimen Collection Form that the participant will be coming back for a re-collection at another date. If the participant is unwilling to come back for a re-collection then state on item #15 of the Biospecimen Collection Form that the biospecimen set on this participant is a partial collection and no other specimens will be obtained and proceed to shipping.
2. Send Tube #3 (daily shipment) to the Central Laboratory whether or not some or all of the other biospecimen collection tubes/urine can not be obtained. (If tube #3 was not collected, send the Biospecimen Collection Form completed as describe in #1 above in the daily shipment.)
3. If the participant is scheduled for a re-collection appointment, process all of the collection tubes/urine that were obtained as directed in the Biospecimen Collection and Processing Manual and save them in a designated location in the freezer. DO NOT send the incomplete frozen biospecimen set to the Central Laboratory if the participant is coming back for a re-collection appointment.
4. Assign a new Lab ID to the HCHS participant for the re-collection appointment. Attempt to re-collect the entire sequence of biospecimen collection tubes/urine, including Tube #3.
5. Choose the most complete biospecimen set; either the biospecimen set that was obtained at the first visit or the biospecimen set that was obtained at the re-collection appointment. DO NOT combine biospecimens from both sets to make a full set.
6. If the biospecimen set from the first visit is the most complete, then send this set to the Central Laboratory and indicate on the Frozen Contents Sheet that this biospecimen set is incomplete and no other specimens will be obtained. Tube #3 was already sent to the laboratory on the day of the first visit. Discard the other incomplete biospecimen set from the re-collection appointment. For the Field Center records, save the Biospecimen Collection Form from the re-collection appointment but insert a comment on item #15 that the biospecimens were discarded and the biospecimens from the first visit were sent to the Central Laboratory.
7. If the biospecimen set from the re-collection appointment is the most complete, then ship this set to the Central Laboratory and send Tube #3 and the new Biospecimen Collection Form to the laboratory. Insert a comment on item #15 of the Biospecimen Collection Form that this participant had a re-collection. The new Lab ID number will be entered in place of the old Lab ID number from the first incomplete visit into the field center's data management system. Discard the incomplete biospecimen set from the first visit. For the Field Center records, save the Biospecimen Collection Form from the first visit but insert a comment on item #15 that the participant was re-collected and assigned a new Lab ID number and the first set of biospecimens were discarded.
8. The time limit for re-collection appointments is one month. If the participant can not be re-collected within one month, then send the first set of incomplete biospecimens to the Central

Laboratory. Indicate on the Frozen Contents Sheet that this biospecimen set is incomplete and no other specimens will be obtained.

9. Once a set of frozen biospecimens from a HCHS participant is sent to the Central Laboratory, no other biospecimens from this participant can be sent on another date.
10. Contact the Central Laboratory if any unusual circumstances or questions arise with any biospecimen collections.

Phantom QC Sample Set

1. If a full Phantom QC sample set can not be obtained, a partial Phantom QC sample set is acceptable. The following guidelines should be observed.
2. One of Tube #1 or Tube #2 must be completely (100%) full. A partially filled second tube is acceptable to provide as much serum as possible.
3. Tube #3 is acceptable if it is at least 50% full (2 mL).
4. One of Tube #4 or Tube #5 must be completely (100%) full. A partially filled second tube is acceptable to provide as much plasma as possible.
5. One of Tube #6 or Tube #7 must be completely (100%) full in order to maintain the proper ratio of blood to liquid anticoagulant. A partially filled second tube should be discarded.
6. Tube #8 must be completely (100%) full. This tube must be completely full in order to maintain the proper ratio of blood to liquid anticoagulant and preservative.
7. Tube #10 is acceptable if it is at least 50% full (2 mL).
8. The urine aliquots must be completely full since it is simple to select a urine sample with adequate volume.

Appendix 4 Shipping forms

SHIPPING FORMS INSTRUCTIONS

There are two types of shipping forms: (1) the face sheet and (2) the contents sheet. Both forms are included in every frozen shipment. (A copy of the Biospecimen Collection form is sent with the daily refrigerated samples.)

FACE SHEET

The FACE SHEET is a two part form. Part One, on the top of the page, is completed by the Field Center. Part Two, on the bottom of the page, is completed by the Central Laboratory.

The NAME AND ADDRESS of the SHIPPER (Field Center) and the RECIPIENT (central laboratory) is printed on each shipping form.

The date and time the SHIPMENT was PACKED AND SEALED is recorded.

The STARTING and ENDING DATE of the REPORTING PERIOD is recorded.

The TOTAL NUMBER OF SPECIMENS ENCLOSED in the shipping container is confirmed by the Field Center technician by counting specimen bags and the total number of specimens within them.

The NUMBER OF CONTENTS PAGES ATTACHED is recorded. This varies depending on the number of samples in the shipment.

Remarks (peculiarities) about the shipment are written in COMMENTS CONCERNING SHIPMENT CONTENTS.

The INITIALS OF THE PERSON COMPLETING PART ONE OF THE SHIPMENT FORM are recorded.

Part Two of the SHIPPING FORM is completed by the receiver (e.g. the Central Laboratory).

The date and time the SHIPMENT ARRIVED at the Central Agency is recorded.

COMMENTS on the CONDITION of the SHIPMENT upon ARRIVAL are recorded, such as "shipment totally thawed."

The INITIALS OF THE PERSON COMPLETING PART TWO OF THE SHIPMENT form are recorded.

CONTENTS SHEET

The contents sheet lists the complete inventory of tubes in a given shipment. The original form is sent to the Central Laboratory with the specimen shipment, and a copy is filed at the Field Center. More than one contents sheet may be used in each shipment, depending on the number of specimens enclosed. The number of pages attached and each page number are filled in at the top of the contents page (e.g. "page 1 of 5"). This form is filled out at the Field Center as the specimens are collected and stored. This form must be checked against the specimens when packed for shipment.

The SPECIMEN ID number is entered in the left hand column of the contents sheet. This is most easily done by attaching one of the adhesive specimen ID number labels in the space provided. This is done at the time of collection. It is suggested that a second person check these IDs against the IDs on the vials to correct any errors.

The tubes comprising a complete sample are listed in the upper left hand corner of the sheet. Under the category SPECIMEN COMPLETE?, YES or NO is marked for each participant to indicate whether the correct number of tubes has been shipped. If there is some deviation from the correct count, "NO" is marked, and a description of the problem follows in the column headed MISSING VIALS. The number of missing tubes and the color of their caps is recorded here.

COMMENTS on the quality of the specimens upon receipt are recorded at the agency receiving the specimens. These are optional, but are Participant ID number specific, such as tube broken, thawed, etc.

Face Sheet
HCHS/SOL SHIPPING FORM
PART ONE (To be completed at Field Center)

TO: HCHS/SOL Central Laboratory
University of Minnesota Medical Center, Fairview
Room L275 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, MN 55455

FROM: Name and address of Field Center printed here.

SHIPMENT PACKED AND SEALED:

AM

TIME: __: __ PM DATE: __/__/__.

REPORTING PERIOD: STARTING DATE: __/__/__

ENDING DATE: __/__/__

TOTAL NUMBER OF SPECIMENS ENCLOSED: _____

NUMBER OF CONTENTS PAGES ATTACHED: _____

COMMENTS CONCERNING SHIPMENT CONTENTS:

INITIALS OF PERSON PACKING AND COMPLETING SHIPPING FORMS: _ _ _

PART TWO (To be completed at Central Laboratory)

SHIPMENT ARRIVED AT CENTRAL LABORATORY:

AM

TIME: __: __ PM DATE: __/__/__.

COMMENTS ON CONDITION OF SHIPMENT ON ARRIVAL:

INITIALS OF PERSON UNPACKING SPECIMENS: _ _ _

HCHS/SOL Central Laboratory
 University of Minnesota Medical Center, Fairview
 Room L275 Mayo Memorial Building
 420 Delaware Street S.E.
 Minneapolis, MN 55455

Complete frozen sample for each participant includes 7 bags containing:

- | | |
|--------------------------------|--|
| 7-blue top microvials | 15-red top microvials |
| 16-purple top microvials | 3-clear top microvials |
| 2-5 mL blue top (packed cells) | 5-urine microvials (3-yellow, 1-green, 1-orange) |
| 2-Paxgene tubes | |

SPECIMEN ID	SAMPLE COMPLETE?		MISSING VIALS		COMMENTS
	YES	NO	#	COLOR	

[Place Lab ID
label here]

Appendix 5 Instructions for Use of SureStepPro Glucose Meter

(Refer to SureStep Owner's Booklet for detailed instructions)

1. Maintenance
 - a. Perform once every 24 hours (at end of day) on days when the meter is used.
 - b. Remove strip holder, clean strip holder and optics with water. Dry with tissue.
 - c. Document cleaning on QC record sheet.
2. Perform QC Test
 - a. Record test strip lot number, code and expiration date on the QC record sheet. Also record lot number and expiration date of controls.
 - b. Analyze controls daily in A.M. before specimens are run. Also analyze controls if the battery has been changed in the instrument, when test result conflicts with clinical symptoms, when trouble shooting the system, or when starting strips with a different code number.
 - c. Turn meter on by pressing blue button.
 - d. Check that the code number displayed matches the strip code number. To change the code number, press the green button on the side of the meter until the correct code number is displayed.
 - e. Gently shake bottle and apply control to pink square of test strip. Check confirmation dot on reverse side to ensure there is a uniform blue dot. Two minutes is allowed from application until strip must be inserted.
 - f. With the pink pad up, insert all the way until the strip stops.
 - g. Record the control result on the QC sheet. Check that result is in range. If out of range, repeat.
 - h. Turn meter off by pressing blue button (or it will automatically turn off after 3 minutes).
 - i. Repeat testing with other control.
3. Perform Patient Test.
 - a. Turn meter on.
 - b. Check that the code number displayed matches the strip code number. To change the code number, press the green button on the side of the meter until the correct code number is displayed.
 - c. Mix the tube of blood (Tube #4) by inverting 12 times and remove the lavender stopper.
 - d. Using a plastic dispo pipette, place a drop of blood from the stopper on the pink square of the test strip. Check confirmation dot on reverse side to ensure there is a uniform blue dot.
 - e. Record result on the participant's Biospecimen Collection form (Item A4). If above 150 mg/dL, exclude this participant from the OGTT.
 - f. Meter will display HIGH if results >500 mg/dL. If this occurs, record 500 on the form.
 - g. Turn meter off by pressing blue button.
4. Reagents/Supplies
 - a. SureStepPro Complete Blood Glucose Monitoring System and Owner's Booklet, Lifescan.
 - b. SureStepPro Test Strips, Lifescan B5375-6BV. Store test strips tightly capped in original bottle in a cool, dry place at room temperature (below 30°C). Protect from heat and direct sunlight. Do not refrigerate or freeze. Discard 4 months after opening or after expiration date printed on bottle label.
 - c. SureStepPro High Lifescan B5375-3 and Low Lifescan B5375-5 Glucose Control Solutions - Store at room temperature (below 30°C). Do not refrigerate or freeze. Discard 3 months after opening or after expiration date printed on vial label.

Appendix 6 Urine Ketone Procedure

1. Pour 1 mL of well-mixed, room temperature urine into a tube.
2. Completely immerse the entire reagent area of the strip in the urine aliquot. Remove the reagent strip immediately. While removing, run the edge of the reagent strip against the side of the tube to remove excess urine.
3. Hold strip close to the color block on the strip container.
4. Read the test at 15 sec for the Chemstrip K or at 60 sec for Diascreen 1K strips
5. Perform a normal and abnormal QC strip each day that a ketone test is performed on a participant.
6. Reagents/Supplies:
 - a. Ketone strip (either strip may be used):
 - 1) Chemstrip K (ketone strip), 100/vial from Fisher Scientific, part #BC00515. This strip has a shelf-life of up to 2 years opened or unopened.
 - 2) Diascreen 1K (ketone strip), 50/vial from Fisher Scientific, part #02-675-275. This strip has a shelf-life of 18 months opened or unopened.
 - b. QC material
 - 1) Sentry Urinalysis Control, 2 levels x 25 mL each from Fisher Scientific, part #23-029-375. This material may be used with either Chemstrips or Diascreen strips and can be used until the expiration date on the package if stored at 2-8° C when not in use.
 - 2) Diascreen Liquid Urine Control, 2 x 12 mL each from Fisher Scientific, part #02-675-289. This material should only be used with Diascreen strips and expires 90 days after the bottle is opened. Unopened bottles have a typical expiration date of up to 1 year.

Appendix 7 Aliquot Tray (sponge rack) Cleaning Procedure

NOTE: Wear safety glasses and gloves for this procedure.

1. Perform this procedure weekly or sooner if there is noticeable contamination.
2. Make a solution of 10% bleach by adding 1 part of household bleach to 9 parts of tap water in a bucket. Make this fresh each week.
3. Submerge the racks in the bleach solution and squeeze in and out 5 times.
4. Rinse under running tap water. Squeeze the racks under running tap water 10-20 times.
5. Squeeze out any remaining liquid and air dry overnight.