Appendix

SPECIMEN COLLECTION PROCEDURES
BLOOD, ARTERIAL: RADIAL ARTERY

Equipment

The necessary equipment for an arterial puncture is usually available as a packaged, sterilized set.

Antiseptic—povidone-iodine
Local anesthetic—lidocaine hydrochloride
Sodium heparin solution
Sterile cotton gauze pads
Sterile syringes and plungers
Disposable needles—a 25-gauge needle is used when administering the anesthetic. A medium bore needle (e.g., 21-gauge) is usually used for the actual puncture
Specimen containers—almost always the syringe itself will serve as the specimen container

Procedure

1. Identify the artery by its pulsations.
2. Cleanse the skin over the puncture site using the antiseptic. Allow it to air dry.
3. The use of local anesthesia is not required but is encouraged. Infiltrate the skin and soft tissue at the puncture site with the anesthetic.
4. Draw 1 ml of sodium heparin solution into the syringe and with it thoroughly lubricate the barrel. Test the plunger to assure easy mobility, then expel the heparin, leaving the dead space filled with residual heparin.
5. Change the needle on the syringe. For puncture, the needle gauge should be appropriate to the caliber of the artery to be entered.
6. Position the arm so that it is well supported and comfortable. Dorsiflexion of the wrist is useful and may be achieved by placing a rolled towel under the patients vein.
7. Hold the needle parallel to the artery at an angle of 45-60 degrees, bevel up.
8. Puncture the skin and underlying artery, using a steady, moderately fast movement. The needle should be advanced no further than the estimated distance needed to enter the lumen of the artery. A slight give can usually be felt when the artery is entered.
9. Arterial blood usually fills the syringe under its own pressure but slight negative pressure generated by gentle retraction of the syringe plunger may be needed. Once the specimen has been collected withdraw the needle and immediately compress the puncture site for at least 5 min using a sterile gauze.
10. If air has been aspirated into the syringe, expel it.
11. Remove the needle, place an airtight cap over the tip of the syringe, and place the syringe into ice.
12. Transport the specimen immediately.

Sources of Variability

1. Contract with air, even as air bubbles within the syringe, will result in substantial alterations in the partial pressure of oxygen (pO₂) in the specimen. Because the pO₂ of arterial blood is always subatmospheric in patients who are not receiving oxygen therapy, exposure to air for even short periods will cause the pO₂ to increase. Air bubbles should be expelled from the syringe, and the tip of the syringe should be capped securely.
2. Because carbon dioxide is readily absorbed into heparin solution, a large volume of heparin in the collection syringe (as can happen in small syringes with large dead spaces) will cause a decrease in the partial pressure of carbon dioxide in the specimen. Minimize the residual heparin in the syringe prior to obtaining the specimen.
3. Cellular respiration in a blood specimen leads to a decrease in its pO₂. Cooling the specimen by immersing it in ice water effectively slows this process. Immediate delivery and processing of the specimen further reduces the likelihood of significant oxygen consumption.

Medical Considerations

1. Local anesthesia can greatly reduce the discomfort experienced by the patient so its use is encouraged.
2. Local trauma from an arterial puncture is usually minimal when arm arteries are used. In adults, femoral arteries are frequently atherosclerotic. Consequently, puncture of these arteries can lead
to disruption of atherosclerotic material, with downstream embolism. In addition, hemostasis is much more difficult to achieve with an atherosclerotic vessel. This is especially problematic for the femoral arteries, which lie deep in the soft tissues of the groin where direct pressure cannot be applied effectively. Massive blood loss can occur. In consideration of these concerns, femoral artery punctures are discouraged.

3. At the end of the procedure, direct pressure must be applied to the puncture site until the bleeding has stopped. This takes at least 5 min. A much longer time will be required for patients who are anticoagulated or who have a bleeding disorder.

4. Thrombosis is an uncommon complication of arterial puncture. Collateral circulation to the hand via the ulnar artery can be confirmed using the Allen test.

5. When the brachial artery is used as a puncture site care must be taken to avoid the underlying brachial nerve.
BLOOD, VENOUS: ANTECUBITAL VEIN

Equipment

Antiseptic—70% isopropanol (disposable gauze wipes soaked in isopropanol are available)
Sterile cotton gauze pads
Sterile syringe or vacuum tube holder
Disposable needle—the gauge of the needle should be appropriate to the size of the vessel to be entered. A "butterfly" needle (a short needle attached to a flexible plastic tube that ends in a syringe hub) may be used. Two-sided needles are required when vacuum tube containers are used.
Tourniquet
Specimen tubes

Procedure

1. Have the patient sit or lie down.
2. Prepare the specimen tubes and the syringe assembly and place them beside the patient.
3. Select the arm to be used for the procedure. Position the arm so that it is straight, well supported, and comfortable. Position yourself so that you are comfortable and have ready access to the puncture site.
4. Place the tourniquet 6-10 cm above the elbow to distend the veins. By palpation, identify a vein in the antecubital area that is of adequate size, pliant, and well seated (visual inspection alone will not detect many excellent deeper veins). If the veins are difficult to palpate, blood flow to the arm may be accentuated by wrapping the arm in a warm towel for 10 min prior to the procedure. Also, limited forearm exercise (for example, making a fist) can be used in an effort to "bring out" a vein. Do not massage or slap the arm.
5. Release the tourniquet before proceeding.
6. Cleanse the puncture site with antiseptic and allow it to air dry or wipe it dry with a sterile gauze pad.
7. Reapply the tourniquet.
8. Hold the skin taut over the puncture site by applying downward tension on the forearm with the thumb of the free hand. The free hand may provide additional support for the patient’s arm.
9. Hold the syringe assembly in the line of the vein to be punctured at an angle approximately 30° with the arm. The bevel of the needle should be up, the cutting tip down.
10. Puncture the skin and underlying vein, using a steady, moderately fast movement. The needle should be advanced no deeper than the estimated distance needed to enter the lumen of the vein. A slight give can usually be felt when the vein is entered. Also blood can often be seen at the needle hub.
11. Apply negative pressure by puncturing the vacuum tube or by gently retracting the syringe plunger. Blood should flow freely into the tube or syringe. If the flow is irregular, rotate the needle to reposition the bevel. Sometimes the needle tip has passed through the vein - the lumen can be reentered by pulling the needle backward slightly.
12. Remove the tourniquet once blood is flowing into the tube or syringe to prevent venous stasis at the puncture site.
13. Once the specimen has been collected, remove the needle and immediately apply pressure to the site, using a sterile gauze pad until the bleeding stops. The patient may apply the pressure with his or her free hand. Do not allow the patient to bend his or her arm as this reopens the incision in the vein.
14. Specimen tubes containing anticoagulants must be mixed promptly and may be inverted with one hand while applying pressure to the venipuncture site with the other.
15. Apply a sterile adhesive bandage.

Sources of Variability

1. Increased capillary hydrostatic pressure causes water to shift from the intravascular into the interstitial space. Blood cells, plasma proteins, and protein-bound constituents will be present in increased concentrations in this setting because they will be distributed in a reduced volume of plasma water. It can result from a systemic increase in capillary pressure such as is seen with prolonged standing, or from local effects, most notably a prolonged time of application of
the tourniquet during venipuncture. Both the
time of standing prior to venipuncture and the
time of tourniquet application should be kept to a
minimum.
2. Rapid flow of blood through small-bore needles
and exposures to large negative pressures lead to
hemolysis with its accompanying contamination
of the plasma portion of the blood specimen with
red cell cytoplasmic constituents. Hemolysis is
minimized by the use of large-bore needles,
moderate flow rates, and moderate negative
pressures. Invert specimen tubes gently to mix
the blood with additives.
3. Blood specimen contamination with intravenous
fluids is not uncommon. Blood should not be
drawn from a site above as intravenous infusion,
but must be obtained from a site on the patient’s
other arm or, if necessary, below the infusion
site.

Medical Considerations
1. Local trauma from a venipuncture is usually
minimal. If bleeding into the soft tissues or
from the skin puncture site is noted during the
procedure, the tourniquet should be removed
immediately and direct pressure applied.
2. At the end of the venipuncture, direct pressure
should always be applied to the puncture site
until bleeding has ceased. This may take a long
time in patients who are anticoagulated or who
have a bleeding disorder.
3. Thrombosis and thrombophlebitis are rare
complications.
4. Some patients become faint during venipuncture.
The procedure should be terminated immediately
and the patient should lie flat until he or she
recovers.
Equipment and reagents

The necessary equipment for obtaining bone marrow is usually available as a packaged, sterilized set.

Antiseptic—povidone-iodine solution
Local anesthetic—lidocaine hydrochloride
Sterile cotton gauze pads
Sterile syringes and plungers—a 10 ml syringe is used to administer the anesthetic. A 5 or 10 ml syringe is used to collect the specimen.
Sterile surgical blade
Disposable needles—25 and 20 gauge needles are usually used when administering the anesthetic.
Aspiration needle and stylet or biopsy needle, stylet, and probe
Sterile adhesive bandage or butterfly closure

Procedure

1. Place the patient in the prone position with his or her head resting on his or her folded arms.
2. Identify by palpation the posterior superior iliac spine of the iliac crest.
3. Cleanse the skin over the puncture site using the antiseptic. The remainder of the procedure is performed using sterilized equipment and sterile technique.
4. Local anesthesia is achieved by infiltrating the skin, soft tissue and periosteum at the puncture site with 2-3 ml of lidocaine hydrochloride. Use the 25-gauge needle for the skin and the 20-gauge needle for the soft tissue. Wait 4-5 minutes for the full anesthetic effect.
5. If a biopsy is to be obtained, make a 3 mm skin incision using the surgical blade to allow the biopsy needle to pass through the skin easily.
6. Insert the needle with stylet in place holding the needle perpendicular to the plane of the back.
7. Advance the needle through the bony cortex using firm pressure and an alternating twisting motion. Penetration into the marrow space is usually accompanied by a sudden increase in the ease of advancing the needle.
8. Remove the stylet and attach the specimen syringe.
9. Aspirate marrow by withdrawing the plunger. If no marrow enters the specimen syringe, remove the syringe, replace the stylet and advance the needle a few millimeters. Again remove the stylet, attach the specimen syringe, and attempt the aspiration. If this fails, remove the syringe, replace the stylet, and withdraw the needle until the tip is in the subcutaneous tissue. Redirect the needle into a nearby site.
10. Aspirate about 0.5 ml of marrow. The patient will usually experience a few seconds of suction pain during the aspiration.
11. Remove the syringe from the aspirating needle and hand it to the assistant or technician who will process the specimen.
12. If only an aspirate is to be obtained, replace the stylet and withdraw the needle. Apply firm pressure to the incision site using a sterile gauze pad.
13. If a biopsy specimen is to be obtained, replace the stylet, withdraw the needle from the bone, and reinsert the needle into nearby bone.
14. When the needle is firmly fixed in bone, remove the stylet and then slowly advance the needle 2-3 cm into the medullary cavity using an alternating twisting motion.
15. Replace the stylet. The length of the core specimen will be shown by the distance the end of the stylet projects from the needle hub.
16. Break off the specimen by rotating the needle through several turns in one direction then in the other or by rocking the needle from side to side.
17. Withdraw the needle and apply firm pressure to the incision site using a sterile gauze pad.
18. Remove the biopsy specimen by inserting the probe into the needle from the cutting end and pushing the core out through the hub. The assistant or technician will process the specimen.
19. Apply a butterfly closure to the skin incision and cover the site with an adhesive bandage.
20. Examine the incision site periodically for bleeding in patients who are thrombocytopenic.
Sources of variability

1. Failure to aspirate marrow (a "dry tap") may occur in a patient with a condition resulting in excessive collagen disposition in the marrow. A biopsy specimen must be obtained in such a circumstance.

2. Rapid processing of the specimens is essential. This is extremely difficult to do if the procedure and the processing must be performed by the same individual. It is desirable to have an assistant or laboratory technician present to process the specimens.

3. Correct technique in the processing of the specimens is essential. It is usually best to have a trained laboratory technician present to process the specimens.

Medical Considerations

1. Reassurance of the patient is often necessary prior to and during performance of the procedure.

2. In elderly individuals and in patients with myeloma the bone may be soft. Take care not to penetrate too deeply into bone.

3. At the end of the procedure, direct pressure should be applied to the incision site until bleeding has stopped. This may take a long time in thrombocytopenic patients.
Equipment

The necessary equipment for a lumbar puncture is usually available as a packaged, sterilized set.

- Antiseptic—povidone-iodine
- Local anesthetic—lidocaine hydrochloride
- Sterile syringe and plunger—a 10-ml syringe is used to administer the anesthetic.
- Disposable needles—25- and 20-gauge needles are usually used when administering the anesthetic
- Spinal needle and stylet - 20-gauge or smaller; a 26-gauge needle is best
- Three-way stopcock
- Manometer
- Specimen containers
- Sterile adhesive bandage

Procedure

1. Monitor the patient’s cardiorespiratory status during and following the procedure.
2. Place the patient in the lateral recumbent position with the craniospinal axis parallel to the floor and the flat of the back perpendicular to the procedure table.
3. Have the patient assume the flexed knee-chest position with the back at the edge of the procedure table. An assistant is often needed to aid the patient in maintaining this position.
4. Identify by the palpation the spinal processes and interspaces. The line connecting the tops of the two iliac crests usually crosses the L3-L4 interspace. Use interspace L3-L4, L4-L5, or L5-S1.
5. Cleanse the skin over the puncture site using the antiseptic. Allow it to air dry. The remainder of the procedure is performed using sterilized equipment and sterile technique.
6. Local anesthesia is usually employed. Infiltrate the skin and soft tissue at the puncture site with 2-3 ml of the anesthetic. Use the 25-gauge needle for the skin and the 20-gauge needle for the soft tissue.
7. Insert the spinal needle with stylet in the midsagittal line of the prepared interspace. Hold the needle perpendicular to the plane of the back. Advance the needle through the longitudinal ligament into the subarachnoid space. A slight give is usually felt when the needle penetrates the dura.
8. Remove the stylet. If cerebrospinal fluid (CSF) appears, the space has been entered. If no fluid appears, replace the stylet and rotate the needle 90°. Again remove the stylet and check for CSF. If there is still no fluid, replace the stylet and advance the needle a few more millimeters. Feel for the give of the dura and check for fluid. If this fails, replace the stylet and withdraw the needle until the tip is subcutaneous, then redirect it along a new midline path.
9. When fluid appears at the needle hub, quickly attach the three-way stopcock and manometer. Orient the manometer in the true vertical. CSF should flow freely into the manometer. If the CSF flow is sluggish, rotate the needle or, if necessary, reposition it.
10. Record the "opening pressure" (mm CSF) once it has become steady. The patient should be relaxed with legs extended during the measurement.
11. If the "opening pressure" is elevated (greater than 200 mm CSF) or if the pressure quickly falls, only 1-2 ml of CSF should be removed. If the opening pressure is less than 200 mm CSF, withdraw adequate fluid to perform the desired studies. (If more than 20-30 ml is removed rapidly, a mild transient postural headache is likely.)
12. After the CSF sample has been removed, record the volume of CSF obtained and the "closing pressure" (mm CSF).
13. Replace the stylet and remove the needle.
14. Apply a sterile adhesive bandage.

Sources of Variability

1. The CSF pressure is raised in patients who are straining. The patient should be relaxed and quiet during the determination of the opening pressure.
2. Incision of a vessel in the ventral vertebral venous plexus can lead to contamination of the CSF specimen with blood. This is referred to as a traumatic tap. In order to distinguish a
traumatic tap from a valid finding of bloody CSF, centrifuge the first and last specimen tubes collected. If the fractional volume of blood in the last tube collected is much less than that in the first, the blood probably comes from a traumatic tap. A xanthochromic supernatant following CSF centrifugation indicates that blood was present in the CSF prior to puncture.

3. Adequate fluid should be withdrawn to perform the requisite laboratory studies. It is not the volume of fluid removed at the time of puncture but the subsequent leakage of CSF through the dural defect that is usually responsible for the complications of the procedure related to CSF volume depletion.

Medical Considerations

1. There are three settings in which the performance of a lumbar puncture entails a significant risk of a life-threatening complication. These are: a) the patient with increased intracranial pressure; b) the patient who has a hemorrhagic diathesis; and c) the patient with an infection at the proposed site of the lumbar puncture. Each of these settings is a relative contraindication for a lumbar puncture. The need for a CSF specimen must outweigh the risk involved if a lumbar puncture is performed in such cases.

2. Respiratory compromise, which can mimic ventilation failure from brain herniation, can develop in weak patients or patients with pulmonary disease who are held in a highly flexed position. Be certain that the patient can breathe comfortably while positioned for the procedure.

3. The most common complication of lumbar puncture is postural headache, which is often accompanied by backache. The incidence of headache depends upon the technique and can be as high as 20 percent. Headache is uncommon when small-bore spinal needles are used and when the number of punctures is minimized.

4. Radicular symptoms following a lumbar puncture suggest spinal nerve root trauma. Incorrect technique is the most frequent explanation for this complication. Spinal nerves are displaced and stretched when the CSF specimen is obtained using plunger action or when the spinal needle stylet is not replaced prior to withdrawal of the needle.
PERITONEAL FLUID

Equipment

The necessary equipment for an abdominal paracentesis is usually available as a packed, sterilized set.

- Antiseptic—povidone-iodine solution
- Local anesthetic—lidocaine hydrochloride
- Sterile syringes and plungers—a 10-ml syringe is used to administer the anesthetic. A 30 or 50-ml syringe is used to collect the specimen
- Disposable needles—25- and 22-gauge needles are usually used when administering the anesthetic
- Intravenous catheter—a 20- or 22-gauge catheter with trocar is preferred
- Three-way stopcock
- Sterile tubing—two 30-50 cm lengths tubing may be needed
- Specimen containers
- Sterile adhesive bandage

Procedure

1. Have the patient empty his and her bladder.
2. Place the patient in the semirecumbent position.
3. Identify the puncture site - the avascular midline caudad to the umbilicus and caudad to the level of percussible dullness. Avoid surgical scars. If a midline scar is present, use a site in the lower abdomen 1-2 cm lateral to the margin of the rectus sheath. Use the side which is more dull to percussion. If the volume of peritoneal fluid is small, such that dullness to percussion can be demonstrated only when the patient is in the hands-knee position, the patient should undergo the procedure in that position. If the patient is too weak to maintain the position, place the patient in the prone position spanning two beds, and perform the procedure sitting on the floor.
4. Cleanse the skin over the puncture site using the antiseptic. Allow it to air dry. The remainder of the procedure is performed using sterilized equipment and sterile technique.
5. Infiltrate the skin and soft tissue at the puncture site with 5 ml of the anesthetic. Use the 25-gauge needle for the skin and the 22-gauge needle for the soft issue.
6. Retract the skin at the puncture site toward the symphysis and insert the trocar with catheter. Hold the trocar perpendicular to the abdominal wall. Advance the trocar into the peritoneal cavity. When fluid appears in the catheter tubing remove the trocar while keeping the catheter in place. Attach a length of tubing to the catheter hub and the large syringe to the free end of the tubing.
7. Withdraw adequate fluid to perform the desired studies.
8. If a large volume of fluid is to be removed, insert the stopcock into the free end of the tubing. Attach the large syringe and the other length of tubing to the stopcock. Aspirate fluid into the syringe then expel it through the open tubing.
9. Remove the catheter. Apply direct pressure to the puncture site.
10. Apply a sterile adhesive bandage.

Sources of Variability

1. Incision of a vessel can lead to contamination of the peritoneal fluid specimen with blood. The volume of fluid is usually so large that such contamination has little effect upon the laboratory studies. However, this possibility must be kept in mind if the study values are at variance with the clinical impression.

Medical Considerations

1. The performance of an abdominal paracentesis in a patient with a hemorrhagic diathesis is associated with a significant risk of serious abdominal wall or intraperitoneal hemorrhage. Because of this risk, this setting is a relative contraindication for a paracentesis. The procedure can be made much safer by therapeutic correction of the bleeding disorder, if possible.
2. Perforation of bowel is unusual if the bowel is mobile. Even if punctured, the bowel usually does not leak its contents. Peritonitis can develop, however, so closely monitor any patient who suffers a bowel perforation during paracentesis. The chance of puncturing the bowel is minimized by not selecting a puncture
site near a surgical scar (intraperitoneal adhesions can tack the bowel to the anterior abdominal wall) and awaiting decompression of the bowel in patients with bowel distention.

3. Puncture of the bladder is avoided by making certain that the patient’s bladder is empty.
4. Peritoneal fluid may leak from the puncture site and may infiltrate along the puncture track into the abdominal wall.
PLEURAL FLUID

Equipment

The necessary equipment for a thoracentesis is usually available as a packaged, sterilized set.

Antiseptic—povidone-iodine
Local anesthetic—lidocaine hydrochloride
Sterile syringes and plungers—a 10-ml syringe is used to administer the anesthetic. A 30 or 50-ml syringe is used to collect the specimen
Disposable needles—25- and 20-gauge needles are usually used when administering the anesthetic
Intravenous catheter—a 16- or 14-gauge catheter with trocar is preferred
Three-way stopcock
Sterile tubing—two 30-50 cm lengths of tubing may be needed
Specimen containers
Sterile adhesive bandage

Procedure

1. Place the patient in the sitting position, preferably with his or her legs over the side of the procedure table. Support the patient's feet and rest his or her arms on a pillow on a bedside stand.
2. Identify the puncture site - the intercostal space at the location of maximum dullness to percussion, usually in its posterolateral aspect. Posteriorly the site should be above the ninth rib, and laterally, above the seventh rib.
3. Cleanse the skin over the puncture site using the antiseptic. Allow it to air dry. An area incorporating three interspaces should be cleansed. The remainder of the procedure is performed with sterilized equipment and sterile technique.
4. Infiltrate the skin and soft tissue at the puncture site with 5 ml of the anesthetic. Use the 25-gauge needle for the skin and the 20-gauge needle for the soft tissues. Always advance the needle perpendicular to the chest surface and above the lower rib. The intercostal nerve and blood vessels located at the lower margin of the upper rib are thereby avoided. Advance the needle in 1-2 mm increments injecting a small portion of the anesthetic at each step. Negative pressure is applied to the syringe prior to each injection to assure that the anesthetic is not injected into a blood vessel. The patient will usually complain of pain when the parietal pleura is reached. Inject a generous amount of anesthetic there. Continue to advance the needle in steps until pleural fluid is aspirated. If the needle is inserted all the way to its hub without obtaining fluid, withdraw it slowly while applying constant negative pressure. Puncture at a site one interspace inferior or superior to the original site may then be considered.
5. When pleural fluid is aspirated, withdraw the needle, insert the trocar with catheter into the prepared site, and advance it on through the parietal pleura, always staying just above the lower rib. When fluid appears in the catheter tubing remove the trocar while keeping the catheter in place. Attach a length of tubing to the catheter hub and the large syringe to the free end of the tubing.
6. Withdraw an adequate amount of fluid.
7. If a large volume of fluid is to be removed, insert the stopcock into the free end of the tubing. Attach the large syringe and the other length of tubing to the stopcock. Aspirate fluid into the syringe then expel it through the open tubing.
8. Remove the catheter. Apply direct pressure to the puncture site to seal the puncture track and prevent aspiration of air.
9. Apply a sterile adhesive bandage.
10. Monitor the patient's respiratory status.

Sources of Variability

1. Incision of a vessel can lead to contamination of the pleural fluid specimen with blood. The volume of fluid is usually so large that such contamination has little effect upon the laboratory studies. However, this possibility must be kept in mind if the study results are at variance with the clinical impression.

Medical Considerations

1. The most common complication of thoracentesis is pneumothorax due to puncture of the visceral
pleura. This is usually small and does not produce symptoms. Larger pneumothoraces require prompt therapy. The risk of puncturing the visceral pleura is minimized by avoiding those portions of the chest where pleural adhesions are known to exist and by advancing the needle and the trocar less than 1 cm beyond the parietal pleura.

2. Subcutaneous emphysema caused by the needle track is avoided by sealing the puncture site immediately after withdrawing the needle.

3. Hemorrhage into the intercostal space and the pleural cavity will occur if the intercostal vessels, especially the artery, are punctured. Significant acute blood loss and hemothorax can result. This complication is rare if the needle and the trocar are kept just above the lower rib as they are advanced through the intercostal space.

4. Puncture of the diaphragm and subdiaphragmatic organs is avoided by selecting the puncture site carefully. The site should not be below the ninth rib posteriorly or the seventh rib laterally.
URINE: TIMED COLLECTION

Equipment

Specimen container—disposable plastic containers are preferred. The container should be large, usually 4 L. The appropriate preservative should be placed into the container prior to the start of the collection. Preservatives are usually added by the laboratory. If the analyte to be assayed is light sensitive, a dark container is necessary.

Procedure

1. Patient cooperation is imperative for a successful timed urine collection so instruct the patient carefully in the procedure and encourage his or her cooperation.
2. Warn the patient if the urine preservative is caustic.
3. Instruct the patient to discard a voiding and record the time. For 24 h collections, it is usual to discard the first morning voiding.
4. Have the patient collect every voiding for the duration of the timed collection. The urine may be collected in a wide-mouthed, chemically clean container and then poured into the specimen container.
5. The specimen container should be kept refrigerated throughout the collection period.
6. The last urine collection should be a complete, forced voiding at the exact end of the timed period.
7. Seal the container tightly and submit the specimen immediately.

Sources of Variability

1. The specimen container should be chemically clean.
2. The analyte of interest must be preserved during the storage of the urine while the collection is in progress. Light-sensitive analytes should be shielded in dark bottles. Refrigeration is used to retard bacterial growth as well as to stabilize certain analytes. Acidification of the urine is necessary to assure stability of a large number of analytes.
3. Since the timed urine collection is used to calculate an excretory rate, i.e. amount of analyte excreted per unit time, it is imperative that the collection be complete and properly timed. Unfortunately, timed collections very frequently are incomplete, usually because of the forgetful discarding of a voiding during the collection. Over-collection does happen but is much less common. Variability in the completeness of the collection is by far the most important variable in timed collections. Consequently, care must be taken to instruct the patient or nursing staff in the importance of a complete collection.
URINE: RANDOM COLLECTION

Equipment

Specimen container—disposable plastic cups are preferred

Procedure

1. Random specimens may be collected at any time.
2. Instruct the patient to urinate into the specimen container.
3. Seal the container tightly and transport the specimen immediately.

Sources of Variability

1. The specimen container should be chemically clean.
2. Perform the examination of the urine immediately, that is, on fresh, warm urine. Delay will result in the disappearance of leukocytes, casts, and bilirubin; the appearance of crystals and crystal aggregates; and the proliferation of bacteria with resultant pH changes.
## INDEX

### Equations

<table>
<thead>
<tr>
<th>Equation</th>
<th>Page References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayes’ formula</td>
<td>3-9, 3-10, 3-11, 3-17, 3-18, 12-17</td>
</tr>
<tr>
<td>Beer-Lambert Law</td>
<td>2-2</td>
</tr>
<tr>
<td>Bicarbonate concentration</td>
<td>1-4</td>
</tr>
<tr>
<td>Body surface area</td>
<td>1-4</td>
</tr>
<tr>
<td>Confidence interval, proportion</td>
<td>2-28</td>
</tr>
<tr>
<td>Creatinine clearance rate</td>
<td>6-4, 12-9</td>
</tr>
<tr>
<td>Detection limit</td>
<td>2-22</td>
</tr>
<tr>
<td>Drug bioavailability</td>
<td>12-10</td>
</tr>
<tr>
<td>Drug clearance rate</td>
<td>12-9</td>
</tr>
<tr>
<td>Drug concentration in steady state</td>
<td>12-4, 12-13, 12-16</td>
</tr>
<tr>
<td>Drug disposition curves</td>
<td>12-2</td>
</tr>
<tr>
<td>Drug dosing interval</td>
<td>12-7</td>
</tr>
<tr>
<td>Drug elimination rate</td>
<td>12-3, 12-16</td>
</tr>
<tr>
<td>Drug extraction fraction</td>
<td>12-3</td>
</tr>
<tr>
<td>Drug half-life</td>
<td>12-13</td>
</tr>
<tr>
<td>Drug loading dose</td>
<td>12-5, 12-7, 12-8</td>
</tr>
<tr>
<td>Drug maintenance dose</td>
<td>12-7, 12-14</td>
</tr>
<tr>
<td>Efficiency</td>
<td>3-4, 3-17</td>
</tr>
<tr>
<td>Equilibrium mass action</td>
<td>7-13</td>
</tr>
<tr>
<td>Half-life</td>
<td>7-2</td>
</tr>
<tr>
<td>Minimum distinguishable difference</td>
<td>2-6, 2-22</td>
</tr>
<tr>
<td>Nonlinearity</td>
<td>2-17</td>
</tr>
<tr>
<td>Predictive value</td>
<td>3-4</td>
</tr>
<tr>
<td>Organ absorption rate</td>
<td>7-5</td>
</tr>
<tr>
<td>Organ clearance rate</td>
<td>7-2, 7-3, 7-4</td>
</tr>
<tr>
<td>Organ synthetic rate</td>
<td>7-2</td>
</tr>
<tr>
<td>Recovery</td>
<td>2-19</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>3-1</td>
</tr>
<tr>
<td>Significant difference in marker concentration</td>
<td>5-5, 5-6, 11-19</td>
</tr>
<tr>
<td>Specificity</td>
<td>3-1</td>
</tr>
<tr>
<td>Standard deviation, between-run</td>
<td>2-22</td>
</tr>
<tr>
<td>Standard deviation, replicate results</td>
<td>2-20</td>
</tr>
<tr>
<td>Standard deviation, within-laboratory</td>
<td>2-6</td>
</tr>
<tr>
<td>Standard deviation, within-individual</td>
<td>2-7</td>
</tr>
<tr>
<td>Standard deviation, within-run</td>
<td>2-12, 2-22</td>
</tr>
<tr>
<td>Standard error, regression slope</td>
<td>2-25</td>
</tr>
<tr>
<td>Threshold likelihood ratio for acceptance</td>
<td>3-13, 10-11</td>
</tr>
<tr>
<td>Threshold likelihood ratio for followup</td>
<td>3-13, 5-2, 10-11, 11-8</td>
</tr>
<tr>
<td>Threshold likelihood ratio for rejection</td>
<td>3-13</td>
</tr>
<tr>
<td>Variance, within-laboratory</td>
<td>2-6</td>
</tr>
<tr>
<td>Variance, replicate results</td>
<td>2-12, 2-22</td>
</tr>
</tbody>
</table>

### Extended Clinical Examples

<table>
<thead>
<tr>
<th>Condition</th>
<th>Page References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital adrenal hyperplasia</td>
<td>10-7, 10-11</td>
</tr>
<tr>
<td>Factor VIII deficiency</td>
<td>10-13</td>
</tr>
<tr>
<td>Hepatitis, viral</td>
<td>9-16</td>
</tr>
<tr>
<td>Iron, cobalamin, and folate deficiency</td>
<td>8-4</td>
</tr>
<tr>
<td>Iron deficiency in infants</td>
<td>3-1</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>9-2</td>
</tr>
<tr>
<td>Prostate cancer</td>
<td>11-7</td>
</tr>
</tbody>
</table>
Topics

A

ABO blood group
antibodies 9-10
typing 9-10

Absorption rate
as determinant of substance plasma concentration 7-5
determinants of 7-5

Accuracy
definition 2-3

Acute phase proteins
clinical use 9-6
erthrocyte sedimentation rate 9-6

Acute phase response
acute phase proteins 9-6
definition 9-6
expression of 9-6
in infection 9-13
neutrophilia 9-13

Adulthood
as source of variability 6-7

Age
age-based variability 6-6
periods of life 6-6

Allele-specific oligonucleotide hybridization
molecular diagnosis 10-5

Alpha-fetoprotein
as a cancer marker 11-5

Analytic methodology
in evaluation of classification studies 4-5

Analytic variability
definition 1-6
sources of 1-6

Antibodies
to ABO and Rh blood group antigens 9-10
to infectious agents 9-16

Antimicrobial susceptibility testing
in infection 9-17

Anti-nuclear antibodies
in systemic autoimmune disease 9-7

Ascertainment bias
in evaluation of classification studies 4-2

Antoautoantibodies
anti-nuclear antibodies 9-7
in autoimmune disease 9-5
laboratory measurement 9-8
organ-localized disease 9-6
rheumatoid factors 9-7
systemic disease 9-6
table of high specificity autoantibodies 9-8

Autoimmune disease
organ-localized disease 9-6
pathobiology 9-5
systemic disease
acute phase response 9-6
autoantibodies 9-7
complement activation 9-7

B

Bayes’ formula
imprecision of probability estimates 3-12
in diagnostic classification
likelihood ratio form 3-10
sensitivity, specificity form 3-9
in drug toxicity 12-17
in prognostic classification
fraction correctly classified form 3-18
likelihood ratio form 3-17
multiple diagnostic study results
combination analysis 3-11
logistic function 3-11
serial analysis 3-10
multiple prognostic study results
logistic function 3-18
prior probability 3-8
posterior probability 3-9

bcr/abl fusion gene
in chronic myelogenous leukemia 11-3, 11-5

Benign prostatic hyperplasia
screening for prostate cancer 11-7

Between-laboratory imprecision
causes 2-6
definition 2-6

Between-run imprecision
causes 2-5
definition 2-5
evaluating 2-20

Bias
method bias
causes 2-4
definition 2-4
ascertainment bias 4-2
diagnostic-review bias 4-2
incorporation bias 4-2
sampling bias 4-4
selection bias 4-4
test-review bias 4-5
work-up bias 4-4

Bioactive fraction
definition 7-13
determinants of 7-13
of calcium and magnesium 7-14
of hormones 7-13, 7-14
Biologic variability
age-based variability
biorhythms
circadian rhythms 6-8
menstrual cycle 6-9
components of 1-5, 6-1
continuous heterogeneity
definition 6-1
constructing a reference frequency distribution 6-3
definition 1-5
discrete heterogeneity
definition 6-1
constructing a reference frequency distribution 6-1
race-based variability
constructing reference frequency distributions 6-6
generic races of man 6-5
sex-based variability
causes 6-4
pregnancy 6-5
sources of 1-5, 6-1
Biorhythms
circadian rhythms 6-8
menstrual cycle 6-9
Blood cells
genetic disorders 10-9

C
Calcitonin
as a cancer marker 11-6
Calcium
endocrine regulation 7-6, 7-11
bioactive fraction 7-14
Calculated value
calculation 1-4
Calibration
calibrators 2-2
constructing a calibration curve 2-2
evaluating a calibration curve 2-17
regression analysis 2-3
Cancer
cancer cells 11-2
diagnosis 11-14
local effects 11-2
genetic abnormalities 11-2, 11-15
marker substances 11-4
monitoring
assessing therapy 11-17
tumor recurrence 11-18
prediction
predictive factors 11-16
quantification 11-16
prognosis
prognostic factors 11-15
quantification 11-16
staging systems 11-15
screening for cancer 11-7
screening for a predisposition to cancer 11-12
systemic effects 11-1
Carcinoembryonic antigen
as a cancer marker 11-6, 11-18
Carrier detection
genetic disease 10-12
Cellular injury see Injury
Childhood and adolescence
as source of variability 6-7
Chromosome
abnormalities 10-1
fluorescence in situ hybridization 10-2
G-banding 10-1
Classification correlation
definition 3-6
in repeat testing 3-6
Clearance rate
as determinant of substance half-life 7-1
as determinant of substance plasma concentration
with absorption rate 7-5
with synthetic rate 7-1
clearance of exogenous substances 7-3
definition 7-1
drugs see drug clearance
organ clearance rate 7-2
Cobalamin
circulating forms 8-4
deficiency 8-5
Combination testing
diagnostic study performance 3-4
diagnostic plot 3-8
diagnostic ratio 3-7
discriminant function 3-7
multiphasic health screen 3-6
positivity rules 3-6
Complement
activation 9-7
Common units
conversion to SI units 1-4
definition 1-4
Confirmation of a diagnosis
threshold likelihood ratio for acceptance 3-13
Congenital adrenal hyperplasia
21-hydroxylase deficiency 10-7
newborn screening 10-11
Control material
use in internal quality control 2-9
Control rules
in internal quality control
detection of current quality degradation 2-9
detection of persistent quality degradation 2-11
multiple-rule procedure of Westgard 2-12
Creatine kinase
as a marker of myocardial infarction 9-2
isoenzymes of 9-2
Creatinine clearance rate
calculation 6-4, 12-9
in adulthood and old age 6-4, 6-8
Creatinine physiology
in adulthood and old age 6-7
Cross-validation
in evaluation of classification studies 4-8

D

Definitive method
definition 2-6
Detection limit
definition 2-6
evaluating 2-22
Diagnostic-review bias
in evaluation of classification studies 4-2
Diagnostic study performance
combination testing 3-6
comparing diagnostic study performance 3-14
efficiency 3-4
likelihood ratio 3-9
multiphasic health screen 3-6
predictive value 3-4
prevalence 3-4
repeat testing 3-5
ROC curve 3-2
sensitivity 3-1
specificity 3-1
Diagnostic plot
positivity rule for combination testing 3-8
Diagnostic ratio
positivity rule for combination testing 3-7
Diagnostic window
definition 9-3
variable timing 9-3
Difference analysis
in method comparisons 2-26
Discriminant function
positivity rule for combination testing 3-7
Drug bioavailable fraction
definition 12-3
individualized 12-10
Drug clearance
definition 12-3
extraction fraction 12-3
individualized 12-8
nonlinear elimination kinetics 12-16
organ clearance 12-3
polymorphisms of metabolizing enzymes 12-9
Drug disposition
clearance 12-3
determining individual kinetic parameters 12-10
distribution 12-1
half-life 12-13
multiple dosing
individualized dosing 12-7
dosing interval 12-4, 12-7
loading dose 12-4, 12-7
maintenance dose 12-4, 12-7
plasma disposition curves 12-4
single dosing
plasma disposition curves 12-2
variability 12-5
Drug effect
effect site disposition curves 12-5
instantaneous and noninstantaneous 12-5
Drug elimination see drug clearance
Drug dosing
adjusting dose regimen
clinical monitoring 12-12
therapeutic drug monitoring 12-12
individualizing initial dose regimen 12-7
Drug half-life
definition 12-13
Drug molecular heterogeneity
active metabolites 12-15
chirality 12-15
plasma protein binding 12-16
Drug toxicity
Bayes’ formula 12-17
Drug volume of distribution
definition 12-1
individualized 12-8

E

Efficiency
definition 3-4, 3-17
Endocrine systems
evaluation of function 7-8
plasma protein binding of hormones 7-12
regulatory function 7-8
Erythrocyte sedimentation rate
as a measure of plasma fibrinogen concentration 9-6
definition 9-6
Essential nutrients
definition 8-1
table of 8-1
Exclusion of a diagnosis
threshold likelihood ratio for rejection 3-13
External quality control
definition 2-13

F

Factor VIII deficiency
carrier detection 10-13
mutations causing 10-14
Fetal period
  as source of variability 6-6
Field method
  definition 2-6
Fluorescence in situ hybridization
  chromosome analysis 10-2
Folate
  circulating forms 8-4
  deficiency 8-5
Fraction correctly classified
  definition 3-16
Frequency distribution
  see reference frequency distribution

G
G-band
  chromosome analysis 10-1
Genetic abnormalities in cancer
  genetic alterations seen in cancer 11-2
  cancer diagnosis and classification 11-15
Genetic disease
  carrier detection 10-12
  prenatal detection 10-14
  reproductive risk assessment 10-12
  screening 10-10
Genetic disorders of blood cells
  protein deficiency 10-9
  protein phenotyping 10-10
Genetic disorders of metabolism
  congenital adrenal hyperplasia 10-7, 10-11
  model of metabolic fluxes 10-7
  newborn screening 10-11
  substance accumulation in 10-7
Genetic disorders of plasma proteins
  factor VIII deficiency 10-13
  protein deficiencies 10-8
  protein phenotyping 10-9
Glomerular filtration rate
  creatinine clearance rate
    calculation 6-4
      in adulthood and old age 6-4, 6-8
    inulin clearance rate 6-3

H
Half-life
  definition 12-13
  determinants of 7-1
Hair analysis
  in the evaluation of nutrition status 8-7
Hemophilia see factor VIII deficiency
Hepatitis, viral
  markers 9-16
Hereditary nonpolyposis colorectal cancer
  screening for 11-13
Heterogeneity
  discrete heterogeneity 6-1
Histocompatibility testing
  in organ transplantation 9-8
  in red cell transfusion 9-10
HLA antigens
  definition 9-8
  typing 9-9
Homeostatic systems
  endocrine systems see endocrine systems
  dysfunction 7-7
  regulatory function 7-6
Hormones
  bioactive fraction 7-14
  plasma protein binding 7-12
  use in evaluation of endocrine function 7-8

I J
Immune complex-mediated injury
  markers 9-5
  pathobiology 9-5
Immunologic injury
  autoimmune disease 9-5
  immune complex deposition 9-5
  mechanisms of injury 9-5
  tissue transplantation 9-8
Imprecision see variability, method imprecision
Incorporation bias
  in evaluation of classification studies 4-2
Infection
  acute phase response 9-13
  antimicrobial susceptibility testing 9-17
  demonstration of infectious agent
    direct microscopy 9-14
    culture 9-14
    immune response 9-16
    microbial substances 9-15
    specimen collection 9-14
    hepatitis, viral 9-16
    neutrophilia 9-13
Infectious agents
  antimicrobial susceptibility testing 9-17
  direct microscopy 9-14
  culture 9-14
  microbial substances 9-15
  specimen collection 9-14
Injury
  diagnostic window 9-3
  estimating magnitude 9-4
  immunologic injury 9-5
  infection 9-12
  injury versus death 9-1
  test panels 9-4
  tissue specificity of injury markers 9-2
Interindividual variability
age-based variability  6-6
classification and  1-6
definition 1-5
pharmacologic variability  12-5
race-based variability  6-5
sex-based variability  6-4
sources of  1-5
Internal quality control
control material 2-9
control rules 2-9
definition 2-9
test-sample based control 2-12
Intraindividual variability
age-based variability  6-6
biorhythms  6-8
definition 1-5
monitoring and  1-6
pharmacologic variability  12-6
pregnancy  6-5
Iron
circulating forms  8-4
deficiency  8-5
excess  8-8
Isoenzyme
definition  9-2
K
Karyotype
definition 10-2
spectral karyotyping 10-2
L
Laboratory error
how to recognize  1-6
Likelihood ratio
definition 3-9
in Bayes’ formula 3-10
threshold likelihood ratio for acceptance  3-13
threshold likelihood ratio for followup 3-13
threshold likelihood ratio for rejection 3-13
Likelihood ratio curve
constructing 3-10
in evaluation of classification studies  4-6
Load test
in evaluation of micronutrient deficiency  8-6
Logistic function
probabilistic diagnostic classification  3-11
probabilistic prognostic classification  3-18
M
Magnesium
bioactive fraction  7-14
Markers
cancer
cancer cells  11-2
plasma substances 11-4
cobalamin deficiency  8-5
folate deficiency  8-5
genetic disorder of metabolism  10-7
hepatitis, viral  9-16
immune complex-mediated injury  9-5
injury
diagnostic window  9-3
estimating magnitude  9-4
injury versus death  9-1
test panels 9-4
tissue specificity  9-2
iron
deficiency  8-5
excess 8-8
monitoring disease activity  5-7
monitoring physiologic change  5-3
monitoring therapeutic response  5-8
myocardial infarction  9-2
organ function
clearance rate  7-2
synthetic rate 7-2
post-transfusion hemolysis  9-12
screening for subclinical disease 5-1
significant change in value  5-4
trace minerals
body stores 8-3
deficiency  8-5
supply reserve 8-3
transplant rejection 9-10
vitamins
body stores  8-3
deficiency  8-5
supply reserve 8-3
Matrix effects
cross-reaction effects  2-4, 2-19
definition 2-4
interference effects  2-4, 2-19
Measurement
calibration curve 2-2
measurement curve 2-2
measurement procedure 2-8
steps  2-1
Meta-analysis
in evaluation of classification studies 4-9
Metabolism
genetic disorders  10-7
Method comparison
clinical equivalence  2-23, 2-27
components 2-23
difference analysis  2-26
regression analysis 2-24
Method evaluation
evaluating a calibration curve  2-17
evaluating method quality  2-18
components  2-14
optimization of analytical variables  2-16
Method practicability
components  2-13
Method quality
analytical range  2-22
bias  2-4
definition  2-3
definitive method  2-6
evaluation  2-18
detection limit  2-6, 2-22
field method  2-6
imprecision  2-5, 2-20
measurement procedure  2-8
quality assurance program
external quality control  2-13
internal quality control  2-9
quality goals  2-6
reference method  2-6
resolving power  2-6
trueness  2-3, 2-18
Microbiology  see Infectious agents
Minerals  see Trace minerals
Minimum distinguishable difference
definition  2-6
evaluating  2-22
Model
active homeostatic regulation  7-6
drug disposition  12-1
endocrine homeostasis  7-8
markers of cancer  11-4
markers of infection  9-13
markers of tissue injury  9-1
metabolic fluxes  10-7
natural history of a disorder  5-2
trace minerals and vitamins  8-2
Molecular diagnostic studies
allele-specific oligonucleotide hybridization  10-5
definition  10-4
Northern blot hybridization  10-7
PCR (polymerase chain reaction)  10-4
PCR-based studies  10-4
polymorphism
diagnostic application  10-4
restriction fragment length polymorphism  10-5
Southern blot hybridization  10-5
Monitoring
markers of disease activity  5-7
markers of physiologic status
monitoring rules  5-7
time course following a status change  5-3
significant difference  5-4
markers of therapeutic response  5-8
Multiphasic health screen
diagnostic study performance  3-6

Mutations
carrier detection  10-12
definition  10-3
factor VIII deficiency
genetic disorders of blood cells  10-9
genetic disorders of metabolism  10-7
genetic disorders of plasma proteins  10-8
molecular diagnosis  10-4
prenatal detection  10-14
reproductive risk assessment  10-12
Myocardial infarction
cellular markers  9-2

N
Neutrophilia
in infection  9-13
Newborn period
as source of variability  6-7
Normal range
see reference range
Northern blot hybridization
molecular diagnosis  10-7
Nutrients
classes of  8-1

O
Old age
as source of variability  6-7
Organ function
clearance rate  7-2
synthetic rate  7-2
Operating characteristic curve
in internal quality control  2-10

P
PCR (polymerase chain reaction)
description  10-4
PCR-based molecular diagnostic studies  10-4
Performance characteristic function  see ROC curve
Plasma binding proteins
as determinant of bioactive fraction  7-13
disposition of trace minerals and vitamins  8-2
functions  7-11
table of  7-12
Plasma proteins
genetic disorders  10-8
drug binding  12-16
Polymorphisms
molecular diagnosis  10-6
of drug metabolizing enzymes  12-9
restriction fragment length polymorphism  10-5
Positivity rules
diagnostic ratio  3-7
discriminant function 3-7
for combination testing 3-6
for repeat testing 3-5
Postanalytic variability
definition 1-6
sources of 1-6
Precision
definition 2-5
Predictive value
definition 3-4
Pregnancy
source of biologic variability 6-5
Preanalytic variability
definition 1-5
sources of 1-5
Prenatal detection of genetic disease
fetal cells 10-15
maternal blood 10-14
Prevalence
definition 3-4
effect on diagnostic study performance 3-4
Prior probability
imprecision 3-12
in Bayes’ formula 3-8
Prognostic study performance
comparing prognostic study performance 3-19
efficiency 3-17
fraction correctly classified 3-16, 11-16
ROC curve 3-16
Prostate cancer
natural history 11-7
monitoring therapy 11-17
screening for 11-7
Prostate specific antigen
as a cancer marker 11-6, 11-12
as a screening study for prostate cancer 11-7
monitoring therapy of prostate cancer 11-17
PSA density 11-11
PSA velocity 11-11
Posterior probability
imprecision 3-12
in Bayes’ formula 3-9
Q
Quality assurance program
external quality control 2-13
internal quality control 2-9
R
Race
definition 6-5
constructing reference frequency distributions 6-6
geographic races of man 6-5
race-based variability 6-5
Recovery
evaluating method trueness 2-18
Red cell transfusion see Transfusion
Reference frequency distribution
constructing
basic approach 1-7
given continuous heterogeneity 6-3
given discrete heterogeneity 6-1
steps in establishing 1-7
Reference materials
primary reference materials 2-6
secondary reference materials 2-6
Reference method
definition 1-7, 2-6
in evaluation of classification studies 4-1
Reference range
definition 1-9
Regression analysis
constructing a calibration curve 2-2
in method comparisons 2-24
Repeat testing
classification correlation 3-6
diagnostic study performance 3-5
positivity rules 3-5
Resolving power
definition 2-6
evaluating 2-22
minimum distinguishable difference 2-6
Result correlation
accounting for when using Bayes’ formula 3-11
definition 3-11
Rh blood group
antibodies 9-10
typing 9-10
Rheumatoid factors
in systemic autoimmune disease 9-7
ROC curve
area under ROC curve
comparing diagnostic study performance 3-14
comparing prognostic study performance 3-19
characterizing diagnostic study performance 3-2
characterizing prognostic study performance 3-17
construction from frequency distributions 3-2
definition 3-2
evaluation of classification studies 4-6
S
Sampling bias
in evaluation of classification studies 4-4
Scatterplot
nonparametric scatterplot smoothing 6-3
slicing 6-3
Screening
for cancer
prostate cancer 11-7
screening for a predisposition to cancer 11-12
screening window 11-7
for genetic disease
newborn screening 10-11
screening for adult-onset disease 10-12
threshold likelihood ratio for acceptance 10-11
threshold likelihood ratio for followup 10-11
for subclinical disorders
components 5-1
probability of detecting a disorder 5-1
threshold likelihood ratio for acceptance 3-13
threshold likelihood ratio for followup 3-13
Selection bias
in evaluation of classification studies 4-4
Sensitivity
definition 3-1
variability 3-3
Sex
pregnancy 6-5
sex-based variability 6-4
SI units
conversion to common units 1-4
definition 1-2
table of 1-3
table of magnitude prefixes 1-4
Southern blot hybridization
molecular diagnosis 10-5
Specificity
definition 3-1
variability 3-3
Stimulation study
in the evaluation of endocrine function 7-9
Study population
in evaluation of classification studies 4-3
Suppression study
in the evaluation of endocrine function 7-9
Synthetic rate
as determinant of substance plasma concentration 7-1
organ synthetic rate 7-2
T U
Test panels
of injury markers 9-4
Test-review bias
in evaluation of classification studies 4-5
Therapeutic drug monitoring
definition 12-12
dosing adjustment 12-14
plasma concentration target 12-12
steady state 12-13
therapeutic range 12-13
Tissue injury see Injury
TNM staging system
in cancer prognosis 11-15
Trace minerals
circulating forms 8-3
deficiency 8-5
storage form 8-3
supply reserve 8-3
table of 8-1
Transfusion
ABO blood group 9-10
compatibility testing 9-10
markers of post-transfusion hemolysis 9-12
monitoring post-transfusion 9-12
Rh blood group 9-10
Transplantation
histocompatibility testing 9-9
HLA antigens 9-8
markers of transplant rejection 9-10
monitoring post-transplant 9-10
transfusion 9-10
V
Validation study
in evaluation of classification studies 4-8
Variability
age-based variability 6-6
analytic variability
definition 1-6
sources of 1-6
biorhythms 6-8
biologic variability
components of 1-5, 6-1
continuous heterogeneity 6-3
definition 1-5
discrete heterogeneity 6-1
sources of 1-5, 6-1
laboratory error 1-6
method imprecision
components 2-5
definition 2-5
evaluation 2-20
pharmacologic 12-5
preanalytic variability
definition 1-5
sources of 1-5
postanalytic variability
definition 1-6
sources of 1-6
race-based variability 6-5
sex-based variability 6-4
study performance 3-3
sources 1-5
V(D)J rearrangement in cancer 11-5
Vitamins
circulating forms 8-3
deficiency 8-5
storage form 8-3
supply reserve 8-3
table of 8-1
Volume of distribution
  definition 7-1, 12-1
  as determinant of substance half-life 7-1

W

Within-laboratory imprecision
  definition 2-5
Within-run imprecision
  causes 2-5
  definition 2-5
  evaluating 2-20
Work-up bias
  in evaluation of classification studies 4-4

X Y Z
Sweet is the melody, so hard to come by
It's so hard to make every note bend just right
You lay down the hours and leave not one trace
But a tune for the dancing is there in its place.

Iris DeMent