Dear Future Exam Success Story:

Congratulations on your purchase of our study guide. Our goal in writing our study guide was to cover the content on the test, as well as provide insight into typical test taking mistakes and how to overcome them.

Standardized tests are a key component of being successful, which only increases the importance of doing well in the high-pressure high-stakes environment of test day. How well you do on this test will have a significant impact on your future- and we have the research and practical advice to help you execute on test day.

The product you're reading now is designed to exploit weaknesses in the test itself, and help you avoid the most common errors test takers frequently make.

How to use this study guide

We don't want to waste your time. Our study guide is fast-paced and fluff-free. We suggest going through it a number of times, as repetition is an important part of learning new information and concepts.

First, read through the study guide completely to get a feel for the content and organization. Read the general success strategies first, and then proceed to the content sections. Each tip has been carefully selected for its effectiveness.

Second, read through the study guide again, and take notes in the margins and highlight those sections where you may have a particular weakness.

Finally, bring the manual with you on test day and study it before the exam begins.

Your success is our success

We would be delighted to hear about your success. Send us an email and tell us your story. Thanks for your business and we wish you continued success-

Sincerely,

Mometrix Test Preparation Team

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Written and edited by the Mometrix Exam Secrets Test Prep Team
Printed in the United States of America

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Operating room cycle

Pre-operative phase

All of the aspects of the operating room cycle directly correlate with the three basic phases of surgical case management: 1) the pre-operative phase, 2) the intra-operative phase, and 3) the post-operative phase. In the pre-operative phase, the activities begin with initial cleaning of the operating room furniture if the procedure is the first case of the day. This may be simply done with a damp cloth and possible use of disinfectants, if facility policy mandates it.

All pertinent furniture and specialty equipment are then brought into the room, and the function of everything is checked. The case cart is then brought into the room and items to be used for the procedure are positioned for opening. The sterile field is established, pertinent scrub team members are scrubbed and in place, the patient is anesthetized, positioned, prepped and draped. The surgical team is now ready to move into the intra-operative phase.

Intra-operative phase

The intra-operative phase portion of the operating room cycle in which the surgical procedure is being performed, the patient is under anesthesia, and all surgical team members are present. Traffic into and out of the room is restricted and the operating room doors are kept closed. During this portion of the operating room cycle, all pertinent aspects of the surgical procedure, including counts, sterile technique, etc. are implemented. This cycle is in effect until the procedure has been completed and the patient is safely transferred to the PACU. Once this occurs, the transition into the post-operative phase can begin.

Post-operative phase

Once the procedure is finished, the post-operative phase of the operating room cycle begins. The sterile field is preserved until the patient is safely transferred to the post- operative gurney or bed and taken to the PACU. Breakdown of the case set up begins. All sharps are placed in puncture proof containers and disposed of properly. Unused supplies are returned to their original storage compartments. Specimens should be processed accordingly. Linen, waste and biohazardous materials are to be bagged appropriately. All bags should be removed from the operating room, labeled, scanned or otherwise processed according to individual facility policy. The operating room and associated furniture are decontaminated. All personal protective equipment is removed from the room and discarded appropriately. The operating room is set up for the next procedure.

Instrument cycle

The instrument cycle has essentially three main phases: preoperative, intra-operative, and postoperative. Instruments and sets are handled in a different manner in each of the three phases. The surgical technologist must take great care in handling instrumentation through all phases of the instrument cycle. This careful handling will ensure proper maintenance of instrument integrity, extend the life of the instrument and reduce the possibility of injury to the patient or any member of the surgical team that use the instruments.

The intra-operative phase involves the actual usage of the instruments and the employment of critical thinking skills by the technologist. The postoperative phase involves retrieving instruments, ensuring proper instrument count and proper disposal containment, and early disinfecting of instruments.

Pre-operative phase

In the preoperative phase, instruments are gathered and sets are opened and organized on back table and mayo stand to procedure specifications. Specialty instruments are gathered, sterilized if necessary and opened for use according to the procedure to be performed.

In this phase, the surgical technologist must have knowledge of the procedure to be performed. Instruments pertinent to the procedure, as well as the surgeon's preference will be gathered. This may include specialty retractors, relevant power tools, and other ancillary equipment such as video/endoscopic equipment. In this phase, the surgeon's preference card is considerably important as it will outline general instruments used, as well as those specifically requested or unique to various aspects of the surgical procedure.

Intra-operative phase

In the intra-operative phase, the surgical instruments and equipment are put to specific use relevant to the procedure being performed. During this phase the actual handling of the instrumentation occurs, which requires several skill sets. It requires the manual dexterity to grasp and pass the instruments according to their specific use and the surgeon's preference. The surgical technologist must monitor the progress of the procedure and anticipate the surgeon's needs, so the surgeon operates more efficiently.

Knowledge of normal and abnormal anatomy, the specific disease or injury process, operative methodology and the overall procedure specifications allow for optimum use of instrumentation during the intra-operative phase.

All instruments carry within them an instrument list/count sheet. This sheet provides the surgical technologist with an itemized accounting of type and number of instruments within the set. The count sheet also verifies that the proper number

and type of instruments are indeed in the set and that the set is complete. The count sheet is usually dated and initialed by the person preparing the set and performing the instrument count.

The surgical count and instrument list will also identify instruments that are missing, out for repair, or otherwise not in the set for any number of reasons. The surgical technologist must ensure that the count sheet matches the actual instrument count, at the beginning and the conclusion of the surgical procedure. Any alterations must be immediately reported to the surgeon and reconciliation of the discrepancy must occur prior to the patient leaving the room.

The postoperative phase

The postoperative phase of the instrument cycle commences at the conclusion of the surgical procedure. It involves retrieving instruments, properly disposing of sharps, and placing dirty instruments in the proper bins, readying them for transfer to the SPD Department. Postoperatively, several steps are taken to prepare instrumentation for use in subsequent procedures: 1) cleaning and decontaminating; 2) inspecting and maintaining, which involves identifying the broken or damaged instruments and/or lubricating pertinent moving parts; and 3) replacing instruments as needed. Reassembly of the instrument sets occurs in the postoperative phase as well. Upon completion of the reassembly, the instrument sets are prepared for sterilization according to facility policies. The sets are then wrapped and put through the appropriate sterilization cycle. Upon completion of proper sterilization and drying, the sets are returned to their proper location and stored for future use.

Diagnostic results

Knowledge of diagnostic tests and procedures provides invaluable insight into the overall and pertinent health of the surgical patient. Abnormalities in the results of these tests and procedures can, and frequently do, have a direct impact on the patient's ability to withstand the trauma of surgery and to heal properly.

The surgical technology professional should have a working knowledge of and appreciation for normal laboratory test values, normal appearing radiological and angiography films, and normal blood/urine results, in order to identify potential hazards to the patient prior to the procedure.

White blood cells

Normal lab values for white blood cells are typically 5,000 – 10,000 / mm^3. Elevation of these numbers can indicate potential infection/inflammatory processes. Depression of these numbers can be a sign of immunosuppression, i.e. leukemia, or can be drug-induced, as seen with chemotherapy.

There are a variety of white blood cells, which can be seen at various stages of maturity. Alterations in the lab values of these blood cells can indicate whether an infective or inflammatory process is localized, acute, chronic, or systemic. The presence or absence of any of these processes can have a significant impact on tissue healing. If the healing process is impaired, infection could become systemic and the use of antibiotics may be warranted.

Red blood cells

Erythrocytes (RBC'S) are the cells that carry oxygen to the cellular structures of tissues and organ systems. Normal values range from 4.3-5.9 x 10^6 /mm^3.

Abnormalities in these values can be indicative of many types of anemias, hypovolemia secondary to illness or trauma, hemodilution or hemoconcentration as seen in dehydrated elderly patients, and chronic occult hemorrhage as seen in gastric ulcers. Abnormal levels due to deformity of the RBC's themselves are seen in sickle cell anemia.

Knowledge of normal and abnormal RBC values allows the surgical technology professional to anticipate the potential for excessive bleeding. Identification of this potential can lead to alteration in the surgical procedure itself, in the methods of hemostasis, in wound closure, in the use of drains, etc.

Orthopedic extremity x-rays

Three basic views seen in orthopedic extremity x-rays:

- AnteroPosterior (AP) View: This is the typical front-to-back radiologic view. Bones of extremities are seen from front-on, which aids the professional in determining whether an extremity is in proper position relative to its medial/lateral axes. Angular deformity can be assessed as it relates to the midline of the patient's body, i.e. varus (bowing away from middling) and valgus (bowing inward toward midline) deformities. AP views of joints aid the surgeon in pre-operative planning for joint replacement.
- Lateral View: Seen from the side of the patient, this view illustrates position and alignment of extremities as they relate to the anterior and posterior half of the body, arising from its respective midline. Lateral projections can also be extremely helpful in diagnosing problems with the cervical, thoracic and lumbar spinal segments, e.g. kyphosis and hyper lordosis.
- *Oblique View:* This view provides a tangential view of various body parts, such as the foot and ankle, in which additional views of joint surfaces to determine integrity is critical. Oblique views can be done with either internal or external rotation of the body part for maximum visualization.

Diagnostic procedures

Myelography

Myelography (myelogram) is a very useful diagnostic tool for determining abnormalities, tumors, disc herniation and other problems of the cervical, thoracic and lumbar spinal structures. This test is performed by introducing contrast material (dye) into the intrathecal (inside the spinal sac) space, performing a variety of fluoroscopic exposures, and obtaining x-ray films. Myelography is used to help diagnose nerve root impingement due to herniation of intervertebral disc material, bony encroachment of facet joints, or other compressive entities such as scar tissue. While myelography does not specifically illustrate the disc or bony material that may be encroaching upon the nerve root, it does show an opposite indentation or deformity that is being caused by the offending agent. Myelography allows for the visualization of the *effect* of the causative agent, rather than the causative agent itself.

Fluoroscopy

Fluoroscopy is a radiological process that provides a real-time or *live* image of a body part or structure through the discharge of continuous radiation. This is a valuable tool for diagnostic procedures where the introduction of needles, catheters or contrast material into difficult-access areas or areas not readily visible, is warranted. In fluoroscopy, the radiation beam is produced by an *image intensifier,* and fed into a *collector* at the opposite end where it is transferred onto a monitor screen. The image can be in stop-action format or "still" picture, or can be in a constant, live emission mode. The surgical technologist should understand the process of fluoroscopy so that proper radiation safety measures can be employed and monitored, including the proper wearing of lead aprons, the distance one should stand from the fluoroscopic unit, and the nature of "scatter" or the deflection of radiation particles out to other parts of the operating room.

Magnetic Resonance Imaging (MRI)

MRI procedures have been extremely important and beneficial as a diagnostic tool for many different pathologies. While conventional x-ray is limited to visualizing objects with radiopaque properties such as calcium in bones or calcified soft tissue, MRI imaging provides expanded visualization to include all manner of soft tissue with exceptional clarity. Magnetic resonance implies that a very strong magnetic field is used to excite the cellular components of tissue, causing them to align in certain patterns and to maximize their visibility. During the process, computerized "slices" of the tissues being evaluated are performed at various thicknesses, allowing for accurate visualization and evaluation of the tissues.

Knowledge of the MRI process is important for the surgical technologist. Patients with retained hardware or a history of metal fragments under the skin or in the eye should be identified in order to determine if there is a safety issue or to exclude the patient from this type of test.

Angiography

Angiography is the process by which contrast material is injected in to the patient's vascular system. This is typically performed under fluoroscopy for live studies of structures such as vessels and organs. Angiography is important in the diagnosis of such abnormalities as aneurysm of arterial structures in body parts or organs, occlusions, i.e. thrombi (clots), or plaque formation. The carotid artery is a common location of angiographic study for occlusion. Lower extremity angiography is frequently performed in patients if there is a suspicion of arterial blockage. Such blockages could threaten the viability of limbs if left undiagnosed and untreated. Angiography is very important in the diagnosis of potential problems in organ systems as well. For example, renal angiography is utilized to diagnose tumors that are fed by the blood stream or adjacent tumors that can compress the vessels.

Ultrasound

Ultrasound is a process by which sound waves are emitted from and received by a probe. The sound waves deeply penetrate tissue and organ structures to provide a visual representation of the targeted tissue or organ for evaluation. Ultrasound evaluation can be a very important diagnostic tool for patients who are allergic to contrast material and cannot undergo diagnostic studies that employ the use of dye, or who are unable to undergo MRI procedures due to the presence of metallic debris or devices within their bodies, such as retained metal shavings and/or pacemakers. Ultrasound, in contrast to procedures using dye or other injectable material, is safe, non-invasive and typically does not require any special preparation. The clarity of the picture is not as optimal as an MRI, so reading the images from ultrasounds can be difficult.

Cardiac catheterization

Cardiac catheterization is a procedure in which a small catheter is inserted into the femoral artery and advanced up and into the base of different coronary arteries. The arteries are injected with contrast material and evaluated for different types of abnormalities, such as clots or plaque formation. The severity of coronary artery disease can be determined by this procedure and this procedure can aid the cardiac surgeon in planning surgical intervention. Cardiac catheterization has most recently been coupled with the insertion of small catheters. Catheters can expand a small balloon, which compresses plaque and dilates the vessel lumen in order to maintain vessel patency. This procedure is known as *angioplasty.* Additionally, small *stents* can be placed at the location of the angioplasty to maintain patency after the procedure. Successful angioplasty can result in the avoidance of open cardiac bypass surgery.

Patient transporting

The gurney, or cart, is the most common mode of transporting a surgical patient to the operating room. This cart is built for short-term occupation, as in the outpatient setting. It is equipped with side rails and allows for positional changes, e.g. head up, feet elevated, Trendelenburg position, etc. The most appropriate way to transport a surgical patient to the operating room is in the supine position; feet first, with side rails locked in the up position, and appropriately covered with a blanket to protect the patient's dignity.

Patients who are already admitted to the hospital and whose condition or problem does not allow for transportation via gurney are brought to the surgery department in their hospital bed. Transportation of the patient into the operating room in a hospital bed is typically a two-person function. It can be accomplished by either the circulating nurse and an anesthesia caregiver, or the circulating nurse and the surgical technologist, depending on the patient's condition. The mode of transport is the same as with a gurney.

<u>Pediatric patients</u>

Pediatric patients can be transported to the operating room in a wagon. Providing the child's medical condition allows for this, and there is no potential for compromising the surgery, the patient can be placed in the wagon. Wagons must be fitted with appropriate side rails. Patients should be properly covered to avoid unnecessary exposure and chilling. This method typically works well for patients without IV lines, etc. To lessen anxiety and promote a more relaxed environment, the child may have a favorite stuffed animal accompany him/her in the wagon to the operating room.

Pediatric patients may also be physically carried to the operating room. This method works well with very young patients and infants, in that it reduces anxiety

caused by unfamiliar surroundings. This mode of transport allows for maximum physical control of the patient and reduces potential for injury secondary to difficulty understanding directives.

Protecting the patient from injury

To protect a patient from injury during transportation to the operating room, care should be taken to ensure that all bony prominences are free from potential pressure points by padding appropriately or removing potential pressure-causing agents, e.g. wrinkled linen, medical cords or cables, or foreign objects such as portable monitors. Gurney side rails should be locked in the up position. The patient's arms should not be touching the side rails. This will ensure that there is no pressure on the arms, thereby preventing injury to the radial nerve at the distal humerus level.

Protecting patient's dignity

The patient should be adequately covered to prevent unnecessary heat loss and over exposure of extremities. If there are complaints of low back pain, the head may be gently elevated to relieve stress on the lumbar area. Pillows can be placed under the knees, if permissible, to relieve low back strain as well. The patient should be adequately covered to prevent unnecessary heat loss and over exposure of extremities. If there are complaints of low back pain, the head may be gently elevated to relieve stress on the lumbar area. Pillows can be placed under the knees, if permissible, to relieve low back strain as well. Care should also be taken not to discuss the patient's condition openly while in transit to the operating room.

Catheterization

Catheters are used to evacuate fluid, remove clots, and insert fluid and diagnostic media. One of the most commonly used catheters is the Foley catheter. Its primary use is to remove urine from the bladder. This is especially important in procedures

where accurate fluid inflow and outflow must be measured and accounted for. The indwelling catheter is typically placed into the bladder after the onset of anesthesia. The balloon is tested for competency before insertion and secured in a manner that avoids unnecessary pulling. The Fogarty catheter is used to remove clots from blocked vessels in the leg. This catheter also has a balloon that expands once the tip of the catheter is beyond the clot. The catheter is inflated and the clot is removed as the catheter is pulled out of the vessel.

Equipment

Urinary catheterization differs from male to female only in the anatomical considerations. The equipment used is the same, and the sterile technique is similar. The surgical technology professional should have knowledge of the pertinent anatomy in order to achieve proper placement and to maintain the sterile technique. After equipment preparation, one hand must be kept sterile in order to properly insert the catheter, while the other hand provides exposure.

The equipment typically comes with the Foley catheter connected to the appropriate drainage container, which can be a bag or a calibrated *urometer*. A calibrated urometer is used if close monitoring of urinary output is warranted, e.g. for lengthy procedures. Pre-packaged Foley catheters typically come in #16 or #18 sizes. "Straight drainage" kits are also available if there is a need to empty the bladder without maintaining an indwelling route.

Proper technique for catheterizing an adult male patient

Once the proper catheterization kit has been selected (straight drainage versus urine meter), and the patient is in supine position, the kit can be opened and sterile gloves donned. Care should then be taken to test the balloon on the distal end of the catheter for proper inflation and absence of leaks. Open the prep solution and have the kit ready.

With one hand, hold the penis in a somewhat extended position and pull back the foreskin if necessary. This hand is now contaminated and will continue to hold the penis. The other hand is used to cleanse the penis, beginning at the meatus and working proximally. With the dominant hand, pick up the catheter utilizing the enclosed forceps and properly lubricate the tip for easier, less traumatic insertion. Insert the catheter approximately 7-9 inches into the urethra. After proper balloon inflation, gently pull back on the catheter until it stops. Reduce the foreskin if necessary, and affix the catheter tubing to the leg, or in some other manner to prevent undue traction on the catheter.

Proper technique for catheterization of an adult female patient

Select the proper catheterization kit and ensure that the patient is in the supine position. The patient's legs must be abducted so that the hips can externally rotate and the knees can flex. The patient should be in a frog-leg position, with the feet together. This position exposes the perineum for preparation.

Properly test the catheter, prepare the prep solution, and drape the fenestrated drape. Using the non-dominant hand spread the external labia to expose the urethral meatus. Prep the area in an anterior-to-posterior method to avoid contamination from vaginal secretions, and discard each swab after one pass. Pick up the catheter with the appropriate forceps, and insert the catheter approximately 2" (5cm) or until urine is seen. Inflate the balloon and gently retract to ensure placement into the bladder. Properly secure the catheter in such a fashion as to avoid unnecessary traction and yet maintain patency.

Patient positioning

Basic tenets of proper surgical patient positioning

The patient should be positioned in such a way as to provide the optimal surgical site exposure for the surgeon; however, the position should also provide maximal protection of the patient and prevention of injury from the positioning itself.

The surgical technologist should have adequate knowledge of anatomy in order to assist the team with positioning to ensure that all bony prominences are adequately padded, that extremities are not positioned outside the normal functional position or beyond joint range of motion, and that vital organ systems are not compromised by unnecessary pressure, e.g. respiratory depression secondary to pressure on the rib cage, etc.

Knowledge of anesthesia can also aid the team in positioning. While under anesthesia, the patient cannot complain of pain from improper positioning. General anesthesia causes profound muscle relaxation, which can have an impact on the support of vital structures, e.g. the conscious patient can support the head with the neck muscles; the patient under general anesthesia cannot.

Supine position

The term supine refers to positioning the patient flat on his/her back on the operating table. The supine position is preferred for anterior abdominal, pelvic, anterior cervical spine, thyroid, cardiac, and many upper and lower extremity procedures.

Further enhancements of the supine position are necessary to ensure optimal surgical site exposure, as well as maximum patient comfort and protection. In addition to proper positioning of the main trunk of the body on the operating table, the upper extremities must be positioned to allow for access to IV lines and blood

pressure monitoring equipment by the anesthesiologist. Typically, the arms are placed on arm boards at relative 90 degrees of abduction. Over-abduction of the arms should be avoided to prevent stretching of the brachial plexus. The hands and wrists are supinated, and padding is placed under the elbow to reduce pressure on the ulnar nerve.

If the procedure is lengthy, padding of the heels is beneficial, and placing a pillow under the knees reduces potential for lumbar strain. If the procedure is lengthy, padding of the heels is beneficial, and placing a pillow under the knees reduces potential for lumbar strain.

Lateral position

The lateral position is utilized when surgical exposure is needed for thoracic, hip, kidney and other retroperitoneal procedures. Common procedures requiring lateral positioning include hip replacements, fracture procedures, thoracotomies, and splenic abscesses.

Care must be taken to prevent injury to the patient, including brachial plexus injuries from pressure on the down-side axilla and nerve injury to the down-side peroneal nerve at the bony prominences of the lateral knee. Additionally, there is potential for respiratory compromise secondary to restriction of respiration from positional pressure. Precautions should also be taken to avoid pressure points to the down-side hip, shoulder, and ankle by utilizing proper padding protection.

The upper arm must be adequately supported in the lateral position by using a supportive device such as a pillow or an arm suspension device.

Draping

Principles of surgical site draping

Proper surgical site draping should isolate the site from the rest of the body and from any other potential factor that could result in a surgical site infection (SSI). Proper utilization of surgical drapes helps to reduce and eliminate the migration of contaminants into the site of the incision. These drapes serve as a barrier to infection between the wound and surrounding tissue.

Surgical drapers should also be made of material that reduces the risk of injury from fire, static electricity and body heat. The material should also be fluid, puncture and tear resistant to prevent the potential for strike-through or cross-contamination. The color of the material should prevent surgical light glare.

Basic types of drapes

There are two basic types of surgical drapes that are frequently used: the *fenestrated* and the *non-fenestrated* drape. Fenestration refers to a specific opening in the drape to accommodate the surgical incision, as well as the area of the body being operated on. Fenestrations can come in a variety of shapes and sizes, many of which are procedure specific.

A non-fenestrated drape is typically used for "squaring off" a given operative area, or to cover non-essential or non-operative sites. These drapes can also be layered to enhance fluid resistance. These drapes can be used to ensure that all pertinent body parts and surface areas are adequately covered and separated from the actual surgical site.

Examples of fenestrated drapes include: laparotomy drapes, used primarily for abdominal procedures; the thyroid drape, used for most neck procedures; the *extremity* sheet, used for most extremity work, i.e. total joint replacement and

fracture procedures from the groin to the toes; and the *transverse laparotomy* sheet, used for many thoracic and kidney procedures.

Plastic adhesive drapes

Plastic adhesive drapes can be applied to the skin and held in place by adhesive strips to secure a barrier around the incision or operative area. They are typically made of a clear plastic so as not to obstruct the surgeon's vision.

The *incise* drape is made of a clear plastic material with an adhesive backing that may or may not be treated with an antimicrobial iodine solution, which slowly releases over time. The drapes are applied directly to the patient's skin after the surgical site has been draped off with either paper or cloth towels. Since this drape is place directly on the skin, the incision is usually made through the drape.

The aperture drape has an opening that is surrounded by adhesive backing. It is used quite frequently in eye surgery. This type of drape allows the surgeon to better visualize important landmarks or anatomical structures.

Surgical skin preparation

Basic principles

Surgical preparation of the patient's skin is not unlike surgical preparation of the hands of the scrub team and surgeon. The goal is to remove as many transient superficial microorganisms from the sterile field and incision area as possible, thus dramatically reducing the chances of a surgical site infection (SSI).

The skin surrounding the actual site of the incision should be cleansed in a prescribed fashion, to minimize any wound contamination. Skin preparation is not limited to the physical cleansing of the skin; it includes hair removal, nail cleansing and polish removal, to name a few.

Hair removal

Hair removal is one of the most important and controversial aspects of skin preparation. In addition to incision preparation, hair removal may be necessary for proper placement of electrocautery electrodes, EKG patches, wound closure and dressing application. The most commonly accepted method of hair removal today is the use of clippers and/or depilatories. The main reason for the use of clippers and depilatories is that they are atraumatic and do not create breaks in the skin. Breaks in the skin can increase infection risks. Decisions must be made preoperatively as to the extent, location and technique of hair removal. The hair should be removed as close to the operative time as possible to reduce potential growth and re-colonization of bacteria.

Skin preparation solutions

Skin preparation solutions are used to maximally reduce microorganism levels prior to the surgical procedure. The type of solution used is contingent upon the operative area, mucosal involvement, and any allergies the patient may have. Prep solutions include "soap" or "pain" solutions, as well as alcohol-based single-use dispensers. Many solutions require specific drying times to maximize their effects.

Prep solutions include: alcohol, usually 70% strength, which provides a rapid decrease in the level of microorganisms; iodine, which provides similar rapid reduction in microorganism levels as alcohol, but should be removed in a timely manner to reduce the chance of skin irritation; chlorhexidine, which does not provide as rapid a reduction in microorganism levels, but has a residual effect of 5-6 hours.

Patient needs

Patients' basic needs are physical, psychological, social, and spiritual. While all patients have the same basic needs, how those needs are met will vary from patient to patient. The surgical technologist is responsible for helping each patient have his or her needs met, without bias and with ultimate respect. Having a working knowledge of what makes a patients unique can go a long way in ensuring that his or her needs are met. For example, a patient who is an amputee may need more assistance from the surgical technologist in having his basic physical needs met.

Maslow's Hierarchy of Needs

In 1968 Maslow constructed a pyramid in an effort to prioritize the needs of humans, ranging from the most basic and instinctive to the most highly developed and complex. Meeting the needs at each level from birth properly prepares the person for further physical and psychological growth.

- The first level (the bottom of the pyramid) is *Physiological*. This level represents what a person needs to physically survive: food, water, air and regulation of temperature.
- The second level reflects the need for *Safety*. One must interpret his or her environment in order to be safe from harm.
- The third level, *Love and Belonging*, represents basic social needs, i.e. to be cared for by and to care for others.
- The fourth level, *Esteem*, defines the need to have respect for one's self, to be respected by and respectful of others, and to have confidence in one's achievements.
- The top of the pyramid, or the fifth level, is called *Self-Actualization*, which is the need to fulfill what one believes is his/her purpose in life.

Pediatric patients

While pediatric patients will inevitably require surgical procedures in the same ways as adults, several elements will vary dramatically as to the physical and psychological needs of the pediatric patient. Many differences are readily appreciated: small body mass, less circulating blood volume, immaturity both physically and emotionally, etc. These differences can result in vastly different and equally complicated problems. Others differences are less apparent but equally important: separation anxiety, fear of anesthesia and anatomical differences, which are not visible but must be appreciated.

Methods for reducing these anxieties and meeting these patients' special needs can include allowing the child to bring a favorite stuffed animal to the operating room, allowing parents to be part of the transport to the operating room, and allowing parents to be with the child in the PACU.

Psychological impact of surgery

The prospect of having surgery of any kind can have a tremendous impact on the patient from a psychological perspective. He/she faces a number of disconcerting concepts, such as loss of control when under anesthesia, loss of dignity, the prospect of severe pain post operatively, and the fear of death. As the patient prepares to face the unknown, the need for reassurance is great

Patients undergoing diagnostic surgical procedures, such as biopsies, face the unique uncertainty of the diagnosis and potential disfiguring subsequent surgery. Even in elective surgery such as joint replacement, the uncomfortable feeling associated with turning over one's control over self can be particularly difficult.

As part of the surgical team, the technologist can play a decisive role in helping the patient deal with these uncomfortable concepts. By helping to educate the patient and offer compassionate understanding and support, the patient will be more prone to have optimal outcomes from decreased stress and anxiety.

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Surgical scrub process

The surgical technologist is one of the surgical team members that will be present in a sterile field, touching and handling sterile instruments and equipment, and coming in contact with the surgical incision. In order to meet these requirements, the technologist must perform an appropriate and adequate surgical scrub of his/her upper extremities before applying the sterile gown and gloves.

The main purpose of the surgical scrub is to rid the skin of as many bacteria and microorganisms as possible before the gown and glove application. While it is impossible to sterilize the skin, the goal is to render it surgically clean. Because there are many transient as well as resident microorganisms at various depths on the skin, the use of an antimicrobial surgical scrub solution is critical and necessary. Use of an approved solution will provide protection on the skin for a period of time after the actual scrub.

<u>Two main methods</u>

- *The Timed Method*: In this method of scrubbing, the hands, arms and fingers are scrubbed in a predetermined fashion for a given time period. The scrub is begun at the distal portions of each hand, starting with the fingers, and moves proximally in an orderly manner, culminating at a point approximately 2" above the elbows. Care is taken to make sure that web spaces between the fingers are also scrubbed properly. Scrub the first of the

two upper extremities in proper fashion, then switch to the opposite extremity and repeat the process.

- *Counted Brush Stroke Method:* With this method, the principles for how each extremity is cleansed remains the same; however each part or section of the extremity such as the fingers, hands, and arms, are scrubbed with a prescribed number of brush strokes. The accepted method is that the fingers are held together and all nails, cuticles, and fingers are scrubbed for a total of thirty strokes, followed by scrubbing the remainder of the arms in separate planes, utilizing 10 strokes per plane.

The finishing process

Once each extremity has been properly scrubbed, the brush is discarded, the extremities are rinsed individually, beginning at the fingertips and working to the elbows. The forearms should be in a vertical position to prevent water from running from a dirty-to-clean area. Allow the water to adequately drain off the arms and to drip into the scrub sink. Once this has been accomplished, the water is turned off and entry into the operating room is allowed. Keep the elbows flexed and in a vertical position and the hands between the middle of the chest and the waistline. Open the OR door with the hips and proceed into the room to the area where gowns and gloves are positioned.

Pertinent equipment

Proper surgical scrubbing begins with using a scrub sink that allows for water activation with body parts other than the hands, such as the knee, hip or foot. Nail cleaners are typically packaged with the scrub brush in a sterile manner; although, most scrub locations have a supply of non-sterile cleaners for nail cleansing prior to beginning the scrubbing process. Once the nails have been cleansed, the scrub brush can be used. Scrub brushes come packaged sterile, with or without scrub solution in them. If a scrub brush comes without solution, it can be soaked in a scrub solution obtained from a foot-operated dispenser located at the scrub sink.

Gown and gloves

Upon entering the operating room after scrubbing, the technologist must dry his/her arms prior to donning gown and gloves. Typically, the surgical gown is opened and positioned on a mayo stand with a disposable drying towel. Once in the room, the disposable towel is removed from the top of the gown. No residual water should drip on to the gown. Arms should be dried from fingers to elbow without re-drying any areas. Grab the gown by the fold that exposes the inside of the gown, and visualize the folds of the sleeves. Slide the hands into the folds of the sleeves. The gown is then opened. Care is taken not to come into contact with any non-sterile objects or surfaces. The hands should stop short of exiting at the cuff end of the sleeves.

Once the gown has been donned, the packet of gloves is opened with the sleeve-covered hands of the technologist. The gloves will be contaminated if the hands touch them. The first glove is then grabbed and laid upon the sleeve of the right hand/arm, with fingers pointing toward the elbow. The thumbs of the hands are then slid under the folded edge of the glove on the palm side and subsequently "flipped" so that the right hand inserts into the glove. With the opposite hand still covered by the sleeve, the glove is pulled up over the cuff of the gown until all fingers and the thumb are seated. The process is then repeated for the opposite hand until both are seated in the gloves with cuffs covered.

Intra-Operative Procedures

Surgical department design layout

All surgical services departments employ one of a variety of design layouts, depending upon the age of the hospital, and the layout of the surrounding

departments. The first design example is the "race track" plan. This plan incorporates a layout where the operating rooms surround a central sterile core. In this layout, entrances to the operating rooms are from a separate hallway and supplies are delivered through access areas adjacent to the sterile core.

The second example is the "hotel" plan. In this plan, the operating rooms are situated along a common central corridor. There are separate clean and soiled work areas. This layout also directs all traffic along this common hallway.

The third example is the "specialty grouping" plan. This plan, which can be a "hotel" or "race track" design, groups operating rooms by specialty. Each group has its own clean and soiled areas.

Traffic flow and patterns

All surgery departments employ strict traffic flow patterns for staff and ancillary personnel. While there are many variations to this theme, there are three basic traffic patterns that are typically utilized: 1) unrestricted, 2) semi-restricted, and 3) restricted areas.

Unrestricted areas typically are located near entrances and are usually separated from the main hospital areas by doors. Frequently these areas contain dressing rooms, offices, and support staff changing areas. Street clothes are typically allowed in these areas. Semi-restricted areas mandate that scrub attire be worn. Quite often, these areas are only separated from unrestricted areas by way of signs and/colored lines on the floor warning against entry. Restricted areas usually comprise the surgery department proper, inclusive of the operating rooms and associated clean and sterile core areas. In addition to surgical attire being required, masks are usually mandated as well.

Laminar air flow, humidity and temperature

Laminar air flow provides unidirectional, positive-pressure air flow that creates a flow of air from inside the operating room outward. This air flow system also filters microbes. This type of system works best when operating room doors are kept closed. Prolonged opening of doors reduces the positive air pressure in the room. The elevated air pressure forces the air into HEPA filters and out of the room, thus reducing microbial counts.

Humidity, the amount of moisture in the air, should be kept at a maximum of 55% in order to minimize bacterial growth. The temperature should be between 65-75 degrees depending on the patient and the procedure to be performed. Exceptions to this rule would be made for the pediatric patient.

Personal protective equipment (PPE)

Personal protective equipment is designed to protect the caregiver from exposure to harmful substances such as bodily fluids, radiation, and sharp instruments. Hazards can come in microbial and environmental forms and can be present concomitantly.

Examples of this equipment are surgical masks, which protects both patient and caregiver from droplet and airborne microbial transfer and surgical gloves, which protect against direct contact hazards such as injuries from sharps. Protective eyewear is mandated in virtually all surgical departments and protects particulate matter from entering the eye. It also protects the eyes against splatter and contamination from bodily fluids and other chemicals. Protective eyewear includes goggles, and partial and full face shields. In orthopedic joint surgery, the full helmet "space suit" is the used for global protection.

Space suit

The space suit is personal protective equipment that includes the surgical gown and a "helmet" type apparatus that completely covers the head and face. The "helmet" usually has a clear plastic disposable front face shield. Frequently called "togas," this apparel is typically utilized when there is a distinctly higher infection potential, e.g. in open orthopedic joint replacement procedures. This system also offers optimal protection to the scrub person from splatter that occurs from power saws and pulse irrigators. These helmets come with self-contained, battery powered ventilation systems that consist of a small fan at the back or top of the helmet. This system helps reduce the potential of overheating while working. The battery pack is usually worn on the waist and is quite portable and not exceptionally heavy.

Foot and shoe coverings

Shoe and foot covers are universally disposable and serve more than one purpose. First and foremost, shoe covers offer a protective barrier from contaminants that are housed on or in the material and sole of the shoe. Shoe and foot coverings reduce the potential for spread of microorganisms and unwanted contaminants brought in from outside the department. In the days when flammable anesthetics were routinely used, shoe covers had to be outfitted with anti-static straps located on the bottoms of the covers to prevent accidental explosion and/or fire caused by static electricity sparks. Today's shoe coverings comes in an assortment of disposable materials and range from a basic shoe cover to thigh-high, water-proof covers for use in urologic and arthroscopic procedures where significant volumes of fluid are used.

Handling sterile instruments

Opening a sterile wrapped instrument set

Sterile instrument sets can be opened in one of two ways. First, the set can be placed on a prep stand or ring stand and arranged so that the apex of the outermost

taped fold is pointing toward the person opening it. The first fold should be opened away from the person. The two side folds should be opened next by grasping the innermost corner and opening to the respective sides. The last fold should be carefully grasped by the folded corner and opened toward the person opening it. In situations where there is a double covering, each layer is to be opened in the same manner. Another method of opening is to hold the sterile instrument set with the non-dominant hand supporting it from underneath. Unfold the wrapper in the same fashion and in the same order as previously mentioned. This technique allows for placement of the set on the back table.

Peel packs

Peel packs are sterile paper and plastic pouches that hold smaller instruments and supplies. They typically have a strip that seals the clear plastic to the paper material when exposed to heat. The strip has a pointed configuration on the end, which leaves the corners of the pack loose for opening. To open the pack, grasp one of the loose corners of the paper and plastic with one hand on each. The hands and fingers are then positioned as close to the center of the pointed end as possible. In an action that resembles opening a book, the two opposite sides are separated and opened with a rolling motion of the wrists. The object inside the pack can then be presented to a sterile person to grasp.

Patient safety and monitoring

Universal precautions

In an effort to standardize the way patients are treated in the operating room and to maximize patient safety during surgical procedures, universal precautions were adopted. Universal precautions create a safe environment for the patient and surgical staff members and ensure that safety measures are utilized for every patient. Examples of universal precautions include cautious handling of sharps (i.e.

"no-touch" zone), double gloving, appropriate protection from environmental hazards such as lasers and x-ray radiation, and the placement of electrosurgical pencils in their appropriate holster when not in use. Universal precautions should be employed by all surgical staff members for every patient regardless of whether or not that patient has a diagnosis of HIV, hepatitis, or any other potentially communicable medical condition.

Safety measures employed to protect patients

Additional measures that can be employed to maximize patient safety in the operating room include ensuring that the surgical scrub solution, if alcohol-based, has appropriately dried before beginning a procedure and using electrocautery, appropriately covering reproductive areas in the younger patient when x-ray or fluoroscopy is in use, and properly shielding the patient's eyes when lasers are in use. Proper patient positioning and appropriate padding of extremities and bony prominences are also key elements in providing for patient safety, as is using various patient heating devices to maintain optimal core temperatures. Proper ergonomics and maintenance of optimal positioning of the patient during transfers is also a key element in maintaining safety.

Tissue handling and retraction techniques

The manner in which wounds are exposed and tissues are handled has a direct impact on the overall safety of a patient undergoing surgery. Over retraction of tissue can lead to inadvertent injury and possible necrosis of important adjacent tissues and structures. These types of injuries can often lead to healing difficulties, wound dehiscence, infection and possible tissue death. Improper handling of tissue with surgical instruments can lead to accidental crushing of the tissue causing permanent damage. The surgical technologist must have an appropriate knowledge of the instruments and their respective use and be able to utilize these instruments and retractors to prevent unintended injury.

Electrocautery grounding pads

There are two major types of electrocautery used in surgical procedures. Monopolar cautery utilizes an electrical current that passes from the cautery pencil through the patient and exits by way of the properly placed grounding pad. Bipolar electrocautery allows the current to pass from one tip of the forceps to the adjacent tip and affects only the tissue being touched by the instrument. Care must be taken to determine the proper location for grounding pads. It is important that electrical current is not directed into unwanted areas such as a previously implanted artificial joint, a cardiac pacemaker, or an automated internal defibrillator. Implanted metallic objects such as screws plates, rods and prostheses create a potential for altering the path of the current and increasing the risk of burn injuries. The surgical technologist must have a working knowledge of electrocautery systems as well as a knowledge and appreciation of the patient's physical status in order to ensure that grounding pads are placed appropriately.

Patient monitoring equipment

The typical monitoring equipment used in the operating room during surgical procedures and while the patient is under an anesthetic can include EKG monitor, pulse oximeter, blood pressure , and core temperature. The primary purpose for such monitoring devices and techniques is to ensure that the patient's vital signs, respiration, and heart rate are all within normal and optimal range. For example, blood pressure monitoring will alert the anesthesiologist, the surgeon and surgical team if the values fall outside the normal range. Hypotension can lead to problems related to inadequate perfusion of vital organs such as heart, lungs, kidneys, and brain.

The pulse oximeter measures the circulating oxygen in the red blood cells during the surgery and while the patient is under an anesthetic. A patient's temperature can be monitored in a variety of ways. Typical methods include esophageal temperature

probes, adhesive strips placed on the patient's forehead, and rectal temperature probes.

Pulse oximetry

The pulse oximeter is a noninvasive tool used to assess the level of oxygen saturation of the hemoglobin in the blood in the arterial system. The oximeter measures the speed and amount of light that is absorbed by the hemoglobin, which varies at different saturation levels. There are several locations on the human body that are considered optimal points for measuring oxygen saturation. The three most commonly used sites are the fingertip, the earlobe and the bridge of the nose. The use of the pulse oximeter offers a real-time evaluation of oxygenation during a surgical procedure and anesthetic. Deviations from normal saturation percentages during surgery can be attributed to such things as hypoventilation, mechanical respiratory obstruction, aggressive retraction, hemorrhage, and hypothermia.

Temperature monitoring devices

There are a variety of ways to monitor a patient's core temperature. Maintaining optimal body temperature throughout an anesthesia or surgical procedure reduces the likelihood of tissue and/or organ system injury or damage, offers the patient the best opportunity for proper healing due to optimal homeostasis, and decreases the potential for surgical site infections. A temperature monitoring strip that is applied to the patience for head offers a generalized temperature level of the patient; however this method is not as accurate as more invasive measures such as the esophageal or rectal temperature probes. The esophageal and rectal probes are clinically more beneficial in that they offer a more accurate core temperature reading.

In the preoperative setting, the three most common venues for patient temperature evaluation are oral, rectal and axillary. Oral temperatures may be taken using a mercury-style thermometer or, most commonly, a digital and electronic

thermometer. Temperature evaluation is typically done in the pre-surgical holding area. The normal temperature value for oral thermometer readings is 98.6° F (37° C), for rectal temperature readings 99.6° F (37.6° C), and for axillary readings 97.6° F (36.5° C).

In pediatric surgery, external body temperature readings are typically less accurate than internal core evaluations because of substantially smaller body size and body mass indices. Because body heat can be lost much more rapidly in children and infants than adults, additional care must be taken to maintain normothermia.

In cardiac bypass surgery, and for lengthy cases where major body cavities are exposed, heat loss can be extreme; therefore, monitoring of core temperatures via rectal and esophageal probes are the preferred methods.

Surgical instrumentation

Surgical instrumentation is the tools used to perform operative procedures. There are many varieties of surgical instrumentation.

Most surgical instrumentation is constructed of surgical stainless steel. Other metals and alloys, such as carbon, chromium, iron and other alloys, are used in the construction of the instruments to increase durability, strength and resistance to corrosive forces. These corrosive forces are especially significant in instrumentation that requires repeated sterilization. Instruments with higher concentrations of carbon are less likely to corrode than those with lower carbon percentage. Chromium allows for increased durability and resistance to corrosion.

Surgical instruments also come in a variety of finishes. Some possess a dull or satin finish; however, these can be somewhat distracting to the surgical team due to glare

from the surgical lights. Other finishes include ebonized or black chromium, which is nonreflective.

Cutting/dissecting instruments

One of the most proliferate classifications of surgical instruments are those that perform cutting and dissecting maneuvers. These instruments possess one or more sharp edges and are primarily utilized for incising, dissecting and excising. Examples of these instruments include scalpels, scissors, various knives, osteotomes, gouges and chisels.

Instruments such as rongeurs, curettes, saws, drills and dermatomes are also in the cutting/dissecting family. Any instrument that ends in "-tome" signifies that it is used for cutting. The root word in the name of the instrument describes the target tissue for cutting. For example, "osteotome" refers to an instrument designed for cutting bone.

The two most common instruments utilized in cutting and incising are the scalpel blade and scissors. Scalpel blades come in a wide variety of shapes and sizes depending on the function to be performed. The three most common sizes of scalpel blades are #10, #15, and #11. The #11 blade is typically used for “stab" wounds, while the #10 blade is used for much longer linear incisions.

Grasping/holding instruments

Instruments used to hold on to and manipulate tissue to aid in cutting or incising fall into the grasping/holding category. These instruments also come in a wide variety of shapes, sizes and functional purposes. Some instruments may have locking mechanisms, while others have ratchet-type mechanisms. Many of these instruments have range-type handles for forefinger and thumb insertion, while others require a pinching type maneuver to operate them. The most common example of a grasping or holding instrument is the forceps. This instrument comes

in a wide variety of lengths, widths and with a variety of tips. Some have teeth, while others have serrated tips. Other forceps possess smooth tips and are the least dramatic of the varieties.

Clamping/occluding instruments

Surgical instruments that grasp and/or create blockage (occlusion) of tissue or vessels are considered clamping/occluding instruments. Occlusive instrumentation is commonly utilized in vascular and general surgery/bowel procedures where delicate tissue and vessels require clamping and occlusion without additional trauma.

Vascular clamps typically have long serrated tips, are curved, and have elongated ratchet-type connectors between the rings of the handle to allow for locking the clamp in position.

Hemostats are surgical instruments that are commonly used to occlude bleeding vessels. They typically are curved in shape and have long serrated tips. Straight hemostats are more commonly used for "tagging" sutures. Larger hemostats are frequently used for clamping a large ligament in tendinous structures.

Retracting/viewing instruments

Instruments specifically designed for exposure of the operative site are called "retractors." These instruments are typically flat, come in a variety of widths and can be either rigid or malleable. The retractors can be handheld or self-retaining. Many retractors come in pairs and are used to expose opposite sides of the wound. Others are very smooth and are used to retract such tissues as bowel and muscle. Some retractors have serrated tips or tips with teeth designed to grab and retract non-vital tissue. Malleable retractors are made of soft metal, which allows the shape to change during a procedure. Instrumentation used for viewing may also have some retracting capabilities; however, their primary purpose is to provide optimal

visualization of a structure or body cavity. Examples of viewing instruments include vaginal and nasal speculums. Otoscopes and laryngoscopes are used for viewing the inner ear and trachea/vocal cords respectively.

Probing and dilating instruments

Flexible wire-like instruments that are frequently used for exploring structures such as fistulas, ducts and vessels are called probes. Probes are used to determine patency of vessels and ducts. They are also used to determine if an obstruction exists in the lumen of a vessel or duct. Occasionally, probes are used to determine the direction of a fistula when its path cannot be determined visually. Probes are also used to determine patency after structures have been anastomosed, such as in the surgical formation of an A/V fistula or a cardio-vascular anastomosis.

Instruments used for enlarging the lumen of various structures are called dilators. One of the primary purposes of dilators is to enlarge the diameter of a variety of tubular structures such as vessels, the esophagus, ducts and surgically induced openings. Dilators not only increase diameter, but they reestablish patency in structures with strictures, e.g. the esophagus and the ducts of many organs.

Instruments used for suturing

Instruments that are designed to hold needles of various sizes and shapes for the purposes of suturing are called "needle holders." These instruments may be long or short, with heavy, fine or delicate tips, and straight or curved jaws. The needle holder allows the surgeon to position the needle in such a manner as to efficiently place sutures while closing wounds, repairing tissue or performing anastomosis. Needle holders are typically used to navigate curved needles through tissue layers. The jaws on some needle holders may be curved so that needles can be place at unique angles during suturing. Because needles vary in gauge size, the tips of needle holders can range from heavy-duty to exquisitely fine. Some needle holders

also have suture cutters, which allow the surgeon to cut the suture after tying without exchanging instruments.

Instruments used for suctioning

Instrumentation designed for the evacuation of blood, bodily fluids, and irrigation solutions are called suction instruments. These instruments come in a variety of shapes, sizes and lengths to accommodate various surgical procedures and the speed at which fluid must be evacuated. In delicate areas or where there is a high potential for tissue injury, a small bore suction tip, such as the Frazier neuro suction tip, may be required. In large open abdominal procedures, large bore suction, such as the Poole tip, may be needed for rapid evacuation of blood or fluid. Some suction tips have a feature that allows the user to regulate the amount and intensity of the suction on the field. Some suction tips are shaped so that there is no entrapment of tissue while fluid is evacuated.

Hemostasis

Mechanical methods

Mechanical hemostasis is the method by which instruments, equipment and devices are employed to control bleeding until a clot forms or until the procedure has ended. One method of mechanical hemostasis is the use of a pneumatic tourniquet. This device applies external pneumatic compression to an extremity to a degree sufficient enough to occlude arterial flow. This allows operative procedures to be performed without the time-consuming process of clamping, ligating and cauterizing small bleeding vessels; however, this occlusion lasts only during tourniquet inflation. Once the tourniquet is deflated and the surgical site re-perfuses, other methods of hemostasis will normally need to be employed. Other methods of mechanical hemostasis include the use of hemostats, direct pressure on the vessels, surgical packing and ligation of vessels. Additionally, a liga-clip, which is

a small non-reactive metal clip that is applied to a vessel and squeezed to hold its position, can be used to control bleeding.

Thermal methods

Thermal energy is used to provide hemostasis via electro-cautery. Electro surgery involves the use of a thermal cautery unit, which is typically the active electrode or "pencil." The unit is connected to a power-generating source adjacent to the operating table. The most common current utilized in electro surgery is the monopolar current. With this type of current, the power is generated at the tip of the pencil and must exit the patient at an alternate site. Because of the pathway of this current, a grounding pad is placed on the patient in an optimum location. Care must be taken to avoid locations over bony prominences, metal prostheses, cardiac pacemakers or automated internal defibrillators. Monopolar electrocautery current can be adjusted to two different types of current: *coagulation* and *cutting.* When the cutting current is used, there is little to no ability to coagulate bleeders. The use of the coagulating current is more dispersive and reduces its ability to cut.

Laser

In many cases, the use of a laser beam in surgical procedures is quite similar to the use of electrocautery. The laser emits a beam of intense light that allows it to cut and cauterize at the same time, with very little collateral injury or damage to tissue. On the cellular level, the action of the laser beam upon the tissue causes a rupturing and searing of cell membranes and provides hemostasis. Many different types of lasers can be used; therefore, it is necessary for the surgical technologist to have a good working knowledge of the particular laser unit that will be employed in a particular surgery. Care must also be taken to ensure that the technologist, as well as the entire surgical team and the patient, have the appropriate personal protective equipment in place. In addition to the use of personal protective devices during laser surgery, care must be taken to use surgical instruments that are non-reflective to avoid inadvertent deflection of the laser beam.

Chemical cauterization

Many types of chemical agents are available for use in providing hemostasis in a surgical site. For example, absorbable gelatin, which is composed mainly of collagen, can be found in powder form or in the form of a foam pad. When the powder or foam comes in contact with the blood, the material enhances the deposition of fibrin from the blood. This material can be left in the body and will be absorbed over the course of approximately 1 month. Collagen, which is also used for chemical cauterization, can be found in several absorbable varieties and helps with the development of the clotting process. This collagen material is typically dissolvable, and as hemostasis proceeds, this material gradually disappears.

Chemical cauterization agents

Silver nitrate is a chemical compound that is frequently used to control cervical or nasal bleeding. It comes in several forms with the most common being in solid form on the end of a wooden applicator. This material is considered poisonous in larger amounts, so care must be taken while using it.

Epinephrine is a potent vasoconstrictor and is frequently mixed with local anesthetic agents. This mixture can be used in conjunction with materials such as gelfoam, which contains the mixture to a localized area. The addition of the local anesthetic agent can also offer some transient pain relief.

Thrombin is an enzyme found in the blood that is present when pro-thrombin is activated during the coagulation process. Thrombin can be poured directly onto bleeding surfaces; however, it is most frequently used in conjunction with gelfoam or powder substances.

Wound closure

Surgical stapling

Surgical stapling devices come in many forms. The staples can be made up of stainless steel, titanium and a variety of absorbable materials. Surgical stapling devices are most frequently used to close anastomoses in bowel surgery. They can also be used to perform wound closures at the skin level. Disposable stapling devices are now preferred over nondisposable. They come preassembled and pre-loaded with either metallic or absorbable staples. The staples come in cartridge form, which may or may not be removable, to allow for additional staple placement. Stapling of tissue is the preferred method of closure because the tissue undergoes fewer traumas with the stapling process than with suture placement. Surgical stapling results in accelerated and better quality wound healing. Surgical stapling also allows for rapid closure that is watertight, airtight and leak-proof. Rapid closure decreases operative and anesthesia time.

Skin staplers are used to approximate and close the wound edges to allow for optimum skin healing. The stapler deploys one staple at a time, and typically comes preloaded with staples in quantities ranging from 5 to 35. The staplers are typically disposable. *Linear staplers* are typically used to close off an area to be transected, typically in the abdominal or thoracic cavities. This stapler typically fires staples in two parallel rows, allowing for transection of tissue in between the rows. *Linear cutters* produce parallel rows of staples and transect the tissue simultaneously. This device is especially useful in bowel resection surgery, as well as in partial resection of lung tissue.

Sutures

The three main types of suture material are absorbable, non-absorbable, and metallic. The metallic suture is made of fine gauge wire in a variety of sizes. Because metal is the most inert of the materials that sutures are made of, metal

sutures are used in closure of wounds where the sutures are anticipated to remain for several weeks. Wire sutures are frequently used in wounds that have been re-opened due to sepsis or dehiscence.

Non-absorbable suture material is typically used when there is a need for long-term integrity of the suture. This suture is used to maintain the position of repaired tissue or bone. Examples of this type of suture include Ethibond, Prolene, nylon, and silk. Ethibond is frequently used in deep internal layers, whereas nylon and Prolene are typically used for skin sutures.

Absorbable sutures are used in deep internal layers to aid in tissue healing. Examples of absorbable suture material include Vicryl, PDS, Monocryl and cat gut.

Surgical techniques

Cryotherapy

Cryotherapy is a surgical technique employing equipment that generates extreme cold at the tip of a probe. This ultra cold probe can be used to devitalize tissue, to control bleeding and to instantly solidify fluid filled structures. Cryotherapy is a technique frequently used by obstetricians, gynecologists, ophthalmologists and plastic surgeons. It can be used topically/externally to treat lesions or on certain mucosal surfaces such as the vagina and cervix of the uterus. It is used to treat a wide variety of diseases and conditions. Liquid nitrogen is typically the agent used in cryosurgery due to its extremely cold nature. Cryosurgery/cryotherapy is considered a minimally invasive surgical technique and is very effective in the destruction of abnormal cells.

Cryosurgery/cryotherapy is used by dermatologists and plastic surgeons to treat external skin lesions via cryo probe or topical application of a liquid cryogenic

substance. Cryotherapy/cryosurgery is also often used to treat external hemorrhoids.

Cryosurgery is used to aid in the extraction of cataracts. When the cryo-probe comes in direct contact with the lens of the eye, the extreme cold temperature freezes and solidifies the lens and causes it to adhere to the cryo-probe, enabling the probe to help in the lens extraction

Radiologic surgical techniques

Radiologic surgical techniques employ the use of standard x-ray machinery or fluoroscopy. Examples of these surgeries include pacemaker insertion, fluoroscopic-guided biopsies, intra-operative fracture fixation, and intra-operative spinal stabilization with hardware. Radiologic techniques used in surgery include fluoroscopic guided intra-vascular procedures, such as Greenfield filter placement, and various angiography procedures.

Lumbar epidural steroid injections are also performed under fluoroscopic guidance in the operating room, as are a wide variety of hardware implantations for fracture reduction and fixation in trauma surgeries.

With the ever-increasing usage of radiation producing equipment in the operating room for surgical procedures, it is critical that the surgical technologist has a good working knowledge of radiation safety. Many pieces of equipment and techniques can be employed to improve radiation safety and decrease exposure. Examples of these techniques include the use of lead impregnated barrier shields, lead aprons, thyroid shields and keeping a safe distance from radiation producing equipment and understanding safe exposure times.

Laparoscopic surgery

Surgical procedures of the abdominal and pelvic cavities that employ the use of video assistance in the equipment fall under the general heading of laparoscopic

surgery. Surgical procedures using this technique include laparoscopic hernia repair, gallbladder removal and appendectomy. Laparoscopy involves the creation of one or more working portals in the abdominal or pelvic cavity. The scope is inserted and contents visualized through one portal, while instrumentation is inserted through the remaining portals to perform the procedure itself. Laparoscopic clamps, scissors and thermal cutting units are examples of equipment that can be inserted through the various working portals. During a laparoscopic procedure, the surgical technologist should keep inflation pressures within safe limits. The technologist should avoid coming into contact with organs or tissue that could be burned by the high-intensity light while operating the video and the scope.

Basic abdominal laparoscopy is performed in the modified lithotomy, with hip flexion to approximately 45°, in approximately 15° of Trendelenburg position and under general anesthesia. After appropriate skin preparation and draping, a Veress needle is inserted into the abdominal cavity at an angle of 90° perpendicular to the elevated plane of the body. After attaching appropriate tubing from the insufflator, carbon dioxide is pumped into the nominal cavity to a pressure not exceeding 15mmHg. Typically, four to 5 L of carbon dioxide are used in the procedure. Upon completion of a midline and a 1 cm stab wound, the first trocar is inserted and the procedure is performed. At the conclusion of the procedure, carbon dioxide inflow line is discontinued and the trocars are removed.

Whether the laparoscopic procedure is diagnostic or interventional will determine if internal organ structures will be manipulated. Manipulation of internal organ structures increases the risk of injury.

During a diagnostic procedure, the risk of injury is minimized during the abdominal distention phase by proper needle and trocar insertion. Additionally, thermal and direct contact injury from the endoscopic telescope can be avoided by ensuring that

the fiber-optic tip of the endoscopic lens does not come in direct contact with any organ structure or tissue.

If the procedure is interventional or therapeutic and direct manipulation of organ and surrounding tissue is performed, care must be taken to ensure that no inadvertent damage occurs to these tissues from inappropriate contact from instrumentation, trocars or endoscopic lens.

Care must be taken to ligate appropriate bleeders as well as any duct that is transected.

Harmonic scalpel

The harmonic scalpel is an ultrasonic instrument that produces sound waves at a level suitable for cutting and coagulating tissue. Instruments come in a broad range of cutting and coagulating tips, including scissor configuration.

One of the main benefits of ultrasonic surgery is that the instruments can cut and coagulate tissue simultaneously. The harmonic scalpel typically operates in cutting and coagulation modes at temperatures much lower than in electro-surgical equipment, thereby greatly reducing potential for collateral tissue damage and injury. Procedures in which the harmonic scalpel is frequently used include open procedures such as thyroidectomy, mastectomy /lumpectomy and hemorrhoidectomy. This instrumentation can also be used in laparoscopic cholecystectomy, laparoscopic nephrectomy, laparoscopic splenectomy and laparoscopic gastric bypass.

In as much as ultrasonic instrumentation operates at lower temperatures, care should be taken to avoid inadvertent tissue injury, secondary to heat produced by the vibrating tip of the surgical instrument. In laparoscopic cases, safeguards should be undertaken to avoid over distention of the abdominal cavity.

Phacoemulsification

Phacoemulsification is a surgical method that uses a combination of irrigation/aspiration simultaneously. This surgical technique is primarily utilized in ophthalmic surgery. It is typically considered minimally invasive surgery and often requires no closing sutures.

The phacoemulsification equipment consists primarily of the ultrasonic generator, hand piece and "phaco" tip. This procedure utilizes the image of ultrasonic waves to literally fragment the lens of the eye, while simultaneously irrigating and aspirating the resultant fragments. Once the fragments have been adequately removed, the phaco tip is used to irrigate and evacuate any remaining debris.

Potential safety concerns when using the phaco emulsification equipment include inadvertent activation of the equipment causing injury to surrounding tissue of the eye, or failure to terminate sound wave emissions at the proper time resulting in injury to the internal structures of the eye. The surgical technologist must have proper fluid replacement products readily available to reduce potential risk to the internal aspect of the eye.

CUSA system

The CUSA system (Valleylab/Radionics) is a versatile ultrasonic aspiration system designed for precise tissue removal, e.g. tumor or other varieties. Its primary function is tumor evacuation. This system uses high frequency ultrasonic waveforms to fragment tissue and simultaneously aspirate/evacuate those fragments. Different tissue structures can be targeted with the use of different tips, and there are attachments to these tips that allow for concurrent electrosurgical applications. The CUSA system can be used during in the laparoscopic surgery as well. Because it is a relatively compact, mobile unit, it can be used in different operating rooms. Care should be taken to safely operate the equipment and to be mindful of patient safety issues. Possible safety hazards and potential injuries

include inadvertent fragmentation of normal viable tissue and thermal injury from the probe tips

Injuries in operative environment

Because the surgical environment is one in which there is proliferate use of instrumentation and equipment that have sharp ends and edges, the potential for exposure is that much higher than in other areas. Since that vast majority of sharps-related injuries occur in the operating room, the surgical technologist must be aware of proper handling of such equipment and be especially mindful of the situations that can present injury potential.

Situations in which there is an increased injury potential in the operating room include positioning and passing a suture needle in a needle holder, suturing, manually retracting tissue in the presence of sharp instruments, leaving needles on the field, dropping a needle or scalpel on a worker's foot, reaching for objects or instruments that are sliding off drapes, overfilling containers and placing sharp items in a disposal container not designed for sharps.

<u>The "Neutral Zone" or No-Touch Zone"</u>

The neutral or no-touch zone was established in order to reduce the potential for sharps-related injuries that were occurring during hand-to-hand instrument exchanges between surgeons and surgical technologists. The location of the neutral zone should be mutually agreed upon by the surgeon and the surgical technologist. Additionally, when sharps are placed in the zone, the surgeon should be notified as to which particular instruments will be located there, and the instruments should be placed in a position so that the surgeon can pick up and utilize the sharps with one hand without having to change position. Many different instruments are placed in a neutral zone for use: scalpels, needles, loaded sutures with needle holders,

osteotomes and many other instruments and equipment with cutting and/or sharps edges. The key to the success of a neutral zone is teamwork and communication.

Specific practices used in the transfer of a scalpel to the surgeon

Since the scalpel represents one of the most dangerous and potentially harmful instruments used in surgery, specific techniques and practices have been established for the use and transfer of them in the operating room. The first practice is handing and receiving the scalpel to and from the surgeon. Newer and safer techniques are constantly being implemented. The second is handing the scalpel to the surgeon, but then having him/her place the scalpel in a designated safe area. In the third technique, the surgical technologist places the scalpel in the neutral zone. It is then picked up and used by the surgeon, returned to the neutral zone and picked up by the technologist. The fourth is the no-hand technique in which a basin is used as the transfer vessel for the scalpel. Extreme care must be taken while reaching into a basin in which sharps reside.

Standard precautions

The concept of standard precautions is an enhancement of the original Universal Precautions model adopted by the CDC in 1996 in an effort to reduce the potential for transmission of infectious materials and fluids among healthcare workers.

The protocol of standard precautions applies to blood and all bodily secretions and excretions, except for sweat. All fluids are to be treated as if they are infectious.

In an effort to standardize patient care, all healthcare workers are charged with the responsibility of executing standard and universal precautions. In the surgical environment, the surgical team can use gowns, gloves and masks when handling body fluids to protect skin and mucous membranes from exposure.

Disease transfer

Standard modes of transmission for disease transfer

The Standard Precautions Model essentially recognizes four basic routes (modes) of transmission of infectious material for disease transfer: 1) airborne, where transmission and contamination occur via droplets in the air; 2) contact, where infectious material is transferred either by direct or indirect contact; 3) common vehicle, where disease is transferred by way of blood; and 4) vector, in which infectious or disease microbes are transferred from one host to another by way of an animal, insect or other living "vehicle." In the unique venue of the operating room, two forms of contamination exist: *exogenous* and *endogenous.* There are essentially two major forms of exogenous transmission of disease microbes: 1) the environment and 2) surgery personnel.

Fomites, or inanimate objects, can be carriers of microbes and must be thoroughly cleaned and/or sterilized before use. Air must be filtered regularly (min. 15 air exchanges / hour). Vectors must be eliminated. Surgery personnel must keep hair covered. Skin and nails must be clean at all times.

Patient as an endogenous mode of disease transmission

As an endogenous source of disease transmission, the patient can present many of the same concerns that the surgery personnel present. Sources of transmission include hair and skin, nail beds and subungual (under the nail) areas, and blood and bodily fluids from open incisions or from breeches in the integrity of the skin such as open sores or draining lesions. Protection against contamination is critical in the prevention of transfer of infectious and/or disease microorganisms.

When preparing the patient for surgery, carefully evaluate the skin for any breeches and inspect the nails and beds. Placing patient caps over hair prior to entering clean areas is also necessary for prevention of transfer. Properly disposing of any blood

or urine soaked garments, bedding or linen, such as prep towels, prior to entering the operating room is necessary to reduce the potential for contamination.

Management of smoke plumes

When a beam or current comes in contact with tissue during the use of lasers and electrosurgical units, the resultant coagulation, or searing of the tissue, routinely produces smoke. The smoke contains coagulated proteins, cells and potentially intact DNA. It is the responsibility of the surgical technologist to properly position the evacuator wand during laser surgery. The evacuator wand should be placed approximately 1 cm. from site of laser impact. At this distance, approximately 98% of the smoke plume can be recovered, while a modest increase in distance from the wand to 2 cm can reduce plume recovery by as much as 50%. Current surgical practice for evacuation of electrosurgical smoke is the use of standard suction equipment. This may ultimately change in the near future as efforts to be more protective may require special evacuating units for this type of smoke.

Drains

Drains are used to remove any excess fluid accumulation at a surgical site. Typically, these drains types are either passive or active. Active drainage systems are used to maintain a state of decompression in a cavity or surgical area while drainage fluid is evacuated. The Hemovac© is an active drain system which has a reservoir that produces a vacuum when the chamber is compressed.

Passive drains allow for evacuation of fluids via gravity or pressure from fluid build-up. The Penrose is a passive drain. Passive drains are frequently placed in the abdominal cavity after surgery to allow egress of bloody fluid. They can also be placed in a wide variety of surgical wounds.

Dressings

The basic function of a dressing is to protect the surgical site from post-operative trauma and contamination. Dressings can be occlusive or transparent. They are frequently used to absorb post-operative drainage.
Dressings are used to support the incision, to provide pressure, to decrease dead space and to prevent hematoma formation. Dressings can make the surgical site appear more aesthetic to the patient.

Dressings can also be rigid in structure to limit motion, to absorb fluid and to protect the surgical wound. They also should be proportionate to the size and shape of the patient, to the surgical incision and to the procedure performed. The dressing should be applied in a manner that is safe for the patient, e.g. avoid a "tourniquet effect" from circumferential dressings on an extremity.
The *one-layer* dressing
One-layer dressings are usually applied to an incision where drainage is expected to be minimal, e.g. endoscopy access sites. IV sites are also areas where single layer dressings are used. "Op Site" is a transparent one-layer dressing. Collodion is a single layer dressing that comes in liquid form. This compound is flammable and may not be approved in many health systems. Many surgical procedures utilize adhesive strips as a one-layer dressing and as a way to maintain skin edge approximation. The most common trade name for this type of dressing is 'Steri Strips'. Other one-layer dressing include a variety of aerosol sprays that dry to a protective film, as well as foams, and gels that protect the incision without the additional use of gauze.

The three-layer dressing
The three-layer dressing is frequently used when drainage from a surgical procedure is moderate to heavy in volume. As its name implies, this dressing type consists of three essential layers: 1 the *inner layer* is in physical contact with the

wound itself; 2); the *intermediate layer* absorbs the bulk of the drainage; and 3) the *securing layer* is the outermost layer.

The innermost *contact* layer comes in three varieties: 1) non-permeable, which creates an air/water tight seal to the outside but allows drainage to the middle layer; 2) semi-permeable which allows for air and fluids to pass through to the intermediate layer; and 3) permeable, which "draws" fluid away from the wound.

The pressure dressing

The pressure dressing is three-layer dressing with added material in the intermediate layer. The added material in the intermediate layer is tightly secured to provide tissue compression and closure of any potential dead spaces. When this type of dressing is used on an extremity, the pressure frequently comes from the application of wraps such as ace bandages. Often times, the mere bulk of a dressing, once taped into place, is enough to exert adequate pressure over the surgical site. Pressure dressings can also be effective in reducing motion and edema of an extremity. In orthopedic surgery, Robert Jones is often used as a compressive dressing. For this dressing, large amounts of cotton batting are rolled over the extremity and secured with one or more ace bandages. This allows for wide distribution of compression and motion limitation.

Rigid dressings

Rigid dressings can be multi-layered, any degree of permeability and can be compressive in nature. The outer layer of a rigid dressing is specifically designed to restrict motion. It can be as simple as an arm board over a wrist to restrict movement at an IV site, or as complex as a fully circumferential cast. Splints are rigid dressings used in situations where total immobilization is not required. Splints can be made of plaster, fiberglass, metal or composite materials. Casts can be made of either plaster or fiberglass depending upon the procedure, the body part and the choice of the surgeon. Rigid casting can be employed in areas other than extremities

for the purpose of immobilizing a patient in the post-operative phase. For example, spinal "jackets" are used for immobilizing the thoracolumbar spine after extensive fusion or re-alignment procedures.

Specialty dressings

Many dressing types are available for use in procedure-specific situations. They can be used to effect tissue removal with each dressing change or as a receptacle for bodily waste. Examples of specialty dressings include the *bolster dressing*, which is sutured into position, and the *wet-to-dry* dressing, which is applied to a wound and allowed to dry. The dry dressing is removed as along with any tissue that adhered to the dressing. Other examples include the *wet-to-wet* dressing, which allows for minimal tissue debridement, the ostomy bag, which allows for unrestricted drainage from the stoma, and the "Queen Anne's Collar," which is a circumferential dressing and neck wrap used in thyroid surgical procedures.

Surgical implants

Intra-medullary rod

In orthopedic surgery, one of the ways to reduce, stabilize and bridge fractures of long bones is through the use of implants placed inside the canals of the bones. These devices frequently can be "locked" by a variety of screws, creating a rigid and fixed construct. Intra-medullary implants come in a wide variety of lengths, shapes and diameters. They can be made of stainless steel or titanium. They can be solid or hollow in structure. They can be small enough to fit within the canal of a finger bone (phalanx) and large enough to fit within the canal of the femur. One of the many benefits of intra-medullary rod fixation is the ability to begin early range of motion and partial weight bearing ambulation to reduce the risk of clots, infection or respiratory problems.

Plates and screws

Plates and screws have long been a staple of open reduction and internal fixation of fractures. Plates are usually fixed to the outer cortex of a bone and screwed into place, bridging the fracture. Internal fixation plates come in a vast array of shapes and sizes, and frequently are designed to be bone-specific in their shape, size and contour. Current technology allows for plates and screws to literally be "locked" to each other and to the bone, greatly improving the stability and quality of fixation. Plates can be contoured for an exact fit to any bone, maximizing their fixation ability. Most screws and plates are constructed of stainless steel, with some specialty screws being titanium. The screws used in fixing a plate to a bone have special functions as well. Cortical screws have a thread pitch and diameter and can be secured to the cortex of the bone. Cancellous screws have larger diameter thread designs, which allow for maximum purchase in the softer medullary bone.

Hip hemi-arthroplasty

Implants used in the partial or hemi-replacement of a hip joint mainly consist of the femoral stem, the femoral head, and, frequently, the bi-articulate or bi-polar cup/head combination. The hemi-arthroplasty typically involves replacement of the femoral side of the hip joint. For the most part, the acetabulum does not need resurfacing or replacement unless significant disease or fracture is present.

The femoral stem is usually comprised of a mixture of metals, but predominantly cobalt chrome. The surface of the stem can be either smooth or rough, depending on whether bone cement will be used. The cop/head combination is also predominantly cobalt chrome, but frequently will have a high density polyethylene "liner," which acts as a plastic spacer between the two metallic objects and allows for smooth, low friction motion.

Hip pinning procedure

In orthopedic surgery, they are two basic types of hip pinning procedures: 1) the compression/side plate procedure; and (2) the in-situ pin/screw fixation.

The compression/side plate procedure involves inserting a lag screw into the femoral head and connecting it to a side plate that is fixed to the femoral shaft with cortical screws. The fracture is locked in place. This procedure allows for a stable fracture fixation and reasonable maintenance of the femoral neck angle. Reduction and fixation of the fracture helps reduce pain because the fracture now moves as a single unit.

The in-situ to pins/screw fixation is typically performed for a hip fracture that demonstrates little to no displacement of the fracture components, especially the femoral head. Three long, cannulated, partially threaded screws are inserted in parallel fashion to secure the femoral head to the femoral neck. This type of procedure is only done under when the possibility of healing is high.

Breast enlargement

Breast surgery in women is typically performed for cosmetic reasons or in response to pathologic diagnoses. In many instances, the patient may require the insertion of an implant to maintain or restore aesthetics and symmetry and to support tissue.

In cosmetic breast surgery, implants sacs are filled with silicone or saline. Temporary implants are called tissue expanders. In cosmetic surgery, spaces are created beneath the breast tissue, either external or inferior to the chest wall muscles, and the fluid filled sacs are implanted. These implants come in a variety of sizes to physically enhance the female breast.

In surgical procedures performed for a diagnosis of breast cancer, implants are often considered postoperatively to correct significant and visible deformities

created by mastectomy procedures. Frequently, tissue expanders are put in place until the patient has healed from the mastectomy and are gradually inflated over time to create the necessary cavity to hold the final implant.

Biologic implants

The need for surgical implants is increasing for all surgical specialties. In orthopedic surgery, implants can be metallic, plastic, bio-absorbable screws and pins, or biologic implants fashioned from human and animal tissue. In orthopedic surgery, biologic implants can be made from various tendon materials. These implants can be used during ligament reconstruction procedures. Biologic implants harvested from the patient at the time of surgery are called auto grafts, while those harvested from cadavers are called allografts. In cardiac surgery, heart valves from pigs are often used in valve replacement surgery. Veins harvested from a patient's leg and used for coronary bypass also represent biologic implants. When using cadaver donated allografts, the graphs must be meticulously harvested, appropriately cleansed, and must undergo terminal sterilization. These graphs typically function as a scaffold on which new host tissue can grow and proliferate.

Radioactive "seeds" used in prostate surgery

Occasionally, after a diagnosis of prostate cancer has been made, radioactive "seeds" are implanted into the glandular tissue that will be receiving localized radiation therapy. These radioactive “seeds” are used in an effort to reduce the size of the tumor and to render tumor cells inactive prior to prostatectomy. These seeds may preclude the need for prostatectomy.

These seeds are typically small metallic cylindrical objects that are implanted in clusters in and about the prostate gland and the tumor tissue. These implants can be permanent indwelling implants, and occasionally are removed if prostatectomy becomes necessary. These radioactive pellets are typically inserted percutaneously into various points between the scrotum and the rectum through hollow needles.

Vascular implants

Vascular implants come in many sizes, shapes and forms ranging from vascular grafts to stents. Vascular grafts can be fabricated from materials such as Gore-Tex and woven fabric. These particular grafts are primarily utilized for rerouting the blood flow around diseased or obstructed vessels in order to preserve the viability of extremities and organ structures. Stents can be used in the carotid arteries or in the abdominal aorta. Many of these stents/implants are pretreated with anti-thrombotic agents to reduce the likelihood of clot formation. A very common type of metallic vascular implant is he Greenfield filter. This implant is typically inserted into the inferior vena cava for the primary purpose of trapping and securing mobile fragments of blood clot that usually originated in the lower extremities.

The use of stents as implants in vascular surgery

In vascular surgery, stents are often used as implants to maintain the patency of arterial vessels. Stents can be placed in coronary arteries, carotid arteries, and even in the major portions of the aorta, iliac and femoral arteries. Many stents are implanted during interventional procedures instead of during surgical procedures and can be performed under fluoroscopy and with minimally invasive techniques. Vascular stents can be constructed from a wide variety of materials. Early stents were primarily metallic, but now they are constructed of biocompatible materials. Carotid stents are used when primary endarterectomy has gone on to re-stenose. Coronary artery stents can be medicated to prevent clot. Newer vascular stents are now made of a material called *nitinol*, which is a combination of nickel and titanium. The major advantage of this material is that it is MRI compatible.

Total knee replacement surgery

The three basic implants used in total knee replacement are: 1) the metallic femoral component, 2) the metallic tibial component, and 3) the polyethylene spacer. The femoral component is typically constructed of cobalt chrome or, on rare occasions,

titanium. The texture of the back surface of this component can be either smooth or rough to accommodate either bio in-growth or cemented fixation. The tibial component is constructed similarly, and with similar surface finishes to accommodate either mode of fixation. The high density polyethylene spacer, also called the tibial articular surface, is placed between the two opposing metallic surfaces to allow for optimal motion of the knee without metal-on-metal contact and debris formation. The tibial articular surface also allows for maximum longevity of the prosthetic construct. In most cases, the under surface of the patella is also resurfaced during total knee replacement. This implant can be solid polyethylene or a combination of plastic and metal. The backing may be either smooth or rough to accommodate either mode of fixation.

Penile implant

The penile prosthesis implant is most commonly used for the treatment of impotence in the male, which can occur because of diabetes, trauma, vascular disease or nerve damage. The major purpose for the insertion of a penile prosthesis is to restore the ability to achieve an erection in order to have sexual intercourse. Typically, the prosthesis is comprised of a number of inflatable rods connected to a remote port that can be manually accessed beneath the skin and pumped to achieve erection. This procedure is performed under spinal or general anesthesia. Postoperatively, when the patient reaches orgasm, the inflatable rods can be deflated and the penis returned to normal pre-erection status.

Bariatric lap band

The bariatric procedure known as "Lap Band" is a restrictive surgical procedure that involves the implantation of a circular band around the upper part of the patient's stomach. This band is adjustable and can be inflated or deflated by adding or removing saline from the band through a portal located just under the skin. The insertion of the lap band device and subsequent attachment around the upper part of the stomach is typically done via the laparoscopic approach. Once the band is

freshly attached around the stomach, a new, smaller pouch is created in a location where, due to proliferate nerve endings, the feeling of being full and satisfied occurs more rapidly. The portal used to adjust the size of the lap band is a small circular reservoir, which is implanted just beneath the skin, usually in the upper left quadrant of the abdomen. It is accessible in the surgeon's office, where small amounts of saline are either injected or removed to either tighten or loosen the band respectively.

Artificial disc

For many years, spine surgeons have been plagued with the dilemma of how to adequately treat their patients that suffer from chronic, severe and disabling back pain. Spinal fusion has long been the treatment of choice for chronic, intractable back pain, when the root cause is a degenerative disk segment. While fusion surgery has been the gold standard over the years, it has not been without its own set of troubles, mainly that of accelerated wear and tear to adjacent spinal segments that have increased workloads, secondary to a fused spinal segment. In the 1990s, isolation of disk related back pain increased, which has necessitated the design and development of artificial lumbar discs. The artificial disc has been touted as a substantial option in the treatment of discogenic back pain. While there are many different styles of implants, the typical artificial disc is comprised of metal and plates and a movable polyethylene insert. This is designed to alleviate pain, yet maintain a reasonable level of spinal segment motion.

Heart valve replacement surgery

In cardiovascular surgery, two main types of prosthetic valve replacements are used: the mechanical heart valve and the bio-prosthetic heart valve.

The primary function of heart valves is to keep the blood flow moving in the intended direction while open and preventing backflow when closed. In valve disease, the ability to open and close and the ability to remain closed and prevent reflux or regurgitation of the blood are often compromised. The mechanical heart

valve is typically made of a combination of stainless steel, silicone, Teflon, and polyester rings to accommodate sutures. The main advantage of a mechanical heart valve is its durability and longevity. These valves are typically implanted in the younger patient and usually last the life of the patient. The bio-prosthetic valve can be made of either human or animal tissue. The human tissue valve is called a homograft; whereas, the animal tissue implant is called a xenograft.

Endoscopes

In the surgical environment, a wide variety of endoscopes are routinely used. Flexible fiber-optic endoscopes are frequently used in the lower gastrointestinal tract for colonoscopy procedures and other trans-rectal diagnostic studies. Fiber-optic scopes are also used by the anesthesia department when intubating a patient is difficult. In general surgery, abdominal laparoscopic procedures are typically performed with a long rigid endoscope. These are typically larger in diameter, which provides an exceptionally clear picture. Endoscopic equipment is frequently used in procedures such as thoracoscopy, mediastinoscopy, hysteroscopy and sigmoidoscopy. Other smaller endoscopes are used in orthopedic surgery for arthroscopic evaluation of joints such as the shoulder, knee, and ankle.

The scopes typically have an eyepiece, rigid shaft, light cord attachment, and fiber optics within the shaft encased in glass. The distal tips of these endoscopes are typically beveled so that images are seen from an angle versus straight on

<u>Knee arthroscopy</u>

Prior to the 1970's, percutaneous endoscopic evaluation of the knee joint was performed by Japanese surgeons. Following this breakthrough, revolutionary changes have been made in evaluating and treating the knee joint. The vast majority of knee procedures performed today are done arthroscopically. The typical arthroscope is rigid, approximately 4.0 mm in diameter and has either a 30° or 70°

angled tip. This scope is typically attached to a digital or high-definition camera and the images are displayed on high-definition monitors. Virtually all sections of the knee joint and associated internal structures can be adequately viewed by the use of the arthroscope.

The knee is no longer the only place in which an arthroscope can be used. With increasing frequency, other joints such as the shoulder and ankle are using arthroscopy for diagnosis and treatment. For the most part, the standard 4.0 mm endoscope can be used in all joints except the smaller ones in the hand and wrist.

Small joint surgery

When performing arthroscopy in orthopedic surgery, the typical endoscope that is used is the 4.0 mm 30° or 70° lens. This particular size is compatible in virtually all joints, except the small joints of the hand and wrist. In many instances, a 2.7 mm lens is often used in pediatric surgery or adult small joint spaces. The small joint endoscope may also be used for carpal tunnel release. The mechanics and dynamics of the small joint lens are identical to its larger counterparts except that the field of vision on the monitor is considerably smaller. On occasion, a smaller endoscope may be used in the knee when the joint spaces are extremely tight or if there is difficulty in maneuvering the leg to provide adequate visualization of the intra-articular anatomy.

Culposcope

The culposcope is a unique telescopic device that is primarily used to visualize the anatomy and tissue configuration of the female vagina, cervix, and vulva respectively. This cope may be used for detecting hard-to-find and occult evidence of child sex abuse. The colposcope, when attached to a digital camera device, is capable of taking pictures of normal, abnormal and injured tissue that may otherwise go unnoticed. Forensic evaluation with the use of the colposcope greatly enhances the examiner's ability to make otherwise difficult diagnoses and to

identify causes of injury. Because of the sensitivity of the colposcope, it may help the examiner detect early stages of cervical cancer in women.

Lasers

The term "laser" is an acronym for Light Amplification by Stimulated Emission of Radiation. The laser machine produces an intensely hot and a precisely focused beam of light on to target tissue either to alter the structure and nature of the tissue or to destroy it. There are three basic and most frequently used types of lasers in the surgical environment. The carbon dioxide (CO_2) laser is a very strong unit that converts light into heat for the purposes of cutting tissue and coagulating bleeders. The Argon laser is a much less destructive unit and has a much more superficial depth of penetration. It is commonly used for the treatment of superficial skin lesions and other skin disorders. The neodymium laser has the most depth of penetration. This laser can effectively stop bleeding at greater depths.

Thermal ablation units

Thermal ablation units are used frequently in orthopedic surgery. These units are used primarily in minimally invasive endoscopic procedures, such as those performed on the shoulder and knee. There are three major brands of thermal ablation units: 1) Arthrocare, 2) Mitek VAPr, and 3) Vulcan. Each of the units utilizes heat generated from one of several sources: electrical current, radiofrequency, or ultrasonic waveforms. These units are capable of emitting heat that can either coagulate blood vessels without destroying adjacent tissue or completely ablate the target tissue. Thermal ablation units are frequently used for surgical procedures such as sub-acromial decompression in shoulder arthroscopy, capsular shrinkage for shoulder instability, lateral retinacular release in knee arthroscopy and re-contouring of torn menisci cartilage in the knee.

Sequence of events

Hemorrhoidectomy

Upon entering the operating room, the patient is placed on the operating table and secured with safety straps, and appropriate monitoring equipment is applied. Anesthesia is administered by way of general, spinal or local. Once adequate anesthesia levels have been reached, the patient is appropriately positioned in either a jackknife, lithotomy or modified lateral position. The buttocks are retracted, typically using benzoin and wide adhesive tape. Once entry and exposure of the anal canal is achieved, typically using a speculum, hemostats are placed onto the protruding hemorrhoid veins. The hemorrhoidal group is then excised using an elliptical incision. External hemorrhoids are removed from the internal and/or external anal sphincters and the tissue is removed. The rectal mucosa is then closed and the rectum is packed with Gelfoam and, occasionally, Nupercainal ointment

Carpal tunnel release

Once the patient has been brought to the operating room and placed supine on the operating table, all pertinent monitoring equipment is applied. The upper arm is appropriately padded with webril prior to application of a tourniquet. The tourniquet is draped off to prevent cross contamination from the prep solution and to keep it clean.

The arm is placed onto an arm board or procedure-specific "arm/hand table" so that the scrub team may sit around the site and work effectively. The pressure of the tourniquet is established by the surgeon. The arm is prepped and draped and the incision is made on the palmar aspect of the wrist. The transverse carpal ligament is exposed and transected to expose the median nerve. After adequate release, only the skin is closed.

Inguinal hernia repair

The patient is placed on the operating table in the supine position. Arms are on boards for IV access and BP monitoring. After the adequate onset of general or regional (spinal/epidural) anesthesia, the patient is prepped with the desired solution. The area to be prepped can vary, but is frequently from nipples to mid-thighs for open procedures and from table-to-table on the sides for adequate lateral prep. Once the incision has been made, the procedure is carried out and the hernia repaired via the primary repair method or with the use of surgical mesh. Upon completion of the repair, proper closure of the wound is accomplished and dressings applied.

Tonsillectomy

Initial considerations must be made depending on whether the patient is a pediatric or an adult patient, as positioning techniques may vary from supine in the child to semi-sitting in the adult. Arms are tucked to the sides and padded appropriately.

Upon the onset of anesthesia, the mouth is kept open with a self-retaining mouth retractor. The tonsils are divided and separated from their mucosum with a snare or with cautery prior to being removed. Once removed, pressure on the stump at the fossa is applied to control any residual bleeding. If adenoids are to be removed, they can be removed at this stage or prior to the removal of the tonsils, depending on what the surgeon deems necessary

Circumcision

The patient is brought to the operating room and placed on the operating table in a supine position. Monitoring equipment is applied and IV access is preserved if done prior to the surgery. Depending upon the age of the patient, pre-operative shave prep may be performed. Once the patient is anesthetized, the penis and surrounding scrotum, proximal thighs and lower abdomen are prepped with the appropriate solution, and sterile drapes are applied.

At the start of the procedure, the surgeon will typically use a straight hemostat and apply "crushing" hemostasis by clamping the hemostat over the dorsal foreskin at the midline. A dorsal slit is subsequently performed, followed by a freehand circumferential cut around the distal shaft of the penis. The raw edges of the remaining tissue are closed using an absorbable suture and the glans is exposed. The dressing is usually comprised of petroleum-based gauze to prevent sticking to the sutures and incision. If the patient is an infant, a clean diaper is applied at this point.

Hip hemi-arthroplasty for fracture

The patient is brought to the operating room and connected to monitoring equipment, frequently while still in their hospital bed. Because of severe pain, the patient is usually anesthetized in bed prior to transfer to the operating table. Many times the patient will already have a Foley catheter in place; however if the catheter is not in place, one should be inserted at this point.

When appropriate, the patient is turned onto the unaffected side and placed into the lateral position. Proper stabilization measures are performed at this point, using one of a variety of means to maintain a stable lateral position (bean bag, peg-board, hip "positioner"). After proper prepping and draping, incision is made and dissection carried down to the hip joint. The fractured femoral head is removed and sized by the technologist. The proximal femur is exposed and broached to size to seat the femoral stem. The broach is usually used for a trial reduction. The final stem and head are inserted and reduced back into the joint. Range of motion is tested and the wound is closed.

Specimen handling

Types of surgical specimens are strictly dependent on the nature of the tissue to be evaluated and the desired pathologic outcome, i.e. diagnosis identification or classification, as seen in cancer staging procedures.

In the case of identification, tissue may be removed via biopsy, or by partial removal of suspect tissue. The sample should be large enough to make a positive identification, and the technologist should have knowledge of the location and type of tissue being removed, e.g. muscle, lung, bone, etc.

Specimens can be a partial representation of the tissue or entity being evaluated and are retrieved by way of the incision or excision biopsy methods. The incision biopsy method entails cutting into the lesion or suspect tissue and removing a portion of it for examination. The excision biopsy requires that the entire lesion be removed to test for clean tissue margins after removal.

<u>When being sent for a frozen section</u>

Typically, when a sample of tissue is sent for a frozen section, information regarding the nature of the specimen and the results of the examination are needed immediately. Therefore, the care and handling of this specimen is carried out as soon as the specimen is handed to the technologist. Depending on the tissue and the desired examination, the specimen can be placed in a sterile specimen container dry, or possibly kept moist with sterile saline. Some specimens, such as breast biopsy tissue, can be handed off and taken to pathology in a sterile towel. The technologist should advise the circulating nurse as far in advance as possible of a pending frozen section so that pathology can be properly notified. The specimen is then handed off to the circulator, identified, labeled and transported to the frozen section room or awaiting pathology department representative. If the patient is

only under local anesthesia, the technologist should avoid passing information over intercoms in the room.

When sent "fresh" to pathology

A "fresh" specimen should be sent to the pathology department without of any preservatives. The presence of saline in the container should be at the discretion of the surgeon, pathologist or both. Specimens are sent for examination in metal basins, sterile towels, or specimen containers, depending on the nature of the tissue and the examination to be performed. For example, bone is typically not sent to the pathology department in a towel. Bone may be sent inside a mesh from a Neptune machine if it has been removed from the patient in a ground up fashion, such as seen in arthroscopy procedures. Fluid specimens, such as urine specimens, are typically removed from the patient by way of aspiration or collected in a container. Fluid removed from mother sources, such as cysts and abscesses, are frequently sent inside the syringe in which they were aspirated, and the syringe is capped with a sterile needle cover. Even blood, frequently sent in tubes, can be sent as a specimen in certain instances.

Bullets

Bullet retrieval is accomplished much the same as any other specimen, only the method of handling differs and may require special handling as mandated by each individual facility. In many instances, bullets or bullet fragments are not only surgical specimens, but also items in an ongoing police investigation that will ultimately become police property after removal. The bullet is removed in the same way as any other specimen and handed off to the circulator, who may log it in the specimen log book prior to sending it with the authorities. Alternately, the specimen may require sign-off by the pathologist before proper disposal. If the procedure is performed in the late night or early morning hours and no representative from the local authorities is present, the specimen may have to be locked up in order to properly secure it until it can be processed.

New technology

The da Vinci surgical system

The da Vinci surgical system is a state-of-the-art surgical navigation that is very popular in the fields of urologic and gynecology surgery. The da Vinci device consists of several robotic arms, which are guided directly by the surgeon, who sits at a remote console.

With the da Vinci system, procedures such as prostatectomy can be performed utilizing several extremely small incisions, versus open abdominal surgery. In doing so, this major surgical procedure can be completed with minimal trauma, decreased bleeding, significantly less pain, and more rapid recovery.
The da Vinci navigation system does not perform procedures by itself; rather it's most intricate movements are always surgeon-directed.

Mako Robotics as new orthopedic technology

Mako Robotics and Makoplasty refer to a procedure, which is relatively new, involving the performance of knee uni-compartmental joint replacements with the accuracy of robotics/stealth navigation. The technology utilizes minimally invasive surgical techniques to prepare the articular surface of the knee for implantation. The procedure involves the use of robotics and stealth navigation to perform pinpoint bone and cartilage surface removal through extremely small incisions, allowing for implantation. This procedure may reduce pain, minimize trauma to soft tissues, reduce bleeding and provide for more rapid recovery and mobilization. In some cases, patients have gone home from the procedure the same day, or one day post surgery. Some patients have returned to sporting activities, such as golf and walking, within days of the surgery. Currently, Makoplasty (the term given to the surgical procedure) is limited to the uni-compartmental knee joint replacement procedure. Applications for total joint replacement are forthcoming.

Stealth Surgical navigation

Stealth Surgical Navigation is a computer assisted technology, whereby surgical procedures are performed based on a starting point in space. Utilization of this starting point allows for micro precision performance. The most popular surgical specialty for use of the stealth surgical navigation system is in neurosurgery. The navigation is used to perform lumbar and thoraco-lumbar spinal stabilization/ implantation. It is minimally invasive and allows for precise implantation of stabilization devices. Patients undergoing spinal implantation utilizing the stealth surgical navigation system can expect smaller incisions, less bleeding, less pain, less tissue damage/injury and a quicker return to activity.

Vascular endo-grafting

In the field of vascular surgery, endo-graft insertion is an emerging technique. One of the most common endo-graft procedures is the insertion of an aortic endo-graft to treat an abdominal aortic aneurysm. The procedure involves the insertion of a delivery device through a growing incision, followed by the deployment of the endo-graft within the lumen of the abdominal aorta without violating the abdominal or retroperitoneal cavities. Only certain patients with certain types of aneurysms qualify for this procedure. Patients who have extremely large aneurysms or who have aneurysms that are in danger of leaking or already leaking may not be suitable candidates for this procedure.

Safety

Troubleshooting in instrument handling

It is the responsibility of the surgical technologist to have frontline knowledge of any deviation from the normal performance of surgical instrumentation or equipment. For example, endoscopic procedures require fully functional, intact light cords as well as undamaged and functional endoscopic lenses and cameras. When

any of these fail to operate, immediate troubleshooting begins to determine the integrity of these items. Surgical power equipment, particularly those that are battery-operated should be evaluated thoroughly prior to use. The equipment should be inspected for adequate electrical contact between the batteries and the device if it is not properly functioning. Moving parts should be evaluated for proper performance. All instrumentation and equipment should be handled with the appropriate level of care specific to its function. If restoration of normal operating function cannot be achieved intra-operatively, repair/replace tags should be attached to the item, and the item should be sent for evaluation to either maintenance or the biomedical engineering department.

Endoscopic equipment

Any surgical procedure that involves the use of fiber-optic visualization equipment and light transporting cords carries with it inherent risks of injury to the patient. If an endoscope is rigid, there is a risk of a penetrating injury to the bowel or adjacent organ structures. Both rigid and flexible endoscopic lenses emit light at intensity sufficient to burn tissue they come in contact with. Care must also be taken to ensure integrity of the light cord so that there are no broken areas that could cause contact burns to the skin. The surgical technologist should also ensure that all endoscopic surgical instrumentation, i.e., endoscopic graspers, staplers and cautery units are functioning properly, so as not to inflict unintentional harm to adjacent tissue or organ structures.

Video equipment

Video equipment can cause harm in many of the same ways as endoscopic equipment. Care must be taken to avoid electrical injury to the patient, to prevent burns from high intensity fiber-optic lighting, or and to keep exposed ends of cords and scopes from coming into contact with drapes or skin. The same risks apply to the surgical team. Serious electrical or burn injuries can occur with improper handling and assembly of video equipment. The surgical technologist must have

knowledge of the assembly process and the potential hazards to other team members, such as hot light cord ends or broken fiber-optic material at the ends of scopes. These may cause injury to circulating nurses or scrub personnel that handle them. Heat from high intensity light source cables can also be a fire hazard when in contact with drapes, so this must be avoided at all times. This can be especially problematic in the presence of pure oxygen and alcohol-based prep solutions.

Robotics

When using robotic equipment to perform surgical procedures, it is critical that all parts of the system are functioning properly. Responsibility for making sure the system functions properly falls to biomedical engineering, the surgery department and the company/manufacturer's representatives. Safety precautions can include ensuring that the articular portions of the robotic arms and the associated tips and instrumentation are fully functional and free of debris. It is also critical to maintain remote consoles and monitors; any deviation should be immediately reported to the proper professionals. Other potential hazards can include faulty calibration of instrumentation and robotic interfaces.

Laparoscopic cautery

There are many potential safety hazards when cautery is used during a laparoscopic procedure. The most common injury is inadvertent damage to surrounding tissues and vessels from the heat of the cautery tip. Loss of proper insulation in the covering of the cautery can result in malfunction and burns. The amount of electrical ablation and coagulation energy needed to adequately perform the various functions of the cautery can vary from patient to patient because of body mass, presence of scar tissue from previous surgeries and the unit itself. The technologist must be vigilant in identifying signs of burning from excess energy input (too high of a setting) Collateral injury and damage to tissue may result from the dispersive pattern of cautery.

Safe Medical Device Act

One of the first important medical device amendments to the Federal Food, Drug and Cosmetic Act, instituted by the federal government was the Safe Medical Device Act. It was signed into law by President Bush in 1990 and is administered by the FDA. The act requires that medical device "users," primarily healthcare facilities, report any incidents that could, in any way, possibly suggest that the incident was caused or contributed in any way, to the death, serious injury or illness of a patient. The term "medical device" in the Act, includes a wide variety of equipment such as needles, syringes, electronic equipment, catheters, components and other supplies. Additionally, these facilities, while reporting the incidents, must have a process in place to reconcile any of these events.

Post-Operative Procedures

Cleanup procedures

Often times the clean up phase of the surgical procedure begins prior to the exiting of the patient to the PACU. This should be done very cautiously to avoid disrupting counts, etc. Once the patient has left the room, the clean up phase can begin in earnest. The technologist can begin to break down the setup. Additional PPE may be needed and should be donned at this time. Sharps are closed and placed into the proper puncture-proof biohazard container on the back table. Dirty, opened instruments are placed into a large basin with water on the case cart. Unused instruments can be returned to the instrument tray and placed on the case cart. All linen from the operating table and surrounding area is gathered and placed into the appropriate linen hamper. All disposable items are placed into appropriate trash containers. Suction canisters and associated tubing are gathered and discarded. Surgical gowns and other personal protective equipment are then removed and

placed into appropriate waste receptacles. All items are then taken to the decontamination area.

Once a surgical procedure is finished and the patient is taken to the recovery room, the process of room and furniture decontamination and preparation for the upcoming case begins. Trash and linen bags are removed and processed appropriately. All surfaces are cleaned with a disinfectant solution, including the operating table, ring stands, back tables, kick buckets and mayo stands. All debris and biohazardous materials, such as blood and other fluids, are removed from the floor and furniture surfaces and properly discarded. Other items such as arm boards, gel pads, and tourniquet cuffs are cleaned and disinfected appropriately. Walls are also cleaned and disinfected if splattered by biohazardous fluids and other wastes. The room is restocked with items that may have been used in the previous procedure and anesthesia equipment is exchanged per policy.

Instrument counting

All instrument trays and sets that are used for a surgical procedure are typically counted in the SPD department and an instrument count sheet is completed. Typically, these count sheets are placed in the tray wrapped and sterilized with the instruments. This enables the list to accompany the tray and instruments to the operating room where the count will be repeated by the technologist and checked against the sheet. Items that are missing or out for repair at the time of initial sterilization should be appropriately marked on the instrument count sheet. Prior to the beginning of a procedure, the instruments should be counted by both the technologist and the circulating nurse and verified for accuracy against the count sheet. This process should be repeated at the conclusion of the procedure and prior to wound or cavity closure. Any discrepancy encountered must be reconciled at that time. If the instrument count cannot be verified and reconciled, x-rays of the surgical site may be necessary.

Process

The process of the surgical count begins when the technologist informs the circulator what items are to be counted, by verbally identifying them, e.g. "lap sponges, or 4X4's." The technologist verifies that the circulator can see the items being counted. The count is done together and audibly by both parties. Items should be physically separated during the count. Numbers are verbalized during the count, e.g. "one, two, three…" Each package of sponges and needles counted should be verified by the circulating nurse upon completion. The information is then entered on to the surgical count sheet. When the procedure is finished and the surgeon wishes to begin closing, the first sponge and needle count should be performed. Another count should be performed after any body cavities are closed, prior to skin closure. Surgical counts are a critical necessity for optimal patient safety and for conforming to medical-legal guidelines. Each facility should have proper counting parameters and procedures in place. Typically, both the technologist and the circulating nurse perform an instrument count. The count sheet from SPD is the form against which the initial count is made. Instruments should be counted before assembly of the mayo stand. Any discrepancies should be dealt with at that time. Sponges are visibly separated and counted and agreed upon by both parties. Needles may be counted in their packets initially before opening, then individually as necessary. They are checked for accurate number and presence of radiopaque strips. Additional needles and sponges are counted as opened. At the conclusion of a procedure, sponges are counted before cavities are closed. Needles are counted individually and visibly at all times by both parties. Dressings may be opened after final sponge counts to avoid mix-ups. All counts must be repeated whenever the technologist is relieved during a case and at shift changes during procedures.

Conflicting counts

Whenever a count of any type is not the same as the initial count, the surgeon is immediately notified and, if necessary, the procedure is halted until the count is resolved. If all attempts at correcting the count are ineffective and the wounds are closed, appropriate x-rays are taken to verify absence of items in, or on, the patient. Linen and trash bags must be scanned for instruments and metallic objects. Magnetic bars can be used to check the floor for any displaced needles or other sharps. The implications of inaccurate counts present more than problems for that one patient or procedure. Misplaced sponges and/or needles can negatively affect counts in subsequent procedures if found on the floor or anywhere else in the room after the start of the next case. Even if the current patient is clean, all efforts to locate misplaced sponges and sharps must be exhausted.

Sponge counting

Sponge counting procedures should be performed by both the technologist and the circulating nurse. Prior to the beginning of a procedure, sponges packed in quantities should be opened, separated, counted individually and visibly verified by the circulating nurse. Smaller, specialized sponges, i.e. "Peanuts," which are frequently packed in groups of 10 and occasionally have strings attached, may not necessarily have to be physically removed from the cardboard device holding them. These can be individually pointed to, counted and verified. During large, complicated procedures, such as abdominal aortic aneurysm resections, large numbers of needles and sponges are often used. During these cases, as sponges are used, turned and removed, they should be grouped in their original quantities, accounted for, and separated from the surgical field to avoid confusion in the overall count. All sponges are accounted for prior to cavity and or wound closure.

Six major areas where counts should be initiated

Counts should be initiated during each of the following: 1) case opening, where all items on the back table are accounted for prior to mayo stand set up; 2) when

additional countable items are placed on the surgical field; 3) team changes, where counts are performed as needed; 4) closing 1 - this count should occur as soon as the closing phase of any first layer is initiated)some procedures such as Cesarean sections, may require additional counts); 5) closing 2 - counts should occur at this point, when either closure of fascia or the layer before the subcutaneous tissue has begun; 6) final count should occur as soon as skin closure is initiated.

Additional Duties

Administrative and Personnel

Surgical consent

Before any surgical procedure can be performed on a patient, he/she must be made adequately aware of the nature of the illness or problem, the intended procedure, the intended benefits and outcomes, and the potential risks from the procedure and anesthetic. The patient must have a clear idea of what the procedure entails and what risks may be present, including the risk of death.

The consent form is intended to give the patient the best possible understanding of the surgery, as well as the expected outcomes and the potential hazards of the procedure. It is not a legal and binding document. The consent form does not completely protect the surgeon, the hospital or the staff from litigation if the patient ultimately feels he/she has been harmed by lack of expertise or misinformation.

Negligence

The term *negligence* refers to either the commission of an act or the omission of an act upon the patient that a "prudent" person would or would not otherwise do. In the surgical universe, this can apply to procedures and/or treatments performed that resulted in a negative outcome or a negative outcome that occurred as a direct result of the omission of the procedure or treatment. Based on the "prudent person" doctrine, examples of negligence include a patient developing a postoperative infection that could have and should have been avoided, or a patient sustaining an unexpected injury during a surgical procedure that should not have occurred. Wrong-site surgery is one

of the most common and infamous examples of negligence resulting from an act of commission.

The act of omission is also considered negligence and can include such scenarios as retained sponges or surgical instruments in the patient's abdomen, or failure to disclose "reasonably known" risks in the surgical consent.

Patient Bill of Rights

In 1998 the President's Advisory Commission on Consumer Protection and Quality in the Healthcare Industry[1] adopted eight areas that consumers have the right to expect regarding healthcare; 1) *The right to information disclosure*: the right to receive accurate and understandable information, as well as assistance in making important healthcare decisions; 2) *The right to chose providers and plans*: the right to a choice in healthcare providers sufficient to allow access to high quality care; 3) *The right to access emergency services*: the right to access emergency services when and where the need arises, with their healthcare plan paying for these services; 4) *The right to participation in healthcare decisions*: this is a right AND a responsibility; 5*) The right to respect and non-discrimination*: considerate treatment from all members of the healthcare community and hospital staff,; 6) *The right to confidentiality of healthcare information*: see HIPAA; 7) *The right to complaints and appeals to insurance plans*; 8) *The right of consumer responsibility*: the patient can improve outcomes with responsible participation.

Operating room record

In all aspects of a patient's hospitalization, from admission through discharge, a fluid, consistent and accurate written record of everything that happens is mandatory. In the specialized area of surgery, unique, specific records are

logged and maintained throughout the entire course of the patient's stay in that department and through the recovery phase.

The patient's operating room record contains information about the patient's physical history prior to surgery, any complicating or risk factors, vital signs before, during and immediately after the procedure, medications and anesthetics used, procedures performed, personnel involved in the care and procedure, implants that may have been used, and any other pertinent information about the patient or the procedure.

Surgical conscience

Surgical conscience is the level of moral accountability that a professional has in dealing with situations that involve the health and welfare of another individual. In the surgical environment, the surgical technologist must be able to ensure that a patient's confidence is kept sacred and to refrain from discriminating against any patient based on the technologist's personal set of values.

The technologist must also have the professional integrity and accountability to take responsibility for his/her own actions and accept any consequences of those actions. The technologist must also be willing to provide any and all information that may be necessary to evaluate those actions.

For the patient's sake, the most important and critical responsibility that a surgical technologist has is upholding the guarantee of sterile technique in the operating room.

<u>Disclosures of breaks in sterile technique</u>

In addition to possessing the moral fiber to ensure proper and optimal patient care and taking responsibility for his/her own actions, the surgical technologist

must be vigilant in monitoring the actions and techniques of the other professionals in the operating room. The surgical technologist must report any break in sterile technique, regardless of the status of the person involved in that break.

Divergence from sterile technique can occur in a purely accidental manner and is frequently unknown to the perpetrator. In this instance, the surgical technologist must put his/her training and moral conscience to work by identifying, reporting and possibly preventing the break from adversely affecting the patient or the surgical outcome. This policing action maintains the integrity of the sterile technique and ensures optimal safety and outcomes for the patient.

Improper behavior in the surgical setting

Maintaining sterile technique and personal/professional accountability are two critical elements of surgical conscience; however, the ability to maintain a professional demeanor and respectful interaction with other professionals is just as paramount.

The surgical technologist must maintain professional relationships with staff, patients and surgeons. Because professional behavior is critical to the overall safety and comfort of the patient, breeches in this behavior should not be tolerated, especially when that behavior can have a direct impact on the patient.

It is the moral and professional responsibility of the surgical technologist to identify and report any behavior that is inappropriate in the environment that the patient occupies. If behavior is identified that can ultimately degrade the professional conduct by a staff member or a surgeon, that behavior must also be reported. Bringing these behavioral breeches to the proper authority helps to ensure a professional, functional and respectful environment that the patient has the right to expect and rely on.

Sterilization

By definition, sterilization is considered the destruction of all microorganisms, including spores, on inanimate surfaces. The destruction of these microorganisms is typically accomplished through the use of flowing or pressurized steam, chemical agents such as alcohol, phenol and ethylene oxide gas, ultraviolet radiation and bombardment with high velocity electrons. Although total sterility cannot be objectively proven, the sterilization process is usually monitored using a combination of mechanical, chemical, and biological indicators to validate that sterility has been achieved. The structure, physical makeup, overall design and size of surgical instruments have a direct impact on the type and length of sterilization process required.

Steam sterilization

Steam sterilization employs the use of moist heat delivered in the form of saturated steam under significant pressure within a closed environment. Steam sterilization is widely accepted as the standard mode of sterilization for all items that are not heat, moisture or temperature sensitive. This type of sterilization is widely regarded as the most dependable method of destruction of all microbes and their spores. While it is widely understood that heat alone is capable of the destruction of microbes, its effectiveness is greatly enhanced when the elements of pressure and moisture are added. Steam alone cannot sufficiently affect sterilization. It requires the addition of positive pressure that is greater than the atmosphere. Positive pressure enables temperatures to rise to levels sufficient for proper microorganism destruction.

One of the primary benefits of steam sterilization is its ability to penetrate the material used in wrapping trays and to affect appropriate microbial destruction. The overall effectiveness of steam is dependent upon additional conditions.

First, to affect optimal steam sterilization, temperature, pressure, and moisture must reach appropriate levels during the sterilization cycle. Second, the type of microbial entity to be destroyed plays a large role in the effectiveness of steam sterilization. For example, the bacterium in the spore stage is considerably more resistant to destruction than the bacterium in the vegetative stage. The number of microbes residing on the items to be sterilized has a direct impact on the effectiveness of steam. This is called bio-burden. The bio-burden level must be low enough to ensure that all microbial agents are destroyed. Depending on the type and amount of soil present on the items, thorough cleansing is beneficial. Instruments with boxes, locks, and hinges create opportunity for additional microbes.

Reasons for failure during the sterilization cycle

While the most common and frequent reason for failures during the sterilization cycle is the lack of contact between steam and item surfaces, most failures result from human error or mechanical malfunction. The five most common reasons for human/mechanical failure in the sterilization process are: 1) an obstructed strainer in the lower portion of the chamber; 2) incorrect positioning of containers on the sterilization cart or shelf (to allow for proper airflow); 3) inadequate cleansing of items to be sterilized - external soil and debris prevent necessary contact between steam and host item; 4) wrapped packs that are positioned to closely together prevents proper escape of air; and 5) pans and faces of instrument trays wrapped too tightly. This prevents proper escape of air, which creates pockets of cooler air, which prevents the necessary rise in temperature to complete sterilization.

Gravity air displacement steam sterilizer

The gravity displacement steam sterilizer relies strictly on gravity for passive air removal from the sterilization chamber as steam enters from the top of it. Because steam is lighter than air and occupies more space, it pushes the air out of the chamber through the terrain located at the bottom of the chamber. As this stage progresses, pressure in the sterilization chamber climbs up until the steam reaches a prescribed temperature level.

This type of sterilizer typically employs four main cycles: 1) the condition cycle is the phase in which steam enters and air leaves the sterilization chamber; the exposure cycle is the phase in which the sterilization chamber is at maximum pressure and temperature for microbial kill; 3) the exhaust cycle - steam exits and air is reintroduced into the chamber and there is a return to normal atmospheric pressure; and 4) the dry cycle is where heated fresh air and internal heat re-vaporize, thus removing moisture from the packs.

Pre-vacuum steam sterilizer

The pre-vacuum steam sterilizer operates on the principle whereby a vacuum pump on the unit removes ambient air just prior to the introduction of the steam. This action reduces the total cycle time. A typical cycle in a pre-vacuum steam sterilizer is as follows: 1) in the pre-vacuum cycle, the vacuum pump removes in excess of 90% of the air in the chamber; 2) during the conditioning cycle, steam is injected into the chamber, which begins the heating process; 3)in the second pre-vacuum cycle, the vacuum pump removes an additional 90% of air in the chamber, resulting in removal of approximately 99% of the air; 4) during the exposure cycle, steam enters the chamber and cooler air is removed and replaced; 5) the exhaust cycle begins at the end of the exposure cycle, and the outlet drain opens and steam exits the chamber; 6) finally, the dry cycle removes air from the chamber via a vacuum. This vacuum is maintained until appropriate drying is completed.

Ethylene oxide sterilization

Ethylene oxide sterilization is typically used to sterilize items that are heat and moisture sensitive. This process can take upwards of 16 hours and presents disadvantages in situations of limited supply and quick turnovers. Ethylene oxide sterilization has long been an accepted standard of practice in situations where steam sterilization is impractical. Ethylene oxide is effective against all forms of microbes and related spores. It is commonly used in the sterilization of items such as plastic, rubber and other materials that would be damaged by high temperatures. Due to its inherent dangers, ethylene oxide sterilization is typically conducted in a special closed room. This room is can vent extra gas at the conclusion of the process without releasing it into the environment. In spite of its effectiveness, the Environmental Protection Agency has issued concerns over potential adverse effects of ethylene oxide on health-care personnel and the environment.

Biological indicators

The biological indicator is a small device that contains a preset number and specific type of microorganism that is destroyed when exposed to sterilizing conditions. This indicator is the only true measure of sterility. Negative growth from the biology indicator validates that the sterilization process was effective.
For steam sterilizers, the biologic indicator contains the spore B. Stearothermophilus. Bacillus Subtilis is the organism used in biological indicators for ethylene oxide sterilization. These two microorganisms were chosen because they are the most resistant to their respective sterilization methods. Most health-care facilities currently purchase commercially developed test packs of these microorganisms in the spore stage.

Bowie Dick Test

The Bowie Dick test is typically used in the pre-vacuum sterilization cycle and is designed to check for air entrapment within the chamber. This test is performed on a daily basis, and typically before the first run of the day. Test packets used for this can be either purchased commercially or prepared within the facility. The Bowie Dick test does not validate sterility; it tests the integrity of the vacuum producing system. The ink used to conduct this test changes color due to its heat sensitivity. The change in color must be uniform. If the change is not uniform, then air is entrapped in the chamber and the vacuum system is faulty.

Sterilization considerations when using the rigid containers

An increasingly popular item used for sterilization is the rigid instrument container. In these containers, items are well contained during the sterilization process. Rigid containers also provide added insurance for sterilizing because they cannot be torn or compromised. Rigid containers can be used to return contaminated items to the surgical decontamination area following a surgical procedure. This reduces the need for additional containers or trays. Rigid containers open more easily and present the sterilized instruments in a more orderly fashion than their soft woven fabric counterparts. Rigid containers can be made from metal, plastic, or a combination of both. These materials give the container strength and structure, while allowing for stacking of multiple containers.

Packaging

Many different types of materials are available for wrapping and packaging reusable items so that they can be safely sterilized before use. Sterilization wraps, also known as central supply room wraps, are class II medical devices. The Federal Food, Drug, and Cosmetic Act states that the primary purpose and function of packaging material is to adequately enclose any medical device that requires

sterilization and is for use by a healthcare provider. Furthermore, packaging and sterilization is intended to allow the enclosed device to remain sterile until such time that the device is used.

Performance standards

There are three important performance standards all packaging material must meet. First, the packaging material must keep the item sterile until its time for use. Different items require different lengths of time that they remain sterile and facility-specific requirements must be met to insure these time frames. Secondly, the package itself must be constructed in such a way that the sterile item(s) can be removed without risk of contamination. The third performance standard mandates that the packaging material must allow the sterilizing agent to penetrate its fabric and reach all surface areas of the item or items to be sterilized.

Performance characteristics

There are many different performance characteristics that packaging material must possess in order to be used for sterilization. The first of which is efficiency: the packaging material must be able to conform to the size and shape of the object to be wrapped, even when the item is irregularly shaped. The size of the packaging material must sufficiently cover and enclose the item or items completely. Care must be taken to completely cover large, irregular items such as orthopedic instrumentation. Care must be taken to avoid any puncturing of the material by pointed or sharp edges found on irregularly shaped items. Additionally, the packaging material must be of sufficient size to create a sterile field around the item or items. The packaging material must be sufficiently durable to withstand the rigors of the sterilization process, i.e. autoclave moisture, pressure, and high temperature.

Types of packaging materials

The first type of packaging material woven textile that is made of either cotton or cotton blended with synthetic materials such as polyester. Woven fabric packaging materials are reusable and can be used for multiple sterilization processes provided their integrity is not compromised. With subsequent sterilizations, the ability to provide an adequate barrier diminishes. As the material is laundered, fibers of the fabric are lost, which creates larger spaces between the fibers and reduces its ability to contain bacteria. Packaging material can also be made of muslin, which is cotton fibers with a thread count of no less than 140, i.e. no less than 140 threads per square inch. Muslin is available in the either a single or double ply. Historically, unbleached double thickness, 140 thread count, was the standard for wrapping materials and for steam sterilization.

General principles of packaging

Laundered woven fabric should be stored in an area where the temperature is between 64 and 72°F, with humidity between 35 and 70% for a minimum of two hours to allow for rehydration of the fabric. The recommended maximum size of a linen pack is 12" high x 12" wide x 20" long, with maximum weight of 12 pounds. When linen packs are wrapped to be sterilized, they must be packaged loosely enough so that steam can penetrate and make adequate contact with all surface areas. To ensure a proper bacterial barrier and satisfactory sterile presentation of the contents, double, sequential wrapping is mandatory.

Preparation requirements for packaging basin sets

Metallic basin sets have a higher propensity for the formation and retention of condensate due to the density of the metal and the overall position of the sets during sterilization. In the case of multiple metal basins, each item should be separated by an absorbent towel. The towel would absorb fluid and condensate, and aid in air removal. The surgical technologist must properly position ancillary items within basins to affect maximum water and air exchange. Items such as hollow light

handles should be placed with the openings downward to allow for proper drainage of condensate.

Wrapping

Nonwoven materials that are used for wrapping sets and trays are considered disposable wrappers and are typically designed for single use. Non-woven wrappers are made of paper, plastic, paper-plastic peel packs and peel packed pouches. Paper wrapping is easily penetrated by steam, so it is a useful sterilization barrier; however, paper wrapping becomes brittle in dry conditions. It can be torn easily as well as easily punctured because of its porosity. Plastics, on the other hand, are particularly suited for ethylene oxide sterilization. Plastic will melt if exposed to the high temperatures of steam sterilization. The paper-plastic peel packed pouch is typically the most common type of pouch packaging that is used in healthcare facilities. The plastic should be a minimum of 2 mm thick and should allow for visualization of the internal contents. The paper and plastic are sealed together along the edges creating an airtight barrier.

Folds

<u>Envelope fold</u>

The major steps in using the envelope fold technique begin with assembling the necessary items to be wrapped. This is followed by placing the wrapping material diagonally on a flat surface. Next, the item to be wrapped is placed in the center of the wrapping material. Any internal sterility indicator is then placed near the center of the package in a visible location. The near corner of the wrapping material is folded over the item creating a small tab of two to 3 inches of the corner most area. This tab is then folded back upon itself. Next one side of the wrapping it is folded over the item and the corner is mitered. The same process is followed on the opposite side creating small tabs at each corner for proper grasping when opening.

When all corners are folded, mitered and tabs created, the final flap is folded over the item and overlaps the sides of the wrapper. The process is repeated if a second layer is required.

Square fold

Unlike the envelope folding technique, the square or rectangular wrapping material is placed squarely on the surface of the table. The process begins with folding the near edge over the top of the item to be wrapped, covering the lower half and creating a cuff. The left and right segments of the wrapper are then folded over the item, creating a cuff from left to right respectively. The process is then repeated if a second layer of wrapping material is warranted. Care should be taken to avoid puncturing the material and to make sure the item is completely covered.

Labeling

Proper labeling of wrapped items is critical as it allows for the identification of the internal contents when visually occlusive materials are used, such as woven or non-woven fabric. Items wrapped and packaged in paper/plastic wrapping combinations are typically visible, but require proper labeling for quality assurance, inventory control and proper stock rotation. Proper labeling information should include a description of the contents, expiration date or duration of sterility, the date of sterilization, proper identification of the sterilizer, the cycle number, and most importantly, the initials of the person who prepared the package. Proper labeling can also result in cost savings, as it will reduce the potential for unnecessary or mistaken opening of incorrect items for a surgical procedure.

Medical terminology

Membrane enclosing the lungs

The lungs are encased in a cavity called the pleural cavity. The cavity contains two distinct membranous layers that protect and lubricate the lungs and heart and prevent friction during respiration. The two major pleural membranes are the parietal and visceral pleurae. The lungs are situated in the visceral pleurae. The visceral pleural membrane both covers and is attached to the lungs.

The pleural space sits between the two membranes and contains a small amount of fluid that minimizes friction when the lungs inflate and deflate during respiration .In situations of inflammation, often called pleurisy, one or both of the membranes becomes inflamed and the fluid decreases, making respiration limited and painful.

Intestinal smooth muscle layers

Peristalsis is the medical term used to describe the action of the intestinal smooth muscle layers. The smooth muscle layers of the small intestine perform regular, rhythmic movements to efficiently move food along its course, which allows for the proper absorption of nutrients. This movement originates in the stomach and moves the food bolus along the intestinal tract during the absorption process.

Peristalsis can be interrupted by many factors, including disease processes, medication, and obstruction. These situations are often remedied only by surgical intervention. Medications called smooth muscle relaxants can be used for many other medicinal purposes; however, their side effect can slow peristalsis. Surgery and anesthesia are frequently responsible for the temporary slowing or cessation of the peristaltic movement of the intestinal tract.

Pedicle

In surgery, the term pedicle typically refers to small projections of bone that are present between the transverse spinous processes and the vertebral body. Pedicles help form the neural arch through which the spinal nerve roots pass and are important positional markers for a variety of lumbar procedures. The lumbar pedicle is the usual site for the introduction of fixation screws when stabilization procedures are performed. It also serves as a positional marker for procedures such as kyphoplasties and vertebroplasties and aids in proper instrument insertion. Pedicles are also the stumps of tissue left behind after resection or amputation. Pedicles can also be found in the retroperitoneal cavity where they serve as attachments to kidney structures.

Phimosis

Phimosis refers to a condition in which the male foreskin is cannot be retracted over the head of the penis. While this situation is considered normal in the developing male infant, the foreskin is expected to become increasingly retractable as the child grows. Occasionally, the foreskin cannot retract due to constriction from bands of soft tissue at the opening of the foreskin. If the condition becomes problematic, the situation can be corrected surgically via circumcision. Females can also suffer from clitoral phimosis thief the tissue covering the clitoris cannot retract from it as it becomes enlarged during sexual arousal.

Suffix itis

The medical terminology suffix “i” is" refers to any condition or situation in which inflammation, or an inflammatory process is present. This inflammatory process can be the result of injury, disease state, overuse, infection or hereditary tendencies. Examples of this inflammatory process include conditions such as colitis, tendonitis, appendicitis, and arthritis. In the surgical venue, inflammatory situations that may have surgical implications include cholecystitis, arthritis, and DeQuervain’s tendonitis. The surgical technologist must have a good working knowledge and be

able to differentiate disease processes and conditions that require patients to undergo surgical intervention.

Abbreviations

C.O.P.D.

C.O.P.D. refers to the condition known *as chronic obstructive pulmonary disease.* In fact, chronic obstructive pulmonary disease describes a variety of diseases and conditions that make breathing difficult. This group of diseases and conditions is typically characterized and manifested by limitations of airflow in a patient's airway. Not infrequently, these disease states are not fully reversible. Some examples of chronic obstructive pulmonary disease include chronic bronchitis, asthma and emphysema. These diseases can be caused by long-term chronic tobacco smoking and chronic inhalation of caustic agents such as solvents, airborne irritants, asbestos, and beryllium. Job hazards can also pose a significant risk for the development of chronic respiratory problems and diseases. For example, a welder can inhale significant amounts of smoke plume from the welding process over time. Commercial installers of fiberglass insulation also run higher risks of developing similar respiratory issues from the inhalation of glass fibers found in the insulation.

V.S.D.

V.S.D. refers to the congenital anomaly ventriculo-septal defect, which is found in the heart. Oftentimes this condition is identified and diagnosed in newborns or early infancy. Patients with V.S.D. can have difficulty breathing or feeding or can fail to thrive.

V.S.D. causes oxygenated blood to leak from the left ventricle into the right ventricle, raising the ventricular pressure to abnormal levels. The blood then passes out of the right ventricle into the lungs and returns to the heart via the left atrium. Chronic, untreated V.S.D. can lead to pulmonary hypertension, which is a very

dangerous condition. Chronic V.S.D. is typically treated either conservatively or surgically. Surgical closure of the septal defect helps to restore normal right ventricular pressure and eliminates the shunting of oxygenated blood into the un-oxygenated right heart system.

A.S.D.

A.S.D. refers to the condition known as *atrial septal defect.* This congenital anomaly is typically the result of a failure of the foramen ovale in the fetal heart. The foramen ovale allows blood to pass from the right and left sides of the heart to be oxygenated by the mother's placenta. The fetal lungs do not breathe any air.

As growth and development proceed, the foramen ovale typically closes prior to birth, thus separating the right and left heart systems. When this fails to occur, both oxygenated and unoxygenated blood is allowed to shunt back and forth between systems. This shunting process can cause pulmonary hypertension if left uncorrected.

C.H.F.

C.H.F. refers to the medical condition known as *congestive heart failure.* During C.H.F., the heart is unable to properly and sufficiently pump blood to the various organ systems throughout the body. Congestive heart failure can result from a wide variety of predisposing factors. For example, congenital abnormalities, such as incompetent heart valves, can play an important role in congestive heart failure. Heart valves can also be damaged from diseases such as rheumatic fever, which renders the valve unable to sufficiently prevent reflux of blood into the heart, or to open sufficiently to allow proper outflow of blood from the heart. Coronary artery disease, previous heart attack, and chronic severe hypertension can also contribute to congestive heart failure.

cc

cc denotes a specific measurement: the *cubic centimeter.* This unit of volume describes the three-dimensional measurement of a centimeter as 1 cc x 1 cc x 1 cc. The cubic centimeter rep presents 1/1000 of a liter. As medical terminology has evolved, many facilities and educational institutions are now replacing the cubic centimeter with the *milliliter.* This is especially true in the measurement of liquid volume. The symbol, cc, is still commonly used in the medical field to measure volume of dosage of liquid medication. The most common item in the operating room that bears the description of cubic centimeters is the syringe.

pH

pH is typically used to describe the level of hydrogen ions in a solution. The level of hydrogen ions compared to the level of hydroxide ions are measured, and if they are equal, the solution is declared neutral. If the level of hydrogen ions exceeds that of the hydroxide ions, the pH decreases and the solution become acidic. Conversely, if the level of hydroxide ions exceeds the hydrogen ions, the pH rises and the solution becomes alkaline.

When a solution is considered neutral, the pH level is 7.0. A pH level lower than 7.0 indicates a more acidic solution; while a pH level higher than 7.0 indicates a more alkaline solution.

BPH

BPH refers to the condition known as *benign prostatic hypertrophy*, or enlargement of the prostate gland. While different from its cancerous counterpart, BPH is caused by hyperplastic growth of the cells of the prostate gland, culminating in the formation of discrete nodules around the peri-urethral area. If these nodules become sufficient in size, they can be responsible for partial to complete obstruction of the urethra, thus partially or even totally blocking the flow of urine.

This condition most commonly affects men over 50 years of age; although, documentation suggests that the prostate begins to grow around the age of 30. Quite often, this condition can be treated medically; however, on occasion, cystoscopy is required and trans-urethral resection of the overgrown prosthetic tissue is warranted.

CABG

CABG refers to a cardiac operative procedure known as coronary artery bypass graft. This operative procedure utilizes the patient's internal mammary arteries, radial artery segments, or saphenous vein segments as bypass grafts. The grafts are connected at one end to the aorta and at the distal end to the coronary artery just past the blockage. These grafts deliver blood to the cardiac muscle that is being compromised by a blockage within the coronary artery lumen. Frequently, one or more coronary artery bypass grafts are performed during one surgery, depending upon the number of diseased coronary artery vessels in need of bypassing. CABG has evolved from an almost exclusive use of saphenous segments to the use of internal mammary arteries, radial arteries of the forearm, and saphenous vein segments from the lower extremities.

p.r.n.

p.r.n. refers to a dosage and administration frequency typically assigned too medications. While many medications have specific dosage and administration time frames, p.r.n. indicates that the medication can be given "as-needed." Medications that fall into this category can be oral, parenteral, topical, drops and sprays for eyes, ears and nose, suppositories and inhalants. Typically, medications in this category do not have prescribed time frames in the same way as antibiotics, anti-hypertensive drugs or other medications with a specific half-life.

Pain medication is usually ordered with a specific administration time interval but will frequently have "as needed" within the order, allowing for the patient's interpretation of pain level.

Anatomy and Physiology

Fractures

Surgical pathology

Fractures refer to disruptions, alterations and strength in the integrity of the bony structure of the skeleton. Fractures can be caused by external forces such as overuse or by internal forces such as disease and neoplasms. There are a wide variety of fracture patterns, ranging from the simple non-displaced fracture to the very complicated, comminuted open fracture. Some fractures require internal stabilization, while others require rest and support. Some bones are so small they are cannot be repaired once they have fractured.

Fractures that are unstable or mal-positioned pose immediate threat to vital structures and vessels. If a fracture severely compromises mobility, immediate surgical intervention is needed. Dislocations may require operative intervention if they cannot be reduced in the emergency room.

Open/compound fracture

A compound or open fracture refers to an injury in which the bone, at the time of injury, fractures and penetrates the surrounding soft tissue, muscle and skin, creating direct exposure to the external environment. A compound fracture is considered a contaminated injury because of the direct communication with the outside environment. More often than not, this type of fracture is a direct result of trauma, e.g. motor vehicle accidents, sports injuries from football or soccer, or falls.

The most common site for a compound fracture is typically in the lower extremities, and most frequently below the knee. Compound tibial fractures are commonly seen as result of motor vehicle accidents and motorcycle accidents in particular.

Compression fracture

A compression fracture is an axial loading injury that involves the cervical, thoracic or lumbar spinal column. This type of fracture pattern can be caused by trauma, disease states, or medication. In the case of trauma, a compression fracture commonly occurs when a patient falls directly onto their buttocks in a seated position. This type of injury causes direct axial compression loading on the vertebral column, literally crushing the vertebral bones. The severity of this injury can range from a mild "wrinkle" to a major loss of vertebral body height and possibly retro-pulsion of bone fragments into the spinal canal. Disease compression fractures, which would be pathologic, can occur in vertebral bones occupied by tumor tissue. In the case of osteoporosis, there is deficient calcium quantity in the bony structure of the vertebral bones, which renders the bones weak and susceptible to fracture. Medications such as steroids can soften the bone, thus increasing risk of compression fracture.

Torus fracture

A torus fracture is an injury that is seen almost exclusively in the pediatric patient. Pediatric bone is less calcified than its adult counterpart, so it is less apt to snap. Because of this increased pliability, the bone may wrinkle. Nevertheless, this is a fracture and should be treated as such. A torus fracture can occur from a fall onto the outstretched arm. On an x-ray, the bone appears to be more prominently wrinkled on one side than the other. Frequently, it is almost impossible to visualize a fracture line completely through the bone, but it exists nonetheless. The most common sites for a torus fracture are the distal radius, the distal tibial shafts and the distal ulnar shafts.

Pilon fracture

The pilon fracture involves the distal tibia and the ankle joint respectively. The injury consists of a vertical fracture of the distal tibia that extends into the articular surface of the ankle joint. This fracture can be comminuted to various degrees and can present with varying amounts of joint surface irregularity. Because of the extent of injury, the pilon fracture must be adequately reduced to restore the integrity of the articulating surfaces of the ankle joint. Failure to properly restore the joint services can result in the premature onset of post- traumatic arthritis. The preferred method of treatment for this type of fracture is open reduction and internal fixation using a combination of plates and screws.

Inter-trochanteric hip fracture

The inter-trochanteric hip fracture is one of the most common fracture injuries in the elderly population. The fracture involves the portion of the proximal femur, where the femoral neck and the greater and lesser trochanteric connect. This type of hip fracture most commonly occurs from a fall. Initial presentation demonstrates a significant shortening of the injured leg, with pronounced external rotation. The shortening of the leg is a result of significant muscle spasm. The external rotation results from a dominating effect of the short, external, rotating muscles connected to the hip. Currently there are a wide variety of surgical treatments for this fracture pattern, including compression screw/side plate fixation and short intra-medullary nail fixation.

Pathologic fracture

The pathologic fracture is any fracture that occurs as a result of alteration to the normal bony structure. Pathologic fractures typically occur as a result of weakening of the cortical bone by a pathologic agent, e.g. a tumor, an arteriovenous (AV) malformation or another space-occupying lesion. Pathologic fractures can occur anywhere in the human skeleton. Patients previously diagnosed with various forms of cancer with subsequent metastatic disease have an increased risk of pathologic

fracture because metastatic lesions can occupy a variety of locations within various bones. Treatment for pathologic fractures can include cast immobilization, and open reduction and internal fixation with the use of bone graft substance after the lesion has been cleaned out of the bone.

Cancer

Osteosarcoma

Osteosarcoma is the most common of all bone cancers and the sixth most common cancer in children. Osteosarcoma begins in the bone; it is not a metastatic result of another tumor. Because osteosarcoma arises from osteoblasts, the bone making cells, it is more commonly seen in young people experiencing growth spurts. Osteosarcoma has a higher incidence in young teenage males, and the area of the body most commonly affected is the knee. Teenage boys who are typically taller than normal experience increased risk of developing osteosarcoma. Treatment can consist of chemotherapy and surgical excision with bone grafting. Limb salvage procedures, as opposed to amputations, are now the preferred methods of treatment.

Carcinoma

Carcinoma refers to any cancer that affects the human body that arises from epithelial cells. These cancers are malignant and often metastasize to the lymph nodes. There are many types of carcinomas that are typically identified by the prefix used to categorize them, including adenocarcinoma, squamous cell carcinoma and basal cell carcinoma. Basal cell carcinomas may be found on the face, the nose and many other areas on the skin. Adenocarcinoma cells are commonly found in the lungs. Small cell carcinoma is widely considered to be directly due to smoking.

Multiple myeloma

Multiple myeloma refers to a type of cancer that invades plasma cells in the bone marrow. Plasma cells make up the immune system and produce anti-bodies. This type of cancer is categorized as a hematologic malignancy. Multiple myeloma is typically incurable. Frequently this myeloma can be induced into remission by chemotherapy, stem cell transplants and systemic steroids. Multiple myeloma presents with five major signs and symptoms. The first is bone pain, which is typically localized to the spine and ribs. The pain worsens with increased activity. This type of bone pain can lead to pathologic fractures. Other signs and symptoms include infection, anemia, renal failure and a variety of neurological symptoms, including loss of bowel and bladder function.

Wound healing

Phases of wound healing

- *Inflammatory phase:* The inflammatory phase of wound healing, also know as the lag phase, begins almost immediately after injury, i.e. the trauma or surgical incision, and can last up to three to five days. This phase typically begins with changes in tissue that demonstrate an inflammatory reaction. These changes include heat, swelling, erythema, pain and loss of function. It is during this phase that platelets begin to accumulate in an effort to stop bleeding and to begin the process of clot formation. Other agents, such as neutrophils, enter the wound and begin the process of fighting infection. Cells called macrophages converge on the wound and begin to break down any necrosis that might be evident, and they also serve to stimulate the activation of the fibroblast response. This phase lasts approximately 24 hours and then heads into the proliferative phase.
- *Proliferative phase:* The proliferative phase of wound healing begins approximately three days post surgery and can last up to 20 days. At this point, the wound has recovered approximately 20 to 25% of its original

tensile strength. This strength comes from fibroblasts, which secrete collagen that forms into fibers. This proliferative phase can last anywhere from 24 to 72 hours and leads into the fibroblast phase of wound healing. Collagen "scaffolding" is created by the fibroblasts in an effort to bridge the wound. Re-vascularization, which creates new vessel networks from existing capillaries, occurs between 5-8 days post-surgery. New lymph system components follow around 10 days post-surgery.

- *Fibroblastic phase:* The fibroblastic phase of wound healing begins at about four to five days after "injury" has been sustained. This phase can last approximately 15 to 20 days before the maturation phase begins. Because of the collagen fiber deposition at the site of the wound, the wound can withstand normal stresses at this point; however, the overall strength of the wound will continue to improve over the next several months. Once the collagen fibers have been laid down in a network fashion, epithelial cells begin to crawl across the wound bed and begin to cover it. As this process progresses, myofibroblasts perform contractions, which cause the wound to decrease in size.

First Intention

First intention wound healing, otherwise known as "primary closure" refers to the manner of healing in which a wound is created under ideal conditions. These wounds typically heal from side to side without the presence of any dead space. Wound edges are approximated in the most anatomically correct fashion under little or no tension. Wounds of this type can heal very rapidly, and rarely incur any wound edge separation. First intention wounds heal in three very distinct phases: 1) inflammatory response; 2) collagen or scar tissue formation; and 3) wound bridging once sufficient collagen has formed.

Second Intention

Wounds that heal by second intention are typically those in which precise wound edge approximation cannot be achieved. Examples include large, irregular shaped wounds, wounds that have some degree of breakdown due to infection, or wounds in which the risk of infection is so high that primary closure and healing by first intention would be contraindicated. Second intention wound healing is a process in which the wound heals from the inside out, i.e. granulation tissue is deposited at the bottom of the wound and builds subsequent layers until the wound closes and the tissue contracts. These wounds take considerably longer to heal, but many do so satisfactorily. The scar that is formed by this mode of healing is usually weaker than those healed by first intention and may, demonstrate excess tissue deposits at the skin level causing "proud flesh."

Third Intention

Wounds that heal by third intention occur when two wound surfaces that have granulated are approximated in a delayed primary closure technique. These types of wounds are usually found in class III and IV wound. Frequently, these wounds require debridement and the protracted use of antibiotics. After several weeks of treatment, which may include return trips to the operating room for additional debridement, the wound can be closed if it is clean. The wound will continue to heal via contraction and further granulation. This treatment regimen is typically best for traumatic wounds that have been contaminated by the trauma episode.

Local factors

Three distinct factors can significantly affect the rate of healing, the strength of the healed wound, and the risks of infection. These factors are 1) the overall physical condition of the patient; 2) how the tissue is handled during surgery; and 3) the quality of aseptic technique. Factors involved in the patient's condition include: 1) age - geriatrics are frailer and have decreased immune resolve; 20 nutritional status - dietary deficiencies can have negative effects on healing; 3) chronic disease such as

diabetes can have a negative impact on healing; 4) smoking; and 5) an immuno-compromised system in which drug-induced or disease-decreasing immune response quality can negatively affect wound healing. Tissue manipulation during surgery is important to healing. Incision types, length of procedure, degree of manipulation and injury to tissues from abusive handling can all disrupt wound healing. Aseptic technique must be adhered to in order to maximize wound healing and the minimize potential for postoperative infection. Breaks in technique can set the stage not for poor wound healing and for flagrant infection.

Systemic factors

Systemic factors that influence wound healing include the aging process, systemic disease, and decreased circulation to the surgical area, which can deprive the wound of necessary oxygen and nutrients for healing. Protein deficiency or inadequate protein intake can have negative effects on wound healing. Protein is necessary for all phases of wound healing. It is widely accepted that deficient protein stores, regardless of the cause, can increase the potential for wound infection. Vitamin deficiencies, primarily A, K and C, can also play a role in the alteration of wound healing. Vitamin A deficiency has been attributed to slow wound re-epithelialization. Vitamin C deficiency causes inadequate formation of collagen, which is necessary for scar formation in healing. Vitamin K deficiency can result in chronic wound bleeding, which negatively affects the wound's ability to heal properly.

Wound classification

Class I surgical wounds are uninfected wounds in which no inflammation is encountered and the respiratory, alimentary, gentle, or uninfected urinary tracts are not entered. Class I surgical wounds are typically closed in a primary fashion and periodically drained with a closed drainage system. Examples of this type of surgical law include hip and knee replacement wounds and other extremity surgical

wounds. Class I surgical wounds are typically made under ideal surgical conditions. There is no break in sterile technique during the procedure, and the surgical site is free from any contamination.

Class II surgical wounds are clean, contaminated wounds. The output of the wound is uninfected; however, cavities and tracts such as the alimentary, gentle, respiratory, and urinary tract may be entered under extremely controlled circumstances avoiding any unusual wound contamination. The class II surgical wound may undergo primary closure. It is also typically drained again with a closed drainage system. Minor breaks in sterile technique may have occurred, but no obvious evidence of infection is encountered. Examples of procedures performed under this wound classification include appendectomy and cholecystectomy. The surgical technologist must be aware of the sterility of the surgical site, the techniques involved, the area of the body being operated on, and whether sterile technique has been maintained.

Class III surgical wounds are contaminated wounds. This wound type carries a 15 to 20% infection rate and may be an open dramatic wound, typically less than four hours old. Acute inflammation is present. There is a demonstrated major break in sterile technique. There is also identifiable entrance into one of the aerodigestive tracts, and some level of spillage has occurred. This wound type is typically fresh in nature, acute, inflamed and non-purulent.

Healing variables

Antibiotic action

There are so many variables involved in the action of antibiotics that only a few will be discussed here. In general, antimicrobial agents act in to either block a microbe's ability to function, or to reproduce it, or both. For example, penicillin inhibits the microbial cell's ability to form its cell wall, which is its protective layer. Tetracycline

serves to block the cell's ability to synthesize protein, which is necessary for cell growth. Other antimicrobials block protein synthesis, cell wall production, and DNA and RNA production, which are required for cell replication and growth. Still others are responsible inhibit cell metabolism by producing certain enzymes necessary for the synthesis of folic acid, which is a necessary compound for the microbial cell.

Hemostatic agents

Hemostatic agents, otherwise known as anti-hemorrhagic agents, are a class of drugs and compounds that serve to stop various degrees of bleeding. Some hemostatic agents work by constricting blood vessels, while others stimulate the production of clotting factors. Still others stimulate the body's ability to cause platelets to aggregate to form clots. Some types of hemostatic agents are topical, such as styptic pencils used for shaving cuts on the skin. Others come in the form of granular substances or powder forms, and can be impregnated into sponges or dressings. Two very common types used in surgery are thrombin spray with Gelfoam sponge material, or Avitene powder.

Lactated ringers as an IV solution

Intravenous fluids serve a variety of purposes. They are primarily responsible for restoring or maintaining proper fluid volume in the circulatory system, as well as restoring or maintaining proper electrolyte concentrations and balances. One of the most common IV solution used today is lactated Ringers solution. Lactated ringers solution is widely preferred because it more closely mimics the electrolyte concentrations and proportions found in human plasma, with just a hint of lactate in it. Use of this fluid in surgery does not significantly alter the patient's plasma makeup, and is therefore acceptable for use in fluid resuscitation.

The Halstead principles of tissue handling

Halstead's principles of safe tissue handling is based upon the premise that every time living human tissue is handled and manipulated, cells are killed. The goal, then,

is to handle it such a way as to minimize tissue cell destruction. Halstead developed the mantra that sharp dissection was less traumatic to tissue and cells than blunt dissection, and that tissue healing was less dependent on the length of an incision, but more dependent on the quality of the wound closure and tissue approximation. Tissue should be re-approximated with as little tension and stress as possible. Additionally, wounds should be closed in such a manner to eliminate the formation of "dead space," which is a breeding ground for hematoma formation and infection.

Aseptic technique

Aseptic technique differs from sterile technique, although both can be utilized concomitantly at any point in time. Aseptic technique can be looked upon as a set of practices and procedures that are employed under strict controls and conditions with the goal of minimizing any potential for contamination by pathogens. In the operating room setting, aseptic technique is practiced under the strictest of terms, mainly due to the extent to which skin and tissues are disrupted by the surgical procedure and the correspondingly high potential for infection if breaks in aseptic technique should occur. Since all patients, whether in or out of the operating room, are susceptible to infection, the practice of aseptic technique should be strictly enforced and respected.

Handwashing

According to the American Association of Operating Room Nurses (AORN), the single most important measure to reduce the potential for the spread of microorganisms is handwashing. In general clinical settings, hands are to be washed when visibly soiled, and jewelry must be removed and washed for 10-15 seconds. Hands must be washed before and after patient contact. In the surgical setting, surgical scrub solutions are typically utilized by all members of the surgical team that will be in contact with the sterile field, the instruments and the equipment. When scrubbing or washing hands and arms, having the fluid flow in

the direction of gravity dictates how the hands and arms are held and positioned during and after scrubbing to avoid recontamination.

Importance of blood and fluid replacement

Surgical procedures, particularly major ones, can cause significant alterations in a patient's blood and fluid volume and balance. Blood pressure can be affected with lowered volumes of blood or fluid. Optimal homeostasis must be maintained for adequate function of vital organs, the heart and the brain. Surgical insult, anesthesia and medication may cause drops in blood pressure. These can be best treated with proper fluid replacement. When significant blood loss occurs intra-operatively, it must be replaced so that oxygen can reach vital organs and tissues. Fluid can be replaced through different mixtures of electrolytes and minerals in IV solutions. Blood can be replaced with whole blood, packed red blood cells, plasma or platelets, depending on the specific needs of the patient.

Types of wounds

Traumatic wounds

Traumatic wounds are classified into five distinct categories. The first is the closed wound, where underlying tissues are damaged or destroyed, yet the skin remains intact. The second category is the open wound, where the continuity and integrity of the skin is compromised. The third is the simple wound in which the integrity of the skin layer is destroyed. There is no tissue loss in the underlying tissue layers and no foreign objects are appreciated in the wound itself. The fourth type is the complicated wound. This wound displays a loss or total destruction of tissue, and foreign bodies are present in the wound proper. The fifth category is the clean wound. The edges of the clean can be approximated and secured without major difficulty.

Chronic wounds

Chronic wounds persist over an extended period of time. Chronic wounds are frequently unable to heal because of a variety of underlying causes, such as a disease state like diabetes, or a smoldering infection. The diabetic ulcer is an example of a chronic wound. This wound is commonly found on the lower extremities of diabetic patients suffering from peripheral neuropathy. More often than not, patients do not realize they have an ulcer until they detect a foul odor coming from the wound that is already infected. High blood sugar levels and diminished or absent sensation can result in the wounds needing months of debridement and cleansing to heal.

Wound dehiscence

Dehiscence refers to partial to total separation of the wound layers. Dehiscence typically occurs between the fifth and tenth post-operative day and can be seen in patients who are frail and/or debilitated, such as the elderly. Frequently, tissue in the elderly population tends to be thin and to tear easily. Dehiscence can be caused by excessive pressure on a wound, improper wound closure techniques, the use of sutures made of inappropriate material or that are the wrong strength, or excessive retraction that comprises the wound.

Dead space

Dead space can be caused by ineffective surgical wound closure, i.e. the deeper layers are closed but a portion of the tissue layer is un-approximated causing a cavity or dead space. Dead spaces can be a source of great trouble because fluids or blood can accumulate in them causing seromas or hematomas, which are prime breeding grounds for infection and further wound breakdown. During surgical wound closure, dead spaces can be avoided by properly closing deeper layers using a multi-layer technique, which will prevent dead spaces and strengthen the closure.

Preventing wound dehiscence

Wound dehiscence can be prevented as follows: 1) avoid long, paramedian incisions because they are inherently weaker by virtue of their length; 2) use interrupted suturing techniques in deeper layers with a non-absorbable suture to create a strong closure that won't degrade prematurely with suture dissolution; 3) use interrupted, non-absorbable sutures on layers such as fascia to maintain a strong closure in areas of high tension, such as in abdominal surgery and associated wounds; 4) use closure techniques that do not diminish blood supply to the tissue and minimize tension on the skin with retention sutures when devitalized tissue is encountered; 5) exercise superb aseptic technique, avoid creating dead spaces, and allow wounds to heal by second intention when encountering infected wounds.

Wound evisceration versus dehiscence

A wound is considered to be eviscerated when portions of internal organs protrude through a completely separated wound. Wound evisceration is an urgent, if not emergent, situation because abdominal contents should not be exposed to the outside environment for any length of time. Exposure dramatically increases the potential for infection and devitalization of the tissues and, ultimately, the organ structures. Immediate surgical intervention is necessary to reduce the exposed, protruding viscera and close the wound.

Evisceration can occur from trauma sustained from such injuries as gunshot and other high velocity projectile wounds. Evisceration can also occur from improperly closed abdominal wounds and from wounds in which tissues are devitalized and compromised from injury and infection. Diminished blood supply to the area can also cause wound degradation and possible evisceration.

Adhesions, keloid and fistula

Adhesions are an abnormal attachment of two tissue surfaces that otherwise would not be attached and often times move adjacent to each other. Adhesions can form anywhere in the body. They are most frequently seen in the abdominal cavity, where visceral contents that normally glide freely within the cavity become attached to the undersurface of the peritoneum at various locations. Adhesions can also form in the pleural cavity after severe infection, injury or surgical insult. Additionally, adhesions can be found between muscle and subcutaneous tissue, as well as in joints between mobile surfaces.

These attachments usually involve fibrous tissue that connects the two surfaces in various locations. These can be rather painful as well. Adhesions can be caused by blunt trauma to the abdomen, surgical procedures or severe inflammatory reactions.

Keloid is proliferate, hypertrophic scar tissue that forms after an insult to the skin, such as in a laceration-type injury or a surgical incision. For the most part, these wounds are clean and capable of healing by first intention. Wounds healing by second or third intention are at significantly higher risk of keloid formation. Keloids typically manifest as elevated scar tissue that protrudes above the skin level. This tissue is often widened and thin. Conversely, the tissue can be extremely hard and irritating, depending upon its location.

A *fistula* is characterized by the presence of a tract between two epithelial cell-lined surfaces and is open at both ends of its structure, allowing for the passage of fluids and other material between the two end locations. Fistulas are frequently seen in procedures that involve the bladder, bowel, and pelvic structures. Occasionally fistulas are surgically created to divert fluids away from an area that has been

injured or infected. The arterial-venous, or A/V fistula, is created as the point of access for dialysis.

Sinus tracts

Sinus tracts are passages that are created, either purposefully or spontaneously, between epithelial cell-line structures at one end and open at the other, frequently to the external environment. Bowel, bladder and pelvic procedures are usually the most common procedures that involve the creation of sinus tracts; however, these tracts can also form on their own. For example, an anal fistula forms as a result of an internal abscess. Pus and other fluids find their way to the external environment and over time and with pressure. In orthopedics, it is not uncommon to find patients who have chronic osteomyelitis (infection of the bone) with sinus tracts. The tracts typically appear when there is dead bone deep in the area of infection. The bone must be removed and débrided in order for the infection to clear.

Incisional hernia

When performing surgical procedures involving the abdominal cavity, the deep fascial layers must be meticulously closed. Failure to do so can increase the chances of developing a hernia involving the incision itself.

This situation typically arises when there has been inadequate closure of the deep abdominal fascia. The abdominal fascia keeps the abdominal contents inside the abdominal cavity. A hernia occurs when the deep layers begin to separate and the contents make their way toward the outside environment. The contents do not fully emerge because of some elements of the subcutaneous layers and the skin. These hernias can be small and localized, or can involve the entire length of an incision.

Taxonomy and domanins

The Science of Taxonomy

Because of the mind boggling number of organism that exist in the world, a means of classifying them was needed. Taxonomy is the science of organism classification. The two-name system (binomial nomenclature) from the 1800's has evolved into the seven classifications we have today: kingdom, phylum, class, order, family, genus and species. Carl Linnaeus, Swedish botanist, laid the foundations for modern-era binomial nomenclature, and is widely regarded as the father of taxonomy. While taxonomy refers to the classification of a wide variety of organisms, animate or not, discussion will be centered on the classification of microorganisms.

Whittaker's "Five-Kingdom" system

Carl Linnaeus established the basic two-kingdom classification for living organism: 1) animalia and 2) vegatabilia. Ultimately, Linnaeus added a third kingdom, mineralia, to include minerals. In the mid 1960's, Robert Whittaker recognized the need to establish an additional kingdom to include fungi. Later on, he incorporated two additional kingdoms to classify simple cellular and unicellular colonies: protista and monera. This system became widely recognized and accepted. Whittaker's classifications were based on the microorganism's intercellular organization and their differences in nutrition, rather than their evolutionary characteristics.

Dr. Carl Woese domains

In 1990, American microbiologist Dr. Carl Woese was credited for defining another domain or kingdom of life: the archea. Upon this discovery, he rewrote the phylogenic tree based on a new three-domain system. The three domains are archea, bacteria and eucarya. There are 23 divisions within these three domains. The divisions are based on genetic relationships, as opposed to morphological

similarities. These classifications are widely held to day. Woese's work has also commanded noteworthy attention in the search for life on other planets. Because of the discovery of the archea (ancient) microbial domain, there is speculation that many of the same or similar ancient microbes that adapted to extreme environments could have sustained a foothold on other terrestrial bodies.

Pathogens

Pathogen comes from the Greek work *pathos***,** which means pain and suffering, and the term gene, which, *to give birth to*. Pathogen is any agent that causes illness or disease to its host. Broadly described, germs are pathogens. Different diseases have specific pathogens that will produce a wide variety of symptoms, such as fever, pus, tissue necrosis, bleeding, diarrhea, etc., when introduced into the host body. Some pathogens are more deadly than others. Pathogens can be bacterial or viral. Some pathogens, such as those found in cholera, the Black Plague, malaria and the HIV virus, can have catastrophic results on populations.

Virulence

The ability of a microbe to cause disease is called its virulence. Bacterial virulence is dependent upon the number of invading organisms, the route by which the microbes enter the host body and the health of the body's defense mechanisms. In some cases, the host's reaction to the invading organisms is so intense that it can cause damage to the body by its very defense against the organisms.

The different methods by which pathogens can cause disease include adhesion, where the bacteria actually binds to the host cell surface; colonization, where the pathogen organizes in great numbers to cause disease and damage, as seen in gastric ulcers; and invasion, where pathogens enter the host cell and destroy and

disrupt the cells themselves causing production of immuno-response inhibitors and toxins.

Toxigenesis

Microorganisms invade the host body, inflict damage and cause disease by producing poisons called toxins. A microbe's ability to produce these poisons is called toxigenesis. There are many different types of toxins that can wreak havoc on the host body, and each type has its own specific mode of action. Entire cells can be destroyed or altered, or they can elicit such a violent immune response that the response itself can be deadly. Toxins present in patients whose immune systems are compromised can face severe illness and permanent injury or damage to organs and tissues from these poisons.

Colonization

The first stage of a bacterial infection is colonization in which a pathogen establishes itself in the host body at the appropriate portal of entry. Pathogens typically colonize in tissue that has direct contact with the external environment, e.g. nasal mucosa, urethra, oral cavity, the respiratory tract and the conjunctiva of the eye. These pathogens have developed the ability to adhere to the target tissue and to withstand attacks by the body's defenses at the point of adherence. For example, Helicobacter Pylori colonizes in a mucosal setting and is predominately responsible for the formation of peptic ulcers.

Bacterial toxins

The two basic types of bacterial toxins are endotoxins and exotoxins. An endotoxin typically resides within the envelope of the microorganism's cell wall. It can be comprised of either a lipopolysaccharide, or a lipooligosaccaride, which is located in

the outer cell membrane of gram-negative bacteria. Exotoxin is typically secreted by the bacterium and exerts its actions at a location removed from the area of bacterial growth. Exotoxins are typically secreted during periods of rapid, large scale bacterial growth. Gram-positive and gram-negative bacteria produce exotoxins, which is predictive of bacterial virulence. Endotoxins are cell-associated poisons, while exotoxins are extra-cellular substances that are secreted and act remotely.

Surgical Pharmacology

Weights and measurements

The apothecaries' system of weights and measures was used by the British and was in widespread use in the United States long before the American Revolution. The apothecaries' system has its roots in the Roman weight system, which used the ounce and the pound as standards of measurement. The pound consisted of 12 ounces, until it was changed to 16 ounces in France. It was the preferred method of measurement for pharmaceuticals and medications at the time. The Metric system is a decimal-based system that was adopted after World War II in response to a global need for standardization of methods of measurement. In 1960, the metric system was adopted with standard units of measurement: the meter, kilogram, second, ampere, degree Kelvin, and candela.

<u>The formula for conversion from pounds to kilograms</u>

As systems of measurement have migrated to the metric system, conversions were necessary to make accurate changes from one system to the other. Formulas were developed to make the necessary changes to the metric system, as many compounds and substances were initially packaged and measured in bulk using the apothecaries' system. One pound (1 lb.) equals 0.4536 kilograms (kg); one kilogram

(1 kg.) equals 2.2 lbs. For example, to convert 5lbs. into kilograms, the formula is 5 x 0.4536 = 2.268.

The formula for conversion from degrees Fahrenheit to degrees Centigrade

The convert a temperature from degrees Fahrenheit to degrees Centigrade, subtract 32 from the number and then multiply by 5/9. To convert degrees Centigrade to degrees Fahrenheit, multiply the number by 9/5, then add 32. For example, to convert 80 degrees F to degrees C: 80-32 = 48; 48 x 5/9 =26.666 degrees Centigrade. To find the degrees Fahrenheit for a temperature of 18 degrees centigrade: 18 x 9/5 = 32.40; 32.40 + 32 = 64.40 degrees Fahrenheit.

Sequence for general anesthetic administration

In surgical procedures that require the use of a general anesthetic, the patient is placed in the supine position on the operating table. Once this has been accomplished, various monitoring devices are attached and applied to obtain baseline readings prior to the administration of the anesthetic. Typically, the anesthesia care provider will then lightly place the airway mask over the patient's nose and mouth and him/her to breathe deeply to pre-oxygenate the lungs and circulatory system. No anesthetic agents are given at this time; however, anxiolytics, such as Versed or Valium can be given at this juncture to decrease anxiety. The next step is to introduce the induction agent, which is typically sodium pentothal or propofol or Diprivan. Once adequate induction has been accomplished, the patient will be maintained by mask ventilation, laryngeal mask airway, or endotracheal intubation.

Types of anesthetics

IV regional anesthetic

IV regional anesthetics involve the exsanguination of blood from an extremity and the replacement with a local anesthetic agent, such as Sensorcaine. This process requires the use of a double-cuff extremity tourniquet to allow for the placement of anesthetic medication beneath one cuff of the tourniquet, thus reducing pain caused by the tourniquet itself. The anesthetic medication then binds to the tissues so the procedure may be performed and completed. Care must be taken at the end of the procedure to deflate the tourniquet gradually, to prevent a sudden influx of anesthetic agent into the vascular circulation. The technologist must be aware of the status of the tourniquet at all times and immediately report and respond to any alterations in normal function.

Digital block

Surgical procedures that involve the fingers and toes often do not require the rigors of a systemic anesthetic. In these instances, localized blocks of one or more digits is usually quite sufficient for procedures that are not too lengthy. One form of local anesthesia for digits is the digital block. This block is accomplished by the introduction of a local anesthetic agent such as Xylocaine, Marcaine, or ropivacaine (Naropin), to areas where the branches of the digital nerves course along the finger or toe. By surrounding the nerves that supply the various portions of the finger or toe, adequate anesthesia can be achieved. Performing this block does not, in itself, require the use of any tourniquet; although, the procedure and the type and/or mixture of the local anesthetic agents can vary according to the length of the action of the block.

Spinal anesthetic

The introduction of the spinal anesthetic, or "saddle block," makes surgery below the level of the diaphragm much more tolerable for the patient and allows for greater post-operative comfort levels. A spinal anesthetic involves the insertion of a

spinal-length needle into the spinal sac, followed by the instillation of an agent that numbs the nerve tracts responsible for sensation and motor functions in the area of the intended surgical procedure. The type and the amount of anesthetic medication used and any other medications that may be mixed in will determine the duration of the anesthetic. One major benefit of a spinal anesthetic is that its effects wear off gradually, making it easier for the patient and caregivers to stay ahead of the pain levels that one encounters after surgery.

Barbotage

Barbotage is the process of alternately injecting anesthetic agent and aspirating spinal fluid until the mixture of both has been fully introduced.

Once the spinal sac has been punctured and the needle is inside the spinal sac, the anesthesia caregiver will verify entrance into the sac by aspirating the syringe and withdrawing spinal fluid. The anesthesia professional will inject a portion of the agent, then aspirate, looking for the intermixing of fluids to verify continued presence of the needle in the sac. This alternating process of injecting and aspirating may continue until the entire anesthetic agent has been injected.

Hyperbaric spinal anesthetic

Spinal anesthesia can be performed by weighting the solution so that it can be placed and maintained in a specific location to maximize its effectiveness. Hyperbaric spinal anesthetic is a solution mixture in which one of the components has greater specific gravity than the host solution, namely the spinal fluid. When a hyperbaric solution is injected into the spinal canal, it mixes with the spinal fluid. Because of its higher specific gravity, the anesthetic solution will have a tendency to sink to it lowest point in the spinal canal. Manipulating the patient's position allows for specifying the location of the anesthetic and targeting particular dermatomes.

Epidural anesthetic

A spinal anesthetic is in injected directly into the spinal sac and mixes with the spinal fluid. An epidural anesthetic is an entirely different approach and process with the same intended end results of a spinal anesthetic: anesthesia of the lower portions of the body. Just external to the spinal sac, and deep in the bony structures of the vertebral column, lies a space in which medication or anesthetic agents and catheters can be inserted. This is called the epidural space.

An epidural anesthetic can be administered with or without the use of a catheter, depending on its intended duration. A catheter allows for multiple administrations of anesthetic solution over time and for analgesic administration post-operatively. The solution coats and affects the spinal nerves from the epidural space, but the epidural, especially with the use of a catheter, has a much higher degree of control of duration and effect than a spinal anesthetic.

Anesthetic equipment

LMA

LMA stands for Laryngeal Mask Airway. This piece of anesthetic equipment is a relatively recent addition to the armamentarium used to administer inhaling agents. Like the endotracheal (ET) tube, the LMA provides for the administration of inhalant anesthetic agents and protects the airway against aspiration from the stomach and esophagus. The LMA is favored for use in shorter length surgeries in which systemic paralysis is not required. It is inserted in a similar fashion to the ET tube, but not with the use of a laryngoscope. Once in place, it is mildly inflated to provide adequate seal over the airway and epiglottis. The LMA comes in several sizes and must be matched with the relative size of the patient. It is also used for the majority of procedures in which the patient is in the supine position, where positional changes are not necessary.

Propofol

Propofol, trade name Diprivan, is a relatively short-acting intravenous anesthetic agent that is used for the induction and maintenance of general anesthesia. In recent years, it has become the agent of choice. Propofol is a white, isotonic solution that is given to achieve states of altered consciousness ranging from mild sedation to deep anesthesia. It is also classified as a hypnotic and is used frequently as a sedation agent for short procedures such as cardioversions and other minimally invasive tests and procedures in which formal deep anesthesia is not required. Propofol allows the patient to emerge from general anesthesia much more clear-headed and with lower incidence of headache. It is an extremely popular drug and is currently being used in approximately 50% of all surgical procedures as the primary induction agent.

Versed: Versed, or midazolam hydrochloride, is a synthetically manufactured compound typically used for pre-operative sedation to relieve anxiety and impair memory. Versed is in a class of drugs called benzodiazepines, which covers all sedatives, hypnotics and muscle relaxants. When given intravenously, Versed depresses the central nervous system rapidly, usually within 2-3 minutes of administration. The effects of this drug can last up to approximately 6 hours; therefore, it is an excellent drug to use for conscious sedation during minor surgical procedures. Versed does not depress respiration, but it can depress breathing, blood pressure and lung capacity if used in conjunction with other depressants such as alcohol.

Practice Questions

1. Which of the following refers to the process of isolating the surgical site from the rest of the body?
   a. Skin preparation
   b. Surgical draping
   c. Aseptic technique
   d. Patient positioning

2. Which of the following is a type of drape that contains a specific opening to accommodate the surgical incision?
   a. Fenestrated drape
   b. Non-fenestrated drape
   c. Adhesive drape
   d. Plastic adhesive drape

3. Which of the following is a type of drape used to cover nonoperative sites?
   a. Fenestrated drape
   b. Non-fenestrated drape
   c. Adhesive drape
   d. Plastic adhesive drape

4. Which of the following is a type of drape in which the surgical incision is made through?
   a. Fenestrated drape
   b. Non-fenestrated drape
   c. Incise drape
   d. Aperture drape

5. Which of the following is the type of drape used commonly during eye surgery?
   a. Fenestrated drape
   b. Non-fenestrated drape
   c. Incise drape
   d. Aperture drape

6. Which of the following skin preparation products provide a rapid decrease in the level of microorganisms?
   a. Alcohol and iodine
   b. Alcohol and chlorhexidine
   c. Iodine and chlorhexidine
   d. Chlorhexidine and peroxide

7. What is the benefit of using chlorhexidine for the purpose of skin preparation?
   a. Chlorhexidine removes microorganisms more rapidly than alcohol
   b. Chlorhexidine removes a greater quantity of microorganisms than alcohol
   c. Chlorhexidine removes microorganisms more rapidly than iodine
   d. Chlorhexidine has a residual effect of 5 to 6 hours

8. What is the first level, or bottom, of the pyramid in Maslow's hierarchy of needs?
   a. Safety
   b. Esteem
   c. Physiological
   d. Love and Belonging

9. Which of the following describes the process in which the surgical technologist rids his/her skin of microorganisms prior to a surgical procedure?
   a. Skin preparation
   b. Aseptic technique
   c. Surgical scrub process
   d. Decontamination procedure

10. Which of the following is the normal lab value for white blood cells?
   a. 2,000 to 5,000/mm3
   b. 5,000 to 10,000/mm3
   c. 7,000 to 12,000/mm3
   d. 10,000 to 15,000mm3

11. Which of the following is the normal value for red blood cells?
   a. 4.3 to 5.9 x 106 cells/mm3
   b. 5.2 to 7.8 x 106 cells/mm3
   c. 8.1 to 9.8 x 106 cells/mm3
   d. 9 to 10.7 x 106 cells/mm3

12. Which of the following diagnostic procedures is used to determine abnormalities, tumors, disc herniation, or other problems associated with the spinal structures?
   a. MRI
   b. Fluoroscopy
   c. Myelography
   d. Angiography

13. Which of the following diagnostic procedures aids in the diagnosis of aneurysms, blood clots, and vascular occlusions?
   a. MRI
   b. Fluoroscopy
   c. Myelography
   d. Angiography

14. Which of the following patient positions is preferred for cardiac and thyroid procedures?
    a. Supine position
    b. Lateral position
    c. Prone position
    d. Trendelenburg position

15. Which of the following patient positions is preferred for hip replacements and thoracotomies?
    a. Supine position
    b. Lateral position
    c. Prone position
    d. Trendelenburg position

16. Which of the following refers to the flow of air from inside the operating room outward?
    a. Negative pressure
    b. Direct pressure
    c. Laminar air flow
    d. Reverse air flow

17. Which of the following is an example of personal protective equipment?
    a. Surgical masks
    b. Scalpels
    c. Retractors
    d. Surgical drapes

18. Which of the following is an example of universal precautions?
    a. Sterilization of equipment
    b. Adequate draping of surgical field
    c. Adequate skin preparation of the surgical site
    d. Proper handling of sharps

19. Which of the following is a tool to assess the level of oxygen saturation of the hemoglobin in the blood and arterial system?
    a. Sphygmomanometer
    b. Pulse oximeter
    c. Arterial blood gas
    d. Electrocardiogram

20. Which of the following is the LEAST effective method for monitoring the patient's core body temperature?
    a. Oral thermometer
    b. Rectal thermometer
    c. Head monitoring strip
    d. Esophageal temperature probe

21. Which of the following are the most common sizes of scalpel blades?
    a. #10, #13, and #15
    b. #10, #11, and #15
    c. #11, #13, and #15
    d. #10, #11, and #13

22. Which of the following is an example of a grasping instrument?
    a. Scalpel
    b. Retractor
    c. Hemostats
    d. Forceps

23. Which of the following is an example of a clamping instrument?
    a. Scalpel
    b. Retractor
    c. Hemostats
    d. Forceps

24. Which of the following is an example of a viewing instrument?
    a. Scalpel
    b. Retractor
    c. Hemostats
    d. Forceps

25. Which of the following type of instrument is useful for exploring structures such as fistulas, ducts, and vessels?
    a. Probing instrument
    b. Viewing instrument
    c. Clamping instrument
    d. Grasping instrument

26. Which of the following type of instrument is used to enlarge the openings of structures?
    a. Probe
    b. Dilator
    c. Clamp
    d. Scalpel

27. Which of the following methods of hemostasis involves the use of instruments to control bleeding?
    a. Mechanical hemostasis
    b. Thermal hemostasis
    c. Laser hemostasis
    d. Chemical hemostasis

28. Which of the following chemical cauterization substances is frequently used to control cervical or nasal bleeding?
    a. Absorbable gelatin
    b. Collagen
    c. Epinephrine
    d. Silver nitrate

29. Which of the following chemical cauterization substances is a potent vasoconstrictor?
    a. Thrombin
    b. Silver nitrate
    c. Epinephrine
    d. Collagen

30. Which of the following is NOT a common type of suture material?
    a. Absorbable
    b. Nonabsorbable
    c. Metallic
    d. Nonmetallic

31. Which of the following surgical techniques involves the generation of extreme cold at the end of a probe?
    a. Laparoscopic surgery
    b. Cryotherapy
    c. Radiation therapy
    d. Fluoroscopy

32. Which of the following is the most commonly used substance in cryotherapy?
    a. Liquid hydrogen
    b. Liquid iodine
    c. Liquid nitrogen
    d. Water

33. Which of the following surgical techniques is employed to perform a Greenfield filter placement procedure?
a. Cryotherapy
b. Radiologic technique
c. Laparoscopic technique
d. Direct incision

34. Which of the following surgical techniques involves the use of video assistance in the equipment?
a. Cryosurgery
b. Radiologic technique
c. Laparoscopic technique
d. Direct incision

35. Which of the following surgical instrument produces sound waves at a level suitable for cutting tissue?
a. Harmonic scalpel
b. Laparoscope
c. Fluoroscope
d. #10 scalpel

36. Which of the following surgical methods uses the combination of irrigation and aspiration simultaneously?
a. Cryosurgery
b. Laparoscopic surgery
c. Fluoroscopy
d. Phacoemulsification

37. Which of the following surgical instruments is used primarily for tumor evacuation?
a. Harmonic scalpel
b. CUSA System
c. Laparoscope
d. Fluoroscope

38. Which of the following is an area that is established in order to reduce the potential for sharps-related injury?
a. Dead zone
b. Hands off zone
c. Neutral zone
d. Danger zone

39. Which of the following are commonly placed in surgical sites to remove excess fluid accumulation?
   a. Pumps
   b. Clamps
   c. Tubes
   d. Drains

40. Which of the following types of dressing is used when drainage is expected to be minimal?
   a. One-layer dressing
   b. Three-layer dressing
   c. Pressure dressing
   d. Rigid dressing

41. Which of the following types of dressing is used when the drainage is expected to be moderate to heavy?
   a. Rigid dressing
   b. Pressure dressing
   c. Three-layer dressing
   d. One-layer dressing

42. Which of the following type of dressing is sutured into position?
   a. Pressure dressing
   b. Bolster dressing
   c. Rigid dressing
   d. Wet to dry dressing

43. Which of the following is a type of surgical implant that is used to reduce and stabilize fractures of long bones?
   a. Screws
   b. Plates
   c. Pins
   d. Rods

44. Which of the following is a surgical procedure in which therapeutic agents are surgically implanted into the body?
   a. Brachytherapy
   b. Cryotherapy
   c. Radiation therapy
   d. Phacoemulsification

45. Which of the following is a type of surgical implant that is obtained from the patient, an animal, or a cadaver?
a. Seed implant
b. Biologic implant
c. Breast implant
d. Penile implant

46. Which of the following is a type of surgical implant used to re-route blood flow around an obstructed vessel?
a. Biologic implant
b. Seed implant
c. Vascular implant
d. Vein harvesting

47. Which of the following is a bariatric surgical procedure that involves a circular band implanted around the upper portion of a patient's stomach?
a. Gastric bypass
b. Lap-Band procedure
c. Liposuction
d. Stomach stapling

48. Which of the following surgical instruments is commonly used to perform colonoscopy procedures?
a. Laparoscope
b. Fluoroscope
c. Sigmoidoscope
d. Endoscope

49. Which of the following surgical instruments is commonly used to visualize the vagina, cervix, and vulva?
a. Endoscope
b. Fluoroscope
c. Colposcope
d. Laparoscope

50. Which of the following refers to an intensely hot, precisely focused beam of light designed to alter or destroy target tissue?
a. Laser
b. Thermal ablation
c. Cryosurgery
d. Phacoemulsification

51. Which of the following refers to a partial representation of a tissue or entity that requires further evaluation?
    a. Tissue sample
    b. Specimen
    c. Cell culture
    d. Blood sample

52. Which type of biopsy requires the entire lesion to be removed to test for clean tissue margins after removal?
    a. Fine needle aspiration
    b. Incision biopsy
    c. Excision biopsy
    d. Sentinel node biopsy

53. Which of the following specimen types is sent without any preservatives?
    a. Cell culture
    b. Tissue sample
    c. Frozen sample
    d. Fresh sample

54. Which of the following is only difference when dealing with bullet specimens?
    a. Bullets must be sent to pathology with preservatives
    b. Bullets must be hand delivered to pathology by a member of the surgical staff
    c. Bullets must be processed differently because they will become police evidence
    d. Bullets must be sent to pathology without any preservatives

55. Which of the following surgical instruments consists of several robotic arms that are directed by a surgeon?
    a. da Vinci Surgical System
    b. Mako Robotics
    c. Stealth Surgical Navigation
    d. Laparoscope

56. Which of the following surgical instruments is a computer based technology in which a surgical procedure is based on a starting point in space?
    a. da Vinci Surgical System
    b. Stealth Surgical Navigation
    c. Mako Robotics
    d. Laparoscope

57. What is the most common injury incurred due to faulty laparoscopic cautery?
    a. Insufficient cauterization
    b. Insufficient incision
    c. Tissue and vessel damage
    d. Uncontrolled bleeding

58. Which of the following is the federal policy requiring all users of medical devices to report any incidents that cause illness, injury, or death of a patient?
    a. HIPAA
    b. MIPPA
    c. EMTALA
    d. Safe Medical Devices Act

59. Which of the following is NOT an appropriate time to perform an instrument count?
    a. Prior to the surgical procedure
    b. During the surgical procedure
    c. Prior to closing the incision
    d. Conclusion of the procedure

60. Which of the following should be performed if an instrument used during a surgical procedure cannot be verified and reconciled?
    a. Re-open the incision and look for it
    b. Replace the instrument
    c. Obtain an x-ray of the surgical site
    d. Thorough check of all waste containers used during the surgical procedure

61. Which of the following two individuals are responsible for the surgical count?
    a. Surgical technologist and circulator
    b. Surgical technologist and surgeon
    c. Circulator and surgeon
    d. Surgical technologist and anesthesiologist

62. Which of the following refers to the act in which the patient is made aware of the procedure, the risks and benefits of the procedure, and the outcome of the surgical procedure?
    a. History and physical
    b. Surgical consent
    c. HIPAA
    d. EMTALA

63. Which of the following refers to the commission or omission of an act that result in a negative outcome?
a. Negligence
b. Vigilance
c. Arrogance
d. Intelligence

64. Which of the following refers to the 1998 legislation that contains eight areas that consumers have the right to expect regarding health care?
a. HIPAA
b. MIPPA
c. Patient Bill of Rights
d. EMTALA

65. Which of the following is a detailed summary of the surgical procedure?
a. History and physical
b. Surgical consent
c. Surgical count
d. Operating room record

66. Which of the following refers to the level of moral accountability that a surgical technologist must have when dealing with the health and welfare of another individual?
a. Patient bill of rights
b. Surgical conscience
c. Surgical consent
d. Operating room record

67. Which of the following is the most critical responsibility of a surgical technologist?
a. Ensure the proper procedure is performed
b. Ensure the surgical count is accurate and reconciled
c. Ensure the proper anesthetic is used
d. Ensure sterile technique in the operating room

68. Which of the following refers to the destruction of all microorganisms on inanimate surfaces?
a. Decontamination
b. Surgical scrubbing
c. Sterilization
d. Sterile technique

69. Which of the following is accepted as the standard mode of sterilization for items that are not heat, moisture, or temperature sensitive?
a. Steam sterilization
b. Ethylene oxide sterilization
c. Alcohol sterilization
d. Ultraviolet sterilization

70. Which of the following refers to the number of microbes residing on items to be sterilized?
a. Surgical debris
b. Bioburden
c. Biohazard
d. Surgical contamination

71. Which of the following is the most common reason for sterilization failures?
a. Surgical staff incompetence
b. Surgical staff negligence
c. Improper handling of surgical instruments
d. Lack of contact between steam and surface of surgical items

72. Which of the following is the type of sterilization used for items that are heat and moisture sensitive?
a. Steam sterilization
b. Ethylene oxide sterilization
c. Alcohol sterilization
d. Ultraviolet sterilization

73. Which of the following is a device that contains a preset number and specific types of microorganisms that are destroyed when exposed to sterilization?
a. Microscope
b. Colposcope
c. Laparoscope
d. Biological indicator

74. Which of the following is the biological indicator for steam sterilizers?
a. E. Coli
b. Bacillus subtilis
c. Spores of B. stearothermophilus
d. Streptococcus

75. Which of the following is the biological indicator for ethylene oxide sterilizers?
a. E Coli
b. Bacillus subtilis
c. Spores of B. stearothermophilus
d. Streptococcus

76. Which of the following refers to the procedure designed to check for air entrapment within the chamber of a sterilizer?
   a. Bowie-Dick test
   b. Air puff test
   c. Sterility validation test
   d. Air pressure test

77. According to the Federal Food, Drug, and Cosmetic Act, which of the following is the primary purpose and function of packaging material?
   a. To ensure proper transport of instruments to the operating room
   b. To ensure all required instruments are packaged together
   c. To allow easier handling of the instruments
   d. To ensure sterility until the instrument is used

78. Which of the following is NOT a performance standard that must be met by packaging material?
   a. Packaging material must keep the instrument sterile until time of use
   b. Packaging material must be constructed so the instrument can be removed without risk of contamination
   c. Packaging material must be water, steam, and heat resistant
   d. Packaging material must allow the sterilizing agent to penetrate its fabric and reach all surface areas

79. Which of the following refers to the membrane that is attached to and covers the lungs?
   a. Parietal pleural membrane
   b. Visceral pleural membrane
   c. Pleural cavity
   d. Pericardium

80. Which of the following is the medical term used to describe the action of the intestinal smooth muscle layers?
   a. Contraction
   b. Digestion
   c. Peristalsis
   d. Constriction

81. Which of the following refers to the small, bony projections between the transverse spinous processes and the vertebral bodies?
   a. Pedicles
   b. Discs
   c. Vertebrae
   d. Carbuncles

82. Which of the following is the suffix that refers to inflammation?
    a. -osis
    b. -itis
    c. -ology
    d. -oma

83. Which of the following conditions does the acronym COPD refer to?
    a. Chronic obstructive parietal disorder
    b. Chronic observed pulmonary disorder
    c. Chronic obstructive pulmonary disease
    d. Chronic observed plantar dysfunction

84. Which of the following congenital anomalies does the acronym VSD refer to?
    a. Venous surgical disorder
    b. Ventricular shunt defect
    c. Venous shunting disorder
    d. Ventricular septal defect

85. Which of the following conditions does the acronym CHF refer to?
    a. Compromised heart function
    b. Chronic heart failure
    c. Congested heart function
    d. Congestive heart failure

86. Which of the following describes the level of hydrogen ions in a solution?
    a. pH
    b. Purity
    c. Concentration
    d. Specific gravity

87. Which of the following acronyms means to administer a medication on an as-needed basis?
    a. t.i.d.
    b. b.i.d.
    c. p.r.n.
    d. q.d.

88. Which of the following conditions refers to a disruption or alteration in the integrity of the bony structure of the skeleton?
    a. Dislocation
    b. Fracture
    c. Osteosarcoma
    d. Paget disease

89. Which of the following is a type of fracture in which the bone penetrates the soft tissue, muscle, and skin?
    a. Compression fracture
    b. Greenstick fracture
    c. Compound fracture
    d. Pathologic fracture

90. Which of the following stages of wound healing begins approximately three days post-surgery?
    a. Inflammatory phase
    b. Proliferative phase
    c. Fibroblastic phase
    d. Lag phase

91. Which of the following surgical wounds carries a 10% to 15% infection rate?
    a. Class I surgical wound
    b. Class II surgical wound
    c. Class III surgical wound
    d. Class IV surgical wound

92. Which of the following refers to the method of tissue handling that minimizes cell destruction?
    a. Whittaker's Five-Kingdom System
    b. Dr. Carl Woese Domains
    c. Stealth Surgical Navigation
    d. Halsted's Principles of Surgery

93. Which of the following is the result of an ineffective surgical wound closure?
    a. Dead space
    b. Staph infection
    c. Wound evisceration
    d. Class III wound

94. Which of the following types of anesthetic requires the exsanguination of blood from an extremity?
    a. Spinal anesthetic
    b. Digital block
    c. IV regional anesthetic
    d. Epidural anesthetic

95. Which of the following refers to the process of alternating anesthetic injections and aspirating spinal fluid?
a. Spinal anesthetic
b. Barbotage
c. IV regional anesthetic
d. Epidural anesthetic

96. Which of the following is a white, isotonic solution used to achieve states of altered consciousness ranging from mild sedation to deep anesthesia?
a. Propofol
b. Midazolam
c. Morphine
d. Hydrocodone/Acetaminophen

97. Which of the following is commonly used for conscious sedation during minor surgical procedures?
a. Propofol
b. Midazolam
c. Morphine
d. Hydrocodone/Acetaminophen

98. Which of the following refers to an agent that can cause illness or disease to the host?
a. Carcinogen
b. Virus
c. Toxin
d. Pathogen

99. Which of the following refers the ability of a microbe to cause disease?
a. Toxicity
b. Prevalence
c. Virulence
d. Colonization

100. Which of the following refers to the ability of a microorganism to produce disease-causing poisons?
a. Toxigenesis
b. Virulence
c. Prevalence
d. Colonization

Answers and Explanations

1. B: Surgical draping is the process in which the surgical site is isolated from the rest of the body. This process is used to protect the surgical site from possible sources of infection. The drapes are used to serve as a barrier between the surgical site and all surrounding tissues.

2. A: A fenestrated drape contains an opening that accommodates and isolates the surgical site as well as the overall area in which the surgery is being performed. Fenestrations can come in many shapes, sizes, and may be specific to the surgical procedure being performed.

3. B: A non-fenestrated drape is used to "square off" an operative area or to cover nonessential or non-operative sites. Non-fenestrated drapes can be used in layers to enhance fluid resistance. This type of drapes is used to ensure other body parts are adequately isolated from the surgical site.

4. C: A incise drape in placed directly to the patient's skin and the surgical incision is usually made through the drape. An incise drape is usually made with clear plastic and an adhesive backing. These drapes may or may not be pretreated with an antimicrobial iodine solution. Incise drapes are normally placed after the surgical site has been draped.

5. D: An aperture drape is commonly used during eye surgery. It contains an opening that is surrounded by an adhesive backing. An aperture drape is used as a benefit to the surgeon in order to better visualize important landmarks or anatomical structures.

6. A: Alcohol and iodine provide similar qualities in rapid decrease in the level of microorganisms. Alcohol is usually used at a concentration of 70%. Although iodine is as effective as alcohol for skin preparation, it should be removed in a timely fashion as it can cause skin irritation for the patient.

7. D: Although chlorhexidine does not provide a rapid reduction in microorganism quantities like alcohol and iodine, it is a beneficial product for presurgical skin preparation because it has a residual effect of 5 to 6 hours.

8. C: The bottom level of Maslow's hierarchy of needs is physiological. The physiological level refers to the patient's basic needs in order to sustain life: food, water, air, and temperature regulation.

9. C: The surgical scrub process is performed by all operating room personnel, including surgical technologists, who will be present in the sterile field, touching and handling sterile instruments, and contacting the surgical incision. The goal is to sterilize the skin and render it clean for surgery.

10. B: The normal value for white blood cells is 5,000 to 10,000/mm3. Values above 10,000 can indicate the presence of infection or inflammatory processes. Values below 5,000 can indicate immunosuppression from disorders, such as leukemia, or chemotherapy.

11. A: The normal value for red blood cells is 4.3 to 5.9 x 106 cells/mm3 . Abnormal values of red blood cells can be indicative of anemia, hypovolemia, or chronic occult hemorrhage as seen with conditions such as gastric ulcers.

12. C: Myelography is the diagnostic procedure used to determine abnormalities, tumors, disc herniation, or other conditions associated with the cervical, thoracic, or

lumbar spine. Myelography is performed by the administration of x-ray dye via lumbar puncture and then obtaining a series of x-ray images of the area in question.

13. D: Angiography is the diagnostic procedure most useful in the diagnosis of aneurysms, blood clots, vascular occlusions, and plaque formation. Angiography involves x-ray dye being administered directly into the patient's vascular system, then using fluoroscopy to obtain live studies of the vascular system.

14. A: The supine position is the preferred position for cardiac, thyroid, abdominal, and pelvic surgical procedures. The term supine refers to positioning of the patient flat on the back on the operating table.

15. B: The lateral patient position is commonly used for surgical procedures such as hip replacements, fracture procedures, thoracotomies, and splenic abscesses. The lateral position refers to positioning of the patient on one side. Care must be taken to avoid pressure points on the dependent hip, shoulder, and ankle by providing proper padding. Respiration may also be compromised in this position because of positional restrictions.

16. C: Laminar air flow provides unidirectional, positive pressure air flow, which maintains the flow of air from inside the operating room outward. This flow of air is beneficial because it helps to filter out microbes that may compromise the sterile surgical area. Laminar air flow is maintained best when the operating room doors are kept closed.

17. A: Surgical masks are one example of personal protective equipment. Personal protective equipment is used to protect the caregiver from exposure to potentially harmful substances, such as bodily fluids, radiation, and sharp instruments. Other examples of personal protective equipment are protective eyewear, space suit, lead aprons, and foot coverings.

18. D: Proper handling of sharps is one example of universal precautions. Universal precautions are implemented in order to ensure maximum safety of the patient and the surgical staff during surgical procedures. Other examples of universal precautions are double gloving, appropriate shielding from lasers or x-ray radiation, and placing electrosurgical pencils in the appropriate holsters when not in use.

19. B: A pulse oximeter is a noninvasive tool used to assess the level of oxygen saturation of the hemoglobin in the blood and arterial system. This device measures the speed and amount of light that is absorbed by the hemoglobin, which varies at different saturations. The three most accurate places on the body to place a pulse oximeter are the fingertip, the earlobe, and the bridge of the nose.

20. C: The use of a head monitoring strip is generally recognized as the effective method in evaluating the patient's core body temperature. The best method of evaluating body temperature during a surgical procedure is with the use of a rectal or esophageal temperature probe. The best method of evaluating body temperature in the preoperative setting is the use of a thermometer in the oral, rectal, or axillary regions of the body.

21. B: The three most common sizes of scalpel blades are #10, #11, and #15. Scalpel blades are produced in a large variety of shapes and sizes depending on the function in which it is to be used. The #11 blade is particularly useful for "stab" wounds, whereas a #10 blade is used for longer, linear incisions.

22. D: Forceps are an example of a grasping instrument. Grasping instruments are used to hold and manipulate tissue to aid in cutting or incising. Most of these instruments have handles that allow for forefinger and thumb insertion, but some require a pinching type maneuver to operate.

23. C: Hemostats are an example of a clamping instrument. Clamping instruments, otherwise known as occluding instruments, are used to create a blockage of tissues or blood vessels. These instruments are used in both general and vascular surgeries. Clamping instruments are used to create a blockage without causing additional trauma.

24. B: Retractors are a common viewing instrument. This type of instrument is specifically designed to obtain optimal visualization of the operative field. Retractors are typically flat, come in a variety of widths, and are either rigid or malleable. Some retractors are made of a malleable, soft metal in order for them to change shape during a surgical procedure.

25. A: Probing instruments are required to explore structures such as fistulas, ducts, and vessels. Probes are flexible, wire-like instruments that are used to determine the patency of ducts and vessels or to determine if there is an obstruction in the lumen of a vessel or duct.

26. B: A dilator is an instrument used to enlarge the diameter of tubular structures such as blood vessels, the esophagus, bile ducts, or surgically created openings. These instruments not only enlarge the structures themselves, but they can also restore patency in structures with strictures, such as the esophagus.

27. A: Mechanical hemostasis is the method in which instruments or devices are used to control bleeding until a clot forms or until completion of the surgical procedure. Mechanical hemostasis can be performed with the use of a pneumatic tourniquet, hemostats, direct pressure on the blood vessels, or surgical packing of the vessels.

28. D: Silver nitrate is the chemical cauterization substance that is commonly used to control cervical and nasal bleeding. The most common form of silver nitrate is in

solid form at the end of a wooden applicator, although it comes in many other forms. This substance is poisonous to the body in larger quantities; therefore, extreme care should be taken when applying silver nitrate.

29. C: Epinephrine is the chemical cauterization substance that acts as a potent vasoconstrictor. Epinephrine is commonly incorporated into several local anesthetics. When epinephrine is combined with a local anesthetic, chemical cauterization is obtained in addition to transient pain relief from the anesthetic.

30. D: The three main types of suture material are absorbable, nonabsorbable, and metallic. Metallic sutures are made of fine gauge wire in a variety of sizes and used when the sutures need to remain intact for several weeks. Nonabsorbable sutures are made of substances such as silk or nylon and used to maintain the position of a repaired tissue or bone. Absorbable sutures are made of substances such as Vicryl or catgut and used to promote tissue healing of the deep internal layers.

31. B: Cryotherapy is a surgical technique in which equipment is used to generate extreme cold at the tip of a probe. This technique is commonly used by plastic surgeons, dermatologists, gynecologists, and ophthalmologists in order to devitalize tissues, control bleeding, or instantly solidify fluid-filled structures.

32. C: Liquid nitrogen is primarily the substance of choice when performing cryosurgery because of its extremely cold nature. Cryosurgery is considered a minimally invasive surgical technique and is very useful in the destruction of abnormal cells.

33. B: Greenfield filter placement procedure is one example of a radiologic surgical technique. Radiologic surgical technique involves the use of x-ray equipment or fluoroscopy. Other examples of radiologic surgical technique are pacemaker insertions, intraoperative fracture fixation, and various angiography procedures.

34. C: Laparoscopic surgery is surgical procedure of the abdominal and pelvic cavities that employs the use of video assistance in the equipment. Laparoscopy involves the creation of one or more working portals in the abdominal or pelvic cavity. Examples of laparoscopic surgical procedures are laparoscopic hernia repair, gallbladder removal, and appendectomy.

35. A: The harmonic scalpel is an ultrasonic instrument that produces sound waves at a level suitable for cutting and coagulating tissue. The main benefit for using a harmonic scalpel is that it can simultaneously cut and coagulate tissue. The harmonic scalpel is often used in open procedures, such as thyroidectomy, Hemorrhoidectomy, and mastectomy.

36. D: Phacoemulsification is a method of performing surgical procedures by using irrigation and aspiration simultaneously. This surgical technique is most often used in ophthalmic surgery. This technique is considered to be minimally invasive and often requires no closing sutures.

37. B: The CUSA system is a versatile ultrasonic aspiration system designed for precise tissue removal with its primary function being for tumor evacuation. The system uses high frequency sound waves to fragment tissues and simultaneously aspirate and evacuate these fragments.

38. C: The neutral zone or no-touch zone is established in order to reduce the potential for sharps-related injuries that occur during hand-to-hand instrument transfer from surgical technologists to surgeons. The area should be mutually agreed upon between the surgical technologist and the surgeon. The instruments placed in the neutral zone should be placed in a manner in which the surgeon can grasp the instrument with one hand without having to change positions.

39. D: Drains are commonly used in order to remove excess fluid accumulation from a surgical site. There are active drains and passive drains. An active drain is used to maintain decompression while the site is being drained. Passive drains allow for evacuation via gravity or pressure from the fluid buildup.

40. A: A one-layer dressing is applied to an incision in which the drainage is expected to be minimal. Common procedures in which a one-layer dressing would be applied are endoscopy access sites and intravenous sites. Examples of one-layer dressings are OpSite, Steri-Strips, and a variety of aerosol sprays.

41. C: When drainage from a surgical procedure is expected to be moderate to heavy, a three-layer dressing is frequently used. The three layers are comprised of the inner layer that is in direct contact with the wound, the intermediate layer that absorbs the majority of the drainage, and the securing layer.

42. B: A bolster dressing is a type of surgical dressing that is sutured into the proper position. This type of dressing is commonly used with procedures involving reconstruction of the ear or any procedure requiring a skin graft. The bolster dressing is commonly in place for a least a week after the surgical procedure or until the surgeon deems it safe to remove the sutures.

43. D: Intramedullary rods are commonly used during orthopedic surgeries in order to reduce, stabilize, and bridge fractures of long bones. Intramedullary rods can be constructed with either stainless steel or titanium. These rods come in a variety of sizes and can be solid or hollow. Intramedullary rods can be small enough to be inserted into the canal of a finger bone or large enough to fit into the canal of a femur.

44. A: Brachytherapy is a surgical procedure in which a therapeutic agent is surgically implanted into the body. The most common example of brachytherapy is

the insertion of radioactive seeds into the prostate for the treatment of prostate cancer.

45. B: Biologic implants are a type of implant in which the material is obtained from the patient, an animal, or a cadaver. Examples of biologic implants are obtaining heart valves from pigs for valve replacement surgery, harvesting vein grafts from a patient's leg for coronary bypass surgery, or obtaining tendon-like materials from a cadaver to perform ligament reconstruction.

46. C: A vascular implant is primarily used to re-route blood flow around a diseased or obstructed blood vessel. Vascular implants come in many sizes, shapes, and forms ranging from vascular grafts to stents. Many forms of vascular implants are pretreated with an antithrombolytic agent in order to prevent blood clots from forming around the implant.

47. B: A Lap-Band band procedure is a form of bariatric surgery in which a restrictive, circular band is implanted around the upper part of the patient's stomach. A Lap-Band is normally implanted using a laparoscopic approach. The band can be tightened or loosened easily by either adding or removing the quantity of saline filling the band.

48. D: An endoscope is flexible, fiber optic instrument that is commonly used for colonoscopy procedures. For general surgery, a long rigid endoscope will be used because they are typically larger and present a much clearer picture. Flexible endoscopes are commonly used for procedures such as thoracoscopy and sigmoidoscopy.

49. C: A colposcope is a telescopic device which is primarily used in order to visualize the anatomy and tissue configuration of the vagina, cervix, and vulva. This instrument is extremely valuable in gathering hard-to-find evidence involved with

sex crimes. The colposcope is capable of taking pictures of normal, abnormal, or injured tissues that may otherwise go unnoticed.

50. A: A laser is an intensely hot, precisely focused beam of light that is aimed at specific target tissues in order to alter or destroy the target tissue. Laser is an acronym for Light Amplification by the Stimulated Emission of Radiation. The three types of laser commonly used in surgical procedures are the carbon dioxide laser, the argon laser, and the neodymium laser.

51. B: A specimen is a partial representation of the tissue or entity being evaluated and can be retrieved by either incision or excision biopsy methods. The specimen that is sent for evaluation should be large enough to make positive identification. It is the surgical technologist's responsibility to know the location and the type of tissue that is being removed.

52. C: An excision biopsy requires the entire lesion be removed in order to test for clean tissue margins after the surgical procedure. An incision biopsy requires cutting into the lesion or tissue to be examined and removing a portion of the lesion or tissue to be sent for further evaluation.

53. D: A fresh specimen is the type of specimen that should be sent to the pathology department without the presence of any preservatives. Fresh specimens occasionally can be sent in saline solution at the discretion of the surgeon, pathologist, or both. Depending on the nature of the specimen, fresh samples are normally sent to pathology in metal basins, sterile towels, or specimen containers.

54. C: Bullet specimens must be handled not only as surgical specimens but also as evidence in an ongoing police investigation. The bullet or bullet fragments are retrieved in much the same manner as other specimens; however, they may ultimately become police property after removal. If the bullet is removed without

the presence of the local authorities, the specimen may have to be locked up in a secure location until it can be properly processed.

55. A: The da Vinci surgical system is a state of the art surgical navigation that is becoming extremely popular in the fields of urologic and gynecologic surgery. This device consists of several robotic arms that are directed by a surgeon sitting at a control console. The da Vinci system can perform a major surgery, such as a prostatectomy, with minimal trauma, less bleeding, less pain, and a quicker recovery period.

56. B: The stealth surgical navigation is a computer-assisted technology in which surgical procedures are performed based on a starting point in space. This technology is becoming popular in performing surgical procedures such as lumbar and thoracolumbar stabilizations. Stealth surgical navigation has the benefits of smaller incisions, less bleeding, less tissue damage, less pain, and quicker recovery.

57. C: The most common injury that is incurred when using cauterization during a laparoscopic procedure is inadvertent damage to tissues and vessels due to improper heat of the cautery tip. The loss of insulation of the cautery tip can cause the cautery tip to malfunction. It is the duty of the surgical technologist to ensure proper functioning of all equipment used during surgical procedures.

58. D: The Safe Medical Devices Act requires users of medical devices to report any incidences that could in any way suggest that the device caused death, serious injury, or illness to a patient. This act is a medical device amendment to the Federal Food, Drug, and Cosmetic Act. It was signed into law by President Bush in 1990 and is authorized by the Food and Drug Administration.

59. B: It is not appropriate to perform an instrument count during a surgical procedure. Accurate counts of all instruments to be used for the surgical procedure

should be counted prior to the procedure and then recounted and reconciled at the conclusion of the surgical procedure and once again prior to closing the incision.

60. C: If an instrument that is used during a surgical procedure cannot be verified and reconciled at the conclusion of the procedure, an x-ray of the surgical site should be performed in order to find the whereabouts of the instrument. If an instrument is left in the patient, re-opening of the surgical incision may be required in order to remove the instrument.

61. A: The surgical technologist and the circulator are responsible for the surgical count. The surgical count begins when the technologist informs the circulator what items are to be counted. The surgical technologist verifies that the circulator can see the items to be counted. The count is done together and verbally by both the surgical technologist and the circulator.

62. B: Surgical consent is the act in which the patient is made aware of the procedure, the risk and benefits of the procedure, and the intended outcome of the surgical procedure. Surgical consent should always be obtained prior to the surgical procedure. Surgical consent is not a legal and binding document and cannot completely protect the surgeon from litigation.

63. A: Negligence refers to the commission or omission of an act upon the patient that results in a negative outcome. Examples of negligence are the patient sustaining an unexpected injury during the procedure, wrong site surgeries, and leaving instruments inside patients.

64. C: The Patient Bill of Rights was enacted in 1998 by the President's Advisory Commission on Consumer Protection and Quality in the Health Care Industry. The Patient Bill of Rights includes eight areas in which all consumers have the right to expect regarding health care.

65. D: The operating room record is a detailed summary of the entire surgical procedure. The operating room records should contain everything, including history and physical, risk factors, vital signs, medication and anesthetics, and personnel involved with the procedure.

66. B: Surgical conscience is the level of moral accountability that a professional must have when dealing with situations regarding the health and welfare of another individual. Examples of this are to ensure the patient's confidence is kept sacred, and refrain from any discrimination based on the surgical technologist's personal set of values.

67. D: The most important and most critical responsibility of surgical technologist is to uphold the guarantee of sterile technique in the operating room. This is critical to ensure against any unexpected or unnecessary infection that the patient may incur as a result of the surgical procedure.

68. C: Sterilization is defined as the destruction of all microorganisms, including spores, on inanimate surfaces. Sterilization is normally accomplished through the use of pressurized steam, chemical agents, and ultraviolet radiation.

69. A: Steam sterilization is widely accepted as the standard mode of sterilization for all items that are not heat, moisture, or temperature sensitive. Steam sterilization is the most dependable method for the destruction of all microbes and their spores. Steam sterilization employs the use of moist heat delivered in the form a saturated steam under significant pressure in a closed environment.

70. B: Bioburden is the term that refers to the number of microorganisms that reside on a surgical instrument that needs to be sterilized. Depending on the amount of soil on the items, a thorough cleansing may be in order prior to sterilization. Instruments with boxes, locks, or hinges create opportunities for microbes to reside.

71. D: The most common reason for failures during the sterilization process is inadequate contact of the surgical instrument with the generated steam. There are several mechanical reasons in which this may occur and several human errors that could cause this to occur. The surgical technologist must ensure proper sterilization of all instruments that are to be used during the surgical procedure.

72. B: Ethylene oxide sterilization is commonly used for items that are typically heat and moisture sensitive. Plastic and rubber items are commonly sterilized by this method. This process can take up to 16 hours and can present problems of limited supply. Although this method is equally as effective as the steam method, the Environmental Protection Agency has issued concerns over potential effects of ethylene oxide on health care workers.

73. D: The biological indicator is a small device that contains a preset number and specific types of microorganisms that are destroyed when exposed to the sterilization conditions. The biological indicator is the only true measure of the effectiveness of sterilization. If the biological indication reveals a negative growth, then the sterilization process was successful.

74. C: The microorganism commonly chosen for steam sterilization is spores of B. stearothermophilus. This microorganism is chosen because it is the most resistant to steam sterilization. For steam sterilizers, a negative growth for spores of B. stearothermophilus indicates a successful steam sterilization procedure.

75. B: The microorganism commonly chosen for ethylene oxide sterilization is Bacillus subtilis. This microorganism is chosen because it is the most resistant to ethylene oxide sterilization. For ethylene oxide sterilizers, a negative growth for Bacillus subtilis indicates a successful ethylene oxide sterilization procedure.

76. A: The Bowie-Dick test is typically used in the pre-vacuum sterilization cycle and is designed to check for air entrapment within the chamber. The Bowie-Dick test should be performed on a daily basis and typically before the first sterilization run of the day. This test does not validate sterility, but does ensure the integrity of the vacuum-producing system.

77. D: The Federal Food, Drug, and Cosmetic Act states that the primary purpose and function of packaging material is to enclose any medical device that requires sterilization and allow the enclosed device to remain sterile until such time the device is used.

78. C: Packaging materials do not have to be water, steam, and heat resistant. Packaging materials must keep the item sterile until used. They must be constructed so the instrument can be removed without risk of contamination and must allow the sterilizing agent to penetrate the fabric.

79. B: The pleural cavity contains two distinct membranes that protect and lubricate the lungs and heart. The two major pleural membranes are the parietal and the visceral pleural membrane. The parietal covers and is attached to the chest wall and the visceral covers and is attached to the lungs.

80. C: Peristalsis is the medical term used to describe the action of the intestinal smooth muscle layers. The smooth muscle layers of the small intestine perform regular, rhythmic movements that allow for proper transport of food through the intestines and for proper absorption of nutrients from the food.

81. A: The small projections of bone that are present between the transverse spinous processes and the vertebral bodies are referred to as pedicles. Pedicles help form the neural arch through which the spinal nerve roots pass. Pedicles also serve as very important positional markers for lumbar spine procedures.

82. B: In medical technology, the suffix -itis refers to any condition in which inflammation or an inflammatory process is present. Common conditions with this suffix that are encountered in the surgical setting are cholecystitis, arthritis, and tendonitis.

83. C: COPD refers to the condition of chronic obstructive pulmonary disease. COPD encompasses several diseases and conditions that are characterized by difficulty breathing. Some conditions classified as COPD are asthma, emphysema, and chronic bronchitis.

84. D: VSD refers to the congenital heart anomaly ventricular septal defect. A ventricular septal defect causes oxygenated blood to leak from the left ventricle into the right ventricle, raising the ventricular pressure to abnormal levels. Individuals with a VSD can experience difficulty breathing, difficulty feeding, or failure to thrive.

85. D: CHF refers to the condition of congestive heart failure. CHF is a condition in which the heart is unable to sufficiently pump blood to the organ systems of the body. CHF can be caused by several medical conditions, such as damaged heart valves, coronary artery disease, previous myocardial infarction, and severe hypertension.

86. A: The term pH is used to describe the level of hydrogen ions in a solution. A neutral solution is an equal number of hydrogen ions and hydroxide ions. More hydrogen ions than hydroxide ions will indicate an acidic solution. More hydroxide ions than hydrogen ions will indicate an alkaline solution. A pH of 7 is neutral. A pH level less than 7 is considered acidic and a pH level greater than 7 is considered alkaline.

87. C: The term p.r.n. means to administer a medication strictly on an as-needed basis. Medications that are usually administered in this manner generally do not

have specific time frames such as antibiotics or anti-hypertensives. Medication can be administered as needed in a variety of methods such as oral, topical, drops or sprays.

88. B: The term fracture refers to a disruption in the integrity of bony structure of the skeleton. Fractures can be caused by internal causes, such as diseases and neoplasms, or can be caused by external factors, such as overuse or trauma.

89. C: A compound fracture, sometimes referred to as an open fracture, is a type of fracture in which the bone penetrates the surrounding tissue, muscle, and skin. A compound fracture is considered to be a contaminated injury because of the bone's exposure to the outside environment. This type of fracture is most commonly the result of a trauma.

90. B: The proliferate phase of wound healing begins approximately 30 days after the surgical procedure and can last for up to 20 days. During this phase, the wound has recovered approximately 20% to 25% of its presurgical tensile strength.

91. C: A class III surgical wound is a contaminated wound that carries a 15% to 20% infection rate. Acute inflammation is associated with class III wounds, and this type of wound can become a traumatic wound in less than 4 hours. When a class III wound occurs, it is generally associated with a major break in sterile technique.

92. D: Halsted's Principles of Surgery includes gentle tissue handling. When human tissues are handled, manipulated, and processed, invariably some cells will be destroyed. Because of this fact, the ultimate goal is to handle, manipulate, and process human tissues in such a manner as to destroy as few cells as possible.

93. A: Dead space is commonly the result of an ineffective wound closure. The deeper layers are closed but a portion of the tissue layer was not well approximated,

causing a cavity or dead space. This is of great concern because blood or fluids can accumulate in a dead space, increasing the risk for infection, seromas, and hematomas.

94. C: IV regional anesthetics require the exsanguination of blood from an extremity and the replacement with a local anesthetic. This process requires the use of a double-cuff extremity tourniquet to allow the anesthetic to be administered under one cuff of the tourniquet, alleviating the pain from the tourniquet. The anesthesia then binds to the tissues so the surgical procedure can be performed.

95. B: Barbotage is the process of alternately injecting anesthetic agent and aspirating spinal fluid until the mixture of both has been fully introduced. Once the spinal sac has been punctured, the proper location is verified by the withdrawal of spinal fluid. Once the location is verified, the intermixing of fluid and anesthesia will commence until the entire amount of anesthesia has been administered.

96. A: Propofol is white, isotonic solution that is given to achieve states of altered consciousness ranging from mild sedation to deep anesthesia. Propofol (Diprivan) has become the anesthetic of choice because patients come out of it more clearheaded and with a lower incidence of headache. Propofol is currently used in approximately 50% of all surgical procedures.

97. B: Midazolam hydrochloride (Versed) is an excellent drug to use for conscious sedation during minor surgical procedures. Midazolam is also commonly used as a presurgical sedative to relieve anxiety and impair memory. Midazolam depresses the nervous system within 2 to 3 minutes of administration and can last up to 6 hours.

98. D: A pathogen is defined as any agent that can cause illness or disease to a host. The term pathogen is derived from the Greek word pathos, which means pain and

suffering, and the term gene, which means to give birth to. Pathogens can be viral or bacterial in nature and different diseases have different, specific pathogens.

99. C: Virulence is the ability of a microbe to cause disease. Bacterial virulence is dependent upon three factors. The first is the number of the invading organisms, the second is the route in which the microbes enter the host body, and the third is the health of the body's defense mechanisms.

100. A: Toxigenesis is the ability of a microorganism to produce disease-causing poisons called toxins. The body can be exposed to many different forms of toxins and each form of toxin has its own specific characteristics and affects the body in its own unique way. For patients with compromised immune systems, certain toxins can cause severe illnesses, permanent injury, or tissue or organ damage.

Pace Yourself

Wear a watch. At the beginning of the test, check the time (or start a chronometer on your watch to count the minutes), and check the time after every few questions to make sure you are "on schedule."

If you are forced to speed up, do it efficiently. Usually one or more answer choices can be eliminated without too much difficulty. Above all, don't panic. Don't speed up and just begin guessing at random choices. By pacing yourself, and continually monitoring your progress against your watch, you will always know exactly how far ahead or behind you are with your available time. If you find that you are one minute behind on the test, don't skip one question without spending any time on it, just to catch back up. Take 15 fewer seconds on the next four questions, and after four questions you'll have caught back up. Once you catch back up, you can continue working each problem at your normal pace.

Furthermore, don't dwell on the problems that you were rushed on. If a problem was taking up too much time and you made a hurried guess, it must be difficult. The difficult questions are the ones you are most likely to miss anyway, so it isn't a big loss. It is better to end with more time than you need than to run out of time.

Lastly, sometimes it is beneficial to slow down if you are constantly getting ahead of time. You are always more likely to catch a careless mistake by working more slowly than quickly, and among very high-scoring test takers (those who are likely to have lots of time left over), careless errors affect the score more than mastery of material.

Secret Key #2 - Guessing is not Guesswork

You probably know that guessing is a good idea - unlike other standardized tests, there is no penalty for getting a wrong answer. Even if you have no idea about a question, you still have a 20-25% chance of getting it right.

Most test takers do not understand the impact that proper guessing can have on their score. Unless you score extremely high, guessing will significantly contribute to your final score.

Monkeys Take the Test

What most test takers don't realize is that to insure that 20-25% chance, you have to guess randomly. If you put 20 monkeys in a room to take this test, assuming they answered once per question and behaved themselves, on average they would get 20-25% of the questions correct. Put 20 test takers in the room, and the average will be much lower among guessed questions. Why?

1. The test writers intentionally writes deceptive answer choices that "look" right. A test taker has no idea about a question, so picks the "best looking" answer, which is often wrong. The monkey has no idea what looks good and what doesn't, so will consistently be lucky about 20-25% of the time.
2. Test takers will eliminate answer choices from the guessing pool based on a hunch or intuition. Simple but correct answers often get excluded, leaving a 0% chance of being correct. The monkey has no clue, and often gets lucky with the best choice.

This is why the process of elimination endorsed by most test courses is flawed and detrimental to your performance- test takers don't guess, they make an ignorant stab in the dark that is usually worse than random.

$5 Challenge

Let me introduce one of the most valuable ideas of this course- the $5 challenge:

You only mark your "best guess" if you are willing to bet $5 on it.
You only eliminate choices from guessing if you are willing to bet $5 on it.

Why $5? Five dollars is an amount of money that is small yet not insignificant, and can really add up fast (20 questions could cost you $100). Likewise, each answer choice on one question of the test will have a small impact on your overall score, but it can really add up to a lot of points in the end.

The process of elimination IS valuable. The following shows your chance of guessing it right:

If you eliminate wrong answer choices until only this many remain:	1	2	3
Chance of getting it correct:	100%	50%	33%

However, if you accidentally eliminate the right answer or go on a hunch for an incorrect answer, your chances drop dramatically: to 0%. By guessing among all the answer choices, you are GUARANTEED to have a shot at the right answer.

That's why the $5 test is so valuable- if you give up the advantage and safety of a pure guess, it had better be worth the risk.

What we still haven't covered is how to be sure that whatever guess you make is truly random. Here's the easiest way:

Always pick the first answer choice among those remaining.

Such a technique means that you have decided, **before you see a single test question**, exactly how you are going to guess- and since the order of choices tells you nothing about which one is correct, this guessing technique is perfectly random.

This section is not meant to scare you away from making educated guesses or eliminating choices- you just need to define when a choice is worth eliminating. The $5 test, along with a pre-defined random guessing strategy, is the best way to make sure you reap all of the benefits of guessing.

Secret Key #3 - Practice Smarter, Not Harder

Many test takers delay the test preparation process because they dread the awful amounts of practice time they think necessary to succeed on the test. We have refined an effective method that will take you only a fraction of the time.

There are a number of "obstacles" in your way to succeed. Among these are answering questions, finishing in time, and mastering test-taking strategies. All must be executed on the day of the test at peak performance, or your score will suffer. The test is a mental marathon that has a large impact on your future.

Just like a marathon runner, it is important to work your way up to the full challenge. So first you just worry about questions, and then time, and finally strategy:

Success Strategy

1. Find a good source for practice tests.
2. If you are willing to make a larger time investment, consider using more than one study guide- often the different approaches of multiple authors will help you "get" difficult concepts.
3. Take a practice test with no time constraints, with all study helps "open book." Take your time with questions and focus on applying strategies.
4. Take a practice test with time constraints, with all guides "open book."
5. Take a final practice test with no open material and time limits

If you have time to take more practice tests, just repeat step 5. By gradually exposing yourself to the full rigors of the test environment, you will condition your mind to the stress of test day and maximize your success.

Secret Key #4 - Prepare, Don't Procrastinate

Let me state an obvious fact: if you take the test three times, you will get three different scores. This is due to the way you feel on test day, the level of preparedness you have, and, despite the test writers' claims to the contrary, some tests WILL be easier for you than others.

Since your future depends so much on your score, you should maximize your chances of success. In order to maximize the likelihood of success, you've got to prepare in advance. This means taking practice tests and spending time learning the information and test taking strategies you will need to succeed.

Never take the test as a "practice" test, expecting that you can just take it again if you need to. Feel free to take sample tests on your own, but when you go to take the official test, be prepared, be focused, and do your best the first time!

Secret Key #5 - Test Yourself

Everyone knows that time is money. There is no need to spend too much of your time or too little of your time preparing for the test. You should only spend as much of your precious time preparing as is necessary for you to get the score you need.

Once you have taken a practice test under real conditions of time constraints, then you will know if you are ready for the test or not.

If you have scored extremely high the first time that you take the practice test, then there is not much point in spending countless hours studying. You are already there.

Benchmark your abilities by retaking practice tests and seeing how much you have improved. Once you score high enough to guarantee success, then you are ready.

If you have scored well below where you need, then knuckle down and begin studying in earnest. Check your improvement regularly through the use of practice tests under real conditions. Above all, don't worry, panic, or give up. The key is perseverance!

Then, when you go to take the test, remain confident and remember how well you did on the practice tests. If you can score high enough on a practice test, then you can do the same on the real thing.

General Strategies

The most important thing you can do is to ignore your fears and jump into the test immediately- do not be overwhelmed by any strange-sounding terms. You have to jump into the test like jumping into a pool- all at once is the easiest way.

Make Predictions

As you read and understand the question, try to guess what the answer will be. Remember that several of the answer choices are wrong, and once you begin reading them, your mind will immediately become cluttered with answer choices designed to throw you off. Your mind is typically the most focused immediately after you have read the question and digested its contents. If you can, try to predict what the correct answer will be. You may be surprised at what you can predict.

Quickly scan the choices and see if your prediction is in the listed answer choices. If it is, then you can be quite confident that you have the right answer. It still won't hurt to check the other answer choices, but most of the time, you've got it!

Answer the Question

It may seem obvious to only pick answer choices that answer the question, but the test writers can create some excellent answer choices that are wrong. Don't pick an answer just because it sounds right, or you believe it to be true. It MUST answer the question. Once you've made your selection, always go back and check it against the question and make sure that you didn't misread the question, and the answer choice does answer the question posed.

Benchmark

After you read the first answer choice, decide if you think it sounds correct or not. If it doesn't, move on to the next answer choice. If it does, mentally mark that answer choice. This doesn't mean that you've definitely selected it as your answer choice, it

just means that it's the best you've seen thus far. Go ahead and read the next choice. If the next choice is worse than the one you've already selected, keep going to the next answer choice. If the next choice is better than the choice you've already selected, mentally mark the new answer choice as your best guess.

The first answer choice that you select becomes your standard. Every other answer choice must be benchmarked against that standard. That choice is correct until proven otherwise by another answer choice beating it out. Once you've decided that no other answer choice seems as good, do one final check to ensure that your answer choice answers the question posed.

Valid Information

Don't discount any of the information provided in the question. Every piece of information may be necessary to determine the correct answer. None of the information in the question is there to throw you off (while the answer choices will certainly have information to throw you off). If two seemingly unrelated topics are discussed, don't ignore either. You can be confident there is a relationship, or it wouldn't be included in the question, and you are probably going to have to determine what is that relationship to find the answer.

Avoid "Fact Traps"

Don't get distracted by a choice that is factually true. Your search is for the answer that answers the question. Stay focused and don't fall for an answer that is true but incorrect. Always go back to the question and make sure you're choosing an answer that actually answers the question and is not just a true statement. An answer can be factually correct, but it MUST answer the question asked. Additionally, two answers can both be seemingly correct, so be sure to read all of the answer choices, and make sure that you get the one that BEST answers the question.

Milk the Question

Some of the questions may throw you completely off. They might deal with a subject you have not been exposed to, or one that you haven't reviewed in years. While your lack of knowledge about the subject will be a hindrance, the question itself can give you many clues that will help you find the correct answer. Read the question carefully and look for clues. Watch particularly for adjectives and nouns describing difficult terms or words that you don't recognize. Regardless of if you completely understand a word or not, replacing it with a synonym either provided or one you more familiar with may help you to understand what the questions are asking. Rather than wracking your mind about specific detailed information concerning a difficult term or word, try to use mental substitutes that are easier to understand.

The Trap of Familiarity

Don't just choose a word because you recognize it. On difficult questions, you may not recognize a number of words in the answer choices. The test writers don't put "make-believe" words on the test; so don't think that just because you only recognize all the words in one answer choice means that answer choice must be correct. If you only recognize words in one answer choice, then focus on that one. Is it correct? Try your best to determine if it is correct. If it is, that is great, but if it doesn't, eliminate it. Each word and answer choice you eliminate increases your chances of getting the question correct, even if you then have to guess among the unfamiliar choices.

Eliminate Answers

Eliminate choices as soon as you realize they are wrong. But be careful! Make sure you consider all of the possible answer choices. Just because one appears right, doesn't mean that the next one won't be even better! The test writers will usually put more than one good answer choice for every question, so read all of them. Don't worry if you are stuck between two that seem right. By getting down to just two

remaining possible choices, your odds are now 50/50. Rather than wasting too much time, play the odds. You are guessing, but guessing wisely, because you've been able to knock out some of the answer choices that you know are wrong. If you are eliminating choices and realize that the last answer choice you are left with is also obviously wrong, don't panic. Start over and consider each choice again. There may easily be something that you missed the first time and will realize on the second pass.

Tough Questions

If you are stumped on a problem or it appears too hard or too difficult, don't waste time. Move on! Remember though, if you can quickly check for obviously incorrect answer choices, your chances of guessing correctly are greatly improved. Before you completely give up, at least try to knock out a couple of possible answers. Eliminate what you can and then guess at the remaining answer choices before moving on.

Brainstorm

If you get stuck on a difficult question, spend a few seconds quickly brainstorming. Run through the complete list of possible answer choices. Look at each choice and ask yourself, "Could this answer the question satisfactorily?" Go through each answer choice and consider it independently of the other. By systematically going through all possibilities, you may find something that you would otherwise overlook. Remember that when you get stuck, it's important to try to keep moving.

Read Carefully

Understand the problem. Read the question and answer choices carefully. Don't miss the question because you misread the terms. You have plenty of time to read each question thoroughly and make sure you understand what is being asked. Yet a happy medium must be attained, so don't waste too much time. You must read carefully, but efficiently.

Face Value

When in doubt, use common sense. Always accept the situation in the problem at face value. Don't read too much into it. These problems will not require you to make huge leaps of logic. The test writers aren't trying to throw you off with a cheap trick. If you have to go beyond creativity and make a leap of logic in order to have an answer choice answer the question, then you should look at the other answer choices. Don't overcomplicate the problem by creating theoretical relationships or explanations that will warp time or space. These are normal problems rooted in reality. It's just that the applicable relationship or explanation may not be readily apparent and you have to figure things out. Use your common sense to interpret anything that isn't clear.

Prefixes

If you're having trouble with a word in the question or answer choices, try dissecting it. Take advantage of every clue that the word might include. Prefixes and suffixes can be a huge help. Usually they allow you to determine a basic meaning. Pre- means before, post- means after, pro - is positive, de- is negative. From these prefixes and suffixes, you can get an idea of the general meaning of the word and try to put it into context. Beware though of any traps. Just because con is the opposite of pro, doesn't necessarily mean congress is the opposite of progress!

Hedge Phrases

Watch out for critical "hedge" phrases, such as likely, may, can, will often, sometimes, often, almost, mostly, usually, generally, rarely, sometimes. Question writers insert these hedge phrases to cover every possibility. Often an answer choice will be wrong simply because it leaves no room for exception. Avoid answer choices that have definitive words like "exactly," and "always".

Switchback Words

Stay alert for "switchbacks". These are the words and phrases frequently used to alert you to shifts in thought. The most common switchback word is "but". Others include although, however, nevertheless, on the other hand, even though, while, in spite of, despite, regardless of.

New Information

Correct answer choices will rarely have completely new information included. Answer choices typically are straightforward reflections of the material asked about and will directly relate to the question. If a new piece of information is included in an answer choice that doesn't even seem to relate to the topic being asked about, then that answer choice is likely incorrect. All of the information needed to answer the question is usually provided for you, and so you should not have to make guesses that are unsupported or choose answer choices that require unknown information that cannot be reasoned on its own.

Time Management

On technical questions, don't get lost on the technical terms. Don't spend too much time on any one question. If you don't know what a term means, then since you don't have a dictionary, odds are you aren't going to get much further. You should immediately recognize terms as whether or not you know them. If you don't, work with the other clues that you have, the other answer choices and terms provided, but don't waste too much time trying to figure out a difficult term.

Contextual Clues

Look for contextual clues. An answer can be right but not correct. The contextual clues will help you find the answer that is most right and is correct. Understand the context in which a phrase or statement is made. This will help you make important distinctions.

Don't Panic

Panicking will not answer any questions for you. Therefore, it isn't helpful. When you first see the question, if your mind goes blank, take a deep breath. Force yourself to mechanically go through the steps of solving the problem and using the strategies you've learned.

Pace Yourself

Don't get clock fever. It's easy to be overwhelmed when you're looking at a page full of questions, your mind is full of random thoughts and feeling confused, and the clock is ticking down faster than you would like. Calm down and maintain the pace that you have set for yourself. As long as you are on track by monitoring your pace, you are guaranteed to have enough time for yourself. When you get to the last few minutes of the test, it may seem like you won't have enough time left, but if you only have as many questions as you should have left at that point, then you're right on track!

Answer Selection

The best way to pick an answer choice is to eliminate all of those that are wrong, until only one is left and confirm that is the correct answer. Sometimes though, an answer choice may immediately look right. Be careful! Take a second to make sure that the other choices are not equally obvious. Don't make a hasty mistake. There are only two times that you should stop before checking other answers. First is when you are positive that the answer choice you have selected is correct. Second is when time is almost out and you have to make a quick guess!

Check Your Work

Since you will probably not know every term listed and the answer to every question, it is important that you get credit for the ones that you do know. Don't miss any questions through careless mistakes. If at all possible, try to take a second to look back over your answer selection and make sure you've selected the correct

answer choice and haven't made a costly careless mistake (such as marking an answer choice that you didn't mean to mark). This quick double check should more than pay for itself in caught mistakes for the time it costs.

Beware of Directly Quoted Answers

Sometimes an answer choice will repeat word for word a portion of the question or reference section. However, beware of such exact duplication – it may be a trap! More than likely, the correct choice will paraphrase or summarize a point, rather than being exactly the same wording.

Slang

Scientific sounding answers are better than slang ones. An answer choice that begins "To compare the outcomes…" is much more likely to be correct than one that begins "Because some people insisted…"

Extreme Statements

Avoid wild answers that throw out highly controversial ideas that are proclaimed as established fact. An answer choice that states the "process should be used in certain situations, if…" is much more likely to be correct than one that states the "process should be discontinued completely." The first is a calm rational statement and doesn't even make a definitive, uncompromising stance, using a hedge word "if" to provide wiggle room, whereas the second choice is a radical idea and far more extreme.

Answer Choice Families

When you have two or more answer choices that are direct opposites or parallels, one of them is usually the correct answer. For instance, if one answer choice states "x increases" and another answer choice states "x decreases" or "y increases," then those two or three answer choices are very similar in construction and fall into the same family of answer choices. A family of answer choices is when two or three answer choices are very similar in construction, and yet often have a directly

opposite meaning. Usually the correct answer choice will be in that family of answer choices. The "odd man out" or answer choice that doesn't seem to fit the parallel construction of the other answer choices is more likely to be incorrect.

Additional Bonus Material

Due to our efforts to try to keep this book to a manageable length, we've created a link that will give you access to all of your additional bonus material.

Please visit http://mometrix.com/bonus948/cst to access the information.