



CE Credit Package 10A

22 Credits for \$37⁰⁰



Please submit your completed Master Answer Sheet along with payment to

AST Member Services

6 W. Dry Creek Circle, Suite 200 Littleton, CO 80120

Or fax with credit card information to (303) 694-9169.

Or scan and e-mail with credit card information to memserv@ast.org.

Table of Contents CE

Credit Package 10 A



Repeat Cesarean Section

Off-pump Coronary Artery Bypass Grafting

Sterilization – Killing the Prehistoric Beast

When Unexpected Complications Arise During Surgery

Blood Pressure

Safety Concepts in the Surgical Setting

Necrotizing Fasciitis

Treatment of War Casualties

Wrist Fusion: Fighting Back Against Rheumatoid Arthritis

Disasters Follow No Rules: Preparing Your Hospital for Disaster Response

Challenging and Changing the Experience of Pain: Acute Pain Management in the Perioperative Setting in Patients with a Substance Abuse History

Gangrene: Recognizing and Treating Cellular Necrosis



Repeat Cesarean Section

BRYCE PHILLIP KIEFER, CST

Reports of surgical removal of a fetus from its dead or dying mother have been dated from as far back as 3000 BCE in ancient Egypt. The procedure was performed at that time so that the fetus and mother could have separate burials.²

An ancient Roman law known as *lex caesaria* required the procedure be performed on dying mothers as an attempt to save the life of the fetus. The name of this law is sometimes cited as the origin of the procedure's name.²

Use of the crude procedure continued into medieval times with reported cases in Germany from the early 1400s and from France in the late 1500s. In 1663, a Dutch physician published illustrations of the procedure in a book on operative gynecology, and in 1738 an Irish midwife is reported to have performed the procedure successfully.²

Mortality rates remained high, though. It is estimated that 50 to 75% of women did not survive the procedure. Massive infection and internal bleeding were the biggest challenges physicians faced, so the procedure remained a last-resort option. Since anesthesia wasn't discovered until 1847, the agonizing pain inflicted on the mother was also a factor in deciding whether or not the procedure was necessary.

It wasn't until the early 1900s that cesarean section became a more acceptable alternative to other options of that time, including high forceps delivery and cutting the pubic bone. By 1960, the mortality rate was near zero, and today it is estimated that 25 out of every 100 births in the US are performed by cesarean section.

Table 1. Indications for cesarean section

Adapted from *Surgical Technology for the Surgical Technologist: A Positive Care Approach*. Thomson Delmar Learning. ©2004

Category	Indication
Maternal	Diseases—Eclampsia or severe preeclampsia; Cardiac disease; Diabetes mellitus; Cervical cancer; Herpes
	Prior surgery of the uterus—Cesarean section (especially classical type); Previous rupture of the uterus; Full-thickness myomectomy
	Obstruction of the birth canal—Fibroids; Ovarian tumors
	Other—Uterine rupture; Failure to progress (etiology unknown); Maternal demise
Fetal	Fetal distress (sustained low heart rate)
	Prolapse of the umbilical cord
	Malpresentation—Breech; Transverse; Brow
	Multiples (depends on number and presentation)
	Fetal demise
Maternal/ Fetal	Dystocia—Cephalopelvic disproportion; Failed induction of labor; Abnormal uterine action
Placental	Placenta previa
	Placental abruption

CASE STUDY: REPEAT CESAREAN SECTION

The patient is a 26-year-old female, gravida 4, para 3 with 41 weeks of high-risk pregnancy, and late prenatal care. According to the patient's medical chart, she has reported abdominal pain, edema in the feet and legs, and no contraception use prior to conception. The patient is morbidly obese.

Weight: 325 lbs

Height: 5 ft, 5 in

BP: 119/45

Temperature: 98.9° F

Pulse: 82 bpm

Respirations: 20/minute

O₂ saturation: 100%

PREOPERATIVE DIAGNOSTIC TESTING

Preoperative diagnostic testing included a urinalysis, a prenatal panel, a drug screen and a serology study. Results for the urinalysis and prenatal panel were within acceptable ranges. Results from the drug screen and serology study were negative.

The findings of the preoperative ultrasound were, "Single living intrauterine pregnancy, transverse lie, anterior grade II placenta with normal amniotic fluid index of 18.2 cm. Heart rate of 137 bpm."

PREOPERATIVE DIAGNOSIS

The patient's principal diagnosis was breech presentation-footling. Secondary diagnosis and concerns expressed by the patient's physician were the possibility that the umbilical cord was wrapped around the baby's neck, the patient's weight, the potential for fetal or placental problems, and previous cesarean section.

ROOM PREPARATION

Supplies

- Prep set
- Cesarean section pack
- Basin set
- Gloves
- Bulb syringe, one per infant
- Cord clamps, two per infant
- Cord blood container, one per infant

- Blood gas containers available
- DeLee suction device available
- Mity vac delivery system
- Suction canister
- Lap sponges, 18x18
- Temperature strip
- Surgical clippers
- Spinal anesthesia tray
- Hyperinflation system
- O₂ cannula
- Pediatric O₂ mask
- 12' suction tube connection
- Laparotomy drape or specialized C-section drape
- Surgeon-specific sutures and dressings

Equipment

- Suction apparatus
- Electrosurgical unit—(In this case, the ESU was set at Cut 60/Coag 60, per surgeon request.)
- Fetal monitor
- Neonatal warming bed, one per infant

Instrumentation

- Knife handles, #3
- Needle holders
- Tissue forceps, short and long
- Adson tissue forceps
- Kelly clamps, short and medium
- Rochester-Péan clamps
- Rochester-Ochsner clamps
- Mayo scissors, curved and straight
- Metzenbaum scissors
- Bandage scissors
- De Lee universal retractor or bladder blade from Balfour retractor
- Richardson retractors
- Goelet or US Army retractors
- Allis clamps

Intravenous solutions

- Normal saline, 500 ml, for irrigation
- Lactated Ringers, 1000 ml
- A secondary IV set should be ready, if needed.



©Stockphoto.com/Karl Blessing

Anesthesia

- Spinal
- Cefazolin sodium, 1 g
- Oxytocin, 10 units added to IV bag (with a second IV bag ready with 20 additional units to be used when directed by surgeon)

PATIENT POSITIONING

The entire surgical team should be in the room prior to the start of the procedure, including the anesthesia provider, surgeon, surgical technologist, circulator, as well as the neonatal team, including a registered nurse, a neonatologist (if necessary) and a respiratory therapist.

After an informed consent, the patient was taken to the O.R. The patient was morbidly obese with a large pannus. The umbilicus and pannus hung below the patient's pelvic bones.

The patient was transferred to the operating table and placed in the supine position. A bolster was positioned under the patient's right hip to offset abdominal weight and thus reduce uterine pressure on the vena cava. The safety strap was secured, and a Foley catheter was inserted.



A blood pressure cuff, thermometer, ECG electrodes and a pulse oximeter were placed on the patient. A grounding pad was then positioned as close to the operative site as possible, taking care to avoid bony prominences.

SKIN PREPARATION AND DRAPING

Skin preparation solution was applied from mid-chest to the pubis and to the sides of the patient all the way down to the operating room table as far as possible. Next, the vaginal region extending to the inner thighs was prepared. Prior to preparation, the circulator shaved the area with disposable clippers.

Folded towels were used to square off the operative site, and a specialized C-section drape was placed.

PROCEDURAL OVERVIEW

After completing the "time-out" procedure, a #10 blade was used to incise the skin via a mid-

line vertical incision. The skin and adipose tissue were retracted, and the incision was carried to the level of the fascia.

The fascia was incised at the midline and carried laterally on both sides using Mayo scissors.

The posterior fascia was bluntly dissected from the rectus abdominus muscle and secured with two Kocher clamps. Sharp dissection of the aponeurosis was accomplished superiorly to near the umbilicus and inferiorly to the symphysis pubis using Mayo scissors.

The peritoneal cavity was entered atraumatically via a longitudinal incision extended to the length of the fascial opening. The uterus was palpated to determine fetal position.

The vesicouterine fold of the peritoneum was incised, and the bladder was freed from the uterus with Metzenbaum scissors and retracted inferiorly with a bladder blade.

A small transverse incision was made in the lower uterine segment and carried bilaterally with Lister bandage scissors.

All sharp and metal objects should be removed from the field before the delivery.

The neonate's legs were grasped and drawn from inside the uterus. The torso was delivered next, followed by the shoulders (left first). And then the head was delivered by arching the baby's torso toward the mother's abdomen.

The umbilical cord was clamped with two Mayo clamps and then cut with Lister bandage scissors. Three loops of the cord were unwrapped from around the neonate's neck, and a cord blood sample was collected.

The neonate was then passed to the awaiting neonatal team. During this part of the procedure, extra caution should be taken by the surgical technologist to protect the sterile field and Mayo stand.

The placenta was dissected from the uterine wall, inspected and placed in a designated basin on the back table to be sent to pathology for analysis. Then the uterus, fallopian tubes and ovaries were exteriorized and enclosed in a wet laparotomy sponge.

The uterine incision was closed in two layers using 0 synthetic absorbable suture. Hemostasis was achieved by use of the electrosurgical unit.

The vesicouterine fold of the peritoneum was approximated with 2-0 synthetic absorbable suture and toothed forceps, and hemostasis was secured.

The uterus, fallopian tubes and ovaries were placed back into the peritoneal cavity. The paracolic gutters and cul-de-sac were cleaned of any remaining clots and blood.

The abdomen was then closed in layers as follows:

- Peritoneal closure was accomplished with 2-0 synthetic absorbable suture
- The rectus sheath was closed with 0 suture.
- The subcutaneous tissue was closed with 2-0 synthetic absorbable suture.
- The skin was approximated and closed using staples and two Adson tissue forceps.

The patient tolerated the procedure well and was sent to recovery in stable condition.

NEONATE'S VITAL SIGNS

Gender: Male

Weight: 10.4 lbs

Height: 21 in

Apgar scores: 9 and 9

Additional: Nuchal cord x3; Old meconium with foul-smelling amniotic fluid

COUNTS

During a repeat cesarean section, four counts are performed. All counts include instruments, sharps and sponges:

- First/initial count—Prior to surgery.
- Second count—While the uterus is being closed.
- Third count—While the peritoneum is being closed.
- Fourth/final count—While the skin is being closed.

All counts were correct in this procedure.



©iStockphoto.com/Marciej Pardek



©iStockphoto.com/Richard Churchill

DRAINS

No drains were placed.

SPECIAL CONSIDERATIONS

Due to the patient's size, extra surgical team members were needed to transfer the patient to the gurney after surgery.

COMPLICATIONS

There were no complications following this procedure.

Potential complications associated with cesarean section include hemorrhage, sepsis, injury to the surrounding structures, weakened uterus (which may necessitate cesarean sections for future pregnancies), pelvic inflammation, failed induction, toxemia, incompetent cervix, and hyperemesis gravidarum.

POSTOPERATIVE CARE

While in the postanesthesia care unit, the patient received two liters of oxygen, and vital signs were monitored.

The patient was restricted to bed rest for the first 24 hours postoperatively. The Foley catheter was discontinued 24 hours following surgery. Dressings were removed and changed 48 hours after surgery.

Prochlorperazine and metoclopramide was prescribed as needed for nausea. Meperidine was prescribed as needed for pain.

The patient was discharged from the hospital two days following surgery, with a follow-up appointment scheduled with her doctor in one week. The patient may follow a routine diet and take acetaminophen with codeine as needed for pain.



© iStockphoto.com/Marcos Patermoser

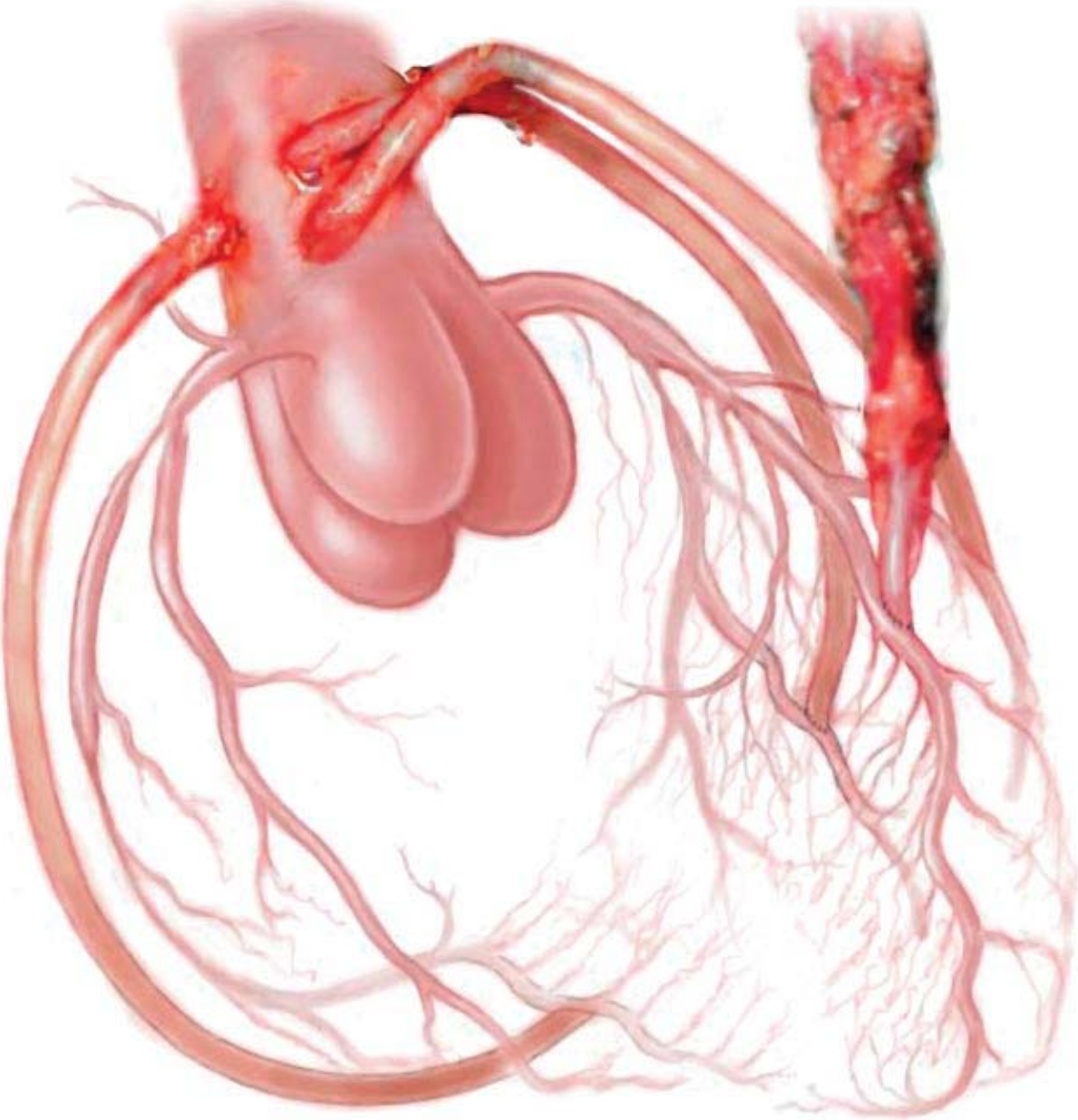
ABOUT THE AUTHOR

Bryce Phillip Kiefer, cstr, currently lives in Denver, Colorado. He is a recent graduate of San Joaquin Valley College in Fresno, California, where he wrote this article as a course requirement.

Editor's note: Procedure-specific information was obtained with permission from the patient's medical chart and the surgeon's report.

References

1. Cervix. Available at: <http://www.pathologyoutlines.com/cervix.html>. Retrieved April 13, 2007.
2. Cesarean section. DISCovering Science. Online edition. 2003. Available at: http://find.galegroup.com/srcx/infomark.do?&contentSet=GSRC&type=retrieve&tabID=T001&prodId=SRC-1&dicId=EJ2103200617&source=gale&srcprod=SRGG&userGroupName=lirn_main&version=1.0. (Available by paid subscription only.) Accessed December 13, 2007.
3. Cohen B J. *The Human Body in Health and Disease*. 10th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2005.
4. Fetal Ultrasound. WebMD. Available at: <http://www.webmd.com/baby/Fetal-Ultrasound?page=1>. Retrieved April 19, 2007.
5. Giving Birth by Cesarean Section. Baby Center. Available at: <http://www.babycenter.com/refcap/160.html>. Retrieved April 13, 2007.
6. Gray H. The Ovaries, in *Gray's Anatomy*. Available at: <http://www.bartleby.com/107/266.html>. Retrieved April 13, 2007.
7. Gray H. The Vagina, in *Gray's Anatomy*. Available at: <http://www.bartleby.com/107/269.html>. Retrieved April 13, 2007.
8. Price P, Frey K, Junge T. *Surgical Technology for the Surgical Technologist: A Positive Care Approach*. 2nd ed. Clifton Park, NY: Delmar Learning; 2005:478-502.
9. Vagina. Retrieved April 13, 2007, from <http://www.pathologyoutlines.com/vagina.html>.



Off-pump Coronary Artery Bypass Grafting

TODD BOICE, CST, CFA

INTRODUCTION

The advent of cardiopulmonary bypass in the early 1960s allowed surgeons to safely perform complex operations on the heart.

Since then, the field of cardiac surgery has progressed to where coronary artery bypass grafting (CABG) has become the most methodically studied operation in the history of surgery. It has achieved widespread use, because its benefits have been documented so thoroughly. The procedure's adverse effects also have been recognized from the beginning and are well documented.

After 40 years of technical and surgical evolution, however, the approach to coronary artery surgery has remained basically unaltered—until the past decade.

U.S. STATISTICS

In the United States, approximately 400,000 open-heart bypass surgeries are performed annually, according to the American Heart Association. The patient population is growing increasingly higher risk due to more catheter-based intervention, the rise in diabetes, and the continued unhealthy lifestyle of a majority of the American population.

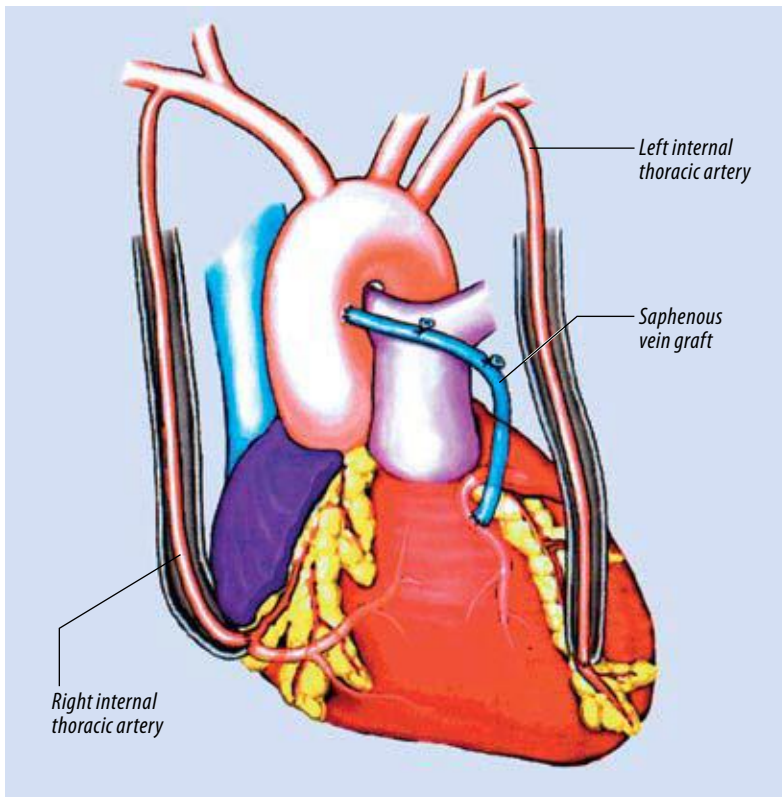
Therefore, the need arises to conquer the beast of coronary artery disease in more innovative ways that enable patients to recover faster and have fewer complications than conventional approaches provide.

HISTORICAL PERSPECTIVE

1953: John Gibbon, MD, performs the first successful open-heart operation using a cardiopulmonary bypass machine.

1967: First off-pump procedure performed—An anastomosis of the left internal mammary artery (LIMA) to the left anterior descending coronary artery (LAD) for treatment of angina pectoris.¹

Figure 1: Internal mammary (thoracic) artery and saphenous vein anastomosed to coronary arteries.



1995: First off-pump coronary artery bypass (OPCAB) procedures performed for multivessel coronary artery diseases.

2007: Nearly 40% of all coronary artery bypass graft (CABG) procedures are performed off-pump.

“Every place that does cardiac surgery needs to be in the off-pump CABG (business),”

Peter Knight, MD, cardiothoracic surgeon and director of robotics, University of Rochester, Rochester, New York.²

RELEVANT ANATOMY

The heart, being a living organ, needs oxygenated blood flow to maintain muscle viability. The coronary arteries fulfill this need.

The coronary arteries originate in the sinus of Valsalva in the proximal aortic root. They are divided into left and right main ostiums.

The left main trunk branches into the left anterior descending (LAD) and the left circumflex arteries. The LAD gives rise to a diagonal branch, and together these vessels supply the anterior wall of the heart, along with the septal wall perforators.

The left circumflex artery wraps around the back side of the heart and divides into the obtuse marginal (OM) branches. In most cases, there are at least two OM branches that supply the posterior and anterior lateral walls of the heart. (Figure 1)

The right main coronary artery wraps around the right side of the heart and gives rise to a left ventricular branch and a posterior descending artery. These branches supply the right and posterior walls of the heart.

PROCEDURAL BENEFITS

The debate between the benefits and risks of off-pump CABG surgery continues to be challenged by the advent of new stabilization equipment, intravenous medications and more case experiences.

Off-pump CABG offers benefits to several types of high-risk patients:

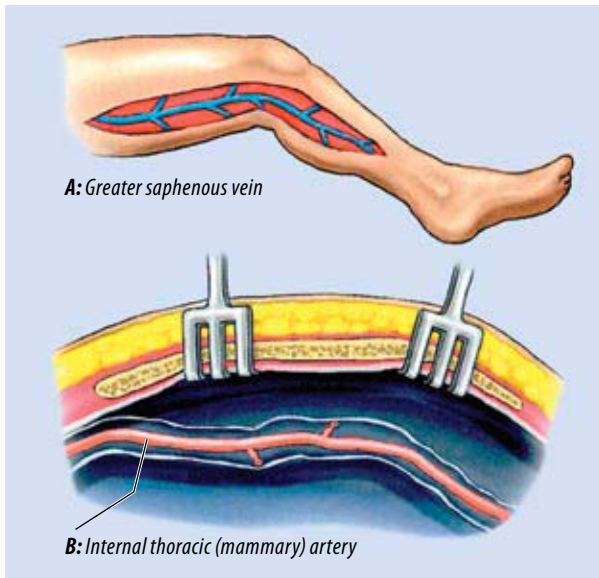


Figure 2:
Graft options for CABG: A: Saphenous vein dissection and (B) Internal mammary artery dissection



Figure 3:
Aortic punch

Figures 1–3 reprinted from *Surgical Technology for the Surgical Technologist: A Positive Care Approach*, Delmar Cengage Publishing, 2nd edition, Copyright 2004.

- Patients with calcified aortas—In conventional CABG, the aorta is clamped. If the patient has any calcification in the area that is clamped, the risk of embolization and stroke is significantly increased.
- People of the Jehovah’s Witness faith—People of this faith often object to blood product transfusions. Therefore, to reduce bleeding and minimize the need for blood products, off-pump CABG offers a reduced risk of morbidity.
- Patients with a history of cerebral vascular accidents
- Patients with renal failure, severe diabetes mellitus and peripheral vascular disease—These patients have an increased risk of adverse reactions when placed on cardiopulmonary bypass.

By reducing use of the heart-lung bypass machine, many of the risks of conventional CABG are likewise reduced, including:

- Systemic inflammatory response
- Full heparinization
- Embolism
- Postoperative bleeding
- Aortic dissection
- Ischemic cardiac arrest
- Coagulopathies due to platelet damage
- Hemodilution

- Extended bypass times
- Transfusions and the need for blood products

Other benefits to performing the procedure without the bypass machine include:

- Shorter hospital stay
- Less cognitive dysfunction (caused by a systemic response to the nonphysiological effects of the cardiopulmonary bypass machine^{3,4})
- Reduced inotropic use

PROCEDURAL RISKS

OPCAB’s risks include a steep learning curve, arrhythmias, bleeding, and ischemic changes.

Any new approach to surgery requires a learning curve for the entire team. The ideal patient for learning OPCAB is one with normal heart function who requires two to three grafts.

Arrhythmias, such as tachycardia, bradycardia, ventricular fibrillation and asystole, may occur during an OPCAB procedure. All of these arrhythmias can be controlled by medication or by cardioversion.

With any surgery, bleeding can be a risk. Due to reduced heparinization, hemodilution and O.R. time for OPCAB, the risk of bleeding is minimized.

Ischemic changes may occur as a result of occluding the target vessel. This risk can be reversed by placing a shunt inside the target vessel. This restores blood flow through the vessel and allows the team to continue the procedure.

TOOLS FOR SUCCESS

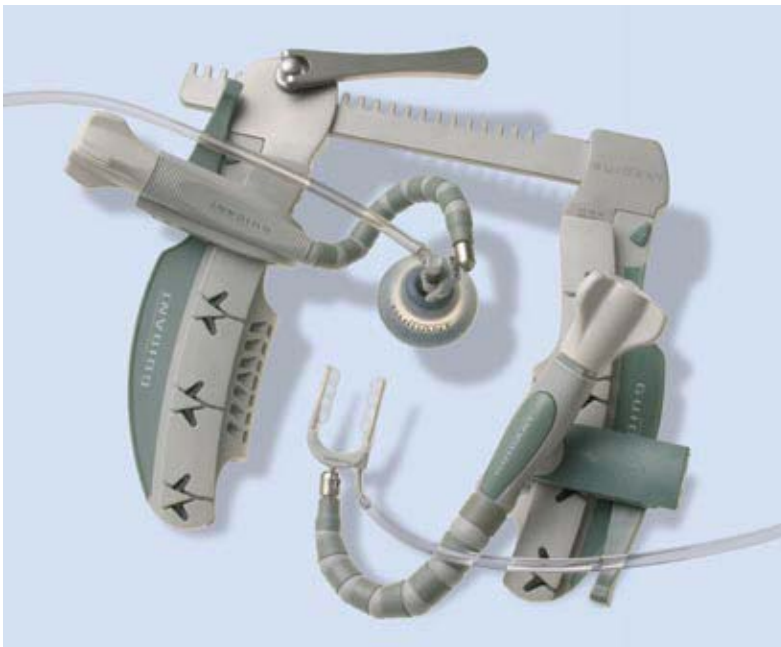
The first step in achieving successful results is to form a team that is dedicated to learning and teaching OPCAB techniques. The team should consist of a cardiovascular surgeon, an experienced anesthesiologist or nurse anesthetist, a circulating nurse, a perfusionist (on stand-by), a first assistant and a surgical technologist.

All team members must be able to handle high-stress scenarios and must know their roles when cardiac resuscitation is required. It is also very beneficial to discuss successful and unsuccessful events, techniques or products used during the case.

The next tools are mechanical. Our facility chooses to use the ACROBAT® off-pump retractor and XPOSE® device. (Figure 4) These devices use controlled suction in order to stabilize and maneuver the heart.

We also use retractor tapes to occlude the vessel and FloCoil® shunts, if necessary, to restore coronary blood flow during the anastomosis.

Figure 4
ACROBAT® SUV
Off-Pump System



In addition, our facility uses the AXIUS® Blower/Mister for visualization of the coronary artery. (Figure 5)

PROCEDURAL OVERVIEW

The patient is brought to the operating room with an IV already in place and then receives sedation. Anesthesia personnel insert a radial arterial line and a Swan-Ganz catheter in the external jugular, and then place EKG leads.

The nursing staff places a Foley catheter and bovie pads and then positions the patient supine with legs frogged and supported and arms tucked to the side. A Hibiclens® scrub is performed, followed by ChloroPrep® or DuraPrep™ skin preparation solution.

Sterile towels are placed between the legs. Ioban drapes are applied, followed by the chest sheet.

A median sternotomy is required for single- or multiple-vessel grafting for both off-pump and traditional CABG. A median sternotomy allows access to all potential targets, including routine access to the right (RIMA) or left (LIMA) internal mammary arteries for harvesting. The procedure also allows rapid institution of CPB should instability occur during the procedure.

A partial sternotomy can be performed for ante-



Figure 5
AXIUS® Blower Mister

Table 1. Agents commonly administered in off-pump coronary bypass graft procedures

Agent	Intended Action ⁵
Albumin human	Plasma volume expander for emergency treatment of hemorrhage or shock.
Amiodarone	Antiarrhythmic drug for treatment of atrial and ventricular arrhythmias.
Dopamine hydrochloride	Adrenergic hormone that increases blood flow to the renal, mesenteric, cerebral and coronary blood vessels at low doses.
Epinephrine	Adrenergic hormone that maintains blood pressure and cardiac output by keeping airways open.
Milrinone	Cardiotonic agent with vasodilation properties used in treatment for congestive heart failure.
Sodium nitroprusside	Vasodilator used to treat hypertensive crises and heart failure.
Norepinephrine	Adrenergic hormone that increases blood pressure via vasoconstriction.

rior grafts, such as the LAD, or diagonal arteries.

Greater saphenous vein grafts are harvested simultaneously by the surgical assistant while the surgeon opens the sternum and harvests the LIMA and/or RIMA. Often, the vasoview endoscopic vein harvest approach is used to minimize infection and maximize the healing time.

During the procedure the surgical technologist maintains the sterile field and focuses on the surgeon's needs.

Simultaneously, the anesthesia team loads the patient with 250-500 cc of 0.5% albumin to increase blood volume. The anesthesia team then performs a transesophageal echocardiogram to determine the productivity of the heart and to visualize the heart valves to rule out potential complications. Poor heart function or a regurgitant valve can cause an OPCAB to be impossible because the heart needs to have a good squeeze to perfuse the body. If that cannot be done medically or by placing an intra-aortic balloon pump, then OPCAB may not be optimal. A heart that functions poorly in its normal anatomical position will not perform when manipulated for OPCAB.

The team also administers a test load of milrinone, and then starts an intravenous drip at 0.375 mg/kg. Amiodarone is given prophylactically to control any arrhythmias that may occur while manipulating the heart. The team also prepares low-dose epinephrine, norepinephrine, dopamine and nitroprusside to control blood pressure during the surgery. (See Table 1)

It is very important to have an attentive anes-

thesia team during the manipulating and positioning of the heart. Cardiac displacement allows the exposure of posterior, lateral and inferior targets and can be achieved either by the placement of deep pericardial retraction sutures or by the use of a rummel tourniquet and suture into the oblique sinus.

Exposure of the LAD artery and its diagonal branches—or the proximal right coronary artery (RCA)—can be achieved with minimal displacement by placing laparotomy sponges in the pericardial sac behind the heart and/or temporary retraction sutures.

Many techniques can be used to expose the circumflex artery and its branches, the posterior descending artery, and the posterolateral branch of the right coronary artery. A combination of maneuvers and techniques, including trendelenburg position, placement of lap pads, slings, and pericardial sutures can all be used in conjunction with the use of the suction device.

This device is typically placed near the apex of the heart with suction initiated at approximately 350 mmHg to ensure the heart is held securely. The heart is then displaced and elevated anteriorly, which provides adequate exposure to the vessels on the inferior wall of the heart.

At this point, the anesthesia team administers heparin, typically between 10,000 and 15,000 units (usually half of the dose needed for cardiopulmonary bypass), depending upon the patient's size in order to achieve an optimal ACT (activated clotting time) above 350 seconds.

Figure 6
HEARTSTRING® II
Proximal Seal
System



Figures 4, 5, and 6 courtesy of MAQUET® Cardiovascular LLC.

Once the target vessel has been marked as a definite target, the heart has been manipulated, and cardiac stability is assured, the retractor tapes are passed around the target vessels proximally and distally to occlude coronary blood flow.

During the learning process, it is important to leave the vessel occluded for approximately two minutes to check the status of the heart in the manipulated position with the vessel occluded. This interval provides time to prepare the conduit being used for the bypass.

Once stability is confirmed, the U-shaped footplate is positioned over the epicardium, and suction is initiated at 250 mmHg to isolate the target and stabilize the working area of the heart.

The target vessel is then opened using a #69 Beaver blade and extended using angled coronary scissors. The conduit is sewn to the target using a running nonabsorbable polypropylene suture. The suture is then tied and cut.

A 30-cc syringe of warm lactated Ringers solution is used to pressurize the saphenous vein grafts through the vein cannula. The LIMA and/or RIMA are checked by releasing the bulldog clamp on the conduit, which pressurizes the target vessel.

Once all the targeted distal vessels have been bypassed, the saphenous vein graft(s) must be connected to the aorta. To reduce the risk of

emboli release associated with the surgery, side-biting clamps may be used.

The site for the proximal anastomosis is selected and should be free of aortic calcification. In the event calcifications are present, it is imperative that the aorta remain unclamped. This is achieved by using a Derra partial occluding clamp or a nonoccluding clamp, such as the HEARTSTRING® II device (Figure 6).

The proximal site is established by using a #11 blade to stab the aorta, creating a large enough incision to allow the aortic punch to pass through the incision. The proximal hole is punched, and the vein graft is sewn to the aorta using a running nonabsorbable polypropylene suture. If the aorta is calcified and a partial or nonoccluding clamp is needed, it should be deployed after the aorta is punched.

Extra focus on blood loss should occur at this time because an open hole in the aorta can cause the surgical field to quickly become flooded. We have found it is best to punch the hole in the aorta and promptly cover it with a fingertip, then deploy the Heartstring by engaging the plunger, then pulling back on the device. The Heartstring is an umbrella-shaped device which has a suture and a V-shaped wire attached, which creates counter traction for the device to pull upward on the internal wall of the aorta. This creates a bloodless opening to attach the saphenous vein.

Once in place, the proximal site is closed with a running nonabsorbable polypropylene suture, and the nonoccluding clamp is removed according to the manufacturer's directions.

Next, the vein grafts should be de-aired by using a 30-gauge needle to create small holes that allow air to escape rather than entering the coronary arteries.

Now that the bypasses are successfully completed, a low dose of protamine is administered to reverse the effects of heparin, and the surgical wound is examined for bleeding.

Chest tubes are inserted into the pleural and mediastinal spaces to drain postoperative blood and prevent cardiac tamponade. Temporary pacing leads are placed and pass through the myocardium of the left ventricle and/or right atrium.

Then they are passed through the skin in the subxyphoid region and connected to an external pacemaker, if necessary to manage bradycardia.

The sternum is then reapproximated using #7 sternal wires (Figure 7). The fascia and subcutaneous tissues are closed using a vertical mattress absorbable suture, and then the skin is closed with a horizontal mattress absorbable suture.

POSTOPERATIVE CARE

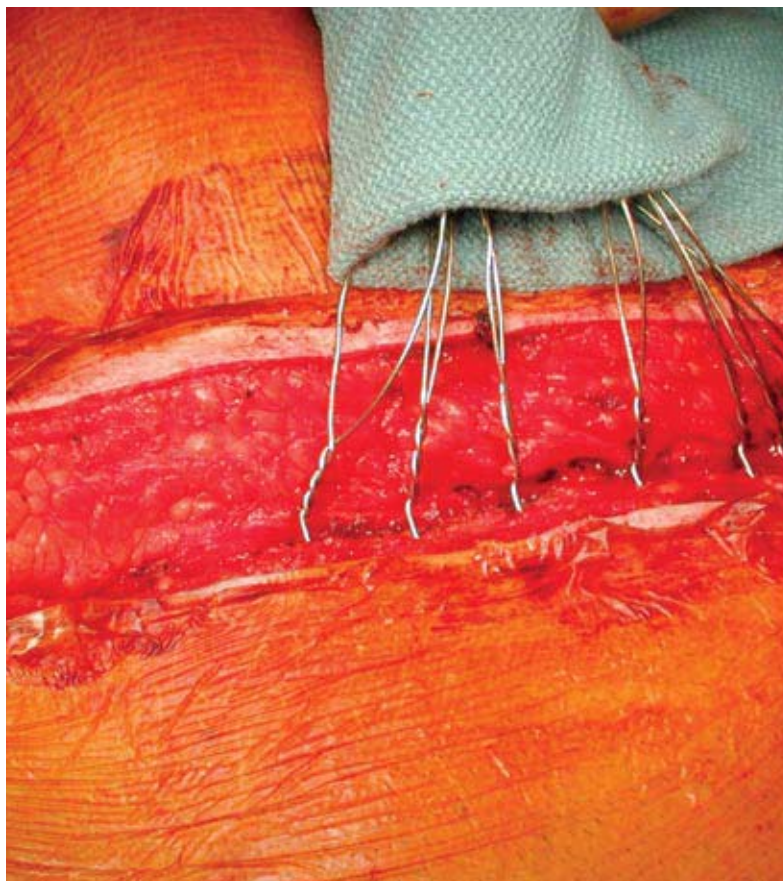
Controlling postoperative pain is a primary factor to consider in expediting a patient's discharge from the hospital. To facilitate postoperative pain management, the ON-Q PainBuster® system and catheters are used at this author's facility.

This system delivers a controlled volume of analgesic medicine through two small catheters. Placement of the catheters is critical for pain management. We use a tunneling technique and place the catheters anterior to the rib cage in a subpectoral fashion to block the intercostal nerves.

The postoperative course for OPCAB patients generally consists of monitoring vital signs and chest tube output, management of cardiac output and pressure, checking wounds, and analyzing lab results and making appropriate adjustments.

The OPCAB patient generally can be extubated from the ventilator much sooner which allows for quicker ambulation—a factor in expediting the patient's discharge from the hospital. As stated previously, discharge to home following off-pump CABG can take place two to four days sooner than is typical for conventional CABG patients. Work and social activities may be resumed sooner than the two to three months usually required following conventional bypass grafting.

The postoperative course for any CABG patient can present with complications, such as bleeding, arrhythmias and cardiac arrest. However, the OPCAB patient benefits by not having the many possible complications that CPB can cause with blood factors, and arrhythmias can generally be regulated with intravenous medication, the use of a temporary pacemaker and, if necessary, cardioversion.



Courtesy of Healix.com

Figure 7

The sternum was reapproximated with #7 sternal wires.

CONCLUSION

In this new millennium, a broad spectrum of myocardial revascularization procedures are available for the treatment of coronary artery disease. The most invasive approach—conventional CABG via full sternotomy—is now being challenged by full and minimally invasive off-pump CABG.

Recent studies, including evidence from randomized controlled trials have shown that although OPCAB may be a new challenge for many surgeons, patients ultimately benefit by recovering more rapidly, requiring less exposure to blood transfusion, and leaving the hospital sooner with quicker rehabilitation.

ABOUT THE AUTHOR

Todd W Boice, CST, CFA, currently works at University Cardiothoracic Surgical Associates in Louisville, Kentucky. He received his bachelor of science degree in 1997 from Spalding University in Louisville, Kentucky. He graduated from the

Table 2. Coronary artery bypass grafting—Practical considerations

Adapted from *Surgical Technology for the Surgical Technologist: A Positive Care Approach*. Thomson Delmar Learning. ©2004

- The following are important points to remember during a coronary artery bypass grafting procedure. The points that apply only to procedures using cardiopulmonary bypass are included as a refresher for those instances in which an off-pump procedure is converted to on-pump.
- Generally, only those surgical technologists who have been properly trained in open-heart surgery are allowed to scrub cardiac procedures.
 - The [surgical technologist] must have good anticipatory skills, and should understand cardiovascular anatomy and physiology, as well as cardiac procedural sequence.
 - The [surgical technologist] should be thinking five steps ahead of the surgeon throughout the procedure, and should pay attention at all times.
 - It is important that the [surgical technologist] understand cardiac dysrhythmias and their relationship to the cardiac procedure, and be able to understand all pressure readings.
 - Room-temperature saline should be used up to the point of aortic cross-clamping; thereafter, cold saline is to be used until the rewarming period. Warm saline should be used after rewarming begins.
 - There should never be water on the back table. It would be too easy to accidentally use water instead of saline when filling the cannulae. Water will cause lysing of RBCs.
 - Be ready to go back on the pump at a moment's notice. Do not discard cannulae after removal, and keep cannulation sutures ready after the patient is removed from CPB. Keep wire cutters and sternal retractor sterile until the patient is safely out of the O.R.
 - For repeat cardiac procedures, be prepared to cannulate femorally. The oscillating saw may be used for sternotomy to prevent cutting into ventricular adhesions to the sternal wall.
 - Pass of defibrillation cables at the same time as electrosurgical cords. The surgeon will not want to wait for the defibrillation paddles if they are suddenly needed.
 - Wet the surgeon's hands with saline when tying polypropylene sutures to prevent breaking them.
 - Remind the circulator to turn on the suction to the closed-seal drainage unit as soon as the chest tubes are connected to it. This prevents clots from forming in the chest tubes.
 - Keep your Mayo stand and back tables as neat as possible.
 - Check polypropylene sutures for knots or kinks before passing to the surgeon. If one is found, do not try to untie it. Load another as quickly as possible.
 - Laying a light-colored paper towel over the Mayo stand during anastomoses helps make the polypropylene sutures visible.
 - Watch polypropylene sutures for dragging when passing them to the surgeon. They can be easily snagged on items between the Mayo stand and the surgeon. Keep tension off the suture as well.
 - Keep the field clear of instruments, blood-soaked sponges, etc. Wring out blood from laparotomy sponges into a bowl and suction with the pump sucker.
 - Do not confuse the terms "atrial" and "arterial" when passing cannulation stitches. One is for the right atrium, and the other is for the aorta. Typically, the arterial cannulation stitch is placed first, but if aortic pressure is high, the right atrium will be cannulated first.

US Navy's Operating Room Technician School in 1991 and Hospital Corpsmen School in 1987.

ACKNOWLEDGEMENTS

Special thanks to my family, my co-workers and AST for providing me the opportunity to serve as a contributing member in the Association.

References

1. Kolesov VI. Mammary artery-coronary artery anastomosis as a method of treatment for angina pectoris. *J Thorac Cardiovasc Surg*. 1967;54:535-44.
2. Alt SJ. Healthcare Strategic Management. 2004.
3. Bull DA, Neumayer LA, Stringham JC, et al. Coronary artery bypass grafting with cardiopulmonary bypass versus off-pump cardiopulmonary bypass grafting: Does eliminating the pump reduce morbidity and cost? *Ann Thorac Surg*. 2001;71:170-5.

4. Buttler J, Rucker GM, Westaby S. Inflammatory response to cardiopulmonary bypass. *Ann Thorac Surg*. 1993;55:552-559.

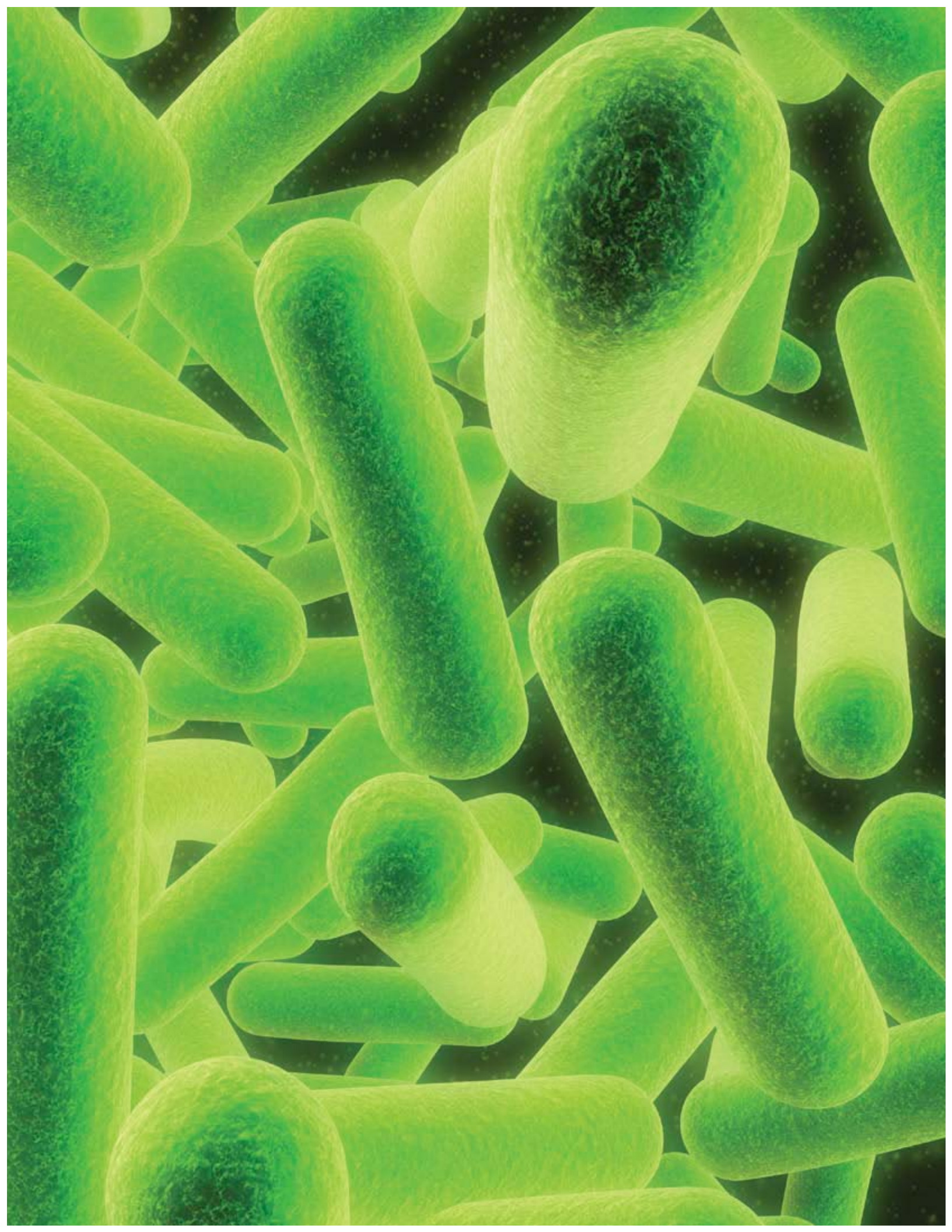
ACROBAT® SUV, AXIUS®, HEARTSTRING®, FloCoil® and XPOSE® are registered trademarks of MAQUET®. MAQUET® is a registered trademark of MAQUET GmbH & Co. KG. Copyright by MAQUET, San Jose, all rights reserved.

Hibiclens is a registered trademark of Molnlycke Health Care.

ChloraPrep is a registered trademark of Enturia, Inc.

DuraPrep is a trademark of 3M Corporation.

ON-Q PainBuster is a registered trademark of I-Flow Corporation.



STERILIZATION — Killing the Prehistoric Beast

JINNIE COOK, CST, CFA

Geobacillus *stearothermophilus* is not the name of an ancient dinosaur, but it may have been around during prehistoric days. *Geobacillus stearothermophilus* is a spore-forming bacteria found in soil, hot springs, arctic waters, ocean sediment and spoiled food products. Judging by the locations where this spore-former is found, it is apparent that it is able to resist and survive in extreme environments.

This particular bacterium is found to be the most resistant to steam. That is why it is the microorganism that is used in biological indicators to determine whether resistant forms of bacteria have been destroyed during the sterilization process.

UNDERSTANDING SPORES

To completely understand the significance of this microorganism, it is important to understand exactly what a spore is. Spores, simply put, are microorganisms which are able to survive in an unfavorable environment. They can survive in ultraviolet light, as well as in many harmful chemicals.

A spore can be thought of as a shield or “force field” around the important components of bacteria.

During spore formation in bacteria, the cell is in the process of reproducing itself. The mother cell makes a duplicate daughter cell. When unfavorable conditions arise for the spore-forming bacteria, the protective mother cell engulfs the daughter cell.

There are now two plasma membranes surrounding the daughter’s cell DNA. Between the two plasma membranes, a hard shell develops.

This is the spore coat or “force field.” The spore protects the new daughter cell and the important DNA. The cell remains dormant until external conditions become favorable.

THEIR POTENTIAL FOR DANGER

Why is knowledge of spores important? Because spores can live on surgical instrumentation if not properly cleaned and sterilized. Knowledge of spores is especially important when dealing with surgically implanted devices.

Spores on surgical instrumentation can have devastating results, but implanted devices represent a higher degree of risk of infection, since they are retained in the body.

Spores on implanted devices can remain dormant in the body for up to one year after the surgery. Once the dormant bacterium wakes up, it becomes an opportunist and begins to multiply rapidly, causing infection within the body.

Orthopedic implants can have more of a devastating impact than other implants. The reason for this is due to the interrupted blood supply when the periosteum is removed from the bone.

The blood supply to the bone travels through the periosteum. When the periosteum is stripped away to allow for plate placement, the blood supply to the area of injury is decreased.

Package closures

From the nationally accepted standard, ANSI/AAMI ST79:2006, 8.3.3 Package closures:

Accessories used to close or secure packages should be chosen to allow the steam sterilization process to occur, avoid constriction of the package, and maintain package integrity. Tape (other than sterilization indicator tape) should not be used to secure packages, nor should safety pins, paper clips, staples, or other sharp objects. Elastomer bands designed specifically for sterile packaging are acceptable as

outside closures only if the wrapper manufacturer explicitly recommends their use and only if care is taken to choose the proper size (relative to the length and width of the package) so that the elastomer band fits snugly yet does not constrict the package (eg, create an “hourglass” effect) or cause excessive wrinkles or folds in the package. Rubber bands or tape should not be used to hold instruments together in a group.



Once the blood supply is decreased, it becomes more difficult for antibiotics to reach the bone through the bloodstream.

Spore-forming bacteria include, but are not limited to, the following:

- *Clostridium perfringens*—a source of gas gangrene
- *Clostridium botulinum*—a source of botulism
- *Clostridium tetani*—a source of tetanus
- *Bacillus anthracis*—a source of anthrax

PREVENTION

How can we as surgical technologists and important members of the operating room team prevent these infections?

Besides strict adherence to aseptic technique, properly reprocessing and sterilization of surgical instrumentation can and will reduce the morbidity and mortality rate in the surgical patient.

THE PROCESS

Many hospitals do not carry multiple instrument sets for each specialty. The reason is that specialty instrumentation is expensive.

So, how do we make our work environment safe for our patients?

Consider, for example, a hospital that performs a high volume of neurosurgical procedures. This hospital may only have three neurosurgery pans.

If six neurosurgery cases are scheduled in two rooms simultaneously, and there are only three neurosurgery pans, what needs to be done to ensure the patients are safe from potentially harmful microbes?

Answer... The instrument sets need to be thoroughly cleaned and decontaminated before being resterilized.

This process begins with placing the soiled instrumentation into an enzymatic cleaner. The enzymatic cleaner aids in loosening and breaking down the adhered blood and tissue.

Next, the instruments are scrubbed individually with a scrub brush, and a bottle brush and/or syringe are used to clean the lumens of the instruments. The instruments are flushed and brushed

until they are free of visible blood and tissue.

Next, the instruments are placed into an ultrasonic cleaner and/or washer-sterilizer to remove the embedded bioburden. Ideally, the instruments should be allowed to dry before they are assembled, placed into an instrument pan, wrapped or placed into a closed system sterilizing pan. Sterilization should be accomplished by the use of a gravity displacement sterilizer or prevac sterilization system.

Unfortunately, this isn't always possible. Surgeons and anesthesiologists don't want to wait more than an hour for the complete sterilization process to be performed, and facilities continue to demand quick turnover times.

Therefore, instruments are usually flash sterilized while the O.R. room is being cleaned and the supplies are being opened for the next surgical procedure.

Is this right? No!

PATIENTS DESERVE CONSISTENT CARE

Biological indicators are run in each autoclave daily. These biological indicators are the only means of ensuring that resistant microorganisms have been killed.

An autoclave that is used for flash sterilization has a biological test run each day. Flash sterilization *does* sterilize the instrumentation. However, there is controversy surrounding flash sterilization and the lack of proper pre-cleaning and disinfecting of the instrumentation.

Therefore, in order to ensure quick turnovers, instrumentation that needs to be turned over quickly generally does not go through the entire decontamination process.

Patients have the right to receive continuity of care. Each patient deserves to have instruments processed to the same degree as the instruments that were used in the first case of the day.

Hospitals should strive to ensure that patients receive this continuity of care by allowing surgical cases to be scheduled in such a way that proper instrument reprocessing can be accomplished without causing delays in the overall surgery schedule.

QUESTIONS THAT MUST BE ADDRESSED

Flash sterilization was designed to be used if a necessary instrument was dropped during a surgical procedure. The instrument is cleaned and flashed sterilized, so that it can be used again on the same patient.

Since the practice of flash sterilization has deviated from its original intended use, there are questions that need to be asked and a process that needs to be adhered to.

Chemical and biological indicators

Chemical indicators (CIs) may be used externally (eg, the thermochromic indicator tape shown here) or internally. The nationally accepted standard, ANSI/AAMI ST79:2006, 10.5.2.1 General Considerations, states:

Chemical indicators assist in the detection of potential sterilization failures that could result from incorrect packaging, incorrect loading of the sterilizer, or malfunctions of the sterilizer. The “pass” response of a CI does not prove that the item monitored by the indicator is sterile.



Biological indicators (BIs) should consist of spores of *Geobacillus stearothermophilus* (formerly named *Bacillus stearothermophilus*) that are intended to be killed during the sterilization process. According to the ANSI/AAMI ST79:2006, 10.5.3.1 General Considerations:

Biological indicators provide the only direct measure of the lethality of the sterilization process. Biological indicators must be incubated for various periods of time (depending on the specific product) until it is determined whether the microorganisms grow (ie, they survived the sterilization process) or fail to grow (ie, they were killed by the sterilization process).

Question #1

Which cycle is being used?

This is important, because it determines the time needed for sterilization.

Parameters for Gravity Displacement at 270-272°F

Open Instrument/Flash Pan	Time
Metal, nonporous, without lumens	3 min
Metal with lumens, porous, implantable	10 min

Parameters for Dynamic Air-Removal (Pre-Vac) at 270-272°F

Open Instrument/Flash Pan	Time
Metal, nonporous, without lumens	3 min
Metal with lumens, porous, implantable	4 min

*Note: In a closed flash pan system, all instruments are processed for 10 minutes gravity, unless the manufacturer's recommendations differ. A closed flash pan system is recommended to help ensure safe, sterile transport of sterile instrumentation from the flash autoclave to the operating room.

Question #2

Which temperature should be used?

Temperature will determine time. Flash cycles will be set at 270-272°F. It is important to check for correct temperature setting before beginning flash sterilization.

Question #3

Which type of internal indicator should be used?

The traditional practice has been to use a chemical indicator only. A chemical indicator is the strip that changes color when exposed to heat.

A chemical indicator does **NOT** determine sterility, though. It only determines that an instrument has been exposed to the sterilization process. Only biological indicators provide direct evidence that the sterilization process is able to kill spores.

The AST Education and Professional Standards Committee has determined that as a profession we should adopt the standards set forth by the American Society for Healthcare Central

Service Professionals (ASHCSP) of the American Hospital Association.

The ASHCSP policy states:

Biological monitoring should be used to challenge the performance of the sterilizer. They should be used routinely in steam sterilization loads, daily preferably, in EACH load that contains critical items, eg, instrument sets, individual surgical instruments, or any item that comes in contact with sterile tissue.

Question #4

How many instruments can be flashed in one pan during a flash cycle?

There is controversy on the amount of instruments that can be flashed at a given time.

According to ANSI/AAMI/ISO standards, the biological indicator test, which is performed each morning on every autoclave and run on all cycles, is placed in the most difficult place for steam to penetrate, such as in the center of an instrument pan, in a corner, or in the center of a layered pan.

If the biological test is negative for the spore-forming bacteria *Geobacillus stearothermophilus*, then the assumption is that subsequent flash loads will have the same negative results.

If this principle is true, the amount of instruments in one flash pan does not matter, because the correct time and exposure of the steam sterilization process will reach all the difficult areas of the instrument pan.

*Note: AAMI standards for 2008 indicate that instrument pans should not exceed 17 lbs. This weight limit has been lowered from the organization's previous guideline of 25 lbs.

Best advice? Follow your facility's policies and procedures.

Question #5

Do any of the instruments have a cannula?

If the answer is yes, there is a process that must be followed before flashing instruments with lumens.

After thorough cleaning, all instruments with lumens must have sterile, distilled water run through each lumen before the flash sterilization process is begun.

The sterile, distilled water does not sterilize the lumens; it is simply the most noncorrosive fluid found in the O.R.

The purpose of running distilled water through the lumens is so the steam is able to penetrate each lumen in the reduced sterilization time of the flash sterilization cycle.

If there is no fluid in the lumen before sterilization begins, there is no guarantee that the steam will be able to heat the inner lumen to the temperature required for sterilization.

Question #6

Are any of the instruments porous?

Porous items, eg magnetic items—as well as items with lumens—take longer to sterilize. These items need to be flash sterilized for 10 minutes, when the need arises.

Question #7

Are the instruments going to be used on bone?

Since postoperative bone infections have such devastating results on a patient, the theory is that more exposure time to the sterilization process is better.

For example, consider a key elevator. The key elevator meets the criteria for minimal flash time of three minutes. It is metal, nonporous and does not have a lumen.

Therefore, does the 10-minute flash cycle at 270-272°F in a gravity displacement sterilizer make the key elevator *more* sterile than it would be following a three-minute cycle at the same temperature?

If one believes that a three-minute flash cycle at 270-272°F in a gravity displacement or pre-vac sterilizer is sufficient time to kill resistant, spore-forming bacteria for metal, nonporous, noncannulated instruments, then why is it not sufficient for a key elevator, which is used to strip the periosteum off of bone?

If we do not believe this, then we may want to consider increasing the minimum flash time on all flash cycles.

Release criteria for implants

According to the nationally accepted standard, ANSI/AAMI ST79:2006, 10.6.3 Release criteria for implants, implantable devices should not be used until the results of biological indicator (BI) testing are known. When emergency conditions dictate the use of implantable devices prior to receiving the results of BI testing, the standard indicates that written documentation—an Exception Form for Premature Release of Implantable Device/Tray—accompany the device to the O.R., where surgical staff complete the form and then return it to Central Service within 24 hours.

When documented medical exceptions dictate (eg, the need for trauma-related orthopedic screw-plate sets), it could be necessary to release an implantable device before the BI results are known. In this case, the release of the device before the BI results are known should be documented; the BI result obtained later should also be documented. It is critical that this documentation be fully traceable to the patient. Releasing implants before the BI results are known is unacceptable and should be the exception, not the rule... Steps should be taken to reduce the frequency of emergency release of implantable items.



Question #8

Are instruments implantable?

It is not the recommendation of AAMI, ANSI, ISO and ASHCSP to flash sterilize implantable devices.

Again, the question is, if all the appropriate flash times and temperatures are adhered to, then why is it not recommended?

Some of the objections to this practice include the lack of proper cleaning and decontamination of the implant prior to the flash sterilization cycle.

Question #9

Do I need to use a biological indicator on each flash cycle?

Yes! Always!

Since the biological indicator is the **ONLY** method to verify that sterility has taken place, it must be used every time for our patients' safety.

Question #10

Which biological indicator should be used?

For flash sterilization, the rapid readout is used most frequently.

The biological indicator with the **BLUE** cap is used for gravity displacement sterilization. The biological indicator with the **BROWN** cap is used with pre-vac.

Both of these biological indicators contain the resistant, spore-forming bacteria *Geobacillus stearothermophilus*. It is classified a *thermophile*, which means it is able to resist extreme temperatures.

Geobacillus stearothermophilus is the most resistant bacteria to heat, and the most difficult to kill. If it is killed, than the other less resistant strains of bacteria are killed as well.

Question #11

How do I use a biological indicator?

Adhere to the following steps:

Important: Do not pop the cap before the sterilization process!

1. Place the biological indicator in the pan
2. Run a complete cycle—Blue cap for gravity; brown cap for pre-vac
3. After the completed cycle, the sterile team member removes the biological indicator from the pan of sterilized instruments.
4. The sterile team member hands off the biological indicator to the nonsterile team member.
5. The nonsterile team member pops the cap, places it into the crusher and rocks it back and forth.
6. The crushed vial is then placed into the appropriate color-coded incubator. The color of the cap matches the color of the appropriate incubator well.

Photo courtesy of Delmar Cengage Learning, *Surgical Technology for the Surgical Technologist: A Positive Care Approach*, Third edition, ©2008.

7. The first readout is taken at 20 minutes.
8. The final readout is taken after one hour has elapsed. (One hour applies to the time before the flashed implant can be implanted.)

Note: The brown-capped vial for pre-vac takes three hours before a final readout is available. After 24 hours, the readouts are conclusive that indeed the ancient prehistoric bacteria have been killed.

The flashed instrument set or implantable device is placed onto a separate sterile table, in order to prevent possible cross-contamination, until a negative biological indicator readout has been determined.

After this process is complete, the sterile item can be placed safely on the back table or Mayo stand.

CONCLUSION

Flash sterilization between cases is not a recommended practice. It is not to be used as the standard of care for lack of sufficient surgical instrumentation.

When flash sterilization is necessary, it should be performed in a designated covered flash pan. The covered pan will help ensure sterility of the surgical instrumentation.

The use of flashing multiple instrument sets between cases needs to stop. The risk of contamination increases with each flash pan moved from autoclave to the operating room.

If we believe the patient is our primary focus, then we need to find methods within our individual facilities to reduce this practice, even if we kill the prehistoric beast *Geobacillus stearothermophilus*.

FOR MORE INFORMATION

Association for the Advancement of Medical

Instrumentation (AAMI) www.aami.org

American National Standards Institute (ANSI)

www.ansi.org

American Society for Healthcare Central Service

Professionals (ASHCSP) www.ashcsp.org

International Standards Organization (ISO)

www.iso.org

ABOUT THE AUTHOR

Jinnie Cook, CST, CFA, currently works at Medical Center of Arlington in Arlington, Texas. Due to a recent injury to her wrist during a fall in the O.R., she is working in the center's education department, where she trains nurse interns, O.R. and labor/delivery staff.

Jinnie also has made significant contributions to the profession as author and contributor of many educational products. She currently serves on the AST Education and Professional Standards Committee.

EDITOR'S NOTE

The AST Education and Professional Standards Committee is writing a new standard on instrumentation sterilization, which will be published in the spring. As a benefit of membership, all AST members will have free access to the new standard on AST's website.

References

1. Association for the Advancement of Medical Instrumentation. ANSI/AAMI ST77:2006, 5.8. 2006.
2. Beaver M. SPD Staffs Face Old Problems, but New Standards Offer Help. *Infection Control Today*. August 1, 2007. Available at: <http://www.infectioncontrolday.com/articles/412/78h177181545724.html>. Accessed February 12, 2008.
3. *Comprehensive guide to steam sterilization and sterility assurance in health care facilities*. ANSI/AAMI ST79:2006. Association for the Advancement of Medical Instrumentation: Arlington, Va; 2006.
4. Dix K. Gram-negative and Gram-positive Bacteria. *Infection Control Today*. September 1, 2003. Available at: <http://www.infectioncontrolday.com/articles/391Clinical.html>. Retrieved November 26, 2007.
5. Kenneth Todar, Gram-positive, Aerobic or Facultative Endospore-forming Bacteria (formerly, The Genus Bacillus. *Todar's Online Textbook of Bacteriology*. Available at: <http://www.textbookofbacteriology.net/Bacillus.html>. Accessed November 15, 2007.
6. Maria Do Carmo Noronha Cominato Bergo. Evaluation of Cleaning and Disinfection Processes Performed by Automatic Washer/Disinfectors. *Infection Control Today*. May 1, 2005. Available at: http://www.infectioncontrolday.com/articles/412/412_551inside.html. Accessed February 12, 2008.
7. Microbial Spore Formation. Microbeworld. Available at: <http://www.microbeworld.org/know/spore.aspx>. Accessed November 26, 2007.
8. The Chemical Basis of Microbiology. Microbiology 101. Available at: <http://www.universalclass.com/i/crn/31712.htm>. Accessed November 26, 2007. [Available by paid subscription only].
9. Young M. Class 5 Integrating Indicators for Steam Sterilization Process. Available at: <http://www.hponline.com/ce/pdfs/0504cetest.pdf>. Accessed February 12, 2008.



When Unexpected Complications Arise During Surgery—

A Case Study of a Total Abdominal Hysterectomy with Bilateral Salpingo-oophorectomy

KELLIE CARDOZA LONGATTI

A total abdominal hysterectomy is defined as the surgical removal of the uterus.

The procedure may be done in conjunction with the removal of one or both of the fallopian tubes and one or both of the ovaries. If all structures are removed, the procedure is called a total abdominal hysterectomy with bilateral salpingo-oophorectomy—or TAH-BSO.

NATIONAL STATISTICS

Total abdominal hysterectomy (TAH) is considered “the most common non-obstetrical procedure for women in the United States.”²² Approximately 500,000 procedures are performed per year with a decrease of about 20% favoring the cervix-preserving supracervical hysterectomy.¹³

SURGICAL INDICATIONS

TAH-BSO can be performed for multiple conditions and pathologies, including:

- “Endometrial, tubal or ovarian malignancies
- Uterine sarcoma
- Uterine fibroids, both asymptomatic (if larger than 12 weeks of gestation size) and symptomatic
- Benign adnexal masses in postmenopausal women
- Dysfunctional uterine bleeding
- Endometriosis, chronic pelvic inflammatory disease and pelvic pain syndromes”¹⁷

TAH is generally the preferred approach when patients present with malignancies or large uterine fibroids. This approach facilitates easier access to lymph nodes, surrounding structures and large masses.

The abdominal approach is also considered the foundation for treatment of uterine and ovarian cancers, because it allows for extensive inspection of other tissues.²

PROCEDURAL OVERVIEW

This article will describe the pre-, intra- and postoperative surgical case management of an 83-year-old female diagnosed with a pelvic mass. The prescribed treatment in this case was an exploratory laparotomy with TAH-BSO.

PATIENT’S MEDICAL HISTORY

The patient’s medical history included several surgeries, including a thyroidectomy, cholecystectomy, fixation of multiple upper and lower extremity fractures, cervical spine surgery, breast biopsy and splenectomy.

The patient had been treated recently for a lower extremity blood clot and acid reflux.

At the time of admittance, the patient was hypertensive with a blood pressure of 180/130 mmHg.

Her medications prior to admittance included:

- Synthroid®, 125 mg daily, to compensate for the removed thyroid gland;
- Nexium®, 40 mg daily, to treat acid reflux; and

- Diovan® HCT, 185 mg daily, for treatment of hypertension.

PATIENT CONDITION UPON HOSPITAL ADMISSION

The patient presented with syncope and emesis. Her syncopal episodes were accompanied by the perception of a halo of light. According to the patient’s chart, the patient had been referred to a cardiologist in the past for treatment of syncopal episodes.

The patient also complained of frequent emesis, frequent urination and pelvic pain.

The patient was alert and oriented at the time of arrival at the hospital. A physical examination revealed a soft, smooth cystic mass in the abdomen without ascites.

A pelvic exam revealed postmenopausal vaginal atrophy. The patient’s cervix was deemed to be effaced.

The patient was admitted to the hospital for further testing due to the findings of the pelvic and physical exams. Further tests included an ultrasound, which determined the location of the pelvic mass, confirmed that no ascites was present and revealed that the mass was uterine in origin.

Frontal and lateral chest radiographs were taken, which revealed no chest masses, but displayed evidence of recent rib fractures. These were attributed to a fall related to her recent syncopal episodes.

Labwork results showed an elevated white blood cell count and the presence of protein in the patient’s blood and urine, but were otherwise inconclusive.

Due to the inconclusive nature of the histology and urologic findings—combined with the presence of abdominal pain, a pelvic mass and syncopal episodes, it was determined that an exploratory laparotomy with TAH-BSO was indicated.

PREOPERATIVE DIAGNOSIS

The patient’s preoperative diagnosis was a pelvic mass. The pathophysiology, which was subsequently discovered during the course of surgery,

was determined by pathologists to be advanced squamous cell carcinoma.

During the course of surgery, carcinoma was discovered in several tissues, including the peritoneum, cervix, vagina, bladder and bowel. The carcinoma was so pervasive that some structures—including the ovaries, fallopian tubes and much of the uterus and cervix—were not distinguishable from surrounding structures.

The tissue was found to be dark in color. In some locations, black, depressed spots were visible from a distance. Some of the tissue was stringy and friable, and in some areas—such as the cervical region—the tissue had the texture of thick liquid. The damage caused by the carcinoma was extensive.

ROOM PREPARATION

Surgical intervention began with preparing the room for the procedure. The anesthesia cart and supplies were placed at the head of the operating room table. The back table and Mayo stand were positioned toward the back of the operating room.

The case cart was brought into the room approximately 30 minutes before the procedure was scheduled to begin. For a complete list of equipment and supplies, see “Contents of Case Cart” on pg 163.

Once the case cart was opened, the back table pack was opened, followed by the basin set, the instrument set and the Bookwalter retractor set. A prep stand was prepared for the circulator, which included the Foley catheter and two sterile towels.

The surgical technologist began to scrub approximately 20 minutes before the procedure was scheduled to begin.

Once the surgical technologist was scrubbed in, the Mayo stand was used for gowning and gloving. The circulator disposed of the gown and glove wrappers, so the Mayo stand could be dressed by the surgical technologist.

The Mayo stand cover was placed on the Mayo stand, followed by two sterile towels laid flat and one sterile towel rolled to keep free ties and instruments steady.

The back table was arranged in a practical and useful manner, and the instrument tray was brought to the back table. Once the instruments had been inspected for sterility and all items were laid out appropriately on the back table, the surgical technologist and the circulator performed an initial count.

The count included the abdominal hysterectomy instrument set, the long dissection instrument set, the Bookwalter retractor, the large vein retractor, X-ray-detectable and laparotomy sponges, all three #10 blades, electrosurgical pencil tips and scratch pad, and all of the suture, excluding the free ties.

The items placed on the Mayo stand were positioned according to their order of use. Free ties were taken out of the packaging and placed under the roll towel, with approximately two inches protruding for access and to prevent tangling.

Two of the free ties were clamped within two tonsil clamps in preparation of ties on passes. The instruments on the roll towel included two Kelly clamps, two Mayo clamps, two Pean clamps, two long Aliss clamps, six long Kocher clamps, two tonsil clamps, two right-angle clamps, two Heaney clamps, two curved Ballentine clamps and two straight Ballentine clamps.

The remaining available space on the Mayo stand held one pair of long Metzenbaum scissors, one pair of curved Mayo scissors, one pair of straight Mayo scissors for suture, one long Debakey forceps, one regular Debakey forceps, one pair of Russian forceps, two medium Richardson retractors, two Army/Navy retractors and two X-ray-detectable sponges.

The three #10 blades were loaded onto knife handles. The first blade was placed onto a #3 knife handle for use on skin. The second blade was placed on a #3 knife handle for use on deeper tissues. The third blade was placed on a #3 long knife handle for the cervical incision. All of the #3 knife handles were placed on the Mayo stand as well.

Long Mayo-Hegar needle holders were loaded with 2-0 Chromic suture ligatures and placed on the Mayo stand.

A sterile towel was placed over these instruments. Then two light handles, suction tubing

with Yankauer suction tip attached, a nonperforming towel clamp and the handheld electro-surgical pencil were placed on the Mayo stand.

The Bookwalter retractor was set up on a second prep stand. The items in the Bookwalter set were counted in the initial count. The items were laid out in such a way that the surgeon could pick out the blades he wanted to use with ease. The oval ring was placed on the back table so that it could be brought up to the field after the peritoneum was opened and the abdomen was packed.

The surgical technologist prepared a pitcher filled with approximately 500 cc of warm normal saline. A small basin was filled with the remaining 500 cc.

Five laparotomy sponges were soaked in the saline-filled basin. The Asepto syringe was filled with approximately 60 cc of warm saline from the pitcher and set aside on the back table.

POSITIONING THE PATIENT

At this time, the patient was brought into the operating room on a gurney. The patient was awake and alert and had been given a sedative.

The patient was asked to aid in positioning herself onto the operating table and was compliant. Once in the supine position, a safety strap was secured approximately six inches above the patient's knees.

The patient's arms were placed on padded arm boards, and a blood pressure cuff and pulse oximeter were secured.

An IV line had been placed while the patient was in the preoperative holding area, and a 1,000-cc bag of lactated Ringers solution was secured to her IV tubing.

The anesthesiologist proceeded with a full induction sequence, and the patient was intubated.

Once under general anesthesia, the patient's vital signs were noted as follows: blood pressure

Procedural overview—Total abdominal hysterectomy with bilateral salpingo-oophorectomy

The steps typically taken in completing a routine TAH-BSO are as follows:

- Open abdomen and retract intestines to expose reproductive organs.
- A tenaculum is placed at the fundus of the uterus for ease of manipulation.
- Heaney clamps are placed around the broad ligaments encompassing the round and ovarian ligaments bilaterally.
- The round ligaments are secured with suture ligatures and then divided with curved Mayo scissors, which creates anterior and posterior flaps—or “leaves”—of the broad ligament.
- The anterior and posterior flaps are then incised with Metzenbaum scissors.
- The bladder is dissected from the uterus and cervix using blunt dissection.
- The broad ligament is dissected from the lateral portions of the uterus using blunt dissection.
- Any bleeding vessels are clamped and tied.
- The posterior portion of the broad ligament is cut with a scissors or scalpel.
- The ureters and external iliac vessels are identified and protected.
- The uterus is manipulated upward and toward the lateral position to facilitate exposure of the uterine vessels and lower ligaments.
- The curved Ballentine clamps are passed, and the vessels are clamped, cut and tied.
- The rectum is freed from the cervix and mobilized out of the way.
- The cardinal ligaments are clamped, cut and tied.
- The uterus is manipulated upward again.
- The uterosacral ligaments are located and then clamped, cut and tied.
- The cervix is amputated from the vagina with a scissors or scalpel.
- The specimen is removed from the pelvic cavity and passed off the field.
- Kochers are passed to elevate and approximate the vaginal cuff, which is then sutured in interrupted fashion.
- The ligament remnants are sutured to the vaginal cuff.
- The peritoneum is approximated over the bladder, vaginal vault and rectum.
- The abdomen is irrigated, and all laparotomy sponges are removed.
- A full count is performed.
- The abdomen is closed, and a final count is performed.

was 180/130 mmHg, O₂ saturation was 96%, and temperature was 97.6° F.

The patient's arms were secured to the arm boards with towels placed around the arm and arm board and fastened with perforating towel clamps.

At this time, the surgeon entered the operating room and began to examine the surgical site. The abdomen was palpated, and the surgical site marked with a sterile marking pen.

The surgeon then left the room to begin his scrub. The patient's legs were put into a slight "frog leg" position.

SKIN PREPARATION

The blanket and gown were pulled back to expose the abdominopelvic area. The abdomen was prepped by the circulator using Betadine® gel and one sterile towel to smooth the gel over the entire abdominal area from just under the breast area to the iliac crests.

A vaginal preparation was performed using Betadine® solution applied to the upper, middle and lower thighs toward the vagina and to the vaginal area from the urethral meatus to the rectum.

The Foley catheter balloon was tested and deemed to be in working order. The Foley catheter was then inserted, and the collection bag was placed below the table in a conspicuous area visible to the circulator. The patient was returned to the supine position.

PROCEDURAL OVERVIEW

Upon re-entering the room, the surgeon was gowned and gloved. The surgeon informed the surgical technologist that an assistant would be assisting him later in the case. The surgical technologist then requested another gown and gloves for the assistant.

Four, folded sterile towels were passed to the surgeon who then used them to square off the surgical site. They were not secured with clamps.

The laparotomy drape was passed to the surgeon, and the tabs were peeled off. The surgeon and the surgical technologist then opened the drape and laid it appropriately on the patient,

allowing for the fenestration to reveal the surgical site.

The anesthesiologist clamped the drape to the IV poles, and the Mayo stand was brought up to the field.

The light handles were handed to the surgeon, while the surgical technologist fastened the electrosurgical pencil and suction tubing to the drape with a non-perforating towel clamp.

The electrosurgical scratch pad and holster were placed conspicuously on the field.

Two X-ray-detectable sponges were laid near the surgical site, and the sterile towel over the instruments was removed and placed on the back table. The back table was then brought to the surgical technologist by the circulator, and no contamination was noted.

The anesthesiologist informed the surgeon that the patient was experiencing hypertension, but to proceed.

The circulator called for a "time-out," and the patient's name, surgeon's name and planned treatment were called out and confirmed.

The #3 scalpel was passed to the surgeon, and an eight-inch midline incision was made from approximately four inches below the xiphoid process to the symphysis pubis—avoiding the falxiform ligament on the right side of the patient's umbilicus. The cut time was 1:45 pm.

The subcutaneous and adipose tissues were dissected with the electrosurgical pencil. X-ray-detectable sponges and the electrosurgical pencil were used to achieve hemostasis.

The adipose tissue was dissected from the rectus fascia with the electrosurgical pencil, and Army/Navy retractors were passed for retraction of the skin, subcutaneous tissue and adipose tissue.

The second #3 knife was passed, and the rectus abdominus fascia was incised. The curved Mayo scissors were passed to the surgeon, and he cut the fascia vertically toward the xiphoid and then down toward the symphysis pubis.

The underlying rectus muscle was spread with Metzenbaum scissors in an opening and closing motion to create an opening which was then retracted with medium Richardson retractors.

Once the opening was sufficient, two Kelly clamps were passed to grasp the peritoneum at each end of the opening. Once the peritoneum was grasped and lifted off the bowel, Metzenbaum scissors were passed, and the peritoneum was cut.

Once the peritoneum was opened, the skin, subcutaneous tissue, adipose tissue, fascia, muscle and peritoneum were pulled and stretched by the surgeon and the surgical technologist preceptor.

A large opening was created by the stretching and pulling, and the bowel was retracted back by hand. The soaking laparotomy sponges were wrung out and passed to the surgeon and the X-ray-detectable sponges were removed. The surgeon used the sponges to pack away the bowel.

The surgeon then asked for the patient to be placed into a slight Trendelenberg position. This allowed for ease of packing away the bowel and for placement of the Bookwalter retractor.

The oval ring of the retractor was passed, and the preceptor held it in place while the surgeon looked for the blades he preferred.

He picked one Balfour blade with ratchet, and three 2"x4" Kelly blades and ratchets. He placed one Kelly blade at the superior portion of the incision and two Kelly blades at the lateral portions of the incision.

He then identified the uterus and manipulated it upward. Using blunt dissection, the surgeon removed the visceral bladder reflection from the uterus.

A laparotomy sponge was placed over the bladder, and the bladder blade was positioned in a manner that retracted the bladder away from the uterus.

Once the Bookwalter retractor was secured, the surgeon asked the anesthesiologist to return the patient to a level position.

The assistant arrived, and the surgical technologist gowned and gloved him. During this time, the surgeon began to study the anatomy of the patient. The surrounding anatomy appeared abnormal.

The uterine tissue appeared jaundiced and, upon palpation, was able to be depressed with a finger as in the manner of a fluid-filled sac.

The surgeon ordered a washing specimen. The Asepto syringe containing warm, normal saline was passed to the assistant, who expressed the saline into the pelvic cavity.

The surgeon then advised the assistant to collect as much of the fluid as possible for cytologic examination.

The assistant collected approximately 40 cc of fluid and passed it to the surgical technologist. The surgical technologist passed the syringe to the circulator, who labeled it appropriately. The cytologist was then called.

Once the cytologist entered the operating room, the specimen was collected and processed in cytology. During the course of the surgery, the cytologist did not report back to the surgeon, but to the circulator.

The surgeon requested a gallbladder trocar to drain the uterus. The circulator located and passed the trocar onto the field.

Once the trocar was inserted into the uterus, it was discovered that the myometrium of the uterus was no longer intact and had become purulent. The visceral layer of the uterus was the only portion still intact.

The drainage of the uterine contents contained approximately 300 cc of ichorous pus. Strings and masses of tissue could be visualized in the suction canister.

At the surgeon's request, the pathologist was called to retrieve the suction canister and examine the contents of the uterine sac.

The uterine sac collapsed and remained attached to the suspensory ligaments. The anesthesiologist reported maintained hypertension and advised the surgeon to proceed quickly.

Due to the pathology and anatomy of the patient, many of the steps typically performed in a TAH-BSO (see sidebar, pg 160) were not able to be carried out during this procedure.

Upon examination, it was noted that the broad ligament and round ligament were intact. The surgeon and the assistant began the process of dividing the ligaments bilaterally.

Debaquey forceps were passed to the surgeon, so he could grasp the round ligament. Then, a Heaney clamp was passed, and the right round

ligament was clamped. DeBakey forceps and a Heaney clamp were passed to the assistant for clamping the round ligament on the left side of the uterus.

A long needle holder was passed to the surgeon with a 2-0 Chromic suture ligature. The surgeon tied the suture, and the assistant cut it with suture scissors.

The surgeon requested another suture ligature to finish ligating the round ligament. The suture was tied and then cut with suture scissors.

The round ligament was then divided with curved Mayo scissors. The broad ligament was clamped with a Heaney clamp and incised with a #3 knife. The broad ligament was dissected bluntly away from the lateral borders of the uterus.

At this time, bleeding began from the vessels of the broad ligament. Electrocautery was used for cessation of the bleeding, but had little effect.

The vessels on both the right and left sides were ligated with approximately ten 2-0 Chromic and 2-0 Vicryl® free ties and stick ties.

Blood loss from the broad ligament was approximately 700 cc. At this time, the surgical technologist requested approximately 20 additional laparotomy sponges to aid in hemostasis.

The anesthesiologist reported that the patient was tachycardic and that the surgery should proceed quickly.

The patient was placed in a slight Trendelenberg position to aid in restoring normal heart rate.

The ovarian ligaments could not be identified, nor could the fallopian tubes or ovaries. There was insufficient mesosalpinx to be noted.

The surgeon manipulated the uterine sac upward to view the posterior sheath of the broad ligament, which was incised using Metzenbaum scissors. At this time, the ureters could not be identified, and bleeding from the uterine vessels became overwhelming.

1 Chromic sutures were passed one after the other in an attempt to stop the bleeding. Laparotomy sponges were passed to apply pressure to the bleeding area.

The case cart used in this procedure contained the following:

- One abdominal hysterectomy instrument set
- One Bookwalter retractor
- One long dissection instrument set
- One large vein retractor
- Gowns and gloves for all team members
- Three six-pack sterile towels, one major abdominal pack, one laparotomy sheet
- One double basin set, one Klenszyme® one-ounce package
- One handheld electrocautery pencil, one electrocautery pencil extender tip, one 10" grounding pad
- Two green bed sheets, one case cart cover
- One 3,000-cc suction canister, one canister lid, one biohazard tag
- One 16-FR Foley catheter tray, one uc/cath strip fastener
- One surgical marking pen with sterile labels, one four-ounce specimen container
- One box of 10 X-ray-detectable sponges, one package of 10 18x18 laparotomy sponges
- One plastic Poole suction tip, one Asepto bulb syringe
- One skin scrub tray, one bottle of Betadine gel
- Two Primapore™ 11.5"x4" sterile dressing, one Primapore 8"x4" sterile dressing
- One kidney basin, two specimen cups, one pour pitcher, one small basin
- One back table garbage bag, one Mayo stand cover, one needle safety counter
- One medium Ligaclip applier and Ligaclips
- One large Ligaclip applier and Ligaclips
- One suction tubing, one plastic Yankauer suction tip
- Three #10 blades, two #3 knife handles, one #3 long knife handle
- One 3-wide skin stapler
- Free ties: 1 Chromic 18", 2-0 Silk 18"
- Stick ties: 2-0 Chromic SH 27"
- Peritoneum: 2-0 Vicryl CT-1 36"
- Fascia: 0 Vicryl CT-1 36"
- Uterus: 1 Chromic CT-1 36"
- Vaginal cuff: 1 Chromic CT-1 36"
- One bottle sterile water 500 cc, one bottle 0.9% sodium chloride 1,000 cc
- 0.5% bupivacaine plain 50 cc

The surgical technologist requested 10 more laparotomy sponges and five 1 Chromic sutures.

Once the bleeding had been controlled, the anesthesiologist requested that the circulator call the blood bank to have one unit of type O whole blood sent to the operating room.

At this time, blood loss was estimated at 3,000 cc. The anesthesiologist consulted with the surgeon, and it was determined to proceed with the case.

The bladder was observed, and some abnormal spotting was noted. Using blunt dissection, the bladder was separated from a mass of tissue that had once been the cervix. The external os and the fornix of the vagina were partially intact. The inferior portion of the intact cervix was grasped with a long Allis, and curved Mayo scissors were passed.

The inferior portion of the cervix was amputated from the vagina. When the surgeon pre-

pared to pass the specimen, the tissue frayed and was removed in string-like masses. The surgeon ordered that the pathologist be called to collect the specimen.

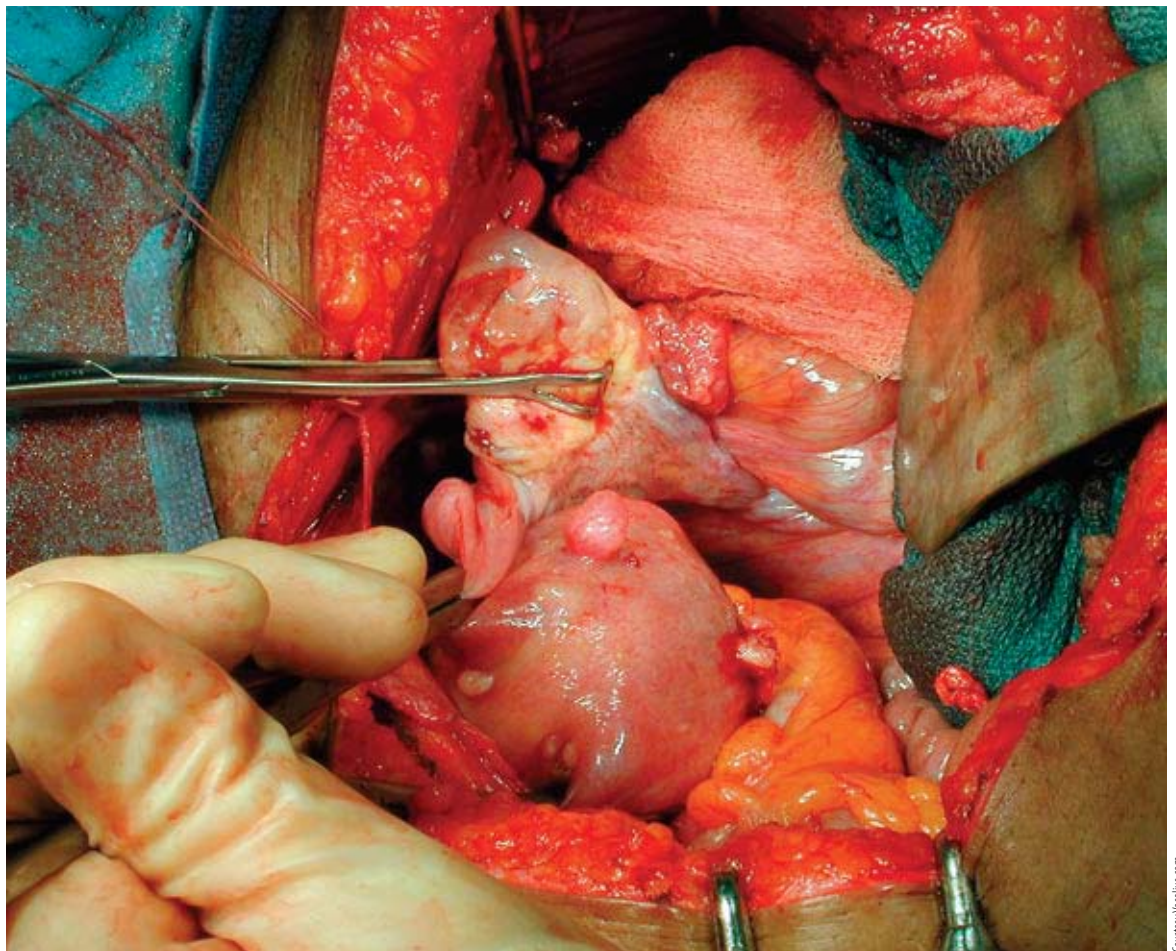
As the vaginal cuff was being grasped with long Kochers, bleeding started again. Several 1 Chromic sutures and laparotomy sponges were passed to aid in hemostasis. The blood loss became so significant that the anesthesiologist ordered the surgery halted.

The abdomen was packed with approximately 10 laparotomy sponges, and pressure was held. Blood loss at this point was approximately 9,000 cc, and the patient was extremely hypotensive with a blood pressure of 60/40 mmHg.

The patient was also bradycardic, pale and diaphoretic. The anesthesiologist began resuscitative efforts.

The anesthesiologist ordered four units of packed red blood cells and a blood warmer. The

Figure 1
The right ovary, as viewed during a TAH.



Courtesy: Vesilias.com

circulator requested that the OPS manager be present for the remainder of the case, and the crash cart was placed just outside the operating room by a surgical services associate.

The anesthesiologist ordered 2,000 cc of warmed lactated Ringers be given intravenously and began IV drug therapy. The anesthesiologist then began administering dopamine to aid in vasoconstriction and myocardial contractility and to increase heart rate, blood pressure and cardiac output.

With assistance from the OPS manager, the circulator and another RN, the anesthesiologist attained central line access and was able to administer norepinephrine and hydrocortisone for acute adrenal insufficiency.

The blood warmer and four units of packed red blood cells arrived, and the anesthesiologist and circulator immediately began their administration. The anesthesiologist then ordered four more units of packed red blood cells.

Once the patient had stabilized enough to continue, the anesthesiologist gave the surgeon permission to proceed.

At this time, the pathologist reported back to the surgeon that there were no clear margins in the specimen collected earlier and that the tissue could not be identified.

The surgeon removed the laparotomy sponges from inside the abdomen and attempted the suturing of the vaginal cuff again. The vaginal cuff was grasped with Kochers, and 1 Chromic sutures with CT-1 needles were passed on long needle holders. The suture scissors were passed to the assistant.

After the first suture was passed through the tissue, the surgeon noted that the tissue was friable and not capable of holding suture. The surgeon began to pull the tissue out in strings in an attempt to reach viable tissue.

Twenty-seven attempts were made to close the vaginal cuff by suture. At this point, the blood loss warranted halting the surgery again. The time was 5:30 pm, and blood loss was estimated at approximately 15,000 cc.

By this time, 65 laparotomy sponges and 34 1 Chromic sutures had been used. The circulator

had wrung out the used laparotomy sponges and collected the blood for measurements.

The surgical technologist and surgical technologist preceptor were relieved for the day. The relief person ordered 20 additional laparotomy sponges and 10 additional 1 Chromic sutures, assisted the surgeon and assistant in hemostatic efforts, and maintained the sterile field.

The anesthesiologist once again began hemostatic, pharmaceutical and cardiac life-saving measures. At 7:02 pm, the patient went into a state of paroxysmal atrial fibrillation, and the anesthesiologist required that the surgery be terminated.

The surgeon packed the vagina and pelvic region with laparotomy sponges and closed the midline incision with a running stitch.

Total blood loss during the procedure was approximately 16,000 cc, and 15 units of packed red blood cells and one unit of platelets were administered. Urine output was approximately 300 cc; gross hematuria was notable.

The patient was transported to the ICU, where several diagnostic tests were performed. Histology results indicated hypothyroidism, stress hypoglycemia and hypokalemia.

The patient was diagnosed with post-traumatic hypoxia, paroxysmal atrial fibrillation, hemorrhagic shock and advanced squamous cell carcinoma.

While in the ICU, the patient received one more unit of packed red blood cells and six units of platelets.

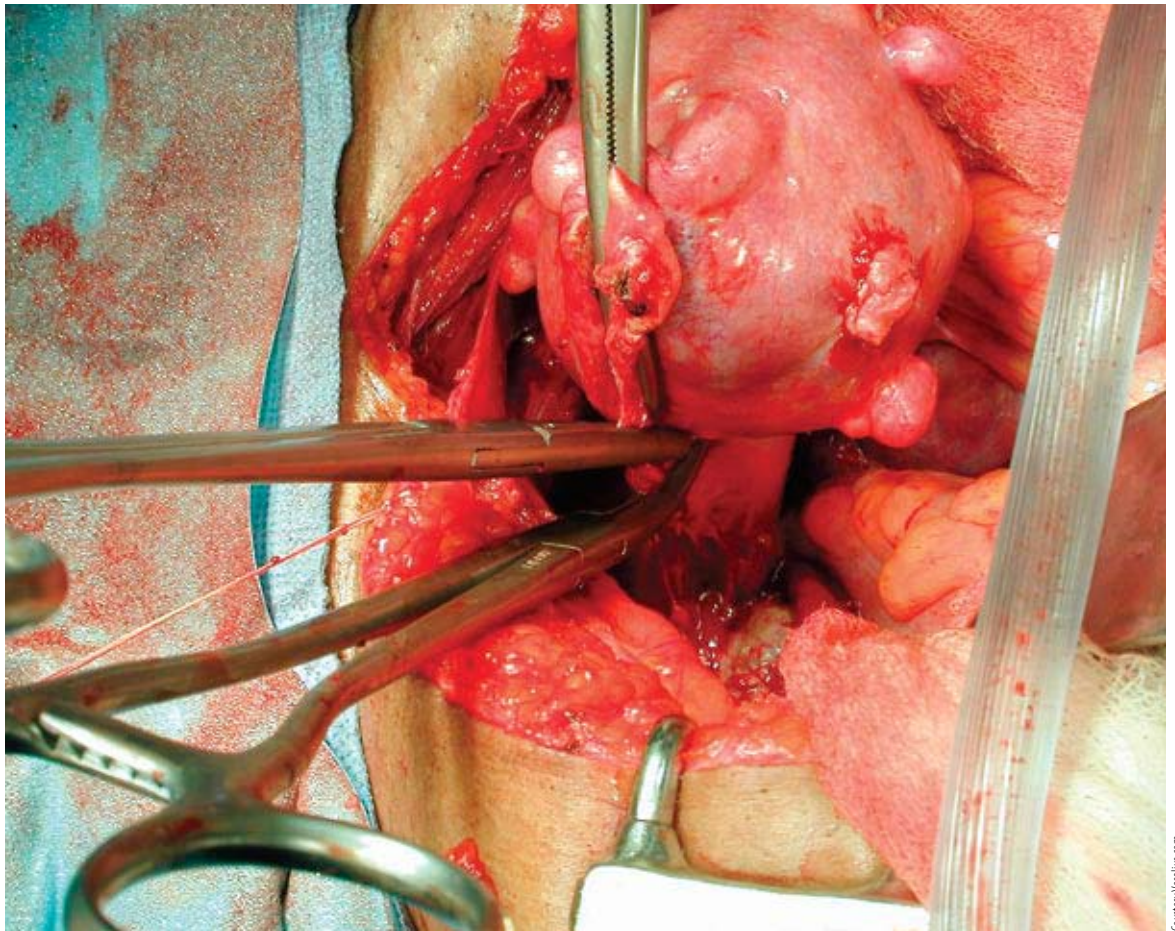
At 11:42 pm, the patient was deemed stable enough to finish the previous procedure and was taken back to the operating room. She was placed in high lithotomy position, and the vaginal area was prepped with Betadine solution.

Due to the extent of bleeding from the previous surgery, the vaginal cuff was left open and packed with laparotomy sponges. During the second procedure, the laparotomy sponges were removed vaginally and replaced with fresh sponges.

At 12:32 am, the patient was taken to the ICU, where antibiotics were administered by request of the surgeon after noting the presence of thick, white vaginal secretions.

Figure 2

The uterine artery is clamped during a TAH.



The patient remained intubated, and her airway was managed mechanically. The patient was sedated and restrained due to combativeness and an attempt to extract the endotracheal tube. The patient did not experience wakefulness, but did respond to basic commands, such as raising her arm.

Upon physical examination at 7:30 am the following day, abdominal distention and firmness was noted. However, it was deemed that the patient could not tolerate any further surgical exploration or correction at that time.

The patient was placed on an insulin drip for treatment of hyperglycemia, fluids and electrolytes to correct fluid imbalance, vancomycin for treatment of infection, and phenylephrine hydrochloride and amiodarone hydrochloride for treatment of paroxysmal atrial fibrillation.

The patient had an advanced directive, which gave the patient's spouse the authority to make critical care decisions on her behalf.

In the presence of several of the patient's family members, the final postoperative care performed before the patient died was the administration of the Sacrament of the Sick.

PROFESSIONALISM AMID GRIEF

Although the patient in this case did not have a positive outcome, it is crucial to remember the surgical technologist's motto: *Aeger Primo*—the patient first.

Regardless of a procedure's possible outcome due to the patient's age, pathology or other circumstances beyond one's control, the patient must come first. Every decision that the surgical team makes must be for the ultimate benefit of the patient.

A surgical team must not be mediocre, unsympathetic or thoughtless. Surgical team members must be willing to continually strive for the best for their patients.

Overview of relevant anatomy

The anatomy of the pelvic cavity pertinent to TAH-BSO is quite extensive.

Peritoneum

The peritoneum is a serous membrane made up of epithelial cells. The peritoneum can be divided into two layers: the parietal layer, which lines the cavities, and the visceral layer, which covers internal organs.¹

The function of the peritoneum includes protecting nearby organs and providing frictionless surfaces for organs to slide over. The peritoneum also carries blood, lymphatic vessels and nerves.¹

Intestine

While the small and large bowel are typically not disturbed surgically during a TAH-BSO, it is important to note that these structures must be retracted back to expose the pelvic contents. Therefore, a brief description of these structures is necessary.

The large and small intestine are the absorbers of the digestive tract. The small intestine absorbs nutrients, water and minerals from digested food. The large intestine also absorbs water and creates waste products.¹

The large and small intestine collectively reach between 15 and 25 feet in length and are compressed into a space that measures approximately 16"x12"x8".¹

Ovaries

The ovaries are the reproductive glands of the female. Typically, females have two ovaries located bilaterally next to the uterus. The ovaries are approximately four centimeters in length and are held in place by the suspensory, broad and ovarian ligaments.^{1,8}

The ovaries house approximately 300,000 eggs. The glandular portions of the ovaries—the corpus luteum—produce estrogen and progesterone.^{1,8}

The oviducts, also called fallopian tubes, are the passages through which the ova travel to the uterus. The fallopian tubes are made up of

smooth muscle and are controlled by peristalsis. They are approximately 5" long and extend from the fundus of the uterus to near the ovaries. The proximal ends are called fimbriae and are "finger-like" projections that produce small, wave-like motions that sweep the ova into the tubes for fertilization.^{1,19}

Uterus

The uterus measures approximately three inches long and is considered a hollow organ consisting of three layers of tissue: the endometrium (the interior lining), the myometrium (the muscular layer), and the perimetrium (the visceral layer).

The uterus is supported by several ligaments and suspensory systems.

The broad ligament consists of folded peritoneum housing the ovarian and uterine vessels, the ovarian ligament and cellular tissue. The broad ligament extends from the pelvic wall to the lateral borders of the uterine corpus. The broad ligament also creates the mesosalpinx, mesovarium and mesometrium.^{8,19}

Bilaterally, the round ligament extends from inferior to the fallopian-uterine attachment, then connects to the broad ligament and continues through the inguinal ring and downward, terminating at the labia major.¹⁹

Cervix

The cervix is the opening of the uterus to the vagina. It begins at the internal os, leads through the cervical canal and the external os, terminating in the proximal end of the vagina. The cervix is also considered the neck of the uterus. It is approximately one inch long and its opening measures less than one millimeter in diameter.¹⁹

Vagina

The vagina is considered the distal portion of the birth canal and measures approximately three inches in length. It is composed of epithelial tissue and is lined with a mucous membrane. The mucous membrane creates folds, called rugae, which increase the surface area of the vaginal canal and expand during childbirth.¹

Bladder and ureters

The urinary bladder and ureters are important anatomic landmarks during a TAH-BSO. Both structures must be identified and retracted away from the surgical site.

The urinary bladder is the collection point for urine. The bladder consists of many layers such as mucosa, connective tissue, involuntary muscle, and peritoneum. The inner layer of the bladder has mucosal folds or rugae much like the interior of the vagina. These are present throughout with the exception of a triangular spot which is in the inferior portion of the bladder called the trigone. The trigone provides bladder stability and does not allow either urine back-flow or ureteral stretching.¹

The ureters, although extraperitoneal, are exposed to some danger during a TAH-BSO. They run bilaterally from the kidneys to the urinary bladder and lie exposed during bladder retraction. The ureters are comprised of epithelial tissue and controlled by gravity and peristalsis. They carry urine from the kidneys to the urinary bladder.¹

Additional

There are several vessels that add vascularity to the pelvic cavity. The smaller vessels include the uterine vessels, the obturator vessels, and the superior vesicle artery, which runs throughout the mesosalpinx and broad ligament.

The larger vessels, which are exposed during a TAH-BSO, are the external iliac vessels. These provide the major blood supply for the pelvic region.¹¹

There are also several lymphatic vessels in the pelvic region, including the periaortic lymph nodes, the common iliac lymph nodes, the external iliac lymph nodes and the deep inguinal lymph nodes.¹¹

The nerve branches that innervate the pelvic region originate from the hypogastric plexuses and are controlled by the autonomic nervous system.¹¹

ABOUT THE AUTHOR

Kellie Cardoza Longatti currently works at a hospital in California. She graduated from San Joaquin Valley College in October, 2007. She wrote this article prior to graduation.

EDITOR'S NOTE:

All procedure-specific clinical information was obtained from the patient's chart and the surgeon's preference card with permission.

References

1. Cohen BJ. *Memmler's The Human Body Health and Disease*. Baltimore, MD: Lippincott Williams & Wilkins; 2005.
2. Crandall CJ. Hysterectomy. Available at: <http://www.medicinenet.com/hysterectomy/article.htm>. Accessed May 4, 2007.
3. Doherty GM, Lowney JK, Mason JE, Reznik SI, Smith MA, eds. *The Washington Manual of Surgery*, 3rd ed. St Louis, MO: Lippincott Williams & Wilkins; 2002.
4. Dominowski G. Pathology: Squamous Cell Carcinoma. Available at: <http://www.emedicine.com/ent/topic671.htm>. Accessed May 4, 2007.
5. Lee JA. *Abdominal Exploration Series*. University of Maryland Medical Center. Available at: <http://www.umm.edu/ency/article/002928.htm>. Accessed May 4, 2007.
6. Marcucci L. Total Abdominal Hysterectomy (Uterus Removal). Available at: <http://www.insidesurgery.com/OBGynsurgery>. Accessed May 4, 2007.
7. National Cancer Institute. *Dictionary of Cancer Terms*. Available at: http://www.cancer.gov/Templates/db_alpha.aspx?Cdrid=46056. Accessed May 4, 2007.
8. Netter F. *Atlas of the Human Body*. New York, NY: Icon Learning Systems; 2006.
9. Patient chart and surgeon preference card. Obtained with permission.
10. Price P, Frey K, Junge TL, eds. *Surgical Technology for the Surgical Technologist: A Positive Care Approach*, 2nd ed. New York, NY: Delmar Learning; 2004.
11. Rothrock JC. *Alexander's Care of the Patient in Surgery*, 13th ed. St Louis, MO: Mosby Elsevier; 2007.
12. Sharma K, Khurana N, Chaturvedi KU. Primary Squamous Cell Carcinoma [Electronic version]. *Journal of Gynecological Surgery*, December 2003.
13. Sills ES. Abdominal Hysterectomy: Trends, Analysis, and Sexual Function. *OBGYN.NET Publications*. Available at: http://www.obgyn.net/women/womanasp?page=/ah/articales/special_5-99. Accessed May 4, 2007.
14. Spratto GR, Woods AL. *PDR Nurse's Drug Handbook*, 2006 ed. New York, NY: Thomas Delmar Learning; 2005.
15. Tighe SM. *Instrumentation for the Operating Room: A Photographic Manual*, 6th ed. St Louis, MO: Mosby; 2003.
16. Vilanova Jr, P. Anesthesiology: Sedation of Patients in the ICU. Available at: <http://www.medstudents.com.br/anest/anest4.htm>. Accessed May 8, 2007.
17. Webb MJ. *Mayo Clinic Manual of Pelvic Surgery*, 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2000.
18. Winter WE, Gosewehr JA. Uterine cancer. Available at: <http://www.emedicine.com/med/topic2832.htm>. Accessed May 5, 2007.
19. Venes D, ed. *Taber's Cyclopedic Medical Dictionary*, 19th ed. Philadelphia, PA: FA Davis; 2001.

Betadine is a registered trademark of Purdue Pharma LP.

Diovan is a registered trademark of Novartis Pharmaceuticals Corporation.

Klenzyme is a registered trademark of Steris Corporation.

Nexium is a registered trademark of Astra Zeneca LP.

Primapore is a registered trademark of Smith and Nephew.

Synthroid is a registered trademark of Abbott Laboratories.

Vicryl is a registered trademark of Johnson & Johnson.

blood pressure

TERI JUNGE CST, CFA, FAST

Editor's Note: This is part of a review series of short articles about blood. Additional related topics include blood basics, blood components, blood types and the blood clotting mechanism.

blood pressure is the force of the blood within the vascular system against the vessel wall. The pressure—or force—is caused by the contraction of the heart pushing the blood into the arteries and also by the size of the blood vessel wall (resistance).

Typically, arterial blood pressure is measured. In certain situations, however, venous blood pressure also may be measured.

Blood pressure is measured in millimeters (mm) of mercury (Hg) and is recorded as two numbers in relation to one another (the format is similar to writing a fraction). Often, when recording blood pressure the designation “mm of Hg” is not included, as it is understood that this is the only method used for blood pressure measurement.

The systolic (when the heart is contracted) portion of the blood pressure is the higher number and is written first. The diastolic (when the heart is relaxed) portion of the blood pressure is the lower number and is written second, with a slash separating the two numbers (systolic/diastolic).

When the numbers are verbalized, the slash is represented with the word “over.” For example, a blood pressure that is written as “120/80” is spoken or heard as “one twenty over eighty.”

PHYSIOLOGY OF BLOOD PRESSURE MAINTENANCE

Several negative feedback systems are in place to help regulate blood pressure and blood flow to keep the body in balance (homeostasis). The body is able to carry out some of these responses within seconds, while other responses may not be evident for several hours or days.

The resultant changes help raise or lower the blood pressure as needed. All blood pressure maintenance systems will not be discussed in this article.

Pressure sensors, called baroreceptors, are located within the walls of the arteries and the heart. The baroreceptors sense if the blood pressure is normal, too high or too low and then send signals to the regulation centers in the brain to maintain, increase or decrease several physiological functions, including:

- Heart rate;
- The intensity of the contractions of the heart;
- Contraction or dilation of blood vessels; and
- The kidneys' ability to retain or release fluid.

Hypertension... Consider the numbers⁵

"High blood pressure precedes 74% of cases of heart failure in the United States.

High blood pressure is the second leading cause of chronic kidney failure in the United States.

High blood pressure causes more visits to doctors than any other condition—just a 10% decline in the number of visits would save \$450 million each year.

High blood pressure affects circulation—creating a higher risk for mental deterioration and Alzheimer's.

High blood pressure and its complications cost the US economy more than \$100 billion each year."

In addition to controlling the amount of fluid excreted in the form of urine, the kidneys also provide negative feedback that helps regulate blood pressure. The juxtaglomerular apparatus of the kidneys produces an enzyme called renin when blood pressure is too low.

Renin, in turn, activates a blood protein called angiotensinogen, which is a product of the liver, and converts it into angiotensin I. Angiotensin I is converted to angiotensin II by an enzyme



called angiotensin-converting enzyme (ACE), which is a product of the lining of the capillaries, particularly those found in the lungs.

Angiotensin II causes four responses that individually contribute to an increase in blood pressure. The presence of angiotensin II in the blood causes:

1. Cardiac output to be increased and the blood vessels to constrict. Cardiac output is the amount of blood that is pumped from the ventricles of the heart in a specified amount of time, such as one minute or one hour. Cardiac output is calculated by multiplying the number of heart beats per minute by the stroke volume, which is the amount of blood forced from either ventricle (the right ventricle to the pulmonary artery or the left ventricle to the aorta) with each heart beat.
2. A hormone called aldosterone to be released by the adrenal cortex, which results in an increase in the amount of sodium that is reabsorbed by the distal convoluted tubules of the nephrons of the kidneys. A secondary effect of the sodium reabsorption is water reabsorption.
3. A hormone called antidiuretic hormone to be released by the posterior pituitary gland, which directly causes the distal convoluted tubules to absorb more fluid and also causes vasoconstriction.

4. The thirst center in the hypothalamus to be stimulated, and fluid intake to be increased.

Epinephrine and norepinephrine are hormones that are released from the adrenal medulla, especially in times of stress. The presence of high levels of epinephrine and norepinephrine in the blood increase blood pressure and heart rate. The response of the adrenal cortex is part of the “fight or flight” response of the sympathetic nervous system.

FACTORS INFLUENCING BLOOD PRESSURE

An individual’s blood pressure normally varies throughout the day and over time. These variations are attributed to age, dietary intake (including, but not limited to, fluids—for example, sodium intake may be a factor), activity levels, cigarette smoking, alcohol intake, hormone levels, and periods of high stress, among other influencing factors.

Blood pressure is also affected by a number of medications and medical conditions.

Additionally, the strength of the contraction of the heart muscle, the volume of blood within the vascular system, the viscosity (thickness) of the blood, and vasomotor changes (constriction or dilation) that increase or decrease the resistance (tension) of the blood vessel walls also affect blood pressure.

Normally, the arterial wall is soft and elastic in nature. Over time, and due to dietary influences, the walls of the blood vessels may harden—causing increased resistance to blood flow, thus raising blood pressure. This condition of hardening is referred to as arteriosclerosis or—if there is a buildup of plaque (atheroma) within the vessel—it is called atherosclerosis.

“The strong association of high blood pressure with obesity and the marked increase in the prevalence of childhood obesity indicate that both hypertension and prehypertension are becoming a significant health issue in the young.”

Normal/optimal blood pressure

In the year 2000, the American Heart Association redefined what is considered normal blood pressure. Blood pressure is considered normal when it is less than 120/80 mmHg.

Blood pressure within the optimal range is necessary for good cardiovascular health and to reduce an individual’s risk of stroke. A consistently abnormal (repeated over time) blood pressure measurement (high or low) is an indication of a problem that may require medical intervention.



©iStockphoto/Lisa Fletcher

Prehypertension

Blood pressure is considered prehypertensive when the systolic reading is between 120–139 mmHg, and the diastolic reading is 80–89 mmHg. A diagnosis of prehypertension is a warning signal that an individual may be headed toward hypertension. An individual with prehypertension needs careful monitoring, and lifestyle changes may be recommended.

Hypertension

Hypertension, or high blood pressure, indicates increased pressure within the walls of the blood vessels. Blood pressure is considered hypertensive when the systolic reading is above 140 mmHg, and the diastolic reading is above 90 mmHg. Typically, both the systolic and diastolic pressures are elevated, although in some cases, only diastolic pressure may be affected.

Hold the salt!

According to the American Heart Association,⁸ Americans eat an average of 6-18g of salt every day ... far more than the 200 mg that our bodies actually need.

Where's all that extra salt coming from?

About 75% of it is coming from processed foods, like premade spaghetti sauce, canned foods and prepared mixes.

Read those food labels!

During your next trip to the grocery store, slow down and read the nutritional information printed on the back of what you're buying.

Ingredient words to avoid:

- Salt (sodium chloride)
- Monosodium glutamate (may be abbreviated as MSG)
- Baking soda (sodium bicarbonate)
- Baking powder
- Disodium phosphate
- Sodium compounds (anything with the word sodium in it, eg sodium alginate, sodium benzoate and sodium nitrite)

Typically, hypertension does not cause any symptoms, which is why it is referred to as the "silent killer." Some individuals, though, do experience symptoms, such as headache, dizziness, and vision problems.

Hypertension is considered a major contributing factor to heart disease and stroke and can result in kidney damage, nervous system disorders and vision difficulties.

In approximately 90–95% of individuals with hypertension, the cause cannot be determined,

and the condition is referred to as essential hypertension. It is suspected that essential hypertension is caused by genetics, caffeine intake, tobacco smoking, obesity, sodium intake, lack of exercise, strong heart contractions, rapid heart rate or vasoconstriction.

Lifestyle changes and the use of medications that reduce resistance to blood flow in the arteries, such as diuretics, vasodilators, renin inhibitors, ACE inhibitors and calcium blockers can lower blood pressure. Beta adrenergic blockers are useful in controlling the heartbeat.

When hypertension is the result of another problem, it is referred to as secondary hypertension. Hypertension may be secondary to diabetes, kidney disease, toxemia of pregnancy, vascular disease and endocrine imbalances. Treatment of the causative condition usually causes the blood pressure to return to the normal range.

Hypotension

Hypotension, or low blood pressure, indicates decreased pressure within the walls of the blood vessels. In most cases, low blood pressure is desired. However, if the blood pressure is too low, organs and body tissues may not receive enough oxygenated blood and nutrients.

If an area of the body does not receive the substances necessary to sustain the life of the cells, permanent damage or tissue death may result. Hypotension is only considered problematic if the patient is experiencing symptoms.



©iStockphoto/Serena Vagci



©iStockphoto/Simon van Den Berg

Symptoms of low blood pressure include dizziness and fainting—especially when moving from a lying or sitting position to a standing position (postural or orthostatic hypotension).

Causes of hypotension that produce problematic symptoms include the administration of various medications, dehydration, hemorrhage (hypovolemic shock), toxic shock, psychogenic shock, vasodilation, slow or inadequate heart contractions and excessive urine production.

Treatment of hypotension includes administration of blood or other intravascular fluids and use of vasoconstrictors and medications to increase the force and/or frequency of the contractions of the heart.

“More women than men have died of cardiovascular diseases every year since 1984. Cardiovascular disease kills as many women each year as the next 16 causes of death combined, including breast cancer.”

BLOOD PRESSURE MEASUREMENT

Blood pressure is measured with a sphygmomanometer. The sphygmomanometer may be an automatic electronically controlled device capable of recording the measurements at specific time intervals, or it may be a manual device that typically requires the additional use of a stethoscope.

A manual sphygmomanometer consists of four main components. All of the components are connected with flexible tubing.

- Inflatable cuff—Available in a variety of sizes
- Pump—Inflates the cuff
- Valve—Controls the pressure in the cuff
- Column of mercury or a dial—Displays the pressure

A series of sounds, called Korotkoff’s sounds, are heard when listening (auscultation) to the blood pressure. Korotkoff’s sounds occur in five distinct phases that must be identified during blood pressure measurement.

Phase I Two initial tapping sounds are heard. The listener notes the pressure on the gauge and interprets that number as the systolic blood pressure.

Phase II A soft, swishing sound is heard as the cuff is further deflated, and more blood passes through the artery.

Phase III Rhythmic tapping sounds are heard as the cuff is deflated further. This phase is often misinterpreted as the systolic blood pressure.

Phase IV The tapping sounds become muffled and faded, as the cuff is further deflated.

Phase V Sounds disappear completely. The listener notes the pressure on the gauge and interprets that number as the diastolic blood pressure.

The following technique is used to measure blood pressure manually. Remember—standard precautions require that the caregiver’s hands are washed before and after providing patient care.

1. Secure the necessary equipment (sphygmomanometer and stethoscope or an automated blood pressure machine). Use of a sphygmomanometer and stethoscope will be described.
2. The patient is typically in the sitting or supine position. (When attempting to diagnose orthostatic hypotension, the blood pressure may also be measured with the patient standing up.)

Women are at particularly high risk³

“Despite the efforts of many health care professionals, voluntary health organizations and policy makers, many women—as well as many healthcare professionals—are still unaware that cardiovascular disease is the leading cause of death among women.”

To commemorate the fifth anniversary of the launch of its “Go Red for Women” campaign, the American Heart Association (AHA) devoted the entire April 1, 2008, issue of its clinical journal, *Hypertension*, to the unique issues and challenges surrounding women, hypertension and the resulting cardiovascular risks.

According to research data published in AHA’s *Heart Disease and Stroke Statistics—2008 Update*, “high blood pressure kills significantly more women than men.”

For free access to the online version of this special issue of *Hypertension*, visit: http://hyper.ahajournals.org/current.dtl#GO_RED_PREFACE

3. Apply the appropriate size blood pressure cuff to the left (preferably) upper arm. (Note: Alternate sites, such as the wrist, ankle or thigh, may be used, but in most situations the upper arm is preferred.)
4. Locate the brachial artery at the antecubital portion of the elbow, and place the stethoscope over the artery.
5. Secure the stethoscope with the fingers (not the thumb).
6. Inflate the blood pressure cuff to the appropriate pressure.
7. Deflate the blood pressure cuff slowly while listening for Korotkoff's sounds.
8. Note systolic (Korotkoff Phase I) and diastolic (Korotkoff Phase V) blood pressure measurements.
9. Continue to deflate the blood pressure cuff, and note the auscultatory gap, if present.

Lowering Blood Pressure with Diet and Exercise

LOWERING BLOOD PRESSURE WITH DIET

There are two kinds of high blood pressure or hypertension. Primary or essential blood pressure has no known specific cause and is the most common type occurring in the population. The other or second type does have an organic causal factor, such as kidney disease or pregnancy. Secondary blood pressure must be evaluated and monitored by a physician who will address the specific cause(s).

Although there is not one specific underlying factor that results in primary hypertension, it is often being successfully addressed by an individual's alterations in lifestyle, such as weight loss, dietary changes, exercises and stress reduction, as well as medications.

Many treatment options are easily accomplished at a very low cost and accessible to everyone. What you eat has a major influence on whether or not you may develop high blood pressure. Certain foods can increase blood pressure. Weight gain increases blood pressure. Healthy eating not only reduces the risk of developing high blood pressure but also contributes to overall health.

- The general rule of thumb for recommended foods that control high blood pressure include:
- Eat foods lower in fat, salt and calories
- Use spices and herbs, instead of salt to flavor foods
- Reduce oil, butter, margarine, shortening and salad dressings

One of the hidden contributors to salt in most diets is prepared foods. Read labels carefully and remember, even such items as parmesan cheese contain high levels of sodium.

Recommended foods include:

- Low fat or 1% milk
- Lean meat

- Skinless turkey or chicken
- Low-salt, ready-to-eat cereals
- Cooked hot cereal (not instant)
- Low-fat and low-salt cheeses
- Fruits, (fresh, frozen or canned without added salt)
- Vegetables (fresh, frozen or canned, no added salt)
- Plain rice, pasta and potatoes
- Breads (English muffins, bagels, rolls and tortillas)
- Lower salt "prepared" convenience food

Foods to avoid include:

- Butter and margarine
- Regular salad dressings
- Fatty meats, lunch meats, sausage, bacon, ham
- Whole milk dairy products
- Fried foods
- Salted snacks, such as chips, pretzels—etc
- Regular canned soups, bouillions, dried soup mixes
- Fast food
- Deli meats
- Weight control prepared foods (often high in sodium)
- Condiments, such as ketchup, soy sauce)
- Pickled or marinated food

What about sodium

The American Heart Association recommends limited daily sodium intake to no more than 2,300 milligrams. Considering that a teaspoon of salt has about 2,400 milligrams of sodium means that most people exceed the recommended amount several times over.

Common table salt is a compound of mostly sodium and chloride (NaCl); a mineral that occurs in many foods naturally. It is the sodium that causes

blood pressure to rise. There are other types of sodium that are also present in food, such as monosodium glutamate (MSG) that is a common ingredient in many Asian recipes.

But there are now other forms of salt available that are not sodium based and are becoming more and more popular. Gray salt, pink salt and others are now available at many food stores and can be used to season cooked foods rather than the common table salt.

Besides salt, it's a good idea to remember that some of these foods, while low in sodium, are also high in fat, which is another factor to consider in lowering blood pressure. Dairy items are often available in low fat varieties and should be given preference when adopting a diet to reduce blood pressure.

Comparison of sodium in food²

Meat, poultry, fish and shellfish (3 oz)

Fresh meat, cooked, 90 mg or less
Shellfish, 100-325 mg
Tuna, canned, 300mg
Lean ham, 1,025

Dairy

Whole milk, 1 cup, 120 mg
Skim or 1% milk, 1 cup, 125 mg
Buttermilk (with salt), 1 cup, 260 mg
Swiss cheese, 1 oz, 75 mg
Cheddar cheese, 1 oz, 175 mg
Low-fat cheese, 1 oz, 150 mg
Cottage cheese, regular, ½ cup, 455 mg

Vegetables

Fresh or frozen, (canned, no salt added), ½ cup, 70 mg or less
Vegetables, canned or frozen (no sauce), ½ cup, 55-470 mg

10. Remove the blood pressure cuff when fully deflated.
11. Record or report findings.
12. Care for the equipment as needed, and return it to its storage location.

Blood pressure also can be monitored internally. A specialized catheter is inserted into a vein or artery and attached to a transducer with the pressure readings displayed on a monitor.

CONCLUSION

Millions of Americans are affected by high blood pressure. Maintenance of optimal blood pressure is essential to living a long healthy life.

In many cases, normal blood pressure can be achieved by eating sensibly and following a moderate exercise program. If a person's blood pressure cannot be brought into normal range with lifestyle changes, various medications are available to help the individual manage blood pres-

Tomato juice, canned, $\frac{3}{4}$ cup, 660 mg

Breads, cereals, rice and pasta

Bread, 1 slice, 110–175 mg

English muffin, half, 130 mg

Shredded wheat, ready-to-eat, $\frac{3}{4}$ cup, 5 mg or less

Cereal, cooked and unsalted, $\frac{1}{2}$ cup, 5 mg or less

Cereal, cooked, instant, 1 packet, 180 mg

Canned soup, 1 cup, 600–1,300 mg

Prepared convenience food

Main dishes, canned and frozen, 8 oz,
500–1,570 mg

Successful Strategies to Lower Sodium

Read food labels. Most of our food displays nutrition information, and order of ingredients is printed from the highest to lowest. Ideally, sodium should be one of the last ingredients shown. A food is considered low sodium if it has less than five percent of your daily value of sodium per serving.

- Buy fresh when possible. Processed foods often contain sodium, and fresh foods naturally have less sodium. If buying prepared food, find the low fat, reduced sodium choices.
- Fresh fruit such as apples, oranges and bananas, berries, dates and apricots are always welcome additions to a low sodium diet. Choose fruit canned in its own juice or water rather than heavy syrup.
- When baking, use low-fat egg substitutes, unsweetened cocoa powder, fat-free cooking spray or even try applesauce or mashed bananas to sweeten your desserts.
- Rinse canned foods, such as tuna and vegetables, to wash away excess sodium.
- Avoid frying foods and grill, broil, poach, or stir-fry.

- Saute onions, mushrooms, or other vegetables in a small amount of low-sodium broth or water.
- Use unsoftened water for drinking and cooking since water softeners may add sodium.
- Be your own chef of low-sodium cuisine and modify recipes that call for a high use of sodium. Experiment with herbs and spices, cinnamon for desserts or fruit. A low-sodium diet does not mean you have to eliminate all the foods you enjoy. Moderation is the key.

LOWERING BLOOD PRESSURE WITH EXERCISE

Another resource that can help individuals lower their blood pressure is physical activity. Regular exercise can assist in the prevention of high blood pressure and for patients with high blood pressure, doctors often recommend a regular exercise routine.

Simply, exercise strengthens the heart muscles and stronger hearts don't have to work as hard to pump blood. When the heart works less, less force (pressure) on the arteries is the result.

For people with high blood pressure, exercise can lower blood pressure by an average of 10 mm Hg, and that's the result that is achieved by some medications. If individuals have a healthy blood pressure, then exercise can keep it from rising and is also effective in maintaining a healthy weight. And obesity is another factor that contributes to high blood pressure. However, to be effective, exercise must be regular and continual.

Aerobic exercise, the type that gets your heart pumping and your breathing accelerated is the most beneficial. A minimum of 30 and up to 60 minutes at least three times per week is suggested.

There are many, many types of exercises that offer physical benefits. Review the following choices and choose several to vary your plan.

- Brisk walking
- Bicycling
- Rowing or canoeing
- Swimming
- High- or low-impact aerobics
- Jumping rope
- Dancing

Almost any activity that accelerates your heart rate and breathing can be considered aerobic—even mowing the lawn, washing windows, etc.

Talk your doctor

Always check with your physician before beginning a new plan of exercise. If you are a male over 40, or a female over 50, consult with your physician. If you are overweight, have a chronic health condition, experienced a heart attack, smoke, have a family history of cardiac problems or felt pain in your chest, or become dizzy when exercising, be sure to talk with your doctor before starting any aerobic exercise program.

Stop exercising if you feel weakness, dizziness, chest pain or discomfort in your neck, arm, jaw or shoulder, and seek medical assistance.

Keep track of your progress with regular blood pressure checks—either at your doctor's or at home. Verify that your home blood pressure unit is accurate.

References

1. www.mayoclinic.com
2. www.clevelandclinic.org
3. www.mayoclinic.com/health/high-blood-pressure/H100024. Accessed April 8, 2008.
4. <http://hypertension.medicweb.org/lifestyle/exercise.php>. Accessed April 8, 2008.

sure that is either too high or too low—thereby avoiding secondary problems related to hypo/hypertension.

ABOUT THE AUTHOR

Teri Junge, CST, CFA, FAST, is the surgical technology program director at San Joaquin Valley College in Fresno, California. She is the medical reviewer for this journal and is the author of numerous educational publications and textbooks.



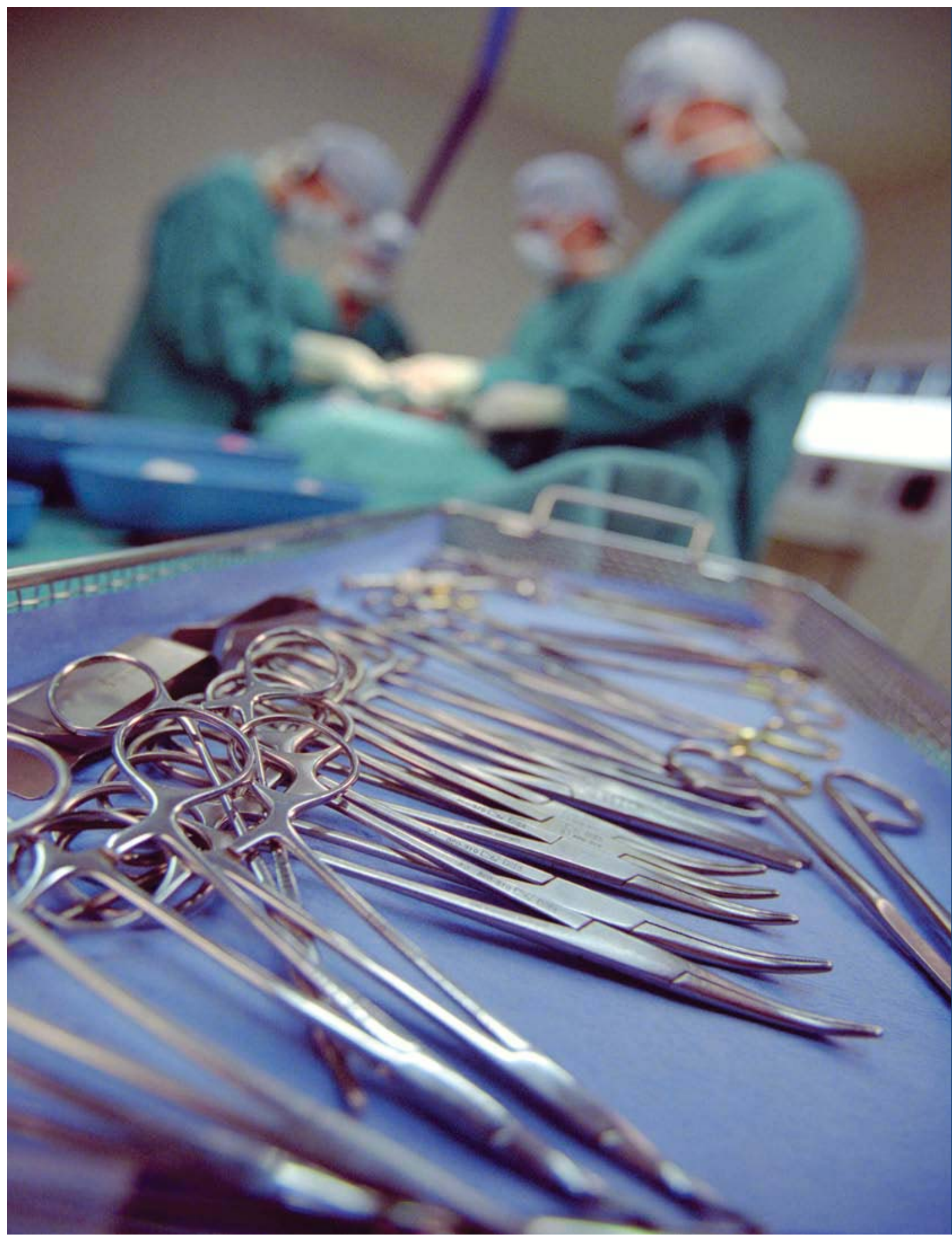
©iStockphoto/Lisa F. Young

EDITOR'S NOTE

May is National High Blood Pressure Education Month, sponsored by the US Department of Health and Human Services—National Heart, Lung and Blood Institute. For information, visit: <http://www.nhlbi.nih.gov/about/nhbpep/index.htm>

References

1. American Heart Association. Available at: <http://www.americanheart.org>. Accessed March 10, 2008.
2. Applegate E. *The Anatomy and Physiology Learning System*, 2nd ed. WB Saunders Co: Philadelphia, PA;2000.
3. Hall JE, Granger JP, Reckelhoff JF, Sandberg K. Hypertension and Cardiovascular Disease in Women. *Hypertension*. 2008;51:951. Available at: http://hyper.ahajournals.org/current.dtl#GO_RED_PREFACE. Accessed April 1, 2008.
4. Heart Center Online for Cardiologists and their Patients. Available at: <http://www.heartcenteronline.com>. Accessed March 10, 2008.
5. High Blood Pressure in the United States. Prevent and Control America's High Blood Pressure: Mission Possible. National High Blood Pressure Education Program. National Heart, Lung and Blood Institute. National Institutes of Health. Available at: <http://hp2010.nhlbi.nih.net/mission/about/bhp/aboutbhp.htm>. Accessed April 1, 2008.
6. Hypotension. Medicine Net. Available at: http://www.medicinenet.com/low_pressure/article.htm. Accessed March 23, 2008.
7. Memmler RL, Cohen BJ, Wood DL. *The Human Body in Health & Disease*, 10th ed. Lippincott Williams & Wilkins: Philadelphia, PA;2005.
8. National Heart, Lung and Blood Institute—National Institutes of Health. Available at: <http://www.nhlbi.nih.gov>. Accessed March 10, 2008.
9. Price P, Frey K, Junge T, eds. *Surgical Technology for the Surgical Technologist: A Positive Care Approach*, 2nd ed. Delmar Thompson Learning: Albany, NY;2004.
10. Shake Your Salt Habit. American Heart Association. Available at: <http://www.americanheart.org/presenter.jhtml?identifier=2106>. Accessed April 1, 2008.
11. Solomon EP. *Introduction to Human Anatomy & Physiology*, 2nd ed. WB Saunders Co: Fort Worth, TX;2003.
12. Strategies for Saving Lives. Prevent and Control America's High Blood Pressure: Mission Possible. National High Blood Pressure Education Program. National Heart, Lung and Blood Institute. National Institutes of Health. Available at: <http://hp2010.nhlbi.nih.net/mission/about/bhp/save.htm>. Accessed April 1, 2008.
13. *The Fourth Report on the Diagnosis, Evaluation and Treatment of High Blood Pressure in Children and Adolescents*. NIH Publication No. 05-5267. Revised May 2005. National High Blood Pressure Education Program. National Heart, Lung and Blood Institute. National Institutes of Health. Available at: http://www.nhlbi.nih.gov/health/prof/heart/hbp/hbp_ped.htm. Accessed April 1, 2008.



Safety Concepts in the Surgical Setting

ANN M MCGUINNESS, CST, CNOR, MEd

The operating room is a place commonly associated with the elimination of disease and restoration of normal body function for its patients. It is, though, one area of the health care facility that potentially includes a significant number of hazards for both the patient and the staff. Keeping both groups free from injury is an important component of the surgical experience. The role of the operating room professional mandates that the O.R. staff assure the creation and maintenance of a safe environment before, during, and after the surgical intervention. This article examines the hazards and dangers commonly associated with surgical practice and some of the practices and safeguards in place to assess and address these issues.

PHYSICAL AND PSYCHOLOGICAL HAZARDS

The primary goal of the patient intervention is to provide a safe and positive operative experience. The operating room, by its nature, is an environment that contains numerous sources of potential injury for the patient. In addition, patients coming to the O.R. often experience alterations in decision-making abilities induced by stress, medications, or other factors that can significantly contribute to iatrogenic injury. It is the duty of the team to ensure that the patient's O.R. experience is safe. This can be achieved by following health care facility policies and procedures, the proper use of equipment, and the implementation of basic safety practices.



PHYSICAL DANGERS

Stretchers on wheels, narrow operating room tables, an unfamiliar environment, and sensory overload can all contribute to a potential for physical patient injury. The primary causes of physical injury include falls and positioning injuries.

Falls

Operating room tables and stretchers are specifically designed with narrow dimensions to meet the needs of the operating room environment and the O.R. team. Safeguards that are implemented to address the concerns related to falls include:

1. Never leave a patient in the operating room setting (holding area, O.R. suite, PACU, etc) unattended. An anxious or medicated patient may “forget” that he or she should not get up or move around, contributing to a fall and possible injury.
2. Side rails and/or a patient safety belt should always be used when a patient is resting on a narrow surface (O.R. table) or a moveable surface (stretcher). The safety belt should be applied in a position to restrict patient movement, but should not be applied so securely that the patient experiences hyperextension of joints or undue skin pressure. For those patients who are young and might attempt to climb over side rails, an enclosed transport/crib should be utilized.
3. When the patient is moving between two surfaces, such as the stretcher and the O.R. table, a minimum of two persons, one on each side of the stretcher and the table, should be available to guide the patient in a safe transfer. Reliance on the break mechanism on the stretcher for stability can leave the patient at risk for injury. When the staff is transferring the patient, a minimum of four people, one on each side of the patient, is required for a safe and effective transfer.

Positioning injuries

Surgical positioning and the use of positioning devices have a potential to lead to physical injury. The anesthetized patient may not be able to “complain” of hyperextended joints or undue pressure on the skin. It is the responsibility of the O.R. team to assure patient comfort by implementing the following practices:

1. Never hyperextend a joint or abduct a joint greater than 90 degrees from midline. Abduction of the upper extremities greater than 90 degrees can lead to brachial plexus palsy and neurovascular compromise.
2. Pad all pressure points, especially over bony prominences.
3. Never place patient skin against “plastic” or non-absorbent surfaces. The moisture secreted by the skin during the operative

intervention can lead to skin maceration and breakdown.

4. Use extreme caution when raising and/or lowering the foot section of the O.R. table. Patient fingers can easily fall across the break of the bed, and can result in finger crushing.
5. Use care when placing the patient in the lithotomy position. Ensure that both lower extremities are raised/lowered, rotated and moved in a mirrored fashion. This prevents hyperextension of any one of the numerous joints involved with attaining this position and subsequent neurovascular injury. It is advisable to have two people involved in positioning the lower extremities, one managing each limb.
6. Never use the patient as a “Mayo stand” by placing large numbers or heavy instruments on a draped patient’s extremities or torso.
7. Monitor and control the position of drains, tubings, and catheters during the patient’s transfer to eliminate accidental dislodgment.

Electrical dangers

The energy source for most modern technology used in the operating room suite is electricity. While electricity will flow within a circuit, any disruption in that circuit, or the creation of an alternative pathway to ground, can serve to include the patient within the electrical circuit. This can lead to inadvertent thermal burns from concentrated electrical flow. The electrosurgical unit, used in almost every operative intervention today, purposefully passes electrical current through patient tissue for the purposes of coagulation and desiccation of tissue. It is important that patient safeguards are utilized to ensure that the electricity returns to the generator without unintended patient injury. This is accomplished by proper application and use of patient return electrodes (grounding pad) for monopolar electrosurgery, and the assurance that all patient skin is not in contact with metal surfaces on the O.R. table.

Lasers, the use of amplified light waves concentrated to a point where they can vaporize tissue and cellular fluids, have added a valuable tool to today’s surgical setting. While the advantages

of using lasers are numerous, the inherent danger of controlling light emission is compelling. Stray laser beams from some types of lasers can travel distances, causing thermal injury at the point of contact. Tissues particularly vulnerable to the effects of laser application include the retina of the eye, thus laser safety glasses or other appropriate eye protection devices are required during laser usage. (See sidebar pg 256.)



Mechanical dangers

The concepts of pressure and shear force are commonly associated with a surgical intervention. Pressure, the application of a force greater than the tissue resistance, can decrease blood flow to the point of creating ischemia, necrosis, and even gangrene. Pressure points on the body include those areas where bony prominences underlie thin adipose tissues and skin layers. Common locations for pressure points include the occipital area, the ear, nose, chin, elbow, pelvis, and heel. During surgery, the patient is rendered immobile by the use of anesthetic agents and is unable

to redistribute his or her weight when increased pressure on an area is detected. The goal of the O.R. team is to reduce the pressure created by an immobilized patient on a firm surface. This can be accomplished by using padding, such as gel pads and pressure relief viscoelastic foam pads under these susceptible areas.

Shear is the force created on skin by the movement of the underlying tissues. This results in compression of blood vessels, which decreases blood flow to the area. Shear force is generated when the body slides on a bed surface, and it contributes to skin breakdown in compromised and immobile patients. It can also occur when a sheet or johnny is “pulled out” from underneath a patient without turning the patient side to side.

The use of proper positioning, transferring, and turning techniques will minimize skin injury caused by friction and shear forces.

Thermal dangers

Burns

Burns, or thermal tissue injury, can occur as a result of many activities in the operating room. The application of a “hot” instrument from the “flash” autoclave, fiberoptic light sources, fiberoptic cords placed on drapes or near patient tissues, the use of irrigating fluids that have been warmed to greater than body temperature, all serve as potential causes of thermal injury. The surgical technologist has the obligation to prevent thermal injuries by controlling fiberoptic

Laser Hazards and Eye Protection

A laser serves as a nearly ideal point source of intense light. A sufficiently powerful laser beam can possibly produce retinal intensities that exceed conventional light sources, including those produced when directly viewing the sun. Consequently, viewing lasers can result in permanent blindness. Direct exposure on the eye by a beam of laser light should always be avoided with any laser, no matter how low the power. Eye protection requires that O.R. personnel be thoroughly familiar with two terms, maximum permissible exposure (MPE) and nominal hazard zone (NHZ).

The American National Standards Institute (ANSI) defines MPE as the level of radiation that an individual may experience without hazardous effects or biological consequences to the eye or skin. The MPE is based on the laser wavelength, exposure time and pulse repetition. According to ANSI, the NHZ is the space where the level of the direct, reflected or scattered radiation during the use of the laser exceeds maximum permissible exposure. Essentially, it identifies the area where safety measures must be mandated. In the operating room, the entire space is considered the NHZ, and appropriate protection is required for any staff member entering the O.R.

when a laser is being used.

Lasers are often employed in the operating room for excision and cauterization of tissue. The operating room staff should be very conscious of the health care facility's policies regarding laser safety. Even the exposure to a small amount of laser light can cause permanent eye injuries. The O.R. team member may be unaware of an exposure to laser radiation (particularly the invisible light). Some lasers are powerful enough to diffuse the reflection from a surface which can unexpectedly cause damage to the eye. Eye injuries are primarily the result of the thermal effects experienced by the retina. A transient increase of only 10 degrees C can cause the photoreceptors in the retina to be destroyed.

Such damage can occur within a fraction of second because of the low divergence angle of laser light combined with the focusing mechanism of the eye which allow the laser light to be concentrated into an extremely small spot on the retina. An injury may be sustained faster than the blink of an eye. Visible to near infrared radiation will penetrate the eyeball and cause heating of the retina. Exposure to lower wavelengths of laser radiation results in the develop-

ment of cataracts or burns, because the light is absorbed by the cornea and lens.

Particularly dangerous in the operative environment are infrared lasers which are invisible to the O.R. personnel. The Nd:YAG laser beam, which is in the near-infrared electromagnetic spectrum is commonly used in the O.R. for vaporizing bladder tumors, laser bronchoscopy and laparoscopy. If a team member has been exposed, he or she may not feel pain or notice immediate damage to his or her eyesight. A pop or clicking noise may be heard indicating that the retina was overheated and a localized boiling resulting in a permanent blind spot may be a consequence.

Based on the potential for biological damage, there are four classes of lasers:

- **Class 1** lasers represent the least dangerous applications of light energy and are regarded as incapable of producing damaging levels of laser emission.
- **Class 2** lasers produce visible laser emissions and may be viewed directly for .25 seconds or less. (The time it takes for a blink of an eye or a head swing).
- **Class 3a** lasers are regarded as dangerous

cords, and checking fluids and instruments for proper temperature prior to patient application.

Fire

The operating room is a prime location for fire to occur. The necessary components for fire ignition—oxygen, a fuel source, and source of ignition—are all readily found in the O.R. environment.

Some of the practices of concern that need to be carefully monitored by the health care team include:

1. Care during the use of flammable skin preparation solutions, such as alcohol and tinctured or alcohol-based solutions
2. Care during the use of flammable liquids and

3. Caution in the presence of ignition sources, such as electrosurgical pencils and lasers, especially near oxygen sources, such as in surgery of the larynx or mouth
4. Monitoring fiberoptic light cords on the sterile field, particularly when placed on, or near, disposable draping materials and the use of standby light settings when light cords are not attached to telescopes
5. Wearing non-cotton garments by O.R. staff, which may produce static electricity
6. Venting heat generated from electrical equipment away from the surgical field and the anesthesia machine

under direct or reflected vision. These lasers are restricted to the visible electromagnetic spectrum.

- **Class 3b** lasers are considered hazardous when viewed intrabeam and may extend over the entire electromagnetic spectrum.
- **Class 4** lasers are the highest energy class of lasers and also extend across the electromagnetic spectrum; they can cause serious damage to skin and eyes.

In the operating room, the most commonly employed lasers belong to class 3b and class 4.

Below is a list of the potential hazards to eyes when working with lasers.

Light Source	Injury to Eye
Ultraviolet C (0.200-0.280 μm)	Photokeratitis
Ultraviolet B (0.280-0.315 μm)	Photokeratitis
Ultraviolet A (0.315-0.400 μm)	Photochemical UV cataract
Visible (0.400-0.780 μm)	Photochemical and thermal retinal injury
Infrared A (0.780-1.400 μm)	Cataract, retinal burns
Infrared B (1.400-3.00 μm)	Corneal burn Aqueous flare IR cataract
Infrared C (3.00-1000 μm)	Corneal burn only

In the operating room, eye protection is designed to protect against radiation from a specific laser. This generally applies only to Class 3b and Class 4 lasers. The effectiveness of eye-wear is critically dependent on the frequency of use. Selecting the right type of eye protection is important. Protective eyewear must be able to block the laser radiation when it strikes the lens portion, or at the minimum reduce the radiation to a permissible exposure level. This protection level is defined as the optical density (OD). Two important factors influence the type of eye protection chosen—wavelength coverage and optical density. Commonly, these specifications are imprinted on the safety goggles. For example, a pair of Nd:YAG goggles may be imprinted with “for use with 1064 nm.” It should be noted that the lens color of the goggles is not related to the protection against the laser beam.

For procedures using ultraviolet and infrared laser radiation, the OD chosen by the team members should provide full protection. For example, using the chart to the left, goggles rated to protect against ultraviolet C would not be effective protecting an individual who was exposed to Infrared A.

In addition to the O.R. team, the patient’s eyes must also be protected by moistened gauze pads, or appropriate safety goggles or glasses.

Health care facility policies will recommend the frequent inspection of laser goggles in order to detect cracks or breaks. A scratched surface permits the transmission of laser light and possible injury. In addition to the actual operating room personnel, other employees who walk by the surgical room must be protected and windows are therefore covered as necessary. To prevent reflection, instruments that are not dulled or ebonized, should be covered with wet towels or sponges.

Surgical technologists may be asked to undergo an ocular examination when hired to work in a surgery using lasers and another examination upon resignation or termination of employment. These eye examinations establish necessary baselines and protect the employee and the hospital. Laser safety should be considered a critical priority of the O.R. staff and health care facility. Inquire about policies where you work and be sure that you are well informed and up to date regarding laser safety.

7. Ensuring electrical cords and wall plugs are intact and appropriately grounded
8. Ensuring proper environmental humidity is maintained to reduce the potential for static electricity formation

Chemical dangers

Antiseptic solution use

Antiseptic agents, used to decrease the transient and resident microbe population of the patient's skin prior to, and during, the surgical intervention, can cause skin irritation with prolonged contact and application. Povidone-iodine solutions that have been warmed are more prone to causing contact dermatitis, especially in patients with delicate skin, such as the young, elderly, or when contacting tissues of the perineum. Antiseptics should only contact the skin for as long as necessary. Excess prepping solution should not be allowed to pool on patient skin surfaces and should be removed at the end of the procedure during dressing application.

Cold chemical sterilant use

Activated glutaraldehyde and peracetic acid, chemicals used for cold disinfection and sterilization of surgical instruments and equipment, can be caustic to the skin of both the patient and the health care worker. Care should be taken to ensure that all traces of activated glutaraldehyde and peracetic acid have been removed by rinsing with sterile water prior to contact with patient skin or mucous membranes.

Latex sensitivity and allergy

Natural rubber latex is a chemical used in the manufacture of supplies employed in the operating room. The protein in natural rubber latex serves as an antigen in selected patients, triggering an immune system response in susceptible individuals. This response can range from contact dermatitis to full-blown anaphylaxis, and even death.

Patients at risk for developing latex sensitive and/or allergy include³:



1. Those who possess a known or suspected allergy to latex by having exhibited an allergic or anaphylactic reaction, positive skin testing, or positive IgE antibodies against latex
2. Those with documented history of intraoperative anaphylaxis of unknown etiology
3. Those with neural tube defects including:
 - Spina bifida
 - Myelomeningocele/meningocele
 - Lipomyelomeningocele
4. Those who have experienced some interaction between their central nervous and immune systems
5. Those who have had multiple operations, particularly as a neonate
6. Those who require chronic bladder catheterizations as a result of:
 - Spinal cord trauma
 - Extrophy of the bladder
 - Neurogenic bladder
7. Those who possess some history of multiple allergies including food products, particularly bananas, avocado, celery, fig, chestnut, papaya and passion fruit

Proper care of the patient is essential to his or her safety from anaphylactic reactions and to assure an ideal outcome. Recommended practices should be developed and implemented within each health care facility. These practices may include:

- scheduling a latex-sensitive patient as the first procedure of the day;
- identification of O.R. products and equipment that contain natural rubber latex and replacing them with latex-free products, or protecting them from contacting patient skin;
- developing a committee to focus and monitor issues related to latex sensitivity; and
- using non-powdered gloves in the O.R. setting

Radiation

Radiation is invisible. The effects of radiation exposure are seen most readily on the cellular level, where they can change the electrical charges of atoms within cells, altering genetic material, even when used in therapeutic doses. Those tis-

sues most susceptible to changes from radiation exposure include the thyroid gland, the lens of the eye, bone marrow, and the ovaries/testes.

In the operating room, radiation is used in the forms of fluoroscopy, X-ray, and radioactive substances. Fluoroscopy is a technique that provides live images of internal structures during an operative intervention. These images are used to guide implantable device placement, check for align-



ment of bones, or the recording of images outlined using contrast media. X-rays are used when live imaging is not necessary, but is less frequently used in today's O.Rs, being replaced by more frequent use of fluoroscopy. Radioactive substances may be injected into the patient prior to arrival in the O.R. suite, or may be implanted during a surgical procedure for the detection or treatment of neoplasms. The effects of radiation seen are related to the amount and length of an exposure. The goal of protection for both staff and patient is to minimize exposure to radiation while permitting diagnosis and monitoring of interventions. Safety interventions can include minimizing the time and length of exposure during fluoroscopy and X-ray; applying lead shielding over the portion of the patient's body that does not need to be viewed; tight focusing the radiation beam, whenever possible; and protecting the unborn fetus from radiation exposure in the pregnant patient.

PSYCHOLOGICAL ASSAULT

The sense of hearing is the last sense to leave and the first to return in the patient undergoing general anesthesia. Patients are acutely aware of the sounds in the O.R. environment, and “assume” that any and all conversation is related to them and their care. It is important that the patient be protected from psychological assault, by the implementation of the following practices:

1. Minimize extraneous O.R. noises and traffic, especially when the patient is awake.
2. Focus all conversation within patient hearing on the issues and needs of that patient. All other conversation should be conducted outside the patient’s range of hearing.
3. Use positive communication techniques during patient-focused conversation.
4. Avoid the use of “trigger phrases.”



Through awareness of the dangers present in the O.R., the surgical technologist can play an instrumental role in providing a safe and positive therapeutic environment.

SAFEGUARDS IN SURGICAL PRACTICE

Standards of Practice

Guidelines for patient safety have been established by many organizations both directly and indirectly related to surgical practice. In 2004, the AST Education and Professional Standards Committee began researching practice issues after it was recognized that there was a need for a comprehensive publication focused on evidenced-based standards of practice. Recently, AST published several recommended standards of practice, position and guideline statements both in print and online. In the near future, additional topic areas will be published. It is anticipated that these standards of practice are considered dynamic and will change as needed to reflect advances in technology and care practices.

In addition to AST, other organizations and nursing groups in the US, Canada, Australia, and Great Britain, such as the Association of Perioperative Nurses (AORN) have published standards of practice that guide perioperative practice.

The Joint Commission requires hospitals to implement written policies and procedures for patient care. Hospitals voluntarily undergo The Joint Commission accreditation review every three years to measure compliance with established standards of practice. Successful attainment of The Joint Commission accreditation is a requirement in order for hospitals to receive JUA (Joint Underwriter’s Association) malpractice insurance.

In 1965, the US Federal Medicare Act was passed, providing medical coverage to individuals 65 years of age and older, or to those with disabilities. When the Medicare Act was introduced, it included policies and procedures that impact health care delivery. Additional federal agencies that have established policies and procedures that affect surgical practice include the Federal Food and Drug Administration (FDA) and Occupational Safety and Health Administra-



tion (OSHA). Other national organizations that have developed regulations, policies, and procedures utilized in the care of surgical patients include the National Fire Protection Association (NFPA), the Association for Advancement of Medical Instrumentation (AAMI), and the American National Standards Institute (ANSI).

Quality assurance

Quality assurance involves the implementation of methods and processes to measure the quality of patient care, based on the standards of practice established by the health care facility. The American Hospital Association's (AHA) Patient's Bill of Rights states that each and every patient is entitled to the same level of care, regardless of his/her ability to pay for that care or any other external factor. Hospitals are required to internally and externally monitor the level of quality care delivered. There are several methods for documenting quality care.

Audits

An audit is a review examination of records or accounts to check their accuracy. In the hospital setting, audits are commonly performed to determine the level and quality of care delivered to any given patient population. This review indicates the degree of compliance with the hospital's established policies and procedures

Peer review

Fellow employees perform peer audits within a department. These audits are required by The Joint Commission as part of an ongoing assessment process. In the operating room, peer audits may be performed to evaluate compliance in applying patient safety devices, management of sharps, proper O.R. attire, and many other areas that directly or indirectly affect quality patient care.

Professional Standards Review Organization

Quality assurance for recipients of federal Medicare and Medicaid programs is overseen under the auspices of the Professional Standards Review Organization (PSRO). This organization was formed by the 1972 amendments to the Social Security Act with the purpose of reviewing the quality of medical care received by its beneficiaries, ensuring necessary, appropriate, and consistent quality of care. The PSRO has the right to review patient charts and examines the documentation of care delivered retrospectively, in order to audit the level and quality of that care.

The Joint Commission, like the PSRO, will also perform routine retrospective audits of patient charts and review the documentation to assess the level and quality of care.

CONCLUSION

Among the many challenges faced by the patient in today's operating room, none is of greater importance than safety. As professional practitioners, it is our responsibility and obligation to minimize the risk of patient and staff injury from the various

hazards and dangers inherently part of the operating room experience. Minimizing and eliminating hazards in the surgical setting follow one of the basic tenets underlying all health care practice: *primum non nocere*—first, do no harm.

ABOUT THE AUTHOR

Ann M McGuiness, CST, CNOR, MEA, is currently serving as the ARC-ST director of accreditation services. Previously, she was the program director of the surgical technology program at Lock Haven University, Clearfield Campus, Clearfield, Pennsylvania. She has been a Certified Surgical Technologist since 1977 and has served on numerous committees for AST, ARC-ST and most recently was a director of the NBSTSA.

References

1. *A Patient's Bill of Rights*. www.patienttalk.info/AHA-Patient_Bill_of_Rights.htm. Accessed May 1, 2008.
2. *AST Recommended Standards of Practice*. www.ast.org. Accessed April 30, 2008.
3. American Association of Nurse Anesthetists Latex Allergy Protocol. <http://www.aana.com>. Accessed May 1, 2008.
4. Ball K. *Lasers, The Perioperative Challenge*. 2nd ed. St Louis, MO: Mosby; 1995.
5. Frey K, Ross T. *Surgical Technology for the Surgical Technologist: A Positive Care Approach*. 3rd ed. Albany, NY: Delmar Cengage Learning; 2008.
6. Fuller, J. *Surgical Technology: Principles and Practice*. 4th ed. Philadelphia, PA; WB Saunders; 2005.
7. Phillips, N. *Berry & Kohn's Operating Room Technique*. 11th ed. St Louis, MO: Mosby; 2007.
8. Rothrock, J. *Alexander's Care of the Patient in Surgery*. 13th ed. St Louis; MO: Mosby; 2007.
9. US Department of Labor. OSHA Technical Manual. *Laser Hazards*. <http://www.osha.gov>. Accessed April 30, 2008.
10. US Department of Labor. OSHA. Guidelines for Laser Safety and Hazard Assessment. <http://www.osha.gov>. Accessed May 1, 2008.
11. US Department of Labor. OSHA. Surgical Suite Module. <http://www.osha.gov>. Accessed May 1 2008.



Necrotizing Fasciitis

VALENTIN RODRIQUEZ

INTRODUCTION

Necrotizing fasciitis is the name of a dangerously fast spreading bacterial infection and is also commonly referred to as the *flesh eating bacteria*. The term necrosis is defined as tissue death. Necrotizing is to cause or undergo tissue death. The term fascia refers to the fibrous connective tissue that covers muscle. When the suffix *-itis*, which means inflammation, is added to the Latin plural form (*fasci*) to make the word fasciitis, the term means inflammation of the fascia.

LEARNING OBJECTIVES

- Identify the causes of necrotizing fasciitis
- Describe the symptoms of necrotizing fasciitis
- Identify the methods to diagnose NF
- Compare the treatments for NF
- Explain the relationship of NF and MRSA

Some historians maintain that necrotizing fasciitis was first described in the time of Hippocrates, who noted problems with erysipelas, a superficial bacterial infection of the skin that was known to spread to the deeper tissues. Hippocrates described the infection in this manner, "...flesh, sinews, and bones fell away in quantities...fever was sometimes present and sometimes absent... there were many deaths"⁵

In 1952, the term "necrotizing fasciitis" was officially introduced by B Wilson, MD, although he never did find the specific bacteria that caused the disease.¹⁵ Necrotizing fasciitis, although rare and incredibly fast-acting, has been seen throughout history. However, because it is more common in third world countries and was not officially identified until after the 1950s, little data is available on this uncommon bacterial infection. The bacterium that causes necrotizing fasciitis enters the body and reacts with other bacteria, causing subsequent chemical reactions. Toxins are released throughout the body

"The treatments for necrotizing fasciitis must be as aggressive as the symptoms, and immediate hospitalization is recommended."

and attack soft tissue layers under the skin. Tissue death then spreads to the nearby fascia that surrounds the muscle.

This article will help practitioners understand the symptoms and causes of necrotizing fasciitis, learn the relevant methods of treatment and identify methods of prevention.

CAUSES OF NECROTIZING FASCIITIS

The most common cause of necrotizing fasciitis is group A hemolytic streptococcus, which appears to be the relevant factor in up to 71% of all human cases. Also known as "GAS," this type of streptococcus is a common bacterium usually found on the skin and in the throat. It is interesting to note that some carriers where this bacte-

rium is present on their throat and skin show no evidence of an illness.

This bacterium may sound familiar, because it is the same bacterium that causes relatively mild illnesses, such as strep throat and the skin condition impetigo. The majority of GAS infections are not life threatening but occasionally this bacterium can produce severe and even fatal conditions when invading parts of the body where bacterium is not usually found, such as the blood, muscle or lungs.

Two of the most dangerous but infrequently occurring forms of GAS disease are necrotizing fasciitis (NF) and streptococcal toxic shock syndrome (STSS). Streptococcal toxic shock syndrome presents with a rapid drop in blood pressure and the kidney, liver and lungs begin to fail. Approximately, 10% to 15% of patients with invasive group A streptococcal disease will die from the infection, but more than 35% of individuals with STSS will succumb. Approximately 25% of patients with NF will die, and this disease is the focus of the article.

Group A hemolytic streptococcus is also known as *A streptococcus pyogenes*. *Streptococcus pyogenes* produces a wide variety of virulence factors which allow for its rapid multiplication and progression through the body. "*Streptococcus pyogenes* owes its major success as a pathogen to its ability to colonize and rapidly multiply and spread in its host while evading phagocytosis and confusing the immune system."¹⁷ After *streptococcus pyogenes* attacks the body, it is in turn attacked by bacteriophages (viruses that attack bacteria). The bacteria then break down and release a gaseous toxin that flows in-between deep fascial planes and subcutaneous soft tissue. The gaseous toxin then starts to kill the soft tissue, fat, and fascia. After the toxin has festered and the tissue is dead, it then flows into the bloodstream. The toxic blood then moves through the organs in the body and causes systemic breakdown.¹⁵

There are plenty of other bacteria that can contribute to, and/or cause, necrotizing fasciitis. One example is a group of rod-shaped anaerobic bacteria called bacteroides, commonly found in the human intestine. When these bacteroides

venture outside the intestine, they can create an abscess filled with pus that usually spreads more bacteria throughout the body. The formation of pus in these wounds is extremely dangerous, because if a leak occurs from an abscess, it will cause infection to organs and muscular tissue, thus resulting in organ failure and muscular deterioration.¹⁸

Clostridium is another bacterium that aids with the progression of necrotizing fasciitis. *Clostridium* can produce spores that will secrete powerful exotoxins that multiply the amount of toxins already present in the body. In an immune system that is already being overwhelmed by bacteria, these toxins help the necrotizing fasciitis to rapidly spread.²

Peptostreptococcus is the anaerobic partner to *streptococcus*. *Peptostreptococcus* also contributes to soft tissue infection. *Peptostreptococcus* and *Enterobacteriaceae* are bacteria that have become resistant to some antibiotics, such as penicillin G and clindamycin.¹⁴

TRANSMISSION

Hygiene can play a huge role in the transmission of necrotizing fasciitis although the spread of this disease is extremely preventable. Areas of infection where the skin has broken open carry the highest risk of transmission, especially if the infection has any leaking or oozing of pus. In rare cases, the bacteria are occasionally spread between people through close contact of bodily fluids, such as coughing, direct contact of open wounds and rarely, kissing. "People who live or sleep in the same household as an infected person or who have direct contact with the mouth, nose, or pus from a wound...have a greater risk of becoming infected."¹¹

Necrotizing fasciitis has been known to begin in the bodies of those whose immune systems have been compromised. The infection has been discovered to affect those who have been diagnosed with comorbid conditions, such as diabetes, cancer, alcoholism, or who recently underwent an organ transplant. Surgical procedures may cause tissue injury, and while the immune system has been weakened, it is unable

to fight even a small bacterial invasion. In several other cases, the infection started when the bacteria entered the body through an opening in the skin, such as a cut on the hand or infected foot. "It can also enter through weakened skin, like a bruise, blister, or abrasion. It can also happen following a major trauma or surgery, and in some cases, there appears to be no identifiable point of entry."¹¹



EARLY STAGES OF SYMPTOMS

The symptoms of necrotizing fasciitis can develop extremely quickly and, in some instances, symptoms have evolved from mild to life threatening in merely 24 hours. Due to the origin of the infection, which typically festers beneath the skin, most patients physically appear to be in good health. In many of the cases reported, the patients first appeared to have flu-like symptoms but later complained of severe pains on the body, which later became the area where the infection was growing. If the infection is closer to the surface of the skin, initially swelling, redness, and sometimes fluid-filled blisters are frequently evident.⁷ Often, the appearance of these symptoms may lead physicians to believe that this is a small infection; meanwhile, the body is beginning to decompose from the inside.

ADVANCED SYMPTOMS

After the third or fourth day, patients tend to notice that their symptoms are not decreasing. As the disease progresses, the redness or discoloration of the skin spreads. The blisters grow, not only by number but in size, and may begin to fill with a yellow fluid. The patient's blood pressure may drop causing them to appear delusional, confused or in a state of shock. In several reported cases, the site of infection was directly linked to a wound, such as a burn, cut, or even insect bite. "Scaling, peeling,



or discolored skin over the infected area, which are signs of tissue death..." often reveal the sight of infection, and then allow doctors to identify the disease and begin treatment.¹³

CRITICAL SYMPTOMS

Once the disease is in its fourth to fifth day of activity, the body starts to shut down. The patient's blood pressure begins to drop dangerously and the body experiences "toxic shock." "Unconsciousness will occur as the body becomes too weak to fight off this infection..." At this point, treatment must be carried out to the fullest. Depending on how aggressive the particular strain of bacteria are that initiated the infection, the symptoms may progress much more rapidly.¹¹

DIAGNOSIS

While early diagnosis and treatment are key to fighting this disease, doctors and patients often fail to recognize necrotizing fasciitis, because it presents flu-like symptoms. In many cases, early diagnosis was not determined because of tests run due to symptoms but by the complications and confusion of symptoms presented. Due to these "red flags," doctors were able to diagnose and provide immediate treatment by administering antibiotics that would help fight several other bacteria as well. Unfortunately, most cases of necrotizing fasciitis have not been diagnosed early enough to fight the infection. However there are several ways to effectively diagnose the condition, including laboratory analysis, X-rays and surgical biopsies.

Gram stains show a poly-microbial flora with aerobic gram-negative rods and positive cocci. Gram staining may provide a clue as to whether a type I or type II infection is present, thereby providing physicians with an accurate indicator to determine which antibiotic therapy would be the most effective.¹⁵

Radiographs detect the presence of gas in subcutaneous fascial planes. However, many factors can cause these gases, so this method is not regarded as necessarily reliable or time efficient.

MRI and computerized tomography (CT) have been effectively used for diagnosing NF. In combination with the clinical assessment MRI, in particular, aids in confirming the presence of NF and whether the patient should undergo surgical debridement.⁷

TREATMENT

The treatments for necrotizing fasciitis must be as aggressive as the symptoms, and immediate hospitalization is recommended. Symptoms will typically start as flu-like, causing no specific alarm. Once the infection grows enough to rise to the surface of the skin, it will appear as gangrene. Immediately, antibiotics must be flushed throughout the patient's body to prevent the spread of the disease to any non-infected areas. The death rate of necrotizing fasciitis reaches nearly 40% in some populations. A quick

“While early diagnosis and treatment are key to fighting this disease, doctors and patients often fail to recognize necrotizing fasciitis.”

response is necessary and several cases reported required prompt amputation of the areas most infected. “Supportive care for shock, kidney failure, and breathing problems is often needed...” as the body begins to shut down after the fourth to fifth day.¹¹

Necrotizing fasciitis and community-associated MRSA^{8,9}

Previously healthy individuals who have recently taken antibiotics may be at a greater risk of contracting methicillin-resistant *S. aureus*. This bacterium is resistant to antibiotics and some individuals may acquire skin problems and even necrotizing fasciitis. *Staphylococcus aureus* was previously overshadowed by the more common *Streptococcus pyogenes* when investigating necrotizing fasciitis.

The resistance of some bacterium to treatment by antibiotics is a growing concern, because such resistance indicates that more aggressive drug therapies must be utilized. Antibiotics, which target specific bacterium, are not appropriate for all bacterial infections. When antibiotics are prescribed inappropriately, such as for the treatment of viral or fungal infections, then the individual does not receive the best medical assistance and also increases the possibility that therapy with antibiotics in the future may not be effective, thereby increasing the risk of contracting MRSA.

MRSA is no longer a challenge faced in the hospital environment by the elderly and chronically ill. Apparently healthy people are contracting it, and some deaths have resulted.

If the MRSA is acquired during a hospital stay, it is considered a hospital-associated MRSA. However, if a healthy individual contracts MRSA outside the hospital, the condition is referred to as a community-associated MRSA.

In Los Angeles recently, a greater number of infections has been noted involving community-associated methicillin-resistant staphylococcus aureus (MRSA).

When examining the records of 843 patients whose wound cultures grew MRSA over a 15-month period, 14 patients showed both clinical and intraoperative symptoms of necrotizing fasciitis, necrotizing myositis, or both.

Causative factors in the patient population include current or past injection drug use, previous MRSA infection, diabetes, chronic hepatitis C, cancer, HIV or AIDs.

The median age of the patients was 46 years and 71% were male.

Medical and surgical therapies were provided as needed to all the patients. There were no fatalities but several patients experienced severe complications. Reconstructive surgery was required for some cases and prolonged hospital stays in the intensive care unit were mandated for others. In 86%, wound cultures were monomicrobial for MRSA. When blood cultures were obtained, 40% of these patients showed positive results.

In a Minneapolis study, two groups of patients were compared; one group was comprised of individuals who contracted community-associated MRSA infections and the other was composed of individuals who experienced community-associated methicillin-sensitive

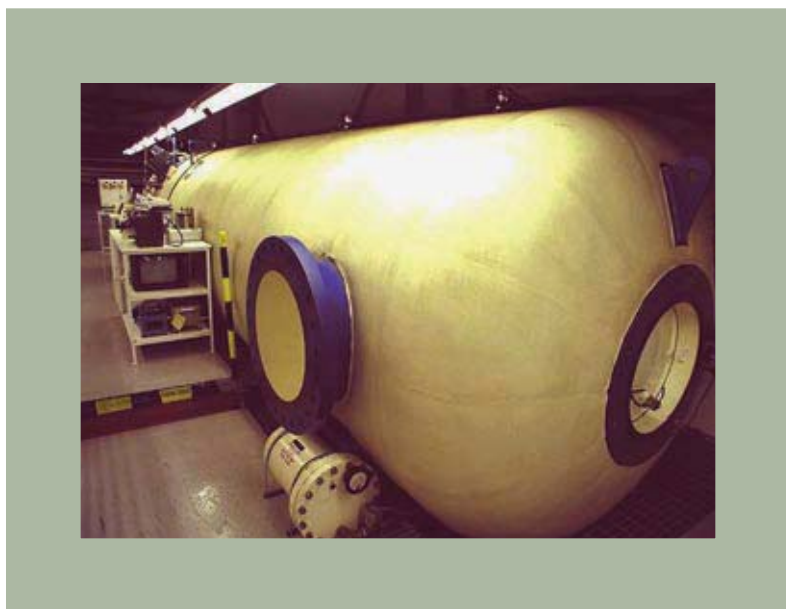
S. aureus (MSSA) infections. The latter population is characterized by a receptivity to antibiotics and their condition is more readily addressed. The study noted that the MRSA group was seven times more likely to have taken antibiotics in the last six months. “We found that the use of any antibiotic puts people at risk for MRSA,” reported Kathryn Como-Sabetti, MPH, senior epidemiologist, Minnesota Department of Health and Children’s Hospitals and Clinics of Minnesota.

In Denver, reports from a study have noted an increasing number of necrotizing fasciitis cases caused by MRSA. Of the five patients in the study, one was an alcoholic, one was a diabetic and the other three had been considered healthy. To remove infected tissue, these patients experienced two to seven surgeries. “Necrotizing fasciitis is still a rare disease, but MRSA no longer is,” said Lisa Young, MD, University of Colorado at Denver, and Health Sciences Center.

It appears that community-associated MRSA is a growing cause of necrotizing fasciitis. In locations where community-associated MRSA infection is endemic, individuals with suspected necrotizing fasciitis should be given empirical treatment including antibiotics that have proven effective combating this infection, such as vancomycin.

DEBRIDEMENT

Debridement is a process used to remove the dead tissue of a wound, in order to allow the underlying living tissue to heal. Many different types of debridement are available, but the two most commonly used in treating necrotizing fasciitis are surgical and mechanical debridement. During surgical debridement, dead tissue is simply removed with a scalpel or scissors. This option is considered to be the quickest and most effective. Mechanical debridement is the oldest and most painful method. The infected area is covered with gauze or some other type of dressing and allowed to dry overnight. Once the dressing is completely



dry, the covering is forcibly removed from the wound, taking away not only the dead tissue, but also possibly pulling away healthy, living tissue. Mechanical debridement is not always recommended because of the inevitable loss of healthy living tissue when uncovering the wound.³

In Iowa, a 52-year old farmer inadvertently hit his shin bone while climbing into a tractor. After a few hours, he experienced a severe headache, fever and uncontrollable pain. His leg was swollen and huge blisters appeared.

He went to the emergency room and was subsequently referred to the University of Iowa Burn Treatment Center. He was under two surgi-

cal procedures and recovered. Another patient at the same facility had 40 pounds of diseased tissue removed during surgery.

The staff at the facility is well trained, and they are able to recognize the symptoms of NF quickly and act immediately, because they regularly treat patients with complex conditions. However, they have noticed an increase in the number of NF cases and speculate that obesity and diabetes may be linked to the higher incidences. A study is currently underway.

MAGGOT DEBRIDEMENT THERAPY (MDT)

In one reported case of necrotizing fasciitis, debridement was used to remove the infection located on the right side of the abdomen and scrotum of a 46 year-old man who had a history of smoking and alcoholism. First, the patient underwent a series of 10 surgical débridements as well as intense antibiotic therapy. When these were not unsuccessful, maggot debridement therapy was initiated. In this particular case, a total of nearly 1,200 *Lucilia sericata* maggots were used in Biobags over a span of 19 days. The process of the maggot debridement therapy, although in this case very productive, is a meticulous and complicated procedure.

“Throughout this study, all maggot applications were performed using the contained technique (Biobags). In the Biobag technique, larvae are enclosed between two layers of 0.5-mm polyvinyl alcohol hydro sponge, which have been heat sealed. Next, a small cube of spacer material is inserted to prevent bag collapse. The bag containing the maggots is placed inside the wound. A net is placed over the bag and taped to an adhesive on the wound edges. Wet gauze and a light bandage are wrapped over the net. Catheters are placed inside the bandages in order to wet the gauze three times daily with normal saline solution (0.9%) in order to prevent maggots dying from dehydration. Every three to four days, new contained maggots were placed on the wound until thorough debridement was reached.”

After the treatment was over, "...a mesh graft was used to close the rest of the wound... and the patient was discharged from the hospital, returned to work, and has remained in good condition for more than three years..."¹⁶

ALTERNATIVE TREATMENTS

A few alternative treatments for necrotizing fasciitis are available, although none have seemed to be as commonly preferred as those described previously. Hyperbaric oxygen therapy is used when anaerobic bacteria are involved and also to increase a patient's oxygen level in the blood, which can help prevent tissue death.

"Necrotizing fasciitis caused by group A *streptococci pyogenes* is the most rapidly progressive and devastating form of the disease."

With necrotizing fasciitis, the soft tissues under the skin and around the muscles are being attacked; therefore, a greater amount of oxygen pumped into the body and blood stream will promote healing of damaged tissues and help fight infection.

This method involves a patient entering an enclosed chamber where pure oxygen is pumped inside under high pressure. Hyperbaric oxygen therapy is utilized to treat severe burns, carbon monoxide poisoning, certain infections, symptoms of decompression, extreme bloodloss, and muscles and soft tissues which have lost their supply of oxygen.⁶

Very similar to debridement therapy, a fasciotomy is a procedure that removes dead tissue. Debridement therapy removes tissue mostly from the exterior of a wound to enable the living tissue underneath to heal properly. A fasciotomy removes dead and damaged fascia, which is the "...thin connective tissue covering, or separating, the muscles and internal organs of the body."⁴

NON-SURGICAL TREATMENTS

When treating necrotizing fasciitis, the first line of defense is to flush the body full with antibiotics. Because necrotizing fasciitis is caused by so many bacteria working together, a wide panel of antibiotics is needed to counteract all of them. "It is common to see misdirected treatment that is aimed at coexisting flora instead of the causative organism."⁷ Due to the abundance and use of modern day antibiotics, some bacteria have become resistant if not immune to antibiotics. This resistance is another reason why the body must be treated with so many antibiotics.⁷

The most common antibiotics used for treatment are¹⁵:

- Penicillin G—Stops multiplication and kills susceptible microorganisms.
- Ampicillin—Alternative to penicillin and amoxicillin.
- Clindamycin—Attacks staphylococcal infection. Stops aerobic and anaerobic streptococci. Stops bacterial growth. Alternative to penicillin G.
- Metronidazole—Used against anaerobic bacteria and protozoa. Causes cell death.
- Ceftriaxone—Effective against gram negative activity. Used in combination with penicillin.
- Gentamicin—Used in combination with a gram positive agent for gram negative effectiveness. Only used in contradiction to other antibiotics.
- Chloramphenicol—Effective against gram negative and positive bacteria

MORTALITY AND MORBILITY

It is difficult to provide a specific mortality rate for necrotizing fasciitis. Death attributed to this disease is directly correlated to how early diagnosis is made and how soon treatment is initiated. Necrotizing fasciitis caused by group A *streptococci pyogenes* is the most rapidly progressive and devastating form of the disease. If it is not diagnosed and treated immediately, the condition results in a large percentage of morbidity and mortality. Nearly 50% of adult cases reported signs of toxic shock and multi-organ shut down. At this point, the mortality rate varies from 30%

to 70%, depending on the severity of other factors in addition to the disease. The mortality rate in cases that were treated immediately ranges from 25% to 40%. Since 1883, more than 500 cases have been reported in the literature.⁷ The average age of survivors is 35 years old, and the average age of non-survivors is 49 years old.

CONCLUSION

The onset of necrotizing fasciitis is frightening because it can begin from a common strain of Group A *Streptococcus pyogenes* bacteria but leave a patient fighting for life within a matter of days. Whether diagnosis is immediate or not,



this disease will change the patient's life forever. Treatment can be an intense flush of antibiotics through the entire system or an extreme procedure of surgical debridement of soft tissues and skin, both leaving the body powerless and feeble. Although cases of this disease are far and few, the condition does not discriminate. It attacks anyone, from the young to the old, the healthy to the chronically ill, diabetics or addicts. When dealing with this infection, medical attention must be sought immediately.

About 9,000 to 11,500 cases of invasive GAS disease occur in the US annually and approximately 1,000 to 1,800 deaths result. Of these

cases, necrotizing fasciitis constitutes about 6% to 7%, as compared to strep throat and impetigo, which are reported to occur in the millions annually. Only a few people who have been in contact with GAS will develop an invasive GAS disease

Practicing good hand washing is the best method of prevention, especially after coughing and sneezing or preparing foods or eating. Individuals with sore throats should visit a doctor who can perform diagnostic tests to determine if strep throat is evident.

Keep all wounds clean, including scrapes, burns, cuts and sores caused by shingles and chickenpox, insect or animal bites. In addition to the previously mentioned symptoms, watch for redness or swelling near the wound. If a muscle has been recently strained or a fever develops, chills or severe pain are experienced, immediate medical care should be sought, because these could be signs of deep tissue injury. Treatment with anti-inflammatory drugs is to be avoided since these medications may reduce the symptoms without treating the actual cause

Health care professionals must be vigilant when observing their patients and themselves. This disease is treatable and damage is much less severe if diagnosed early.

ABOUT THE AUTHOR

Valentin Rodriquez lives in Fresno, California and is a student at San Joaquin Valley College, in Fresno. She is currently enrolled in the surgical technology program and anticipates graduating in 2009. Valentin is 26 years old and loves the fact that surgical technologists are the practitioners in the operating room who are relied up to remain calm and help the surgeon with every step. She is very interested in ophthalmology and finds eyes fascinating.

Before enrolling, he never knew such a career existed and as soon as Valentin discovered surgical technology, he was unable to consider anything else.

References

1. Centers for Disease Control. Group A Streptococcal (GAS) disease. <http://www.cdc.gov>. Accessed May 29, 2008.
2. Clostridium. (1995). University of Texas Web site. <http://medic.med.uth.tmc.edu/path/00001496.htm>. Accessed February 6, 2008.
3. Debridement, (2006) <http://www.healthatoz.com/healthatoz/Atoz/common/standard/transform.jsp?requestURI=/healthatoz/Atoz/ency/debridement.jsp>. Accessed February 6, 2008.
4. Fasciotomy. (2006). <http://www.healthatoz.com/healthatoz/Atoz/common/standard/transform.jsp?requestURI=/healthatoz/Atoz/ency/fasciotomy.jsp>. Accessed February 6, 2008.
5. Feely EA. Necrotizing fasciitis: diagnostic modalities. (1998). Wake Forest University Web site. http://intmed-web.wfubmc.edu/grand_rounds/1998/necrotizing_fasciitis.html. Accessed June 2 2008.
6. Hyperbaric oxygen therapy. (2007). <http://www.webmd.com/hw-popup/hyperbaric-oxygen-therapy>. Accessed February 6, 2008.
7. Maynor M. Necrotizing fasciitis. (2006). <http://www.emedicine.com/EMERG/topic332.htm>. Accessed February 6, 2008.
8. Miller LG, Perdreau-Remington F, Rieg G et al. Necrotizing fasciitis caused by community-associated methicillin-resistant staphylococcus aureus in Los Angeles. NEJM. <http://content.nejm.org/cgi/content/abstract/352/14/1445>. Accessed May 30, 2008.
9. MRSA linked to recent antibiotic use increasing as a cause of necrotizing fasciitis. Infectious Diseases Society of America. <http://www.idsociety.org>. Accessed June 2, 2008.
10. Necrotizing fasciitis – topic overview. (2005). <http://health.yahoo.com/infectiousdisease-overview/necrotizing-fasciitis-flesh-eating-bacteria-topic-overview/healthwise--hw140408.html>. Accessed February 6, 2008.
11. Necrotizing fasciitis. (2005). National Necrotizing Fasciitis Foundation Web site. http://www.nnff.org/nnff_factsheet.htm. Accessed February 6, 2008.
12. Necrotizing fasciitis. <http://www.webmd.com/a-to-z-guides/necrotizing-fasciitis-flesh-eating-bacteria-symptoms>. Accessed February 6, 2008.
13. Necrotizing soft tissue infection. <http://www.nlm.nih.gov/medlineplus/ency/article/001443.htm>. Accessed May 29, 2008.
14. Peptostreptococcus. (1995). University of Texas Web site. <http://medic.med.uth.tmc.edu/path/00001515.htm>. Accessed February 6, 2008.
15. Schwartz R (2007). Necrotizing fasciitis. <http://www.emedicine.com/derm/topic743.htm>. Accessed February 6, 2008.
16. Steenvoorde J, Wong Jukema. Maggot debridement therapy in necrotizing fasciitis reduces the number of surgical débridements. (2007). <http://www.woundsresearch.com/article/6981>. Accessed February 6, 2008.
17. Todar K. (2005). *Streptococcus pyogenes* and the streptococcal disease. University of Wisconsin-Madison Web site. <http://www.bact.wisc.edu/themicrobialworld/strep.html>. Accessed February 6, 2008.
18. What are bacteroides. (1999). East Carolina University Web site. <http://borg.med.ecu.edu/~webpage/about.html>. Accessed February 6, 2008.



Treatment of War Casualties

A COMPARISON BETWEEN VIETNAM AND THE PRESENT

CHARLES J MIDDLETON, MD, FACS

Author's Note: The purpose of this brief article is to compare treatment of war casualties in Vietnam, circa 1971, with the treatment being administered today in Iraq and Afghanistan. I will present some statistics, describe changes in care units, evacuation of the wounded, equipment and training of personnel. I will also describe differences in injuries based on weaponry.

I am a board-certified general surgeon and have been in practice since 1973. I had the privilege of serving in the US Army in Vietnam in 1971 after completing a five-year surgical residency at Hartford Hospital in Hartford, Connecticut, in 1970. During my residency, I saw a moderate amount of blunt trauma, low-velocity gunshot wounds, stab wounds and burns. However, my excellent training did not prepare me for high-velocity gunshot wounds and mine injuries. And I would say that probably pertained to all of the younger general surgeons, including those who were trained at inner-city hospitals, where the number of trauma cases was higher. We learned our lessons largely from those who were there before us—on-the-job training, so to speak.

LEARNING OBJECTIVES

- Compare the treatment provided in Vietnam and Iraq.
- Evaluate how the Forward Surgical Team has contributed to survival rates.
- Compare the wounds experienced in Vietnam and Iraq.
- Explain the mechanisms of injury of a landmine vs roadside bomb.
- Assess the effectiveness of tourniquets.

We cared for GIs, Vietnamese civilians, Korean and Thai allies, North Vietnamese and even a Polish sailor who was injured on a ship off the coast. My first patient was Viet Cong. Our patients arrived by ambulance, truck and out of the field by helicopter. The injured GI was usually seen first by



National Archive



National Archive

a medic at a battalion aid station. Heroic “DUSTOFF”^{*} helicopter crews flew to the aid stations and sometimes to crude landing zones in the middle of fire fights to deliver the wounded to the 24th Evacuation Hospital in Long Binh, where we had the expertise and equipment to perform every surgery but cardiac. Those patients, if they survived long enough, were brought to the 3rd Field Hospital in Saigon.

I began my tour of duty in Vietnam with a two-week orientation phase, where I worked alongside general surgeons who had been in-country for a longer period of time and with orthopedic surgeons who taught me

the critical lessons of adequate debridement of extremity wounds, including frequent returns to the operating room for additional debridement and irrigation, and keeping wounds open until it was safe to close them.

The general surgeons also acted as the Surgical Officer of the Day (SOD) and were in charge of triage, ordering laboratory studies and X-rays (we had no ultrasound, CT scan or MRI), calling of appropriate teams and determining the order of cases for surgery, but not performing surgery themselves, while acting as SOD. Triage is the determination among the injured of those requiring immediate surgery, those whose surgery can be delayed, those requiring minimal surgical care and those in expectant status, who are not likely to live even with surgery.

Survival rate statistics from war to war and generation to generation are illuminating. In World War II, the survival rate of GIs reaching hospitals was 69.7 percent. In Korea, that number improved to 75.4 percent. Vietnam saw another small increase with a 76.4 percent survival rate. Today, 90.5 percent of GIs reaching a field hospital survive the ordeal.¹

During the Vietnam War, the average length of time from initial treatment to transfer to the continental United States (CONUS) was 45 days. This would involve initial surgery at a surgical or evacuation hospital, followed by a transfer to Yakota Air Force Base in Japan, or Clark Air Force Base in the Philippines, for possible additional surgery and transfer back to the United States. In Iraq, a wounded soldier is quickly stabilized, including damage-control surgery when necessary. The time from initial treatment in the field until the time of arrival in Landstuhl, Germany, a Level II trauma facility, might be 12 hours. More surgery could be completed in Germany before the patient is flown to CONUS, all within three days of the time of initial treatment.

Combat units in the field in Vietnam were manned by medics who basically delivered first aid. In today's combat units in Iraq and Afghanistan, Marine and Army infantrymen are all trained in advanced first aid and are taught the ABCs of resuscitation. Every soldier carries two single-handed tourniquet devices they can use on a buddy or on themselves. Since 60-70 percent of wounds are musculoskeletal, and the major cause of death is still exsanguination, surgeons say the tourniquets are the single greatest life-saving advancement to emerge from the Iraq conflict. They are now being used in ambulances in the United States.²

Special forces combat medics have more than one year of training and are certified EMTs. In addition, they undergo an extra six months of training, when they learn to resuscitate, place chest tubes, stabilize fractures and perform some amputations and basic surgery. At battalion aid stations, there are physician assistants (PAs) who are also trained in resuscitation and stabilization and are qualified in Advanced Trauma Life

Whole blood is administered to an airborne casualty, enclosed in a metal capsule attached to the side of an Air Rescue helicopter about to land at an advanced air station in Korea. A medical technician holds a life-giving bottle over the wounded man during the 45-minute flight from the front lines. 12/31/1952

^{*} DUSTOFF stands for Devoted Unswerving Service To Our Fighting Forces.

Support (ATLS). Along with partially-trained surgeons, they start IVs, place chest tubes, stabilize fractures and prepare patients for transfer for additional treatment.³

Generally, the distance traveled for care after initial treatment at an aid station was not far in Vietnam. Surgical and evacuation hospitals were well-established, permanent facilities with relatively large numbers of surgical and medical specialists, nurses, beds and ancillary personnel, such as lab and X-ray technicians. We had a radiologist and a pathologist as well. In Iraq, because of the long distances traveled for care in a large country, the concept of the Forward Surgical Team was developed after the first Gulf War. This is a mobile unit usually comprised of one surgeon, a nurse anesthetist and a medic. Intravenous treatment begins with procoagulants and whole blood, type O, followed by fresh whole blood with thawed plasma instead of crystalloids. High doses of Factor VII are also used to stop bleeding. Surgeons are using temporary intravascular shunts rather than attempting vascular repair at this point. These have not been found to adversely affect subsequent definitive repair.

Patients are then transported to one of two combat surgical hospitals (CSH), where there are two operating rooms, an ICU, and various surgical specialists and a larger staff of nurses and enlisted, noncommissioned officers (NCOs). After reevaluation and possible surgery, the patient is prepared for transfer to Landstuhl by Critical Care Aero-medical Transport Teams (CCATT) developed by the Air Force. Continuous intensive care can be given enroute without a 24-hour delay to assure stability. In Vietnam, I accompanied soldiers to Japan and Thailand in C-141s that contained ICUs, but all patients were stable at the time of transfer and no intense active care was given.

At Landstuhl, the surgical teams are primarily military. They are also comprised of visiting senior surgeons from the United States, who are invited via a senior visiting surgeon program sponsored by the military. The visiting surgeons add their expertise to surgical care and take back the knowledge they have absorbed in order to enrich the teaching programs at their institutions.²

In Vietnam, telecommunication technology was relatively primitive. It usually took weeks for families to learn the whereabouts of their loved ones in a war zone. Now, contact is made from Landstuhl to hospitals like Walter Reed, Brooke and Bethesda Naval, which will be receiving the



Daniel Love/US Army

injured for further definitive and reconstructive surgery, and reuniting them with their families within 24-36 hours. Communications can also take place between Landstuhl and forward surgical teams on the ground in Iraq, which allows the hospital an extra window of time to prepare for the arrival of incoming casualties.

Most combat casualties in Vietnam were caused by the high-velocity AK-47 assault rifle, artillery or land mines. The AK-47 is still the small-arms weapon of choice for the adversary in Iraq and Afghanistan, but .50 caliber rifles and mortars are also used. Fighting in Iraq has seen changes in style and the degree of devastation, compared to Vietnam. The primary cause of injury in Iraq is the 155mm howitzer shell, which can be hidden under asphalt and detonated from a distance, often with a cell phone. Added shrapnel in the form of nails, screws and nuts covered with feces adds to the lethality of this terrible weapon. Other improvised explosive devices (IEDs) are vehicle-borne and may be accompanied by tanks of propane or other inflammable material adding to the burn effect.

A special forces team medic assigned to the Combined Joint Special Operations Task Force-Afghanistan treats another US Army soldier for shrapnel wounds from a rocket-propelled grenade explosion while battling Taliban fighters in the Sangin District area of Helmand Province, Afghanistan, April 10, 2007.

Rocket-propelled grenades (RPGs) and the 122mm rockets are also used.¹

Since injuries to the head and chest are often fatal, improved helmets and body armor have helped reduce deaths from these injuries. With the preponderance of wounds to the extremities, as in Vietnam, aggressive and repeated debridement and irrigation are of paramount importance to prevent death from overwhelming infection and to preserve limbs.



Medical evacuation patients on the deck of the amphibious assault ship USS Tripoli (LPH-10) await transfer to the 22nd Casualty Station in Danang, from which they will be sent to CONUS. July 1967

Since the primary cause of injury to coalition forces in Iraq is the roadside bomb, it is worthwhile to describe its mechanisms of injury. The injuries are significantly different from those administered by land mines in Vietnam.

The explosion is caused by rapid chemical conversion of a solid or liquid to a gas, accompanied by an enormous release of energy. High-order explosives detonate quickly, generating heat, noise and high-pressure gasses in 1/1,000th of a second, forming a supersonic overpressure shock wave. This blast wave moves in all directions and can exert up to 700 tons of pressure. It creates high-velocity fragmentation of its contents and its container, a blast wind that can reach hurricane strength, structural collapse, burns and toxic inhalants. Secondary-blast pressure effects are caused by reflection off other surfaces, which magnifies the effect—particularly in enclosed spaces, where structural collapse increases mortality.

Primary blast injuries are the result of overpressurization, which causes damage mainly to gas-filled structures, such as eardrums, lungs and intestines. Secondary blast injuries result from fragmentation, producing both penetrating and blunt-force injuries. Tertiary blast effects result from bodies being thrown by a blast wind, flying through the air or tumbling and striking other

objects with additional penetrating or blunt-force injuries. Quaternary blast injuries might include burns or inhalation injury due to temperatures from the explosion reaching as high as 3,000 degrees centigrade. Sutphen has given an excellent description of types of injuries and their evaluation and treatment and gives credit to the Israelis and others for what we have learned.⁴

In summary, this article has been written to describe changes that have improved the surgical care of those injured in war since Vietnam. The basic principles remain the same, but changes in training, hospital logistics, equipment and evacuation have resulted in significantly better survival rates. What has not changed since Vietnam is the intensity, courage and dedication of doctors, nurses and surgical technologists who have served in active war zones, sometimes under fire themselves, as they perform their duties. It was an honor for me to have worked alongside them in Vietnam and it provided experiences and memories that I will never forget.

ABOUT THE AUTHOR

Charles J Middleton received his BA from Trinity College and his MD from Downstate Medical Center at the State University of New York in Brooklyn, NY. He previously served as chief of surgery at Berrien County Hospital in Nashville, Georgia, from September 2002-September 2004. He is currently a general surgeon at the Tarboro Clinic in Tarboro, North Carolina.

References

1. Hyer. Extremity War Injuries: State of the Art and Future Directions. <http://www.medscape.com/viewarticle/528624>. Accessed February 1, 2008
2. Frangou C. Controversies in Surgery. <http://www.general-surgerynews.com>
3. Barclay L. Combat Medicine in Iraq, Part I. <http://www.medscape.com/viewarticle/451483>. Accessed February 1, 2008.
4. Sutphen SF. Blast Injuries: A Review. <http://medscape.com/viewprogram/4714>. Accessed February 1, 2008.

Military technology with civilian application: Most effective tourniquets available today

Uncontrollable hemorrhage accounts for almost 50 percent of combat fatalities and up to 80 percent of civilian trauma fatalities in the United States.¹ One of the best methods of combating exsanguination in critical circumstances is the use of a tourniquet. According to some studies, it has been estimated that seven out of 100 battlefield deaths could have been prevented with a properly-applied tourniquet.^{2,3}

In 2005, the US Army Institute of Surgical Research (USAISR) commissioned a study to improve tourniquet use doctrine and training to maximize the potential life-saving benefits of tourniquet use, especially during active combat; and identify an effective, commercially available, simple-to-use, field-compatible tourniquet for issue to all soldiers.⁴

Based on an informal internet search for trauma tourniquets, as well as reports from military medical personnel involved in the Iraq conflict regarding functional parameters, USAISR selected seven models for its evaluation.

The evaluation process consisted of two experiments. In Experiment I, each model was tested for efficacy (elimination of distal Doppler sound) in volunteer human subjects' legs. Those found to be effective in 80 percent or more subjects were then subjected to Experiment II, which tested effectiveness in the sub-

jects' arms. In both experiments, the subjects were required to apply the device to themselves without any external assistance.⁵

The results of the study yielded positive options for both military and civilian application. Of the seven models tested, only three were 100 percent effective in occluding distal arterial Doppler sound in both the arm and leg when self-applied by the volunteer human subjects: the Emergency & Military Tourniquet (EMT), Combat Application Tourniquet (CAT) and Special Operations Force Tactical Tourniquet (SOFTT). Reasons for failure among the other models included mechanical limitations (design or construction), circumferential pain and/or skin-pinching pain.⁵

The mechanical augmentation of both the CAT and SOFTT is the windlass, essentially a tension strap that is twisted to compress the wound. The EMT employs a pneumatic system, similar to that of a blood-pressure cuff.

For military purposes, the CAT and the SOFTT are advantageous for their lighter weight and affordability, an edge that offers a practical application in the field. In the civilian quarter, however, the EMT is the clear winner. According to the Army's tests, the EMT resulted in "significantly less circumferential pain than the other effective tourniquets."⁵

An additional advantage to the EMT is its design. While heavier (215g to the CAT's 59g), it boasts a strap width that is nearly twice that of either the CAT or the SOFTT. Studies have shown that a wider tourniquet allows for occlusion of blood flow at lower pressure, thus helping to minimize the potential for damage to the underlying tissues.⁵

These distinct advantages present the EMT as an excellent option for application in the civilian trauma field in the United States.

References

1. Moore Sauaia A; Moore EE *et al.* Epidemiology of Trauma Deaths: A Reassessment. *J Trauma*. 1995.
2. Mabry RL; Holcomb JB; Baker AM; *et al.* United States Army Rangers in Somalia: An Analysis of Combat Casualties on an Urban Battlefield. *J Trauma*. 2000.
3. Bellamy RF; Hagmann JH; Richards DT. Tactical Management of Urban Warfare Casualties in Special Operations. *Mil Med*. 2000.
4. Baer David G; Holcomb John B; Kauvar David S; Walters Thomas J. Battlefield Tourniquets: Modern Combat Lifesavers. *US Army Med Dept J*. April-June 2005.
5. WaltersThomas J. Laboratory Evaluation of Battlefield Tourniquets in Human Volunteers. *US Army Med Dept J*. April-June 2005. http://findarticles.com/p/articles/mi_m0VVY/is_2005_April-June/ai_n17213746 Accessed June 26, 2008.



Special Operations Force Tactical Tourniquet (SOFTT).



Emergency & Military Tourniquet (EMT)



WRIST FUSION:

Fighting back against rheumatoid arthritis

DEBBIE UCHIDA, CST

Rheumatoid arthritis, commonly known as RA, affects more than 2 million people in the United States annually. The disease affects more women than men and typically develops between the ages of 25 and 50. It is a chronic, inflammatory, autoimmune disease that causes the immune system to attack the joints. It can be a very painful and disabling condition that can lead to substantial loss of mobility due to joint destruction.³

LEARNING OBJECTIVES

- Compare and contrast treatment options of rheumatoid arthritis
- Evaluate the advantages and disadvantages of wrist fusion as treatment for arthritis
- Summarize the steps of a wrist fusion procedure
- Distinguish the different categories of arthritis drugs
- Compare and contrast wrist fusion and wrist replacement

While RA is not inherited, genes that may make an individual more likely to develop the disease can be inherited. Researchers continue to work to discover what roles genes may play in developing the condition. It is important to note that there is no known cause for the disease.

While pharmaceutical options can temporarily curb the onset of RA, surgery is also an option. Surgical fusion, sometimes called arthrodesis, has a high success rate in patients with advanced cases of RA. Arthrodesis comes from the words “arthro,” or joint, and “desis,” or binding.

Although it is desirable to avoid surgery on the wrist joint during a period of heightened activity, delay in the face of rampant disease is inadvisable.

DIAGNOSING RA

The first step in diagnosing the disease is meeting with a rheumatologist, who specializes in rheumatoid diseases, including detecting signs and symptoms of certain types of arthritis. Diagnosis begins with reviewing family history, examining joints for inflammation and deformity, and the skin for rheumatoid nodules, firm, nontender, subcutaneous nodules, which usually occur in chronic active cases of RA. They are commonly associated with more joint deformity and serious extra-articular manifestations, including lungs, eyes and blood vessels.⁹ Certain blood tests and X-rays are often common steps in the diagnosis, which is based on the pattern of symptoms, distribution of the inflamed joints and the blood and X-ray findings. X-rays can show bony erosions typical of RA in the joints. Joint X-rays can also be helpful in monitoring the progression of the disease and joint damage over time.⁹

Abnormal blood antibodies, specifically rheumatoid factor, is found in 80 percent of RA patients. Citrulline antibody is also present in most patients with RA. It is useful in the diagnosis of the disease when evaluating patients with unexplained joint inflammation.

An arthrocentesis may also aid in diagnosis. In this procedure, a sterile needle and syringe are used to drain joint fluid for laboratory testing.

Analysis of the joint fluid can help exclude other causes of arthritis, such as infection or gout.

ANATOMY OF THE WRIST

The wrist is a collection of many bones and joints, making it one of the most complex joints in the entire body. These bones and joints allow us to use our hands in many ways. The wrist must be

extremely mobile to give our hands full range of motion. The metacarpal bones are the long bones in the palm and are connected to the phalanges, the bones in the fingers and thumb. Eight carpal bones, arranged in two rows, compose the anatomy of the wrist

joint. The carpal bones connect the two bones of the forearm, the radius and the ulna, to the bones of the hand. The distal row proceeding from the radius to the ulnar side includes the trapezium, trapezoid, capitate and hamate. The proximal row consists of the scaphoid, lunate, triquetrum and pisiform. Functionally, the scaphoid links the rows as it stabilizes and coordinates the movement of the proximal and distal rows.⁴ (Figure 1)

RHEUMATOID DISEASE OF THE WRIST

RA of the hand and wrist principally affects the synovial lining of joints and tendon sheaths. As it progresses, the disease process invades and destroys ligaments and tendons. Intrinsic contracture, a crippling process, develops during the early, acute inflammatory stage.⁵ The synovial disease may directly invade the tendons, which become frayed, fragile, attenuated or weakened and can potentially rupture, although rupture is more likely when bony compression and friction occur. This process within the wrist joint invades and destroys the supportive ligaments and capsules. The disease can extend into the distal radioulnar joint (DRUJ), which becomes fixed in pronation, and the lower end of the ulna is subluxed dorsally, making rotary motion painful.

Symptoms of RA in the wrist joint include pain, swelling, muscle cramping, stiffness at rest and feeling of weakness, especially after extensive use. Numbness to the areas surrounding the metacarpals and phalanges may also occur if swelling is persistent.

CONSERVATIVE TREATMENT FOR RA

RA of the hand and wrist is part of a generalized disease that requires medical treatment. It is important to remember that managing the disease process is critical. Alternatives to surgery

may begin with medical treatment prescribed by a rheumatologist or an orthopedic surgeon. Fast-acting “first-line drugs,” such as methylprednisolone acetate, cortisone and aspirin, are prescribed to reduce pain and inflammation. Slow acting “second-line drugs,” such as gold salts, methotrexate and hydroxychloroquine, promote remission and prevent progressive joint destruction. Newer prescription drug treatments include etanercept, adalimumab, infliximab and rituximab. These drugs are prescribed based of the severity of the patient’s condition.⁷

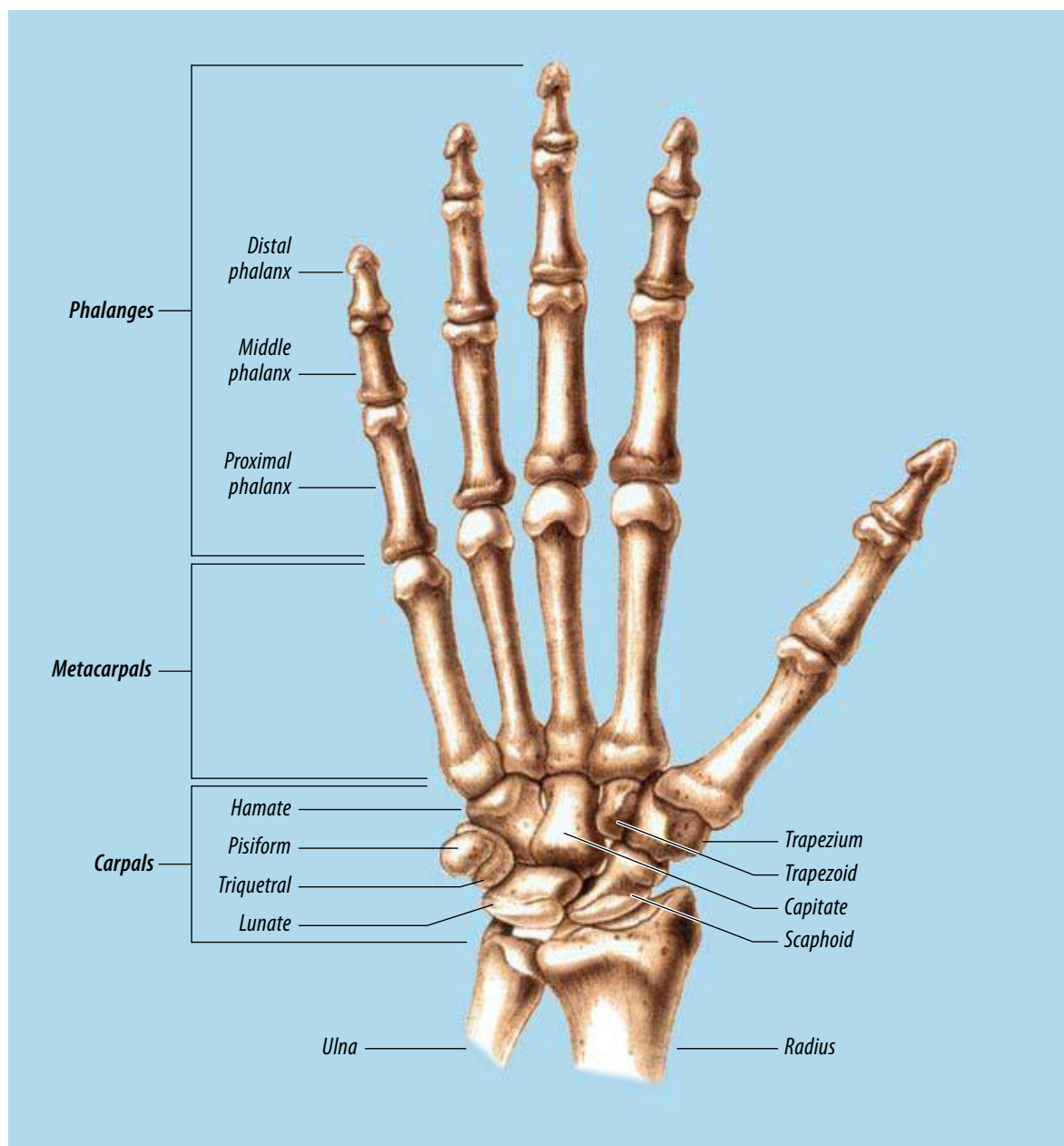


Figure 1.

Surgical Technology for the Surgical Technologist: A Positive Care Approach, Delmar Cengage Learning, © 2008



Figure 2.

Proper regular exercise is important in maintaining joint mobility and strengthening the muscles around the joint. Eating a well-balanced diet is also an easy way to help keep the disease under control.

SURGICAL TREATMENT, INCLUDING FUSION

Although it is desirable to avoid surgery on the wrist joint during a period of heightened activity, delay in the face of rampant disease is inadvisable. Procrastination allows further degeneration of secondary joints, articular destruction and muscle and capsular contracture.⁶

Most joints are made up of only two bones that require fusion; however, the wrist is somewhat different because of the complexity of the joint.

A successful fusion involves several bones. The goal of a wrist fusion is to get the radius to fuse into one long bone that connects the carpal bones

of the wrist and the metacarpals of the hand. Fusing the bones together can prevent further deformity, eliminate pain and improve alignment.

If the ulna is not fused, the patient will have continued rotation in the hand. However, with a fused wrist, the patient will not be able to bend the wrist after the operation.

CASE STUDY WITH RATIONALE FOR A SURGICAL WRIST FUSION

The subject in this case study was diagnosed with

RA at 26-years old. She underwent a right knee arthroscopy for complete synovectomy in April 1999, and a left wrist arthroscopy in December 2002, for severe rheumatoid disease with radiocarpal, midcarpal and DRUJ

“The pain I experienced was indescribable. There were many days when I could not even feel my fingertips.” – Debbie Uchida

involvement. After a flare-up in 2005, radiographic evidence showed significant joint destruction in the left wrist. The subject opted for a wrist fusion

procedure to stop further destruction of the joint. The surgery took place on December 1, 2006.

Procedural overview

The patient is taken to the operating room, placed in the supine position and given a general anesthetic. In this case, the left arm is prepped, draped with a tourniquet, and a time out is performed.

A dorsal, longitudinal incision is made and centered over the Lister tubercle, extending along the middle finger metacarpal, and proximally over the distal forearm. A dissection is made down the extensor retinaculum. An incision is then made down into the third compartment and dissection continues down through the capsule and the second and third compartments are elevated radially and ulnarly, respectively. The radiocarpal joint is then opened.

In this case, the metacarpal and radiocarpal joints were extremely involved with active synovium, so a synovectomy was performed. Dissection continued along the middle finger carpal metacarpal (CMC). The CMC joint was debrided, as were the capitate, lunate, scaphoid-capitate, radioscapoid and radiolunate joints. A high-speed burr was used to debride the distal radius. The lunate bone was very necrotic and fragmented. A bone graft was taken from the Lister tubercle in the distal radius and placed in the midcarpal and radiocarpal joints.

A standard bend, Synthes wrist fusion titanium plate was fixed distally, first to the middle finger metacarpal and then proximally to the radius. The wrist was placed in five degrees of ulnar deviation and five degrees of extension based on the bend of the plate. A surgery-directed fluoroscopy confirmed positioning of the plate clinically and radiographically. Screws were then placed and measured. Once the plate was fixed and the wrist was fused, the distal ulna was addressed.² (Figure 3).

The ulnar head was extremely synovitic and had sharp ridges. A distal ulnar resection was deemed

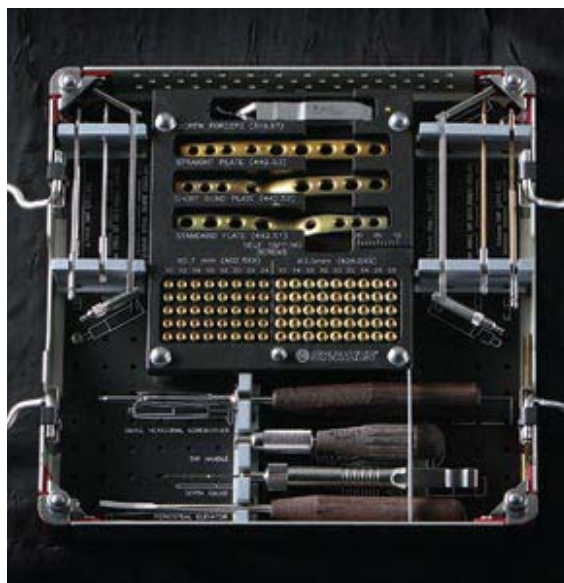


Figure 3.

Image courtesy Synthes, Inc.

necessary because of the synovitis and instability of the DRUJ. The resection was performed using an oscillating saw. The distal ulna was stabilized using local tissue and 3-0 braided nylon suture to imbricate the distal stump of the ulna.

The ulnar head that was removed was used as bone graft in the fusion site, and the wound was irrigated thoroughly. The tourniquet was deflated and bleeding was controlled.

The extensor retinaculum was reapproximated, leaving the extensor pollicis longus (EPL) tendon transposed. The wound was closed with

4-0 polyglactin 910, and 5-0 nylon. A light dressing and volar splint were applied. The patient was taken to the recovery room without apparent complications.¹

CONCLUSION

The goal of a wrist fusion is to halt progression of the disease, relieve pain, provide stability and preserve mobility. Wrist fusion gives patients a stronger wrist for gripping. Regaining strength is especially important to young patients whose work involves intense activities using their hands.

What if surgery isn't the answer?

If surgery is an impractical response to a particular case of arthritis, other, more traditional methods of treatment are available. Prescription drugs have long been considered a primary treatment option for those with chronic arthritis symptoms. Since an individual's response to drugs can vary, and because potential side effects and adverse reactions are also factors, finding the most effective combination of arthritis drugs can be a more difficult process than one might expect. Patients should become knowledgeable about the various arthritis drugs so they can make informed decisions with their doctor.

NSAIDs / COX-2 Inhibitors

Nonsteroidal anti-inflammatory drugs (NSAIDs) are among the most commonly prescribed and widely-used arthritis drugs. There are three types of NSAIDs: salicylates, traditional NSAIDs and Cox-2 selective inhibitors.¹

How they work

Prostaglandins are a related family of compounds that are produced by the cells of the body and have several important functions, including promoting inflammation, pain and fever. They also facilitate the function of blood platelets and protect the stomach lining from the effects of acid. Prostaglandins are produced in the body's

cells by the enzyme cyclooxygenase (Cox). There are actually two Cox enzymes, Cox-1 and Cox-2, both of which produce prostaglandins that promote inflammation, pain and fever. However, only Cox-1 produces prostaglandins that support platelets and protect the stomach. NSAIDs block the Cox enzymes and reduce prostaglandins throughout the body. Consequently, ongoing inflammation, pain and fever are reduced. However, since the prostaglandins that protect the stomach and support the platelets and blood clotting also are reduced, NSAIDs can cause ulcers in the stomach and promote bleeding. NSAIDs differ in how strongly they inhibit Cox-1 and, therefore, in their tendency to cause ulcers and promote bleeding.²

DMARDs

Disease-modifying anti-rheumatic drugs (DMARDs), sometimes called "slow-acting anti-rheumatic drugs," or "second-line agents," can take weeks or months to work and are typically only administered after other treatments have failed. However, research has shown the effectiveness of DMARDs in the treatment of rheumatoid arthritis, psoriatic arthritis and ankylosing spondylitis and the importance of early, aggressive treatment with these drugs. For some, these drugs can stop disease progression and halt joint damage.¹

How they work

DMARDs halt the underlying processes that cause certain forms of inflammatory arthritis, including rheumatoid arthritis (RA), ankylosing spondylitis and psoriatic arthritis. These drugs not only treat arthritis symptoms, but they can also slow progressive joint destruction. Some of these medications are traditionally used to treat other conditions, including cancer or inflammatory bowel disease, or to reduce the risk of rejection of a transplanted organ. However, when chemotherapy medications (such as rheumatrex, trexall or cyclophosphamide) are used to treat RA, the doses are significantly lower and the risk of side effects tends to be considerably less than when prescribed in higher doses for cancer treatment.³

Corticosteroids (Steroids)

Corticosteroids, or glucocorticoids, often called "steroids," are potent drugs that can reduce swelling and inflammation quickly. Most patients notice an improvement in symptoms within days of treatment. These drugs are closely related to cortisol, a hormone produced on the cortex of the adrenal glands. They are prescribed in widely varying doses, depending on the condition and goal of treatment. It has been determined that the potential for serious side effects increases at high doses or with long-term use. Doctors can

It is important to remember to be proactive if a person is experiencing RA symptoms. Early consultation with an orthopedic surgeon or rheumatologist is always recommended. Although there is no cure for rheumatoid arthritis, several medications are available including nonsteroidal anti-inflammatory drugs, steroids and biological therapies to help manage the disease.

ABOUT THE AUTHOR

Debbie Uchida, CST, graduated from surgical technology school in May 1991, and currently

works as a surgical first assistant at Saint Thomas Hospital in Nashville, Tennessee. She has a Synthes wrist fusion plate in her left wrist due to her rheumatoid arthritis. Ms Uchida has served on the Tennessee State Assembly Board of Directors, as well as the education committee, and was awarded the Surgical Technologist of the Year recognition in September 2006, by her co-workers. She would like to respectfully dedicate this article to David Schmidt, MD, and Douglas Weikert, MD.

prescribe short-term, high-dose intravenous steroids in some situations, or give shots or local injections into specific joints for relief.

How they work

Corticosteroids are used to control inflammation of the joints and organs in diseases such as rheumatoid arthritis, lupus, polymyalgia rheumatica and vasculitis. In addition to their anti-inflammatory action, corticosteroids also are immunosuppressive. As a result, they may make certain individuals more susceptible to infection. Corticosteroids closely resemble cortisol, a hormone naturally produced by the body's adrenal glands. This group of medications is available in oral, rectal and intravenous (IV) forms. When people take corticosteroids, their adrenal glands stop producing or slow down the production of normal cortisol. In general, corticosteroids are recommended only for short-term use in order to achieve remission. As valuable as they are in acute situations, corticosteroids are not effective in preventing flare-ups. They are usually given in the lowest possible dosage for the shortest amount of time. *Frequent* short-duration use, however, is not recommended.⁴

Analgesics (Pain Killers)

Analgesics are pain-relieving drugs. Controlling pain is a vital part of treating arthritis. However,

unlike NSAIDs, analgesics do not relieve inflammation. Acetaminophen is the most commonly used analgesic. Narcotic analgesic drugs can also be prescribed for more severe pain.

Biologic Response Modifiers (Biologics)

Biologic Response Modifiers (BRMs) stimulate or restore the ability of the immune system to fight disease or infection. BRMs are drugs derived from living sources, as opposed to being synthesized chemicals. Biological therapy is also called biotherapy or immunotherapy.¹ The body normally produces these substances in small amounts in response to infection and disease. Using modern laboratory techniques, scientists can produce BRMs in large amounts for use in the treatment of cancer and other diseases, such as RA and Crohn's disease.

How they work

Etanercept, infliximab, and adalimumab target TNF-alpha, one of the most important cytokines involved in RA. BRMs, which bind to TNF-alpha, render it inactive, interfering with inflammatory activity and ultimately decreasing joint damage. Anakinra, also a BRM, is considered an IL-1 antagonist. It is the first selective blocker of interleukin-1 (IL-1), a protein that is found in excess in rheumatoid arthritis patients. By blocking IL-1, Anakinra inhibits inflammation

and pain associated with rheumatoid arthritis. It can be used alone, or in combination with DMARDs other than anti-TNF drugs. Abatacept is the first T-cell co-stimulation modulator approved for the treatment of RA. Rituximab, the world's best-selling cancer drug, was FDA approved on March 1, 2006, to be used in combination with methotrexate to treat RA by reducing the signs and symptoms in adult patients, who have moderately-to-severely active RA and have failed with one or more anti-TNF drugs. It is the first treatment for RA that selectively targets the CD20-positive B-cells.⁵

References

1. Eustice Carol. Eustice Richard. Arthritis Drugs: What Are My Options? June 14, 2008. <http://arthritis.about.com/cs/druggen/a/arthdrugoptions.htm>. Accessed July 31, 2008
2. Ogbro Omudhome. Marks Jay W. Nonsteroidal Antiinflammatory Drugs (NSAIDs). September 18, 2005. http://www.medicinenet.com/nonsteroidal_anti-inflammatory_drugs/article.htm. Accessed August 4, 2008.
3. Arthritis: Disease Modifying Medications. <http://arthritis.webmd.com/modifying-medications>. Accessed August 4, 2008.
4. Corticosteroids. February 24, 2006. Chron's & Colitis Foundation of America. <http://www.cffa.org/info/treatment/corticosteroids>. Accessed August 4, 2008.
5. Biological Therapy. April 16, 2002. http://www.medicinenet.com/biological_therapy/article.htm. Accessed August 5, 2008.

References

1. Weikert Douglas MD. Surgeon's dictation obtained with permission. Accessed May 1, 2008.
2. Synthes Wrist Fusion Guide. West Chester PA 2006. Accessed May 1, 2008.
3. Wrist Joint Fusion. Available at: <http://www.allaboutarthritis.com/ALLABOUTARTHRITIS/layoutTemplates/html/en/documentation.com>. Accessed May 1, 2008.
4. Turek Samuel L. Orthopaedics Principles and Their Applications, Fourth Edition, vol.2 J.B. Lippincott 1994. Accessed April 4 2008.
5. Orthopod Wrist Fusion. Available at: http://www.eorthopod.com/public/patient_education/6455/wrist-fusion.html.com. Accessed April 16, 2008.
6. Intrinsic Contracture. Available at: <http://www.ejbs.org/cgi/content/abstract/36/1/10.com>. Accessed April 20, 2008.
7. Lippincott. Raven. Surgical Exposures in Orthopaedics, The Anatomic Approach. Second Edition 1994. Accessed May 1, 2008.
8. Understanding RA. http://www.enbrel.com/ra/understanding_ra.jspchannel=GOSEAandsubchannel=SRAC.com
9. Shiel William C. Rheumatoid Arthritis. http://www.medicinenet.com/rheumatoid_arthritis/page3.htm Accessed July 30, 2008.

Wrist fusion or wrist replacement?

Another surgical option, which many choose over fusion, is wrist replacement. A total wrist replacement is generally indicated when a wrist has sustained a traumatic injury or has been affected by a severe degenerative disease, such as arthritis, and has not responded well to alternative treatments, such as a prescription drug regimen. A wrist replacement eliminates pain and recovers diminished strength in the wrist by restoring length to the muscles and tendons of the fingers and wrist, which improves motion and stability and improves the performance of many every-day activities. Total wrist arthroplasty has become increasingly popular with technological advancements constantly improving results.¹ The most significant advantage to this procedure is that it allows postoperative joint movement, unlike a fusion.

The Procedure

Wrist replacement surgery can be performed under either general or regional anesthesia. Similar to an arthrodesis, an incision is made over the dorsum of the wrist. Sections of the distal ends of the radius and ulna are resected in order to make room for the artificial joint, which is composed of both metal and plastic components. Most of the first row of carpal bones is also removed.²

After the wrist bones have been removed, reamers are used to prepare the central canals in the radius and metacarpals for the stems of the prosthesis, which comes in two parts. The radial component fits against the end of the radius, while the distal, or metacarpal component, replaces the extracted carpals in the wrist. Trial implants are used to determine the proper size of the implant.² Once the correct

size is established and the joint is securely fit into the wrist, a series of tests are performed to ensure proper range of motion and correct movement.¹ The stems of the prosthesis are then permanently secured in place using bone cement. The tendons are returned to their proper position, and the skin is closed and secured with sutures. The wrist is bandaged and secured with a small splint to restrict movement while keeping the wrist in a natural position as it heals. A small drain may be placed in the wound immediately following surgery to prevent fluids from accumulating in the wound, which reduces the chance of swelling and the subsequent stiffness it can cause.¹

While the success rate for total wrist replacements is high, complications do occur, including infection, dislocation, imbalance and loosening. Although early joint replacements were fraught with these problems, complications have been greatly reduced. More attention is being given to the replacement wrist joint after many years of focus on knees and hips. This has generated newer and more effective joint designs and alleviated many of the problems with some of the earlier models. Most implants are expected to last between 10-15 years.¹

References

1. Collins Evan MD. Total Wrist Replacement. http://www.dreanacolins.com/wrist_replacement.html. Accessed: August 11, 2008.
2. Wrist Replacement Surgery. http://allaboutarthritis.com/AllAboutArthritis/layoutTemplates/html/en/contentdisplay/document/condition/arthritis/clinicalArticle/Wrist_Replacement_Surgery.htm;jsessionid=12R2KHWf13YU4CQPCCFVDVYKB2IIWTT1. Accessed: August 11, 2008.

Living and Working with Rheumatoid Arthritis: A First-Hand Account

Debbie Uchida, CST

I have been a surgical technologist for 17 years. My hands, and the tasks they perform, have become my life. I have witnessed many procedures to correct deformities caused by rheumatoid arthritis (RA), including wrist fusions and wrist replacements. You never forget the sight of bone destruction. It was horrifying to imagine that I would one day trade places and become a patient, suffering from the crippling disease.

I was diagnosed with RA at age 25. There is no history of the disease in my family, so the diagnosis came as a big surprise. The early stages of my symptoms included excruciating pain and swelling of my right knee and left wrist joints, which limited my daily activities. Mornings were particularly difficult. My joints felt cold and almost frozen. It became increasingly harder for me to lift instrument pans and even set up a sterile field. I wore surgical gloves two sizes too big to accommodate my swollen hand. Heat applied to my wrist between surgeries offered brief comfort. I also wore a brace on my right knee—standing on my feet in the O.R. for a 12-hour shift was challenging.

My rheumatologist prescribed two medications to treat my arthritis: cortisone and methotrexate. I received cortisone injections in my knee and wrist joints every three months to ease the pain and build strength in my joints. Methotrexate, an antimetabolite drug used to treat certain types of cancer and autoimmune diseases, such as RA, was injected into my subcutaneous tissue once a week for two years. Folic acid supplementation is highly recommended while taking methotrexate. All of these drugs were deemed necessary due to the severity of my condition.

After living with RA for many years and surviving both a knee and wrist arthroscopy for complete synovectomies, my condition seemed to be in remission. However, in early 2006, new X-rays of my left wrist revealed a disturbing image. My wrist was in grave danger. My radius, ulna and all eight bones in my wrist were deteriorating and fusing together as one. The pain I experienced was indescribable. There were many days when I could not even feel my fingertips. I met with my orthopedic hand surgeon, Douglas Weikert, MD, to review operative and non-operative options. He warned me that avoiding surgery could potentially destroy my wrist, and the already intense pain would only worsen. Weikert advised that a wrist replacement would be very involved and would require more than one procedure to have a successful outcome. He told me that at my age, and with my occupation, this would not be his recommendation. Instead, he suggested a wrist fusion. This operation would eliminate my pain and rebuild my wrist. My only limitation would be not being able to bend my wrist.

Nervously, I sat trying to gather my thoughts. It was a huge decision, one that I would have to carefully weigh. However, continued pain, swelling and weakness quickly influenced my decision. I would not undergo the wrist replacement, but rather move forward and have the wrist fusion. I received my wrist-saving surgery in December 2006. I went into the operating room with the mindset that I would soon be healed.

I was slightly nervous on the morning of my surgery, but I remember feeling comforted with my teammates at my side. The major surgery lasted only two short hours. Dr Weikert spoke to my husband while I was in the recov-

ery room, and he was extremely pleased with the fusion. There were no unexpected complications. After the operation, I was fitted with a sugar tong splint and I was back at home seven hours after my operation.

The pain was surprisingly tolerable. A few days of rest allowed me to get back on my feet. The splint was removed five weeks after surgery, and a short arm cast was applied. I began physical therapy (pt) immediately, and for those of you who haven't had the pleasure of pt, it is not a pleasant experience! Intensive daily therapy is necessary to rehab the muscles and tendons. It is a vigorous and painful process, however, regaining my motion was crucial. Dedication, determination and a strong will guided me through my therapy. Every day I regained more motion in my fingers, and I was able to grip and hold items tightly. I returned to my role as a surgical technologist 10 weeks after my wrist fusion was performed. I was once again setting up sterile fields, lifting heavy pans and assisting on all surgeries.

I am now almost two years post-op, and it is amazing how much stronger my wrist has become. A small, four-inch scar is all that is visible. Being a surgical technologist and first assistant helped me through both the surgery and recovery process. The knowledge I have gained regarding wrist fusions is a tremendous aid, and I am so very grateful and proud of my profession.

I would like to extend my deepest gratitude to the physicians at Tennessee Orthopedic Alliance for their on-going care and for helping me manage my rheumatoid arthritis. I would also like to thank Joanna Hearington for retrieving my medical information and Chris Bristow with Synthes Orthopedics.

Disasters follow no rules: Preparing your hospital for disaster response

Tony Forgione, LPN

On October 18, 1989, an earthquake, registering 6.9 on the moment magnitude scale, hit the San Francisco Bay Area of California. The quake lasted only 15 seconds, but caused severe structural damage throughout the Bay Area, including the collapse of portions of double-decker highways, packed with commuters. Sixty-three people were killed and 3,757 were injured in the disaster.

LEARNING OBJECTIVES

- Evaluate a hospital's ability to meet disaster preparedness requirements
- Understand your role as a medical professional in a disaster scenario
- Compare and contrast different types of disasters and their impact
- Evaluate the chain-of-command structure during a mass casualty incident
- Recognize the challenges a hospital will face during a sustained surge

Disasters can be divided into two major categories: *natural disasters*, which include hurricanes, earthquakes and floods; and *manmade disasters*, such as industrial catastrophes and terrorism.

No one can predict the complexity, time or location of the next disaster, however, manmade disasters, especially those involving terrorism, have proven to be the most challenging disaster threat for medical providers due to the unpredictability of the incident and the number of casualties involved.

Today's terrorists have a wide spectrum of threats available to them. They do not necessarily have to kill people to achieve their goals. They just have to create a climate of fear and panic that will overwhelm the health care system. A prime example is the Saran gas attack in Japan in 1995. Of the 5,000 admissions to hospital emergency departments, only around 500 patients were actually suffering from the physical effects of Saran. The remaining patients were all suffering from psychological stress related to the incident.¹

WHAT IS A MASS CASUALTY INCIDENT?

On April 19, 1995, a 5,000-pound truck bomb detonated in front of the Alfred P Murrah Federal Building in Oklahoma City, just after 9 a.m. The blast damaged or destroyed 324 buildings within a 16-block radius, creating a crater 30-feet wide and eight-feet deep. There were 168 fatalities and 853 people injured in the explosion.

A mass casualty incident (MCI) is an event that produces enough casualties to disrupt the normal functional capacities of the affected community. The severity and diversity of injuries, in addition to the number of victims, is a major factor in determining whether or not an MCI will overwhelm the local medical and public health infrastructure.

There is a myth that all disasters are different, but the reality is that there are common, basic medical and public health issues shared by all disasters, regardless of their etiology.

A National Guardsman and a fireman work side by side in the aftermath of the Oklahoma City bombing.



- Medical issues include:
- Search and rescue
 - Triage and initial stabilization
 - Definitive care
 - Evacuation

Public health issues include:

- Water
- Food
- Shelter
- Sanitation
- Transportation
- Communication
- Endemic and epidemic disease
- Security and safety¹

Search and Rescue

Local population and assets close to the disaster are the initial search and rescue resources. In disasters involving large numbers of victims trapped in collapsed structures, the local response may be haphazard.

On September 11, 2001, two hijacked airliners were flown into the World Trade Center in New York City, in the worst terrorist attack in US history. A third hijacked aircraft crashed into the Pentagon in Washington, DC, and a fourth, believed to be targeting either the US Capitol Building or the White House, crashed in a field in Pennsylvania. All told, 2,998 people lost their lives and more than 6,000 were injured.

Many countries have specialized search and rescue teams as an integral part of their disaster response plan. These teams consist of a cadre of medical specialists and technical specialists knowledgeable in hazardous materials, structural engineering, heavy equipment operation and technical search and rescue methodology, including sensitive listening devices and remote cameras. There are also trained canines and their handlers.¹

Triage and initial stabilization

Triage is the most important mission in a disaster response scenario. Disaster triage is different than conventional medical triage in that conven-



Figure 1. Triage tag.

tional triage provides the greatest good for the patient, while disaster triage provides the greatest good for the greatest number of patients.

Disaster triage requires the response teams to prioritize and categorize the casualties, allowing for timely rescue, treatment and evacuation in an orderly fashion. They must also optimize the use of available medical, nursing and emergency personnel at the disaster site. Finally, they must optimize the use of available logistical support and equipment.

There are different levels of disaster triage. The level will be determined by the ratio of casualties to available resources. During on-site triage, patients are characterized as acute or nonacute and are labeled red, yellow or green, respectively, based on the extent of their injuries and the resources at hand. During medical triage, rapid categorization of victims at the casualty site is essential, and should be completed by the most experienced medical personnel available. Victims are color-coded (universal among most emergency medical services) according to the severity of their injuries:

- **Red**—(immediate) is used to label those who cannot survive without immediate treatment, but who have a chance of survival.
- **Yellow**—(observation) is for those who require observation (and possible later re-triage). Their condition is stable for the moment and they are not in immediate danger of death. These victims will still need hospital care and would be treated immediately under normal circumstances.
- **Green**—(wait) is reserved for the “walking wounded” who will need medical care at some point, after more critical injuries have been treated.
- **Black**—(expectant) is used for the deceased and those whose injuries are so extensive that they will not be able to survive given the care that is available.²

Definitive medical care

Definitive medical care improves, rather than just stabilizes, the casualty’s condition. It varies widely, depending on the magnitude of the disaster, number of casualties and resources at hand. Both small and large-scale mass casualty incidents may require the mobilization of specialty medical teams to participate in the field medical response or supplement resources in the disaster region. Definitive care can be provided in either a fixed facility, such as an existing hospital or building, or a mobile facility, such as a free-standing field hospital.

However, lessons in surge capacity management learned in the Iraq War may change the way certain civilian MCIs are approached. Specifically, Iraq’s experience with damage-control (emergency) surgery has shown that more patients’ lives can be saved through temporizing damage-control surgery than if patients received time-consuming definitive surgery.³

Evacuation

Evacuation is useful in a disaster as a means of “decompressing” the disaster scene, removing the patients who are consuming the most resources. Evacuation of seriously-injured casualties to off-site medical facilities not only improves their care, but also allows increased attention to remaining casualties at the disaster site.

Mass Casualty Incident Response

On August 29, 2005, Hurricane Katrina made landfall in Southeastern Louisiana. The high winds and unprecedented rainfall proceeded to batter the Gulf Coast, causing nearly every levee in metro New Orleans to breach, flooding 80 percent of the city. The storm left 1,836 confirmed dead and 705 missing.

Response to a mass casualty incident involves many different organizations with different command structures and missions simultaneously participating in the disaster response. For example, the New York City Police and Fire Departments, New York and New Jersey Port Authori-

Methods of Evacuation	
Method	Cost/Benefit Ratio
Ground	<ul style="list-style-type: none"> • Simple and generally available • Inefficient (low transport capacity) • May remove critical resources
Small Aircraft	<ul style="list-style-type: none"> • High cost and complexity • Inefficient (low transport capacity) • Difficult to provide advanced care • Aircraft may be better-utilized in disaster area
Large Aircraft	<ul style="list-style-type: none"> • Very high cost and complexity • More efficient (medical crew can manage multiple casualties over long distances) • Possibility of retrograde airlift (use of aircraft to bring supplies to disaster area)

In a disaster scenario, all patients should be brought to a casualty collection site, which should be located close enough to the disaster site for easy casualty transfer, but far enough away to be safe. The collection site should be large enough to adequately handle the number of victims of the disaster. Collection sites should not, ideally, be on hospital property and should be located a safe distance from any hazards, upwind and uphill from contaminated areas and sheltered from the elements.¹

ties, state police, FBI, National Guard and the US Coast Guard, among others, were all on hand for the search and rescue effort after the World Trade Center attack on September 11.

A mass casualty response needs to have a consistent approach to disasters based on an understanding of the common features of disasters and the response expertise required. A key component that has brought about this consistent approach is the incident command system (ICS).

INCIDENT COMMAND SYSTEM (ICS)

On April 16, 2007, a shooting incident occurred on the Virginia Tech campus in Blacksburg, Virginia. The shooter entered two campus buildings, where he killed 33 students and faculty, including himself, and injuring 26 others. The incident is the greatest shooting rampage by a single gunman in US history.

S.T.A.R.T.

The simple triage and rapid treatment (START) system was developed to allow first responders to triage multiple victims in 30 seconds or less, based on three primary observations: respiration, perfusion and mental status. It allows rescuers to locate the most severely-injured patients in the least amount of time. As more man power and other resources arrive on the scene, the patients will be re-triaged for further evaluation, treatment and transportation.

Triage tags are the easiest way to designate a patient's status on the disaster scene. The most common types of tags are either colored paper tags or colored surveyors tape. There are four designated colors for triage tags:

■ Minor	Delayed care/can delay up to three hours
■ Delayed	Urgent care/can delay up to one hour
■ Immediate	Immediate care/life-threatening
■ Dead	Victim is dead/no care required

The first step in a disaster setting is to tell all the people who can get up and walk to move to a specific area. If patients can get up and walk, they are probably not at risk of immediate death and are indicated with a green tag. However, if a patient complains of pain on attempting to walk or move, do not force them to do so.

After clearing the green/minor patients, begin moving from where you stand. Work

your way through the remaining victims in a systematic manner. Each assessment should take no longer than one minute. The central point of disaster triage is to find and tag the patients that require immediate care.

Evaluation

The START system is based on three observations: respiration, circulation and mental status.

Respiration: If the patient's breathing rate is greater than 30 breaths per minute, a red/immediate tag is used. This respiratory pattern is indicative of the primary signs of shock and needs immediate care. If the patient is not breathing, clear the mouth of obstructions and tilt the head to open the airway. Position the patient to maintain the airway. If the patient breathes, tag as immediate. Patients who require assistance to maintain an open airway are also tagged as red/immediate. If you are unsure of a patient's ability to breathe, use a red/immediate tag. If the patient is not breathing and does not start to breathe with simple airway maneuvers, tag as black/dead.

While certain steps in this process may contradict standard cervical spine guidelines, they may be ignored during a mass-casualty triage situation. This is the *only* time in emergency care when there may not be time to properly stabilize every injured patient's spine.

If the patient is breathing at a rate of less than 30 breaths per minute, the next step in the 30-second evaluation is circulation.

Circulation: The best method for checking circulation is taking the radial pulse. If it is absent or irregular, the patient should be tagged red/immediate. If the radial pulse is present, move on to evaluate the patient's mental status.

Mental status: Mental status can be evaluated through the patient's ability to follow simple commands, such as "open your eyes" or "squeeze my hand." If the patient can follow these commands and exhibits adequate breathing and circulation, he or she is tagged as yellow/delayed. A patient who is unresponsive to verbal stimuli is tagged as red/immediate.

Follow up

This system is designed to find the most seriously injured patients. As resources become available, patients will be re-triaged for further evaluation, treatment, stabilization and transportation. Keep in mind that injured patients do not remain in the same condition. Conditions may deteriorate over time, necessitating a patient to be upgraded in status. As time and resources permit, patients should be re-evaluated as often as possible.

References

1. CERT Los Angeles. *Simple Triage and Rapid Treatment*. March 26, 2003. Available at <http://www.cert-la.com/triage/start.htm>. Accessed: September 2, 2008



U.S. Coast Guard Petty Officer 2nd Class Lynn Lyono, Gargemini

Medics receive a patient from a Coast Guard helicopter during the Hurricane Katrina disaster.

The ICS provides a common organizational structure and language to simplify communication among disaster responders. The goal of the ICS is to utilize disaster resources in the most efficient manner at the disaster scene. It is a modular system readily adaptable for all incidents and facilities regardless of the site. Functional requirements, not titles, determine the organizational hierarchy, and the structure remains the same regardless of the incident. The ICS should be started as early as possible to prevent the situation from spiraling out of control.

Job description of key ICS leaders

The ICS hierarchy is built around five management activities. *Command* is responsible for all incident or event activities. *Operations* is responsible for directing the tactical actions to meet the incident objectives. *Planning* collects, evaluates and displays the incident information and maintains the status of resources. *Logistics* provides adequate services and support to meet all incident needs. *Administration/Financial* tracks incident-related costs, personnel and equipment records, and administers any procurement contracts.¹

Hospital Emergency Incident Command System

Many hospitals are incorporating the ICS into their emergency preparedness plan. This system is known as the hospital emergency incident command system (HEICS). The HEICS is designed to help minimize a lot of the confusion and chaos experienced by hospitals in a medical emergency. It is a plan designed to fit within

the hospital's emergency preparedness plan. The HEICS features the same flexible management chart used in the ICS, which allows for a customized hospital response to the crisis at hand.¹

The features offered to hospitals are:

- Predictable chain of command
- Flexible organizational chart allowing a flexible response
- Prioritized response checklist
- Accountability
- Improved documentation
- Common language
- Cost effective emergency planning

What is my role in a disaster?

- Be able to respond
- Know where to respond
- Know alternate routes to hospital
- Be flexible
- Remain calm

Good intentions alone do not constitute an effective disaster response. Given the complexity of today's medical disasters, medical personnel need to incorporate the principles of the mass casualty incident response in their training, regardless of their specialties or the size of their institutions.

ABOUT THE AUTHOR

Tony Forgione, LPN, has worked at Massachusetts General Hospital in Boston for more than 30 years. He is a member of the International Medical Surgical Response Team of the Department of Human Services. As a member of this team, Forgione has become familiar with disasters and their aftermath. He was part of the response team in New York during the September 11 disaster and also traveled to Iran in 2003, to care for victims of a massive earthquake.

References

1. Advanced Disaster Medical Response. Harvard Medical International. 2003.
2. Critical Illness and Trauma Foundation Inc. *START—Simple Triage and Rapid Treatment*. 2001. Available at: <http://www.citmit.org/start/default.htm>.
3. National Center for Injury Prevention and Control. *In a Moment's Notice: Surge Capacity for Terrorist Bombings*. Atlanta: Centers for Disease Control and Prevention; 2007.

Case study: Virginia Tech mass casualty incident

Tom Borak

BACKGROUND

On April 16, 2007, a shooting occurred on the campus of Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia. The lone gunman, a Virginia Tech student, entered a student dormitory, where he claimed his first two victims. Nearly two hours later, the shooter made his way across campus and entered an academic building, where he proceeded to murder 30 more students and faculty, before taking his own life.

Blacksburg is a small town in a rural part of Virginia with a population of just under 40,000—including the student population of 25,000. As such, the area does not enjoy the luxury of the advanced medical structure available in many large cities. The closest level 1 trauma center is 42 miles away in Roanoke, Virginia. The next closest is in Charlottesville, Virginia, which is approximately 150 miles from the Virginia Tech campus. The three closest hospitals, Montgomery Regional Hospital (MRH), Carilion New River Valley Medical Center (CNRV) and Lewis Gale Medical Center (LGMC) are either level 3 trauma centers or nondesignated.¹

EMERGENCY MEDICAL SYSTEM RESPONSE

Shortly after 7 a.m., the shooter fired two shots, claiming his first two victims in the West Ambler Johnson Hall dormitory. The incident was phoned in to campus police by a student who suspected that someone had fallen out of bed. The first responders discovered the victims shortly after 7:20 a.m.²

Virginia Tech Rescue requested assistance from the Blacksburg Volunteer Rescue Squad and both patients were transferred to Montgomery Regional Hospital, three miles from the dormitory. One of the victims was pronounced

dead-on-arrival (DOA) and the other, presenting with a gunshot wound to the head, was transferred to the nearest level 1 trauma center, Carilion Roanoke Memorial Hospital (CRMH). A medevac was initially requested, but denied due



to inclement weather: on April 16, 2007, high winds with gusts of up to 60 mph made a medical airlift impossible, meaning all patients had to be moved via ground transport. The second patient died shortly after arrival at CRMH.³

Because the shooting in the dormitory was initially considered an isolated incident, campus-wide action was not taken. Two hours later, while police were still working the initial crime scene, the shooter made his way into Norris Hall, where he chained the three main doors shut and began his rampage on the building's second floor.

At 9:42 a.m., campus dispatch received a 9-1-1 call reporting multiple shots fired at Norris Hall. Police were on the scene by 9:45. The

Police officers carry Virginia Tech student, Kevin Sterne, from Norris Hall. The former Eagle scout was shot through the right leg, severing the femoral artery. He saved his own life by making a make-shift tourniquet from an electrical cord before first responders applied a real one.

first mutual aid vehicle arrived on campus at 9:50 a.m. and staged in the forward staging area as directed by EMS command. Additional EMS was requested via mutual aid with 14 agencies responding.¹ Because of the active shooter, these resources were designated to a second staging area located less than one-quarter mile from campus until the area was secured. Staffing levels were adjusted for all staged ambulances to ensure that each was staffed by advanced life support providers.¹

At 9:50 a.m., two medics entered the building. They were held up in the stairwell for two minutes for safety precautions before being allowed to proceed.⁴ They began triage on victims brought to the stairwells while police were moving them out of the buildings. The triage had two specific goals: first, to identify the total number of victims who were alive or dead; and second, to move ambulatory victims to a safe area where further triage and treatment could begin.⁴ The medics used the Simple Triage and Rapid Treatment (START) system to evaluate the severity of the injuries and assign treatment priorities. Those tagged as red or yellow were immediately transported for hospital care.

HOSPITAL RESPONSE

At 9:45 a.m., MRH was notified of shots fired somewhere on the Virginia Tech campus. Without significant information, the hospital initiated a security lockdown procedure as a precaution.

At 10:00 a.m., the hospital received confirmation of multiple gunshot victims and a “code green” (disaster code) was initiated:

- The hospital incident command center was opened and pre-assigned personnel reported to command.
- The hospital facility was placed on a controlled access plan (strict lockdown). Only personnel with appropriate identification (other than patients) could enter the hospital, and then only through one entrance.
- All elective surgical procedures were postponed.

- Day surgery patients with early surgery times were sent home as soon as possible.
- The emergency department was placed on divert for all EMS units except those arriving from the Norris Hall incident. The emergency department was staffed at full capacity. A rapid emergency department discharge plan was instituted. Stable patients were transferred from the emergency department to the outpatient surgery suite.⁴

The regional hospital coordinator received information from the scene of the shooting at 10:13 a.m. and activated the Regional Hospital Coordinating Center (RHCC), at which time the incident command system (ICS) was set in motion.¹ At the national level, Homeland Security Presidential Directives 5 and 8 require all federal, state, regional, local and tribal governments, including EMS agencies, to adopt the National Incident Management System (NIMS), including a uniform ICS.⁵ The NIMS is defined by Western Virginia EMS Counsel in their Mass Casualty Incident (MCI) Plan as:

A written plan, adopted and utilized by all participating emergency response agencies, that helps control, direct and coordinate emergency personnel, equipment and other resources from the scene of an MCI or evacuation, to the transportation of patients to definitive care, to the conclusion of the incident.⁶

A level 3 trauma center, the MRH emergency department received 17 patients from the Virginia Tech incident, including the two victims of the dormitory shooting.⁴ The first patient from the Norris Hall shooting arrived via self-transport at 10:05 a.m., presenting with minor injuries sustained while escaping from the building. When two more patients arrived via EMS transport at 10:14 and 10:15, the hospital realized that they might continue to receive both expected and unexpected patients. In preparation for the surge, MRH took the following precautions:

- The Red Cross was alerted and the blood supply reevaluated.

- Additional pharmaceutical supplies and a pharmacist were sent to the emergency department.
- A runner was assigned to assist with bringing additional materials to and from the emergency department and the pharmacy.
- Disaster supply carts were moved to the hallways between the emergency department and outpatient surgery.^{4,7}

At 10:17 a.m., the RHCC notified the Virginia Hospital and Health Care Association and the Virginia Department of Health in Richmond, Virginia, of the situation in Blacksburg.

Other hospital planning regions activated their RHCCs and logged onto Web Emergency Operations Center (EOC), a virtual EOC and bed-monitoring system used throughout the state to track hospital resource availability and bed accessibility.¹ After activating its EOC, LGMC canceled some elective surgeries and made hospital staff available to assist MRH if necessary.

Between 10:30 and 10:55 a.m., nine additional patients arrived at MRH via EMS. At 11:30 a.m., a surgeon from LGMC was issued emergency credentials from MRH to assist with emergency procedures, which is notable because LGMC and MRH are not affiliated.⁴

Table 1. All in a day's work: Patients presenting from the Virginia Tech incident

Hospital	Injuries	Disposition
MRH	Gun shot wound (GSW) left hand—fractured 4th finger	OR and admission
MRH	GSW right chest—hemothorax	Chest tube in OR and admission
MRH	GSW right flank	OR and admission to ICU
MRH	GSW left elbow, right thigh	Admitted
MRH	GSW x2 left leg	OR and admission
MRH	GSW right bicep	Treated and discharged
MRH	GSW right arm, grazed chest wall, abrasion to left hand	Admitted
MRH	GSW right lower extremity; laceration to femoral artery	OR and ICU
MRH	GSW right side abdomen and buttock	OR and ICU
MRH	GSW right bicep	treated and discharged
MRH	GSW face/head	Intubated and transferred to CRMH
MRH	Asthma attack precipitated by running from building	Treated and discharged
MRH	Tib/fib fracture due to jumping from second-story window	OR and admission
MRH	First-degree burns to chest wall	Treated and discharged
MRH	Back pain due to jumping from second-story window	Treated and discharged
CNRV	GSW face, pre-auricular area, bleeding from external auditory canal, GCS of 7, poor airway, anesthesiologist recommended surgical airway	Surgical cricothyrotomy; transferred to CRMH
CNRV	GSW flank and right arm, hypotensive	Immediately taken to OR; small bowel resection
CNRV	GSW posterior thorax (exit right medial upper arm), additional GSWs to right buttock and left lateral thigh	OR for surgical repair of left femur fracture
CNRV	GSW right lateral thigh, exit through right medial thigh, lodged in left medial thigh	Admitted in stable condition and observed; no vascular injuries
LGMC	GSW grazed shoulder and lodged in occipital area; did not enter the brain	Taken to surgery by ENT for debridement
LGMC	GSW in back of right arm; bullet not removed	Admitted for observation
LGMC	GSW face, bullet fragment in hair, likely secondary to shrapnel spray	Treated and discharged
LGMC	Shattered tib/fib due to jumping from second-story window	Admitted, taken to surgery the next day
LGMC	Soft tissue injuries, neck and back sprain due to jumping from second-story window	Treated and discharged

To ease communication with EMS at the scene, MRH sent an emergency administrator to determine how many more patients would be transported to the hospital. The last gunshot victim was received at 11:40 a.m., and the on-scene liaison confirmed that all patients had been transported at 11:51 a.m. The code green was lifted at 1:35 p.m.⁴

AFTERMATH

By 11 a.m., the hospital had established a base where staff and counselors could assist family and friends of patients, however, many were unsure of the status or location of the persons they were trying to find.

MRH established a psychological crisis counseling team to provide services to victims, their families, loved ones and hospital staff.^{4,8}

All told, 24 patients were treated in local emergency departments, including MRH, LGMC and CNRV. (Table 1)

CONCLUSION

The overall assessment of the EMS response and hospital preparedness is positive, however, there are always improvements to be made. According to the report issued by the Virginia Tech Review Panel, the hospitals and public safety agencies should have used the RHCC and WebEOC expeditiously to gain better control of the situation. With rumors and unconfirmed reports concerning patient surge, it would have made coordination of the incident much easier.⁴

MRH requested activation of the RHCC at 10:05 a.m. It was activated under standby status at 10:19 a.m. and signed on to WebEOC. At 10:40 a.m., the RHCC requested an update of bed and diversion status from all hospitals in the area. By 10:49 a.m., however, only LGMC (of the hospitals that received patients from the Norris Hall incident) had signed on to WebEOC. MRH did not provide its status until 11:49 a.m., followed by CNRV at 12:33 p.m.⁴

Communication was also a significant issue during the Virginia Tech incident. Similar to the widely-publicized communication roadblocks on September 11, every service operated

on a different radio frequency, making dispatch, interagency and medical communication difficult.⁴ It congested both on-scene and in-hospital situations that could be avoided with more planning and implementation of uniform disaster protocol.

While considered an overall success, given the conditions and circumstances of this disaster, this incident highlights the importance of communication during incident response and preparedness for surge capacity. It also indicates the importance of constant preparation and regular training drills for an unforeseeable event.

References

1. Kaplowitz Lisa. Reece Morris. Hershey Jody Henry. Gilbert Carol M. Subbarao Italo. *Regional Health System Response to the Virginia Tech Mass Casualty Incident*. Disaster Medicine and Public Health Preparedness. Accessed August 25, 2008.
2. Williams Reed. Morrison Shawna. *Police: No Motive Found*. The Roanoke Times. April 26, 2007. Available at: <http://www.roanoke.com/vtshootingaccounts/wb/114655>. Accessed August 25, 2008.
3. Perkins Timothy J. *Virginia Tech Mass Shooting Review Panel Report*. EMS Responder.com. July 8, 2008. Available at: <http://www.emsresponder.com/print/Emergency--Medical-Services/Virginia-Tech-Mass-Shooting-Review-Panel-Report/156353>. Accessed August 25, 2008.
4. Report of the Virginia Tech Review Panel. August 2007. Available at: <http://www.governor.virginia.gov/Temp-Content/techPanelReport.cfm>. Accessed August 25, 2008.
5. Bush George W. Homeland Security Presidential Directive/HSPD-8. December 17, 2003.
6. West Virginia EMS Council. *Mass Casualty Incident Plan: Ems Mutual Aid Response Guide*. 2006.
7. Montgomery Regional Hospital. *Montgomery Regional Hospital VT Incident Debriefing*. April 23, 2007.
8. Heil J. et al. Report to the Virginia Tech Review Panel. *Psychological Intervention with the Virginia Tech Mass Casualty: Lessons Learned in the Hospital Setting*. 2007.

Pandemic disease: The next great disaster?

Tom Borak

Perhaps the greatest natural disaster threat is that of pandemic disease. While it may not cause collateral damage on the scale of a terrorist attack or a category 5 hurricane, this silent killer has a much greater reach and the destructive power to devastate any city in any country around the world. These biological agents know no boundaries and can travel as fast as the hosts that carry them, which in today's fast-paced world can mean global impact in just a few weeks' time.

In November 2002, severe acute respiratory syndrome (SARS) broke out in the Guangdong Province of China. On November 27, Canada's Global Public Health Intelligence Network, an electronic warning system that is part of the World Health Organization's (WHO) Global Outbreak and Alert Response Network, picked up reports of what was being called a "flu outbreak," and notified the WHO.¹

Public awareness, particularly in the United States, did not escalate until February 2003, when an American businessman contracted the disease on a flight from China to Singapore. He was taken to a hospital in Hanoi, Vietnam, where several of the staff that treated him also contracted the disease, despite following hospital protocol. The patient eventually died.

The WHO issued a global alert on March 12, 2003, followed by a health alert by the US Centers for Disease Control and Prevention (CDC).

SARS was identified in 29 separate geographic areas. While it was concentrated mainly in China, cases were diagnosed across Western Europe, Canada and the United States. From November 2002 to July 2003, 8,096 cases were diagnosed, leading to 774 deaths. (Since July 11, 2003, 325 cases have been dismissed in Taiwan, China. Laboratory information was insufficient or incomplete for 135 of those cases, of which 101 died.)²

While SARS was ultimately contained, the speed with which it spread is an important indicator of how fast future pandemics may travel. It is critical that the United States health care system is prepared for such a catastrophic event.



Winnipeg Free Press Archive

ARE WE READY?

It is highly likely that hospitals and other health care facilities will be overwhelmed by the sheer volume of patients at the onset of a pandemic. According to Nancy Donegan, RN, director of infection control at the Washington Health Center in Washington, DC, hospitals can increase their patient care capacity in relatively short periods of time by "surging in place," which involves rapidly discharging existing patients, cancelling scheduled elective procedures, and taking steps to increase the number of patient-care staff in the facility in order to make additional staffed hospital beds available for incoming disaster event

Free Press newsboys don protective masks during the 1918 pandemic. While widely used, the masks had no protective effect against the virus.

patients.³ However, most hospitals operate at or near full capacity, which means they have a very limited ability to rapidly increase the workforce.

While this strategy can provide a temporary ability to increase patient care capacity, most hospitals cannot sustain such a surge for extended periods of time. Individual facilities will quickly become overwhelmed if the disaster involves large numbers of victims presenting over a prolonged period of time—and most projections estimate that a pandemic will last at least a few months.

One of the most significant reasons for this is insufficient funding. According to the American Hospital Association, approximately one-third of hospitals lose money on operations—with Medicare and Medicaid under-funding being a key driver. Another one-third of hospitals operate at or near the break-even point. This means that two out of three hospitals are not able to invest significantly in surge capacity preparation.³

By the same token, financial constraints have forced many hospitals to adopt “just-in-time” supply chains for their equipment, which means that new shipments are scheduled to arrive just as the supply is being exhausted. Therefore, in a sustained surge, as can be expected during a pandemic, hospitals will face an almost immediate shortage of critical supplies, including ventilators, personal protective equipment for staff, drugs and other supplies.³

Since most hospitals are operating on the “just-in-time” model, medical suppliers will be unable to keep up with increased demand from all of their clients simultaneously, which will result in a shortage, and supply rationing.

According to the Center for Biosecurity at the University of Pittsburgh Medical Center, the estimated cost of readiness for a severe (1918-like) pandemic is \$1 million per average-sized hospital (164 beds). The estimated costs include:

- Develop specific pandemic plan: \$200,000
- Staff education/training: \$160,000

1918 Influenza pandemic

Margaret Sterling CST, LPN, MA

Influenza, or simply the flu, can be traced through written records as far back as 412 B.C.¹ Since then, there have been numerous outbreaks that have varied in severity. None, however, has impacted the world with the severity of the pandemic outbreak in 1918-19. Dubbed the “Spanish Flu,” the disease infected between 20-40 percent of the world’s population and killed more than 20 million people worldwide in less than a year—500,000 in the United States alone.²

The US outbreak began at an Army base near Boston in September 1918. While it was identified as influenza, the characteristics of the strain were unique. The majority of deaths were due to bacterial pneumonia, a secondary infection caused by influenza. The virus also killed people directly, causing massive hemorrhages and edema in the lungs.³

The onset of the 1918 flu was very sudden. A victim could go from good health to being unable to walk within a few hours. Symptoms included general weakness, severe aches in muscles, backs, joints and heads. This was often accompanied by a fever that could reach 105 degrees, caus-

ing overwhelming bouts of delirium. When the fever broke, many survivors suffered from post-influenza depression.⁴

The impact on the Eastern seaboard was almost immediate. The Boston stock market was closed, a state-wide order in Pennsylvania shut down every place of public amusement—including saloons, and the Kentucky Board of Health prohibited public gatherings of any kind, including funerals. The dead piled up faster than they could be buried, resulting in piles of bodies in the streets and mass graves. The medical community was overwhelmed. By the time the pandemic had made its way across the country, and eventually faded completely, the nation had been devastated.

References

1. Martin P. Martin-Granel E. “2,500-year Evolution of the Term Epidemic.” *Emerging Infectious Diseases*. 2006.
2. Centers for Disease Control and Prevention. *Pandemic Influenza*. February 12, 2004. Available at: <http://www.hhs.gov/nvpo/pandemics/flu3.htm#8>. Accessed September 3, 2008.
3. Taubenberger J. Morens D. “1918 Influenza: The Mother of all Pandemics.” *Emerging Infectious Diseases*. 2006.
4. Crosby A W. *America’s Forgotten Pandemic*. Cambridge University Press. 1989

- Stockpile minimal personal protective equipment: \$400,000
- Stockpile basic supplies: \$240,000
- Total: \$1 million³

On top of that, the center estimates that annual costs to maintain a state of readiness could reach approximately \$200,000 per year. Based on these numbers, the total for the nation's 5,000 general acute care hospitals for initial pandemic preparedness—not including annual maintenance costs—is about \$5 billion.³

The US government's National Bioterrorism Hospital Preparedness Program has recognized the problem and is working to increase the cash flow to the hospital system, although it is a very slow process:

Preliminary estimates in 2002 suggested that hospitals would require approximately \$11 billion to obtain a basic level of "all hazard preparedness." Since then, Congress has appropriated about \$500 million per year for the program and the fiscal year 2007 request is \$487 million. This amounts to \$2.1 billion over five years, or about \$100,000 per hospital per year to fund preparedness. However, the amount that hospitals have actually received is significantly less due to dollars allotted for the federal government's administration of the program and overhead funds that the state grantees have retained.³

The other significant factor is man power. While there are national plans to improve hospital staffing numbers during a surge by expanding the Medical Reserve Corps and the Public Health Service Commissioned Corps, it becomes a moot point when the call for help simultaneously arises from hospitals across wide geographic areas. In addition, since the Medical Reserve Corps and other advanced registration programs for volunteers often recruit their medical volunteers from hospital staff, it is unlikely that the volunteers' "home" hospital would permit them to deploy elsewhere if there is an expectation that they will

be needed in their own hospitals,³ which, in the case of a pandemic, is exactly the scenario that would likely occur.

Another consideration is that just because hospital staff work in a medical environment, it does not make them immune to the pandemic. Staff will be exposed to the disease both inside and outside of work. Some will likely become infected themselves. Others may choose not to show up for work at all, instead opting to stay home with family. Until the severity of the pandemic is understood, there is no way to know exactly how it will impact the workforce and hospitals' ability to serve.

Despite these shortcomings, it is critical that all hospitals and health care providers maintain a state of readiness for a potential pandemic outbreak. It is advisable for facilities to follow the three pillars of the National Implementation Plan whenever possible: 1) preparedness and communication, 2) surveillance and detection, and 3) response and containment.³

For more in-depth research and additional details on the national strategy, the National Strategy for Pandemic Influenza Implementation Plan can be found at http://www.whitehouse.gov/homeland/nspi_implementation.pdf.

References

1. Mawudeku A. Blench M. *Global Public Health Intelligence Network*. mt-archive. 2005.
2. World Health Organization. *Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003*.
3. Donegan Nancy. Testimony of the American Hospital Association before the US Senate Special Committee on Aging. *Preparing for Pandemic Flu*. May 25, 2006. Available at http://www.ucop.edu/riskmgmt/documents/aha_panflu_testimony.pdf. Accessed July 7, 2008.

Challenging and Changing the Experience of Pain:

Acute Pain Management in the Perioperative Setting in Patients with a Substance Abuse History

DAMIAN BROUSSARD, RN, BSN, CNOR

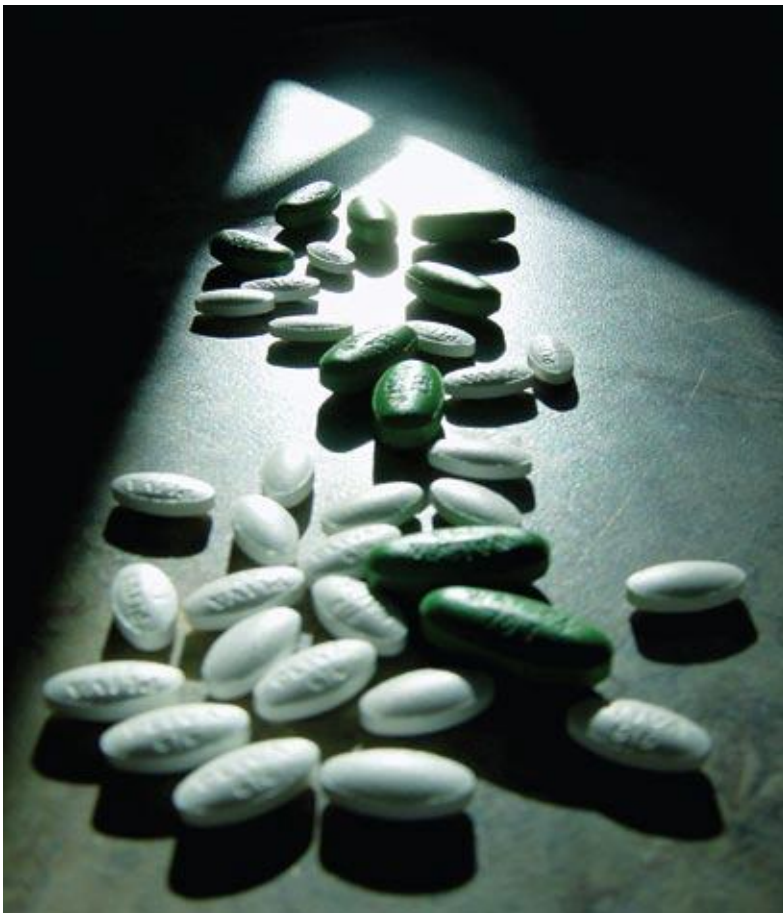
AMY BROUSSARD, CST, CFA

Postoperative pain management presents a challenge in all surgical patients, particularly patients with a history of substance abuse. The current perioperative pain management protocol for recovering substance abuse patients, specifically those with a history of opioid addiction, is inadequate. Most patients undergoing a surgical procedure are treated with the same pain management assessment tools and medications with little regard for current addictions or recovering substance abuse patients.

LEARNING OBJECTIVES

- Identify the differences for administering pain control to patients who suffer from addiction versus those who do not.
- Define the physical and emotional components of pain.
- Describe the etiology of addiction.
- Evaluate the factors used to assess a patient's pain level.
- Assess the benefits of MMT

Prevention of withdrawal or relapse is mostly ignored; however, simple and manageable changes made in hospital policy, patient and staff education and patient assessment can improve this practice. Medication protocol can be individualized. All of these changes in practice can greatly enhance the care needed by this special population of patients by individualizing care rather than treating this population with no regard for their preexisting disease. Whether the patient is an active substance abuser or in recovery and working on a 12-step program, the patient's emotional, physical and psychological reaction to



pain is much different than a patient that has not suffered from addiction. Because of this abnormal reaction, the treatment chosen to control pain should be altered in order to meet the needs of this special population.¹

This issue greatly impacts practice as a surgical team member. The attitude of, "once a

drug addict, always a drug addict," needs to be altered. All patients, regardless of history, need equal treatment in regards to pain management in accordance with the Patient's Bill of Rights in the United States.^{2,3} Just as a patient with a disease process, such as diabetes, has special needs, the substance abuse patient's plan of care for postoperative pain management should be augmented accordingly.⁴

Opioid-addicted patients, in particular, pose a great challenge in the postoperative setting.^{4,5,6} Since pain is such a broad topic with multiple facets, the research for this topic is limited to the patient suffering from past or present opioid addiction. The majority of the medications used in practice for postoperative pain management are opioid-based. Fear of triggering a craving in the recovering patient, or not managing the required serum drug levels to prevent withdrawal symptoms in the active patient while managing postoperative pain, is of constant concern. Pain, as defined by *Webster's Medical Dictionary*, is an unpleasant sensation that can range from mild, localized discomfort to agony. The word is derived from the Latin word *poena*, meaning a fine or a penalty. Pain has both physical and emotional components. The physical part of pain results from nerve stimulation and may be contained in a localized area, such as in an injury, or it can be more diffuse. The emotional components of pain range from anger and sadness to severe depression.^{7,8}

In today's clinical practice, however, the most widely accepted definition of pain is the definition set forth by Margo McCaffery in 1968, which states that, "pain is whatever the experiencing person says it is, existing whenever they say it does."⁷ Acute pain in the postoperative setting is present in a surgical patient because of a pre-existing disease, the surgical procedure, or a combination of the two.⁹ The inadequate treatment of acute postoperative pain has been recognized as a significant cause in the delay of hospital discharge and prolonged recovery time in surgical patients.^{3,10,11} Postoperative pain also increases morbidity and delays returning to normal living.¹² Additionally, unrelieved pain causes a rise

in the body's sympathetic response that leads to a rise in the heart rate and increases oxygen consumption and overall cardiac workload.¹³

In today's operating rooms and post-anesthesia care units, there is a severely undertreated patient population in reference to postoperative pain management. This population includes the individuals with an active addictive disease or a history of addictive diseases.¹⁴ A social stigma exists that addiction is a choice, however, addiction is a disease.¹⁵ A disease is defined as having an etiology, signs, symptoms and causes a specific illness to the body.¹⁶ Addiction is a chronic, relapsing and treatable disease that is characterized by a lack of control over consumption and compulsive use despite harmful consequences.⁴ Addiction also causes chronic mental illnesses and chemical changes in the patient's brain.

In today's operating rooms and post-anesthesia care units, there is a severely undertreated patient population in reference to post-operative pain management.

Addiction's etiology originates in a section of the midbrain called the mesolimbic dopamine pathway. When stimulated by drugs of abuse, such as opioids, this center releases the brain's own endogenous endorphins. These endorphins are linked to the profound, euphoric feeling associated with drug intoxication. This feeling is so reinforcing that patients will seek to repeat using the drug despite dire consequences to their health and social life.^{7, 15} Thus, it can be deduced that addiction's etiology is the stimulation of the dopamine pathway by drugs of abuse, and its signs and symptoms are the destructive behaviors that addicts often exhibit.

Perioperative pain management for the patient with an opioid addiction history must begin with a thorough preoperative assessment of the patient. Proper preoperative assessment is the first and most important step in proper postoperative pain management.⁹ Many pain assessment tools are available to clinicians, including numeric scales, visual analog scales and picture scales. Regardless of which assessment tool is

utilized, the assessment must be done at regular intervals, and it must be well-documented to be effective.

The pain scales used in most settings help to provide accurate pain level assessment. However, all of these scales are very difficult to use in the acute postoperative phase of patient care due to the patient's altered level of consciousness caused by the anesthetic medications used intraoperatively.¹³

In addition to the multitude of assessment scales used to assess a patient's pain level, other factors should also be considered. A patient's preoperative analgesic use (or substance abuse), pain management history, preoperative patient education and site of operation are a few of these considerations.¹⁷ All of these factors play an important role in the way pain is perceived and also how pain is communicated by the patient.^{3, 13, 17}

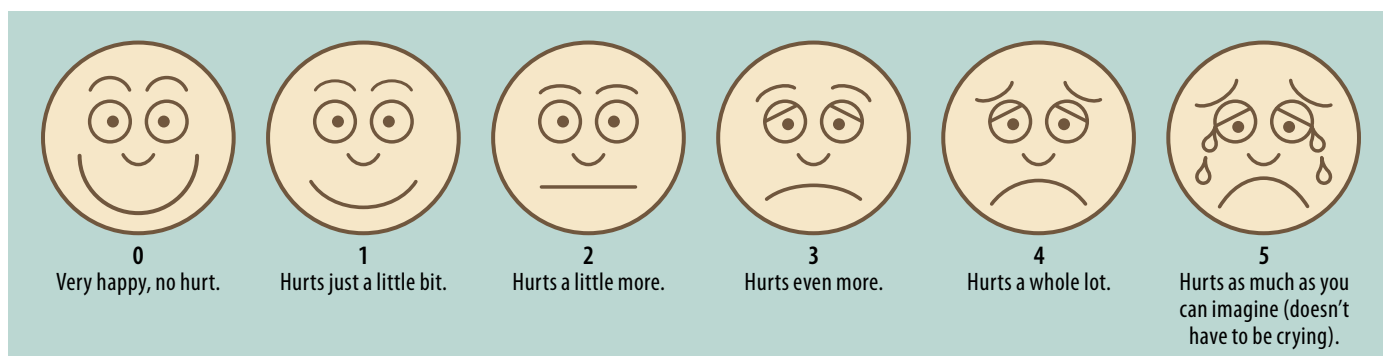
In most perioperative practice settings, a patient's pain level is assessed preoperatively by a registered nurse with a numeric scale that ranges from 0 to 10. Although having a standardized pain scale is a positive attribute for obtaining continuity of care, it seems that the particular scale in use may not be completely effective. A more objective approach in the acute postoperative phase may be appropriate until the sedative effects of the anesthesia medications decrease.^{13, 17}

Use of the numerical scale is neither appropriate nor adequate for the acute postoperative setting. Clinical observations of the patient's appearance, such as sweating, sighing and the inability to move may indicate a patient in pain. Other clinical objective observations, such as an elevated blood pressure, elevated heart rate and a lack of the ability to take a deep breath may also indicate pain in the postoperative patient.^{13, 17} In this regard, continuing education is needed in the perioperative setting. Proper training on clinical objective observations is required to adequately assess the sympathetic responses to pain

that patients experience in the acute postoperative setting.^{11, 13, 17}

The assessment of pain in the acute postoperative phase of patient care is further complicated when the patient has a history of opioid addiction. This issue may, in part, be due to the preconceptions about the addictive behavior in this group of patients by caregivers and the reluctance of these patients to reveal their discomfort for fear of being judged and discriminated against.^{4, 7, 18} Patients with an addictive disease and pain have the right to be treated with dignity, respect and the same quality of pain assessment

pain score, but say they are feeling well overall. This answer may be viewed by the practitioner as drug-seeking behavior when in fact studies have shown that recovering addicts may have a lower overall tolerance for pain due to chemical changes in the brain caused by the drug abuse.^{7, 12} Because of these misconceptions, a more objective approach, as suggested by the World Federation of Society of Anesthesiologists, may be particularly relevant in such a situation.¹³ If the patient continually scores his pain high on a numeric scale, the practitioner may be reluctant to administer needed pain medication because he feels that this



Pain faces scale

and management as all other patients. Thus, all patients who are admitted into the post-anesthesia unit must have their pain assessed and treated with the same resilience. Health care professionals are ethically bound to manage pain and provide care to all patients, including those patients known to have an active addiction or a history of an addictive disorder.^{4, 19} With the standard of practice at many facilities utilizing the numeric pain assessment tool, the addicted patient is treated no differently than a patient without a history of an addictive disease. Therefore, the pain management is inadequate, being directly related to the assessment tool in use.

Another consideration in evaluating this numeric assessment tool is that the treatment is subjective, since an elevated pain score may be viewed by the practitioner as a drug-seeking behavior rather than actual pain.^{7, 19} Patients with a history of opioid addiction often report high pain scores regardless of their overall condition.¹² For example, they may report a high

is simply drug-seeking behavior and not actual pain. Furthermore, the patient may be reluctant to admit he is in pain and give a lower pain score than is appropriate for fear of being judged by the practitioner. The patient may also have exaggerated beliefs that even a small amount of opioids introduced into his system may cause a relapse.⁷ With these findings, it seems that the assessment of postoperative pain needs to encompass not only the physical aspect, but also the emotional and psychological aspect. It should be based on objective findings rather than the subjective assessment tools currently in use.

One change that will help to ensure adequate postoperative pain management for the patient with a history of opioid addiction is to obtain a history of substance abuse in the preoperative assessment. A full history and physical, including the patient's drug history, recovery history and participation in a 12-step program, such as Alcoholics Anonymous or Narcotics Anonymous, should be obtained.⁵ Currently, many

facilities do not include questions on the preoperative assessment form relating to drug abuse history. After a detailed drug and recovery history is obtained, it can be determined whether or not the patient would like to consult a pain management specialist or an addictionologist. These specialists would follow the patient throughout the perioperative experience.⁷

The patient should be informed of the many nonopioid analgesic techniques that are available to them. The patient should also be reassured that these methods will be used fully before opioids are considered.⁵ For a patient who is recovering from an opioid addiction, the relief of knowing that they are being well taken care of and that they are not being judged will reduce the amount of tension and anxiety they have. This method has been shown to be an effective pain-management tool

solely by itself.⁵ Many alternative pain treatment modalities are currently available, including epidural blocks, local and regional anesthesia, NSAIDs and local pain pumps. These methods constitute a multi-modal approach to analgesia. This approach is proven to be the best practice by many studies.^{4, 5, 12, 20}

If the patient is actively abusing opioids or alcohol, the preoperative assessment will play a different role in the postoperative management of pain. Every patient who is opioid dependent is not necessarily obtaining the medication illegally. A population of patients exists who depend on opioids to simply perform activities of daily living because of debilitating pain from injury or illness.^{12, 21} A patient who takes a large dose of opioid medication on a daily basis, prescribed or illegally, naturally has a higher tolerance for the drug. What seems to be an exuberant or exceedingly large amount of medication to the practitioner may be the normal amount for the patient or the patient's tolerance level. Therefore, this amount would be ineffective for treating additional pain

that is experienced during the perioperative setting.^{12, 21, 22} The opioid-tolerant patient will quickly enter withdrawal with a sudden decrease in the amount of opioids in his system due to not receiving the necessary doses. By maintaining the normal serum opioid level for the patient during and after the procedure, the practitioner can avoid this event. By addressing this issue, anxiety and tension, which potentially could complicate perioperative pain management and delay the patient's surgical recovery, can be avoided. Withdrawal, if not properly medically managed, can be life threatening.²¹ Both situations can be

avoided if a complete substance-abuse history is obtained and the plan of care is altered preoperatively.

Planning for postoperative pain management in the substance abuse patient is vital in his or her postoperative experience. Not all

It seems that the assessment of postoperative pain needs to encompass not only the physical aspect, but also the emotional and psychological aspect.

patients should be treated the same, regardless of their history of substance abuse. Additional preoperative or postoperative teaching must be done for this specific patient population. It is shown that patients who are well-educated on their upcoming experience complain of less pain postoperatively than patients who are unaware of the experience they are about to encounter.⁵ A generic preoperative education form is normally given to all patients in most facilities with orders that may include, "nothing by mouth for eight hours before surgery, discontinue aspirin two weeks before surgery, do not wear makeup or jewelry to surgery, and shower with antibacterial soap the evening before surgery." The same is true for the postoperative education form, which may include orders such as, "take medication as prescribed, report any incident of fever above 101°F, do not remove dressings until your doctor sees you in the office, and keep extremity elevated if applicable." Neither of these educational forms do much for the patient with a substance abuse history to relieve his or her anxiety

about pain or alternate methods he or she can use for postoperative pain management.

Since higher levels of preoperative fear and anxiety have been shown to have a direct exacerbation effect on postoperative pain,¹³ it is important to take adequate measures to decrease the patient's preoperative fears with proper patient education and, if necessary, pharmaceutical and other alternative methods. The recovering addiction patient should be assured that his or

her history of drug abuse will not be an obstacle regarding adequate and efficient treatment of postoperative surgical pain.⁵ Several medications can be given before surgery to help reduce postoperative pain.

Preoperative NSAID therapy has been shown to reduce postoperative inflammation and decrease pain and opioid requirements.¹² NSAIDs work by blocking the action of cyclooxygenase, thereby inhibiting the production of prostaglan-

The use of methadone to treat opioid addiction

Methadone is a rigorously well-tested medication that is safe and efficacious for the treatment of narcotic withdrawal and dependence. For more than 30 years, this synthetic narcotic has been used to treat opioid addiction.

Illegal narcotics, such as heroin, as well as opiate-based prescription pain medications, release an excess of dopamine in the body and cause users to need an opiate continuously occupying the opioid receptor in the brain, forming a physical dependence, or addiction. Methadone occupies this receptor and is the stabilizing factor that permits addicts on methadone to change their behavior and to discontinue heroin use.

Taken orally once a day, methadone suppresses narcotic withdrawal for between 24 and 36 hours. Because methadone is effective in eliminating withdrawal symptoms, it is used in detoxifying opiate addicts. It is, however, only effective in cases of addiction to heroin, morphine, and other opioid drugs, and it is not an effective treatment for other drugs of abuse.

Methadone reduces the cravings associated with heroin use and blocks the high from heroin, but it does not provide the euphoric rush. Consequently, methadone patients do not experi-

ence the extreme highs and lows that result from the waxing and waning of heroin in blood levels. Ultimately, the patient remains physically dependent on the opioid, but is freed from the uncontrolled, compulsive and disruptive behavior seen in heroin addicts.

Withdrawal from methadone is much slower than that from heroin. As a result, it is possible to maintain an addict on methadone without harsh side effects. Many patients require continuous treatment, sometimes over a period of years.

Methadone maintenance treatment (MMT) provides the heroin addict with individualized health care and medically-prescribed methadone to relieve withdrawal symptoms, reduces the opiate craving and brings about a biochemical balance in the body. Important elements in heroin treatment include comprehensive social and rehabilitation services.

Availability of treatment

As of 1999, about 20 percent of the estimated 810,000 heroin addicts in the United States receive MMT. At present, the operating practices of clinics and hospitals are bound by federal regulations that restrict the use and availability of methadone. These regulations are explicitly stated in detailed protocols estab-

lished by the U.S. Food and Drug Administration (FDA). Additionally, most states have laws that control and closely monitor the distribution of this medication.

In July 1999, the US Department of Health and Human Services released a Notice of Proposed Rulemaking (NPRM) for the use of methadone. For the first time in more than 30 years, the NPRM proposes that this medication take its rightful place as a clinical tool in the treatment of the heroin addict. Instead of its use being mandated by regulations, programs will establish quality assurance guidelines and have to be accredited. The proposed new system will allow greater flexibility by the treating physician and ensure appropriate clinical management of the patient's needs. This proposed change in policy would eliminate most of the current regulations and allow greater clinical discretion for treatment by the physician. Accreditation establishes a clinical standard of care for the treatment of medical conditions. In the foreseeable future, clinic and hospital programs would be accredited by a national and/or state accrediting body. Responsibility for preventing the diversion of methadone to illicit use will remain with the Drug Enforcement Administration.

dins. Prostaglandins are a principle substance that facilitates pain impulses traveling from the site of injury to the brain.⁷ The reduction of prostaglandins ultimately decreases the patient's pain. A detailed pre-operative assessment should be done to assure that NSAID therapy is not contraindicated by preexisting disease processes or anticoagulation therapy.⁵ Steroidal treatment has also been shown to relieve postoperative swelling by reducing tissue concentrations of inflammatory media-

tors, such as prostaglandins, thus decreasing the postoperative pain.^{7, 12, 23} Research also indicates that a 0.2 milligram Clonidine patch, applied pre-operatively, may decrease anxiety by directly lowering the amount of epinephrine produced by the patient's adrenal glands, thereby decreasing the patient's overall anxiety.^{5, 12, 21, 23}

Former addicts who have been in recovery for a considerable length of time may be familiar with alternative methods of relaxation. These

Is it safe?

Like any controlled substance, there is a risk of abuse. When used as prescribed and under a physician's care, research and clinical studies suggest that long-term MMT is medically safe. When methadone is taken under medical supervision, long-term maintenance causes no adverse effects to the heart, lungs, liver, kidneys, bones, blood, brain or other vital body organs. Methadone produces no serious side effects, although some patients experience minor symptoms such as constipation, water retention, drowsiness, skin rash, excessive sweating and changes in libido. Once methadone dosage is adjusted and stabilized or tolerance increases, these symptoms usually subside.

Methadone is a legal medication produced by licensed and approved pharmaceutical companies using quality control standards. Under a physician's supervision, it is administered orally on a daily basis with strict program conditions and guidelines. Methadone does not impair cognitive functions. It has no adverse effects on mental capability, intelligence, or employability. It is not sedating or intoxicating, nor does it interfere with ordinary activities such as driving a car or operating machinery. Patients are able to feel pain and

experience emotional reactions. Most importantly, methadone relieves the craving associated with opiate addiction. For methadone patients, typical street doses of heroin are ineffective at producing euphoria, making the use of heroin less desirable.

Benefits

Evidence shows that continuous MMT is associated with several other benefits.

- MMT costs about \$13 per day and is considered a cost-effective alternative to incarceration.
- MMT has a benefit-cost ratio of 4:1, meaning \$4 in economic benefit accrues for every \$1 spent on MMT.
- MMT has a significant effect on the spread of HIV/AIDS infection, hepatitis B and C, tuberculosis and sexually transmitted diseases. Heroin users are known to share needles and participate in at-risk sexual activity and prostitution, which are significant factors in the spread of many diseases. Research suggests that MMT significantly decreases the rate of HIV infection for those patients participating in MMT programs.

MMT allows patients to be free of heroin addiction. The National Institute on

Drug Abuse found that, among outpatients receiving MMT, weekly heroin use decreased by 69 percent. This decrease in use allows for the individual's health and productivity to improve. Patients were no longer required to live a life of crime to support their habit, and criminal activity decreased by 52 percent among these patients. Full-time employment increased by 24 percent. In a 1994 study of drug treatment in California, researchers found that rates of illegal drug use, criminal activity and hospitalization were lower for MMT patients than for addicts in any other type of drug treatment program.

The Drug Abuse Treatment Outcome Study (DATOS) conducted an outpatient methadone treatment evaluation examining the long-term effects of MMT. The pretreatment problems consisted of weekly heroin use, no full-time employment and illegal activity. Results of the 1-year follow-up showed a decrease in the number of weekly heroin users and a reduction in illegal activity after OMT. There was no significant change in unemployment rates.

Taken from the Executive Office of the President: Office of National Drug Control Policy. Available at: <http://www.whitehousedrugpolicy.gov/publications/factsht/methadone/index.html>

nonpharmaceutical methods include techniques such as imagery, meditation and breathing exercises. Some patients may wish to use these methods rather than using medications preoperatively. In addition, a patient may wish to have his or her Alcoholics Anonymous or Narcotics Anonymous-appointed sponsor present throughout the operative experience. Others may also wish to hold 12-step meetings before and after the procedure to assist in their mental and spiritual well-being. To relieve a patient's anxiety, all efforts should be made when possible to abide by his or her wishes.¹²

In the author's current practice, the preoperative standing orders for all patients are to administer Versed, Robinul and Reglan. Versed is a benzodiazepam that reduces anxiety and causes mild sedation.⁷ While this medication is useful to reduce anxiety immediately preoperatively and is not contraindicated in opioid-addicted patients, it does very little to address the previously-stated issues that the recovering addict patient faces. Robinul is an anticholinergic medication that has no effect on the patient's mental or emotional state. Reglan is an antiemetic and gastrointestinal stimulant that causes gastric emptying to help prevent nausea.⁷ These two medications do nothing to address the addicted patient's concerns. Improvement in perioperative practice is necessary in relation to preoperative education and medication orders for this specific population of patients to address their needs.

In patients with no history of substance abuse, opioids are the first line medications used for postoperative pain management in most facilities. In the majority of hospitals, the combination of opioids with the above-mentioned standard preoperative medication orders seems to be satisfactory. Unfortunately, this is not the case for patients with a history of substance abuse. Studies show that reintroducing opioids into a recov-

ering patient's system will activate the reward and reinforcement center of the brain involving the ventral tegmental area of the midbrain, where dopaminergic neurons originate. This result causes severe drug craving and seeking behaviors to begin, therefore restarting the addictive cycle over again. For the recovering addict in the acute postoperative phase, it is important to make use of a multimodal analgesic approach.^{5,12,15} As previously mentioned, local anesthetics, regional and epidural blocks, NSAIDs, prostaglandin inhibitors and local postoperative pain pumps are many of the resources available to practitioners. Local anesthetics, regional and epidural blocks help to break the initial pain response felt by patients. Some medications, such as 0.25 percent –0.75 percent Bupivacaine, last as long as three hours. Studies have supported the theory that opioid consumption can be brought to a minimum and maybe even eliminated from use with the

In patients with no history of substance abuse, opioids are the first line medications used for postoperative pain management in most facilities.

proper advent of local anesthetics.^{7,24} In the case of epidural usage, the epidural catheter can be left intact until several hours after the procedure to ensure comfort for the patient in the acute postoperative phase.^{7,12,23,24,25}

Evaluation of the effects of the pain management therapy, whether it is a nonpharmacological or pharmacological method, should be performed at regular intervals. It is much easier to control pain if it is stopped before it begins rather than try to "play catch up." Once the sympathetic response to the pain stimulus is initiated, it is harder to control and eventually halts the effects of the stimulus. Hence, the objective pain assessment methods, as discussed earlier and suggested by The World Federation of Society of Anesthesiologists, should be implemented.¹³

ABOUT THE AUTHORS

Damian Broussard, RN, BSN, CNOR is a member of the practical nursing faculty and a simulation lab coordinator at Louisiana Technical College in Lafayette, Louisiana. Amy Broussard, CST, CFA is a surgical technology clinical coordinator at Louisiana Technical College in Lafayette, Louisiana.

References

1. Rosenblatt M. "Management of Pain in Addicted/Illicit and Legal Substance Abusing Patients." 2005. World Institute of Pain, Vol. 5, Issue 1, 2-10.
2. U.S. Department of Health and Human Services. *The Patient's Bill of Rights*. Available at: [www.http://www.hhs.gov/news/press/1999pres/990412.html](http://www.hhs.gov/news/press/1999pres/990412.html). Accessed: Nov 10, 2007.
3. Arnstein P. Optimizing Perioperative Pain Management. *AORN Journal*. Nov 2002 Vol 76 Issue 5 p 812-818. Accessed Oct 28, 2007.
4. American Society for Pain Management Nursing. *Position Statement on Pain Management in Patients with Addictive Disease*. 2007. Available at: www.aspmn.org/organization/documents/addictions_9pt.pdf. Accessed Nov 4, 2007.
5. May H. *et al*. "The Patient Recovering from Alcohol or Drug Addiction: Special Issues for the Anesthesiologist." 2001. *Anesthesia and Analgesia*. Vol 92, p 1601-1608.
6. Alford D; Compton P; Samet J. "Acute Pain Management for Patients Receiving Maintenance Methadone or Buprenorphine Therapy." 2006. *Journal of Internal Medicine*. Vol 144 p 127-134.
7. McCaffery; Pasero. *Pain Clinical Manual 2nd Edition*. St. Louis. Mosby Inc. 1999.
8. Carr B; Cousins M. "Pain Management: A Fundamental Human Right." 2007. *Anesthesia and Analgesia*. Vol 105 p 205-221.
9. American Society of Anesthesiologists Task Force on Acute Pain Management. 2004. "Practice Guidelines for Acute Pain Management in the Perioperative Setting." *Anesthesiology*. Vol 100(6) p 1573-1581.
10. Pyati. "Perioperative Pain Management." 2007. *CNS Drugs*. Vol 21(3) p 185-211.
11. Schnoll; Finch. "Medical Education for Pain and Addiction: Making Progress Towards Answering a Need." 1994. *Journal of Law, Medicine and Ethics*. Vol 22 p 252-256.
12. Ritchey M. "Optimizing Postoperative Pain Management." 2006. *Cleveland Clinic Journal of Medicine*. Vol 73(1) p 572-576.
13. Charlton. "The Management of Postoperative Pain." 1997. *Practical Procedures*. Vol 7.
14. Iocolano. "Perioperative Pain Management in the Chemically Dependent Patient." 2000. *Journal of Peri-anesthesia Nursing*. Vol 15(5) p 329-347.
15. Narcotics Anonymous World Services. 2006. Chatsworth, California.
16. Webster's Medical Dictionary. 2007. Available at: www.nlm.nih.gov/medlineplus/mpldictionary.html. Accessed Nov 10, 2007.
17. Thompson. *Postoperative Pain; Virtual Anesthesia Textbook*. Available at: www.virtual-anesthesia-textbook.com. Accessed Sept 8, 2007.
18. Vickers. "Acute Pain Management and the Drug Abusing Patient." *The Royal College of Anesthesiologists*. Vol 11 p 246-247.
19. Johnson S. "Legal and Ethical Principles in Pain Management." *International Anesthesia Research Society*. Vol 150 p 5-7.
20. Cooper J; Haetzman M; Stickle B. "Effective Postoperative Analgesia." 2007. Available at: www.edu.rcsed.ac.uk/lectures/lt38.htm. Accessed Oct. 18, 2007.
21. Phillip; Peng; Tumber; Gourlay. "Perioperative Pain Management of Patients on Methadone Therapy." 2005. *Canadian Journal of Medicine*. Vol 52(5) p 513-523.
22. Hoffmann; Tarzian. "Achieving the Right Balance in Oversight of Physician's Opioid Prescribing for Pain: The Role of State Medical Boards." 2003. *Journal of Law, Medicine and Ethics*. Vol 31 p 21-40.
23. Sinatra; Hord; Ginsberg; Preble. *Acute Pain Mechanisms and Management*. St. Louis, Missouri. Mosby Inc. 1992.
24. Filos; Lehmann. "Current Concepts and Practice in Perioperative Pain Management: Need for Change?" 1999. *European Surgical Research*. Vol 31 p 97-107.
25. Doin; Cashman; Bland. "Effectiveness of Acute Postoperative Pain Management: Evidence for Published Data." 2002. *British Journal of Anesthesia*. Vol 89(3) p 409.

Gangrene:

Recognizing and treating cellular necrosis

BRITTANY STAPP-CAUDELL

In 1996, Beck Weathers, a doctor from Dallas, Texas, was a member of an expedition making an assault on the summit of Mount Everest. In what would become the greatest tragedy in the history of the mountain, eight climbers lost their lives in a storm on May 11.

Weathers had retreated from the ascent early due to deteriorating vision. While he was waiting for his guide to return from the summit and lead him back to camp, a storm enveloped the mountain, creating whiteout conditions. Weathers headed back towards camp with four fellow climbers. They got lost in the snow and were forced to stop searching for camp and huddle together for warmth.

When a lull in the storm came, the most able-bodied of the group went for help. When he returned several hours later, Weathers was in a hypothermic coma. Unable to carry him back, the group left him for dead. He spent the night exposed to the elements, frostbite devouring his nose and both of his hands. The next day, two team members found Weathers alive after chipping blocks of ice from his face. Still unresponsive, they were unable to carry him and returned to camp to report his imminent death.

Miraculously, Weathers awoke from the coma and dug himself free of his would-be grave. With one eye swollen shut and the other unable to see more than three feet in front of him, he made his way back to camp, where he was treated for severe frostbite and airlifted back to safety.

Beck Weathers escaped Everest with his life, but the dry gangrene caused by the frostbite cost him his right arm, which was amputated halfway below the elbow. He also lost all four fingers and the thumb on his left hand and had his nose amputated and reconstructed with tissue from his ear.

LEARNING OBJECTIVES

- Distinguish the variations of gangrene
- Identify complications that can contribute to gangrene
- Recognize treatment options that are alternatives to surgery
- Examine the methods of diagnosis for gangrene
- Explore Maggot Debridement Therapy as a treatment option

Gangrene is a general term that can be used to describe a number of conditions that involve the death and subsequent decay of tissue in one regional portion of the body.¹ A complication of necrosis, gangrene can arise as a result of critically insufficient blood supply,^{2,3} which is often associated with comorbid conditions such as diabetes and long-term smoking. It can develop when the blood supply is cut off to the affected area of the body as a result of various processes, including infection, vascular disease or trauma. If the gangrene is widespread, shock can occur, and if left untreated, it can result in death.⁴ Due to its tendency to spread quickly and the possibility of the necrosis of entire appendages, urgent diagnosis and treatment of the condition is necessary for the well-being of the patient. Antibiotics, wound debridement and surgery are the primary treatments for gangrene.

ABOUT GANGRENE

There are several types of gangrene, but the three most common variations are wet, dry and gas gangrene. Less common variations include internal and Fournier's gangrene. Gangrene can involve any part of the body, but the most common sites include the toes, fingers, feet and hands.³ Additionally, gangrene can affect the muscles and internal organs.² The best treatment for gangrene is revascularization of the affected tissue, thus reversing some of the effects of necrosis and ultimately allowing healing of the damaged tissue. Other treatments for gangrene include debridement and surgical amputation. The chosen method of treatment is generally determined depending on the location of the affected tissue and extent of tissue damage, death or loss. Although gangrene can be potentially fatal, the prognosis for recovery is good if gangrene is identified early and treated quickly.²

HISTORY

Before the introduction of antibiotics, fly maggots were commonly used to treat chronic wounds or ulcers. The maggots were utilized to debride the necrotic tissue without harming the healthy, living tissue. This practice largely died out after the

introduction of antibiotics and enzymes as acceptable treatments for surgical, chronic and traumatic or accidental wounds. Recently, however, maggot therapy has regained some credibility and is sometimes employed with great efficacy in cases of chronic tissue necrosis and gangrene infections.

CAUSES

Gangrene occurs when a body part loses its blood supply. The affected tissue may be the skin, muscles or internal organs. Blood provides oxygen and nutrients to feed the tissue cells and immune system components, such as antibodies, to ward off infections. Without a substantially functioning blood supply, the cells struggle to survive and ultimately die.² This necrosis, or cell death, can result when a portion of the body's tissues become infected, injured or constricted, interrupting the blood supply. In addition, tissue in a particular region of the body may have a decrease in the amount of blood supply due to a number of diseases or conditions such as arteriosclerosis, diabetes, smoking or wound infections – including those related to surgery.¹ Any of these afflictions can significantly increase a person's likelihood of contracting gangrene. Another indicator for susceptibility is a suppressed immune system. Patients with HIV or who are undergoing chemotherapy are at a far greater risk of infection due to the weakened state of their immune system. Severe burns or frostbite can also cause gangrene in body tissues due to the necrosis that results from such injuries or conditions.

SYMPTOMS

The symptoms of gangrene depend on both the location and cause of the condition.¹ If the skin is involved, or the gangrene is close to the skin, the symptoms may include discoloration (blue or black if the skin is affected; red or bronze if the affected area is beneath the skin), foul-smelling discharge and/or loss of feeling in the area.¹ If the affected area is inside the body, the symptoms may include, but are not limited to, confusion, fever, gas in tissues beneath the skin, a general ill feeling, low blood pressure and persistent or severe pain.¹

A condition called septic shock can occur if a bacterial infection that originated in the gangrenous tissue spreads throughout the body.² Symptoms of septic shock include low blood pressure, an increased heart rate, lightheadedness, shortness of breath and confusion.²

TYPES OF GANGRENE

Dry Gangrene

Dry gangrene is caused by a reduction in the blood flow through the arteries of certain tissues. It typically appears gradually and progresses slowly. In most people, the affected area does not become infected. In this type of gangrene, the tissue becomes necrotic, cold and black, begins to dry, and eventually sloughs off as a result of the decreased blood supply to the said tissue.² Dry gangrene is commonly seen in patients who suffer from arteriosclerosis, a result of increased levels of cholesterol, diabetes, cigarette smoking and other genetic factors.

Dry gangrene typically begins at the distal part of the limb, due to ischemia, and often occurs in the toes and feet. This type of gangrene usually spreads slowly until it reaches the point where the blood supply is inadequate to keep tissue viable.¹ Macroscopically, the affected tissue becomes dry, shrunken and blackened. The dark coloration is due to the liberation of hemoglobin from hemolyzed red blood cells, which are acted upon by hydrogen sulfide that is produced by the bacteria that causes gangrene, resulting in formation of black iron sulfide that remains in the tissues. The line of separation usually brings about complete severance between the healthy and necrotic tissue, ultimately resulting in the gangrenous tissue falling off if it is not surgically removed.

If the blood flow is interrupted for a reason other than severe bacterial infection, the result is a case of dry gangrene. People with impaired peripheral blood flow, such as diabetics, are at

greater risk of contracting dry gangrene.

The early signs of dry gangrene are a dull ache and sensation of coldness in the affected area along with pallor of the flesh. If caught early, the process can sometimes be reversed by vascular surgery. However, if necrosis sets in, the affected tissue must be removed just as with wet gangrene.

Wet Gangrene

Wet or moist gangrene develops as a complication of an untreated bacterial infection, such as in an open wound. Swelling, blistering and a wet appearance are common features of wet gangrene. It can develop in victims of severe burns, frostbite or other injuries in which blood supply is compromised.² In addition, wet gangrene often presents in patients with comorbid conditions such as obesity or diabetes, where the patient unknowingly gets injured and then the wound becomes infected. Wet gangrene needs to be treated immediately because it spreads quickly and can be fatal.²

Swelling resulting from the bacterial infection causes a sudden stoppage of blood flow, which causes tissue necrosis. Cessation of blood flow facilitates invasion of the muscles by bacteria, which multiply because disease-fighting cells (white blood cells) cannot reach the affected part.

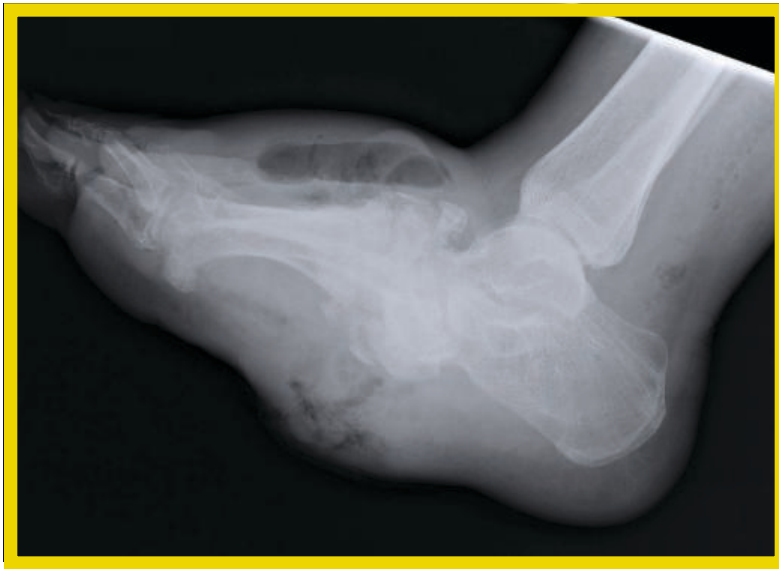
Wet gangrene occurs in naturally-moist tissue and organs such as the mouth, bowel, lungs, cervix and vulva. Bedsores occurring on body parts such as the sacrum, buttocks and heels are also categorized as wet gangrene infections. In wet gangrene, the tissue is infected by saprogenic microorganisms that cause tissue to swell and emit a fetid smell. Wet gangrene usually develops rapidly due to blockage of venous and/or arterial blood flow. The affected part is saturated with stagnant blood, which promotes the rapid growth of bacteria. The toxic products formed by bacteria are absorbed causing systemic manifestation

A severe injury or trauma can increase the risk of gangrene. It causes trauma to the tissues by impeding blood flow and increases the possibility of introducing a malicious bacteria to the wound.

of septicemia and finally, death. Macroscopically, the affected part is edematous, soft, putrid, rotten and dark. The darkness in wet gangrene occurs due to the same mechanism as in dry gangrene.

Gas Gangrene

Gas gangrene is a type of wet gangrene, commonly caused by an anaerobic, gram-positive, spore-forming bacillus of the bacterium family known as *Clostridia*.⁵ *Clostridia* are a type of infection-causing bacteria that grow only in the absence of



X-ray of a foot presenting with gas gangrene.

oxygen. As it grows, it produces poisonous toxins and gas, hence the designation of gas gangrene.⁵ It is usually an internal condition, typically affecting the patient's muscular system.²

The anaerobic bacteria typically enter the body through an open wound caused by an injury or surgery.² This particular gangrene infection spreads rapidly as the gases produced by the bacteria expand and infiltrate healthy tissue in the surrounding vicinity. Gas gangrene can cause necrosis, gas production and sepsis.⁵ Progression to toxemia and shock is often very rapid. Due to the bacteria's ability to spread quickly to surrounding tissues, gas gangrene should be treated as a medical emergency.⁵

The patient suffering from gas gangrene may present with intact surface skin over the infected area. As the condition progresses however, the

skin may become pale and then later evolve to a purple or red color.⁵ The skin may additionally begin to bubble and crackle upon touch due to the accumulation of the toxic gas bubbles centralized beneath the skin.² If the bacterial toxins spread into the bloodstream, the patient may develop a fever, increased heart rate and rapid breathing, signifying an infection of the blood.

Internal Gangrene

If a gangrene infection spreads to or affects the internal organs, such as the intestines, gallbladder or appendix, it is referred to as internal gangrene. This type of gangrene occurs when blood flow to an internal organ is blocked, such as with a hernia or a twist in the gastrointestinal tract.²

Symptoms of internal gangrene are often a high fever and excruciating abdominal pain. Internal gangrene is treatable, but if left untreated, can potentially be fatal.²

Fournier's Gangrene

Fournier's gangrene is an uncommon type of gangrene that affects the genital organs of an infected patient. While it typically affects the genitalia of men, women can also be infected with this particular form of gangrene.⁶ Fournier's gangrene usually arises due to an infection in the genital area or urinary tract and causes genital pain, tenderness, redness and swelling.²

RISK FACTORS AFFECTING GANGRENE

Numerous factors can contribute to a patient's likelihood of contracting a gangrene infection. Age is one such factor. Older patients tend to contract gangrene with a higher frequency than the younger population.⁴ Previously-mentioned conditions, such as diabetes, obesity and vascular damage or disease can also greatly increase the risk of a gangrene infection by interrupting blood flow to certain regions of the body, primarily the periphery regions, and contributing to necrosis. A severe injury or trauma, including surgery, can increase the risk of gangrene due to the fact that it causes trauma to the tissues by impeding blood flow and increases the possibility of introducing a malicious bacteria to the wound.¹ Finally, immu-

nosuppression can increase the likelihood of a gangrene infection due to the fact that the body cannot effectively fight off a pathogenic invader.²

DIAGNOSIS

The diagnosis of gangrene is based on the patient's history, physical examination, blood tests and other exams.⁴ The practitioner must investigate the patient's history of injury, history of any and all possible chronic diseases or conditions (especially those that affect the vasculature of certain regions, such as diabetes and arteriosclerosis), surgery, cigarette smoking and possible exposure to extreme cold is usually investigated when attempting to diagnose a gangrene infection.¹

A physical examination of the affected area is performed in an attempt to look for possible local signs of a wet gangrene infection. The patient's blood test results will ultimately show an increase in the number of white blood cells if the patient is suffering from a wet gangrene infection as the body attempts to fight off the bacteria. If possible, a sample of drainage from the gangrenous wound is examined to identify the bacteria causing the infection.¹ If the analysis of the drainage from the wound of a wet gangrene case does not initially yield the cause of the condition, a culture will be taken and grown in an attempt to identify the type of pathogen present in the wound, as well as aiding in possible treatment options.

In order to diagnose a potential case of gas gangrene, an X-ray can be used in an attempt to examine the affected tissue for the presence of gas bubbles, signifying a potential case of gas gangrene. Imaging studies, including but not limited to a CT scan or an MRI, can additionally aid in the determination of the extent of tissue damage as well as the amount of gas present.¹ In people with dry gangrene, an arteriogram may be performed in order to visualize any obstruction in the artery that supplies blood to the affected part.¹

TREATMENT

In general, treatment of gangrene infections should include the removal of necrotic tissue in an attempt to allow healing of the surrounding living tissue. It is also an important step towards the prevention of further infection. The treatment options of the various types of gangrene, however, differ due to the different natures of the conditions.¹ Antibiotics are usually administered intravenously to a patient suffering from gangrene in an effort to control the spread of an aggressive infection.

Additionally, pain relievers are administered to control the pain of the infection, while anticoagulants are given to prevent blood clotting. Intravenous fluids, such as dextrose in solution and isotonic saline are dispensed to replenish electrolytes and reestablish fluid balance

Gas gangrene is incredibly aggressive and potentially fatal. The infection can progress quickly and once it invades the bloodstream, the potential fatality rate rises to approximately 20-25 percent.

within the infected individual's body.⁴ Because the cause of dry gangrene is a lack of blood flow to certain tissues, restoring the blood supply is a vital characteristic of effective treatment.¹

For a wet gangrene infection, surgical debridement, or removal of the dead tissue from the infected wound, can be performed to evacuate any dead tissue. Additionally, intravenous antibiotics are administered to potentially control the infection causing the wet gangrene.

Due to the threat of rapid spreading of the gas gangrene infection via the bloodstream of the affected individual, this condition needs to be treated aggressively and quickly. The wound resulting from gas gangrene requires immediate debridement. Additionally, antibiotics are administered immediately to the affected patient in an effort to both control and kill the impending infection. Depending on the area that has the gangrene, the person's overall condition and the cause of the gangrene, treatment may include amputation of the infected body part. Emergency operations to locate and debride any and all dead tissue, surgical interventions to improve

blood supply to the given area, and repeated debridement operations to remove all affected tissue in an attempt to reduce the risk of the spread of the infection to healthy surrounding tissues are standard operating procedures.

If the infection cannot be controlled with surgical debridement and the consecutive administration of antibiotics, amputation of the affected part becomes necessary to prevent further deterioration of the surrounding, healthy tissues. Amputation is usually the last effort to be exhausted in the treatment of gangrene, but due to the infection's rapid spread and aggressive presentation, a large handful of patients routinely lose appendages or possibly limbs as a result of gangrene.

ALTERNATIVE TREATMENT OPTIONS

One alternative to standard practice is the use of a hyperbaric oxygen chamber as a means to reoxygenate the damaged tissues. In this method, the patient is entirely enclosed in a pressure chamber breathing oxygen at a pressure greater than one atmosphere, a process known as hyperoxygenation.⁷ Breathing oxygen at three times the normal atmospheric pressure can deliver up to 15 times the amount of physically dissolved oxygen as breathing regular air. This extra supply of oxygen dissolved in the blood plasma generates new capillaries in the wound area. Hyperbaric oxygen therapy has also been shown to inhibit the growth of many anaerobic and aerobic organisms. This effect, known as bacteriostasis, complements the improved ability of the host to combat disease and is useful in conditions where resistance factors are compromised, such as dysvascular conditions and immunosuppressive disorders.⁷ Patients receiving hyperbaric oxygen therapy must be monitored for symptoms of oxygen toxicity, such as profuse sweating, difficulty breathing and convulsions.²

PROGNOSIS

The outlook for a person with gangrene depends on the portion of the body that is affected, the extent of the gangrene, the cause of the infection and the overall health of the patient.¹ Additionally, the outlook for the patient recovering from a gangrene infection is generally favorable except in

people in whom the infection has spread through the blood stream.¹

Gangrene is usually curable in the early stages with intravenous antibiotic treatment and debridement of the infected wound. In the absence of treatment however, gangrene may lead to a fatal infection once the pathogens invade the bloodstream and affect surrounding, healthy tissues and organ systems. If treatment is delayed, the gangrene is extensive, or the person has other significant medical problems, he or she may die.¹

Gas gangrene, in particular, is incredibly aggressive and potentially fatal. The infection can progress quickly and once the infection invades the bloodstream, the potential fatality rate of the condition rises to approximately 20-25 percent. However, if it is diagnosed and treated early, approximately 80 percent of people with gas gangrene survive without the need for any amputation.¹

Alternatively, patients suffering from dry gangrene usually have many other comorbid conditions that ultimately complicate recovery and can prove fatal.

ABOUT THE AUTHOR

Brittany Stapp-Caudell is a second term surgical technology student at San Joaquin Valley College in Fresno, California. She is scheduled to begin her clinical experience in February 2009, and will graduate in September 2009.

References

1. Carson-DeWitt R. Gangrene. 2007. Available at <http://www.bidmc.harvard.edu/YourHealth/ConditionsAZ.aspx?ChunkID=11839>. Accessed September 20, 2008.
2. Diseases and conditions: Gangrene. 2007. Available at <http://www.mayoclinic.com/health/gangrene/D500993>. Accessed September 18, 2008.
3. Ho H. Gas Gangrene. 2006. Available at <http://www.emedicine.com/med/topic843.htm>. Accessed September 18, 2008.
4. McGuigan B. What is gangrene? 2003. Available at <http://www.wisegeek.com/what-is-gangrene.htm>. Accessed September 18, 2008.
5. Sitham SO. Gangrene. 2008. Available at <http://www.nlm.nih.gov/medlineplus/ency/article/007218.htm#Causes,%20incidence,%20and%20risk%20factors>. Accessed September 18, 2008.
6. Uppot RN. Case 54: Fournier gangrene. 2001. Available at <http://radiology.rsna.org/cgi/content/full/226/1/115>. Accessed September 18, 2008.
7. Wound Care Institute Newsletter. 1996. "Commonly Asked Questions on Hyperbaric Oxygen Therapy." Available at: <http://www.woundcare.org/newsvol1n3/ar8a.htm>. Accessed October 27, 2008.

Maggot Debridement Therapy: Biosurgical Treatment for Infected Wounds

TOM BORAK

A patient hobbles into the private examination room at her doctor's office and carefully seats herself on the examination table. It has been two days since her last visit and she is anxious to check on the status of the diabetic ulcer that is threatening to claim her foot. She has exhausted all possible remedies for her ailment, including antibiotic regimens and surgical procedures to remove the necrotic tissue. Nothing, however, has been able to force the growing wound into remission.

Her doctor enters the room with a smile and asks how she's feeling.

"I have a slight tingling sensation in my foot," she says, "but overall, I feel fine."

The doctor nods, pulls up a stool and sits in front of her. A medical assistant positions a trash can beneath the patient's foot and the doctor begins to remove the covering from the wound site. As the gauze pad is slowly pulled away from the wound, a wriggling ball of maggots falls from the wound into the trash can below.

Unfazed, the doctor examines the wound. The necrotic tissue that had been prevalent two days earlier is completely gone. Live, pink tissue is all that remains. The doctor smiles at the patient and says, "Even better than I expected!"



Greenbottle fly.

Fly larvae, or maggots, are making a comeback in the modern medical community. Once a very common and popular means of cleaning infected wounds in the United States, maggot debridement therapy (MDT) fell out of favor with the mainstream medical establishment with the development of advanced pharmacological antibiotic treatments after World War II.¹

The practice was revisited in the 1970s and 80s, used only after all other means of wound care had been exhausted, and ultimately led to the first modern clinical studies of the practice in 1989.¹ The results of those trials, and the studies and reports that followed, indicated that MDT is still an extremely viable treatment tool for cer-

tain types of wounds. In addition, the studies suggest that MDT does not need to be an option of last resort. In fact, while published accounts of “pre-amputation MDT” show a limb salvage rate of more than 40 percent, the success of MDT when used earlier in the course of treatment is even more dramatic.¹

MDT serves three primary functions:

- *Clean the wound* by dissolving dead and infected tissue.
- *Disinfect the wound*. Preliminary studies suggest that maggots are even able to eradicate antibiotic-resistant bacteria, such as MRSA, from infected wounds.² This theory is currently under investigation and could have serious implications for post-surgical infection patients.
- *Speed the rate of healing*.¹ It is also believed, though it has not yet been confirmed in a clinical trial, that the larvae actually stimulate the production of granulation tissue,² the perfused, fibrous connective tissue that replaces a fibrin clot in healing wounds and aids vascularization. This effect has been previously reported in historical records and possible mechanisms for this occurrence are currently being sought.

Of course, the thought of introducing maggots to an open wound is difficult for some patients—and even some practitioners—to handle. Common misconceptions include maggots generating bacteria and increasing the risk of infection, burrowing deeper into the tissue and breeding more maggots. All of these fears, however, are unfounded.

While it is true that certain fly species, such as the screw worm fly, hatch larvae that burrow down into the living tissue, causing massive tissue damage and sometimes death,^{2,3} many spe-

cies are much less aggressive. The species most commonly used in MDT is the blow fly (*Lucilia sericata*), commonly called the greenbottle for its metallic green color.²

When introduced to the wound, the blow fly larvae produce a mixture of proteolytic enzymes,^{2,4} including collagenase, which breaks down the dead tissue into a semi-liquid, which is reabsorbed and digested.² The larvae will not burrow under the skin or attack healthy tissue and there is no danger that they will stay within the wound and breed. A mature larva must leave the

wound to pupate (the stage before it becomes an adult insect) or else it will die. In fact, once the larvae are fully grown they will come to the surface of the wound, where they are easily removed.²

The application process is very simple. A dressing is created by making a tracing of the wound on a sterile plas-

tic sheet, which is then cut out and transferred to a hydrocolloid dressing. The shape of the wound is cut from the hydrocolloid and discarded.² The sheet with the wound-sized hole is then applied to the patient. This dressing serves two functions. It provides a sound base for the second component of the dressing system and protects the healthy tissue from the potent proteolytic enzymes released by the maggots.

The larvae, initially about 2 mm long, are introduced to the wound using a sterile piece of gauze to transfer them from their shipping container. The number of maggots used depends on several factors, including the size of the wound and the amount of necrotic tissue that is present. General guidelines indicate that the wound should contain no more than 10 maggots per square centimeter.²

After the larvae have been introduced to the wound, a sterile piece of fine nylon mesh, a little larger than the wound, but smaller than the

MDT is still an extremely viable treatment tool for certain types of wounds... While published accounts of “pre-amputation MDT” show a limb salvage rate of more than 40 percent, the success of MDT when used earlier in the course of treatment is even more dramatic.

hydrocolloid dressing, is applied to the back of the hydrocolloid with adhesive tape.² An absorbent pad is also applied to the outer surface of the net to catch any liquefied necrotic tissue. The outer absorbent dressing can be changed as often as required. Because the net is partially transparent, the activity of the maggots can be determined without removing the primary dressing.²

The maggots are typically left in the wound for 24-48 hours. Their natural instinct tells them to leave the wound once the dead tissue is gone or they have consumed all that they can eat. When the dressing is removed, most of the maggots will crawl out of the wound on their own. Any that are left behind can be easily removed with gentle irrigation or forceps. If necrotic tissue is still present, additional applications of fresh maggots can be used as necessary. The contaminated maggots should be disposed of by the same means as other biological waste.

Before they can be shipped to medical facilities around the country, the maggots must be raised in a sterile environment. The external surface of the fly's eggs are normally contaminated with bacteria, which must be removed or killed before the eggs hatch if the emerging larva are to remain sterile.²

The eggs are collected on raw liver in a controlled environment. They are then cleaned and sterilized under aseptic conditions, using equipment that is more commonly used for the production of sterile pharmaceuticals.²

The sterilized eggs are then transferred aseptically to sterile flasks, which contain an appropriate substrate on which they will hatch. The substrate is formulated to maintain the viability of the larvae without allowing them to grow too rapidly. With sufficient oxygen, the larvae can be stored in a cool place for extended periods of time until they are ready for use.

In addition to the health benefits associated with MDT, patients can receive this therapy in the comfort of their own home or on an outpatient basis, which can reduce or eliminate the costs associated with hospitalization. It should always be remembered, however, that MDT is a potent therapeutic tool and should be used with caution by properly-trained staff.

References

1. Sherman Ronald A. Maggot Debridement Therapy (MDT). 2008. Available at: <http://www.medicaledu.com/maggots.htm>. Accessed October 30, 2008.
2. Jones M, Jones S, Shutler S, Thomas S. Maggots in Wound Debridement—an Introduction. 1999. Available at: <http://www.smtl.co.uk/WMPRC/Maggots/maggots.html>. Accessed October 30, 2008.
3. Hall M, Smith K. Diptera Causing Myiasis in Man. In: Crosskey Roger W, Lane Richard P, eds. *Medical Insects and Arachnids*. 1995, 429-469.
4. Ksander G, Lee R, Vistnes L. Proteolytic Activity of Blowfly Larvae Secretions in Experimental Burns. *Surgery*. 1981.

Preliminary studies suggest that maggots are even able to eradicate antibiotic-resistant bacteria, such as MRSA, from infected wounds. This theory is currently under investigation and could have serious implications for post-surgical infection patients.

CE Exams

Repeat Cesarean Section

- When should the field be cleared of sharp and metal objects?**
 - Before the delivery
 - Prior to uterine incision
 - After the shoulders are delivered
 - After the umbilical cord is clamped
- The uterus was palpated to determine ____.**
 - Fetal distress
 - Abnormal uterine action
 - Fetal position
 - Location of umbilical cord
- The __ count is performed ____.**
 - 4th, after the skin is closed
 - 2nd, before the uterus is palpated
 - 1st, after the initial skin incision
 - 3rd, while the peritoneum is closed
- Cord blood gas was ____.**
 - Drawn prior to clamping umbilical cord
 - Sent to pathology for analysis
 - Collected by the neonatal nurse
 - None of the above
- Which of the following is incorrect for this problem?**
 - Bulb syringe, one per infant
 - Core blood vial, one per infant
 - Cord clamp, one per infant
 - Both a. and c.
- The uterine incision was ____.**
 - Carried bilaterally with Lister bandage Scissors
 - Closed in one layers
 - Followed by oxytocin injection
 - Closed prior to cord blood collection
- Indications for cesarean section include:**
 - Diabetes mellitus
 - Placenta previa
 - Ovarian tumors
 - All of the above
- The neonate presented with ____.**
 - Abnormal heart rate
 - Umbilical cord prolapse
 - Breech presentation -footling
 - Dystocia
- The bolster under the patient's right hip reduced pressure on the:**
 - Vena cava
 - Uterus
 - Umbilical cord
 - Femoral artery
- In the final stages of a cesarean section, oxytocin may be administered to ____.**
 - Stimulate lactation
 - Control uterine hemorrhage
 - Decrease postpartum bleeding
 - Prevent uterine rupture

Off-pump Coronary Artery Bypass Grafting

1. The first OPCAB was performed in
 - a. 1954
 - b. 1967
 - c. 1973
 - d. 1995
2. What are the main branches of the left main trunk
 - a. RIMA AND LIMA
 - b. RCA AND PDA
 - c. LAD and left circumflex
 - d. Diagonal and obtuse marginal
3. All of the following are risks of conventional CABG except:
 - a. Systemic Inflammatory Response
 - b. Aortic dissection
 - c. Embolism
 - d. Shorten hospital stay
4. OPCAB is beneficial to all of the following except:
 - a. Jehovah's Witness
 - b. Prone to CVAs
 - c. Need valve replacement
 - d. Heavily calcified aortas.
5. The chest incision for OPCAB is called?
 - a. Midline
 - b. Median sternotomy
 - c. Subxyphoid
 - d. Femoral
6. Anesthesia delivers the following drugs for OPCAB except:
 - a. Milrinone
 - b. Heparin
 - c. Albumin
 - d. Plavix
7. The XPOSE device is set at what pressure?
 - a. 350 mmHg
 - b. 500 mmHg
 - c. 50 mmHg
 - d. 150 mmHg
8. Which of the following is not a conduit used in OPCAB?
 - a. LIMA
 - b. Saphenous vein graft
 - c. Temporal artery graft
 - d. RIMA
9. All of these items are placed prior to sternal closure except:
 - a. Vascular bulldog
 - b. Temporary pacing wires
 - c. Mediastinal chest tube
 - d. Pleural chest tube
10. Postoperative arrhythmias can be treated by all of the following except:
 - a. Cardioversion
 - b. Temporary pacemaker
 - c. Intraaortic balloon pump
 - d. Intravenous medication

Sterilization – Killing the Prehistoric Beast

- 1. What is the minimum time needed to flash sterilize a crile clamp in a gravity displacement sterilizer?**
 - a. 15 min
 - b. 10 min
 - c. 4 min
 - d. 3 min
- 2. What does a chemical indicator measure?**
 - a. Removal of residual air
 - b. Exposure to the sterilization process
 - c. Sterility
 - d. Steam pressure
- 3. Which Blood biological indicator is used in a gravity displacement autoclave?**
 - a. Chemical indicator
 - b. Bowie-Dick
 - c. Blue Lid rapid readout
 - d. Brown Lid rapid readout
- 4. What is the minimum time needed to sterilize a Frazier suction tip in a pre-vac sterilizer?**
 - a. 15 min
 - b. 10 min
 - c. 4 min
 - d. 3 min
- 5. What is the number of minutes that a closed flash pan system should be sterilized in a gravity displacement sterilizer?**
 - a. 3
 - b. 5
 - c. 8
 - d. 10
- 6. Immediate – use sterilization was designed for ____.**
 - a. Quick room turnover
 - b. Instruments that were forgotten during opening
 - c. Sterilizing power equipment
 - d. Instruments that were dropped during surgery
- 7. Bacteria form spores when:**
 - a. Steam is present
 - b. In humid climates
 - c. Unfavorable conditions arise for the bacteria
 - d. Favorable conditions arise for the bacteria
- 8. Biological indicators are routinely run:**
 - a. In the morning
 - b. Daily
 - c. In every load
 - d. Once
- 9. What is the minimum temperature for flash sterilization?**
 - a. 250° F
 - b. 270° F
 - c. 272° F
 - d. 275° F
- 10. What is the purpose of running distilled water through lumens before flash sterilization?**
 - a. To irrigate the cannula
 - b. To pre-clean the lumen
 - c. To allow for steam to heat the lumen
 - d. Hospital policy

When Unexpected Complications Arise During Surgery

1. Which ligaments hold the ovaries in place?
 - a. Suspensory
 - b. Broad
 - c. Ovarian
 - d. All of the above
2. Which unexpected surgical instrument did the surgeon request to drain the uterus?
 - a. Jackson-Pratt drain
 - b. Thoracic trocar
 - c. Gallbladder trocar
 - d. Red Robinson drain
3. ____ attempts were made to close the vaginal cuff by suture.
 - a. 27
 - b. 18
 - c. 23
 - d. 31
4. TAH is not indicated for which of the following?
 - a. Uterine sarcoma
 - b. Ascites
 - c. Tubal malignancy
 - d. Dysfunctional uterine bleeding
5. The round ligament terminates at the _____.
 - a. Anterior cul-de-sac
 - b. Vestibule
 - c. Labia majora
 - d. Fallopian-uterine attachment
6. Care was taken to avoid the _____ when the initial midline incision was made.
 - a. Falciform ligament
 - b. Xiphoid process
 - c. Symphysis pubis
 - d. Umbilicus
7. What size and type of suture was primarily used to control bleeding?
 - a. 1 Chromic
 - b. 2-0 Chromic
 - c. 0 Vicryl
 - d. 2-0 Vicryl
8. Estimated blood loss up to the first time the patient was transported to the ICU:
 - a. 16,000 cc
 - b. 17,000 cc
 - c. 18,000 cc
 - d. 19,000 cc
9. The triangular space at the base of the bladder is called _____.
 - a. Triakates
 - b. Trielcon
 - c. Trigone
 - d. Trilabe
10. The uterine sac was incised with _____.
 - a. Jorgenson scissors
 - b. Metzenbaum scissors
 - c. #10 KB on #3 KH
 - d. Curved Mayo scissors

Blood Pressure

- The kidneys help regulate blood pressure by:**
 - Controlling sodium absorption
 - Providing negative feedback
 - Triggering baroreceptors
 - Providing positive feedback
- Renin is produced...**
 - During a hypotensive episode
 - By the juxtaglomerular apparatus of the kidneys
 - By the liver
 - To decrease cardiac output
- Secondary hypertension may occur with:**
 - Toxemia during pregnancy
 - Vascular and kidney diseases
 - Diabetes
 - All of the above
- _____ is/are not a suspected cause of essential hypertension.**
 - Sodium intake
 - Beta blockers
 - Obesity
 - Sedentary lifestyle
- Diastolic pressure is measured during ____ of Korotkoff's sounds.**
 - Phase II
 - Phase III
 - Phase IV
 - Phase V
- _____ hypertension cannot be attributed to any specific cause.**
 - Genetic
 - Arterial
 - Essential
 - Secondary
- Systolic pressure is heard during ____ of Korotkoff's sounds.**
 - Phase I
 - Phase II
 - Phase III
 - Phase IV
- Following the release of _____, sodium reabsorption _____ in the kidneys.**
 - Angiotensinogen; decreases
 - Aldosterone; increases
 - Angiotensin II; decreases
 - Epinephrine; increases
- A patient who experiences orthostatic hypotension was likely:**
 - Hunched over
 - Standing
 - Lying down
 - Sitting with legs crossed
- Angiotensin II causes:**
 - Decreased fluid reabsorption
 - Renin production in the liver
 - Vasodilation
 - Increased cardiac output

Safety Concepts in the Surgical Setting

1. **When the patient is moving between two surfaces:**
 - a. Three people should be available, one on each side and one at the head
 - b. Four people should be available, two on each side
 - c. Two people should be available, one on each side
 - d. Five people should be available, two on each side, one at the head, one at the foot
2. **Abduction of the upper extremities greater than 90 degrees can lead to:**
 - a. Decreased blood flow
 - b. Brachial plexus palsy
 - c. Skin Breakdown
 - d. Gangrene
3. **The application of force greater than tissue resistance can cause:**
 - a. Ischemia
 - b. Necrosis
 - c. Gangrene
 - d. All of the above
4. **Common pressure points are:**
 - a. Ear, nose, toe
 - b. Elbow, pelvis, head
 - c. Ear, nose, chin
 - d. Elbow, pelvis, back
5. **The force created on skin by the movement of underlying tissues results in**
 - a. Decreased blood flow
 - b. Hyperextension
 - c. Skin irritation
 - d. Contact dermatitis
6. **Thermal tissue injury can result from:**
 - a. Shear force
 - b. Fiberoptic light sources
 - c. Neurovascular compromise
 - d. Class 1 lasers
7. **When using electrosurgery, what must be applied to the patient to deliver the current back to the electrosurgery unit?**
 - a. Active electrode
 - b. Patient return electrode
 - c. Electrosurgical generator
 - d. Electrical switch
8. **How is a laser similar to an endoscope?**
 - a. Both emit light
 - b. Both are dependent on photon energy
 - c. Both produce gamma rays
 - d. Both rely on sound waves
9. **A medicated patient is never left alone in order to prevent:**
 - a. Hyperextension
 - b. Dislodging of tubes and catheters
 - c. Falls
 - d. Cardiovascular complications
10. **If a team member is exposed to an infrared laser, he or she**
 - a. Feels immediate pain
 - b. Loses eyesight immediately
 - c. May hear a popping noise
 - d. Experiences photokeratitis

Necrotizing Fasciitis

- 1. Group A hemolytic streptococcus may cause:**
 - a. Impetigo
 - b. Necrotizing fasciitis
 - c. Strep
 - d. All of the above
- 2. The effectiveness of *streptococcus pyogenes* can be attributed to:**
 - a. Colonizing and rapidly multiplying
 - b. Creating an abscess
 - c. Developing fluid-filled blisters
 - d. Secreting powerful exotoxins
- 3. Bacteroides often reside in the**
 - a. Liver
 - b. Lungs
 - c. Intestine
 - d. Mouth
- 4. Which of the following is not normally inhabited by bacterium?**
 - a. Intestine
 - b. Muscle
 - c. Mouth
 - d. Nasopharynx
- 5. Which of the following carries the highest risk for the transmission of NF?**
 - a. Diabetes
 - b. Alcoholism
 - c. Open skin wound
 - d. Cancer
- 6. Which comorbid condition carries the greatest risk for the patient to be infected by NF?**
 - a. Cancer
 - b. Alcoholism
 - c. Diabetes
 - d. all of the above
- 7. Advanced symptoms of NF include:**
 - a. Blisters increase in size
 - b. Drop in blood pressure
 - c. Peeling or discolored skin
 - d. All of the above
- 8. Doctors and patients often fail to recognize NF because it:**
 - a. Resembles the flue
 - b. NO apparent wound
 - c. Body begins to decompose
 - d. Discoloration of skin spreads
- 9. Methods of treatment utilize:**
 - a. Hyperbaric chambers
 - b. Leeches
 - c. NSAIDS
 - d. Aspirin
- 10. Death from necrotizing fasciitis is correlated to:**
 - a. How early the diagnosis is made
 - b. How soon treatment began
 - c. Gas in the subcutaneous fascial planes
 - d. a&b

Necrotizing Fasciitis – questions Continued

11. Which of the following microbiological staining methods can be used to determine whether a type I or type II infection is present?
- Acid – FAST
 - Gram
 - Simple
 - Negative
12. Which of the following antibiotic is an alternative to penicillin G?
- methicillin.
 - benzathine.
 - amoxicillin.
 - clindamycin.
13. A common region of the body in which group A hemolytic streptococcus may be found is the.
- colon.
 - lungs.
 - skin.
 - liver.
14. The gaseous toxin of *streptococcus pyogenes* is released
- When cell death occurs due to invasion by bacteriophages.
 - From the bacterial cell wall.
 - When antitoxins invade causing cellular lysis.
 - When the cell binds to the plasma membrane of an organ.
15. Which of the following antibiotics is ineffective against *Peptostreptococcus*?
- penicillin G
 - chloramphenicol
 - metronidazole
 - ampicillin
16. Routine X-rays are not considered a reliable method for diagnosing NF because the
- Contrast media are ineffective in aiding in the diagnosis of NF.
 - Detection of gas can be due to many other factors.
 - Radiographs cannot adequately show the fascial planes.
 - Infection is superficial and will not appear on the radiographs.
17. Mechanical debridement is not often used due to
- the removal of healthy tissue
 - inadequate removal of dead tissue.
 - contributing to the spread of the bacteria to healthy tissue.
 - time inefficiency allowing spread of the bacteria.
18. ____ of adult reported cases of NF report toxic shock and multi-organ failure.
- 12%
 - 25%
 - 37%
 - 50%
19. Which of the following bacteria is increasingly causing NF?
- Helicobacter pylori*
 - MRSA*
 - Escherichia coli*
 - Pseudomonas aeruginosa*
20. The number of reported cases of GAS disease in the U.S. is ____ the number of strep throat cases.
- equal to
 - more than
 - less than
 - variable as compared to

Treatment of War Casualties

1. Today, __ percent of GIs reaching a field hospital survive the ordeal.
 - a. 69.7
 - b. 75.4
 - c. 76.4
 - d. 90.5
2. Uncontrollable hemorrhage accounts for almost __ percent of combat fatalities.
 - a. 30
 - b. 40
 - c. 50
 - d. 60
3. This article compared the wounds experienced in __ and __.
 - a. Germany and Vietnam
 - b. Vietnam and Iraq
 - c. Iraq and Germany
 - d. Japan and North Korea
4. The surgeon began his tour of duty in Vietnam with a __ orientation phase.
 - a. 1 week
 - b. 2 week
 - c. 3 week
 - d. 1 month
5. Since cause of death is still exsanguination, surgeons say __ are still the single greatest life-saving device in the Iraq conflict.
 - a. Tourniquets
 - b. Stents
 - c. Montgomery straps
 - d. Stent dressing
6. The concept of the Forward Surgical Team was developed after the ____.
 - a. American Revolutionary War
 - b. Civil War
 - c. Gulf War
 - d. World War II
7. Primary blast injuries which cause damage mainly to gas-filled structures, such as eardrums, lungs and ____.
 - a. Arteries
 - b. Pancreas
 - c. Kidneys
 - d. Intestines
8. During the Vietnam War, the average length of time from initial treatment to transfer to the continental United States was __ days.
 - a. 45
 - b. 46
 - c. 47
 - d. 48
9. Which tourniquet is not 100 percent effective in occluding distal arterial Doppler sound in the arms and legs?
 - a. Emergency & Military Tourniquet
 - b. Combat Application Tourniquet
 - c. Special Operations Force Tactical Tourniquet
 - d. War Applications Tourniquet
10. Intravenous treatment begins with procoagulants and whole blood, type __, followed by fresh whole blood with thawed plasma instead of crystalloids.
 - a. AB+
 - b. AB-
 - c. O
 - d. B+

Wrist Fusion: Fighting Back Against Rheumatoid Arthritis

- 1. Diagnosis of rheumatoid arthritis does not involve:**
 - a. Reviewing family history
 - b. Examining joints for inflammation and deformity
 - c. Blood tests
 - d. Stress tests
- 2. A/an _____ utilizes a sterile needle and syringe to drain joint fluid.**
 - a. Arthrocentesis
 - b. Arthroscopy
 - c. Spinal tap
 - d. Synovectomy
- 3. _____ develops during the early, acute inflammatory stage.**
 - a. Subluxation of the ulna
 - b. Intrinsic contracture
 - c. Fixed DRUJ
 - d. Bony compression
- 4. _____ bones are the long bones in the palm.**
 - a. Phalanges
 - b. Trapezium
 - c. Carpal
 - d. Metacarpal
- 5. The proximal row does not include the:**
 - a. Scaphoid
 - b. Lunate
 - c. Trapezoid
 - d. Pisiform
- 6. The ___ coordinates the movement of the distal and proximal rows.**
 - a. Radius
 - b. Scaphoid
 - c. Hamate
 - d. Carpal
- 7. Carpal bones connect the _____ and _____ to the bones in the hand.**
 - a. Capitate and trapezium
 - b. Scaphoid and pisiform
 - c. Radius and ulna
 - d. Trapezoid and lunate
- 8. Second-line drugs include all but:**
 - a. Cortisone
 - b. Methotrexate
 - c. Gold salts
 - d. Adalimumab
- 9. If the _____ is not fused, a patient will have continued rotation in the hand.**
 - a. Radius
 - b. Hamate
 - c. Ulna
 - d. Lunate
- 10. Fusing wrist bones together may:**
 - a. Prevent deformity
 - b. Eliminate pain
 - c. Improve alignment
 - d. All of the above

Wrist Fusion: Fighting Back Against Rheumatoid Arthritis – questions cont.

11. The intraoperative phase of a wrist fusion begins with

a:

- a. Dissection down the extensor retinaculum
- b. Opening of the radiocarpal joint
- c. Dorsal, longitudinal incision over Lister tubercle
- d. Synovectomy

12. Types of NSAIDs are:

- a. Subluxation of the ulna
- b. Traditional NSAIDs
- c. Cox-2 selective inhibitors
- d. All of the above

13. Prostaglandins do all but:

- a. Promote inflammation
- b. Facilitate the function of blood platelets
- c. Protect the stomach lining
- d. Halt joint damage

14. Disease-modifying anti-rheumatic drugs are effective in

- a. Rheumatoid arthritis
- b. Psoriatic arthritis
- c. Ankylosing spondylitis
- d. All of the above

15. _____ is a hormone produced in the adrenal gland.

- a. Calcitonin
- b. Thyroxine
- c. Cortisol
- d. GnRh

16. Steroids are used to alleviate:

- a. Lupus
- b. Rheumatoid arthritis
- c. Vasculitis
- d. All of the above

17. _____ stimulate or restore the ability of the immune system to fight disease or infection.

- a. Analgesics
- b. Corticosteroids
- c. BRMs
- d. Cox-2

18. _____ block the Cox enzymes and reduce prostaglandins.

- a. Steroids
- b. Analgesics
- c. BRMs
- d. NSAIDS

19. The distal ulnar resection was performed using a/an:

- a. Oscillating saw
- b. Burr
- c. Osteotome
- d. Bone cutting forceps

20. Which of the following is not a first-line drug?

- a. Methylprednisolone acetate
- b. Cortisone
- c. Hydroxychloroquine
- d. Aspirin

Disasters Follow No Rules: Preparing Your Hospital for Disaster Response

1. **What is the easiest way to designate a patient's status at a disaster scene?**
 - a. A simple spreadsheet
 - b. Move patients to screening areas
 - c. Triage tags
 - d. Mobile rescue units
2. **The central focus of disaster triage is:**
 - a. Stabilize patient that cannot walk
 - b. Find and tag patients that require immediate care
 - c. Providing definitive care
 - d. Stabilizing critically injured patients
3. **_____ medical care improves the casualty's condition.**
 - a. Expert
 - b. Specialized
 - c. Definitive
 - d. General
4. **Casualty collection sites should not be located:**
 - a. On hospital property
 - b. Downwind from hazards
 - c. Downhill from contaminated areas
 - d. All of the above
5. **"Decompressing" a disaster scene means:**
 - a. Evacuating patients who are consuming resources
 - b. Dismissing excess medical staff
 - c. Expanding the search parameters for survivors
 - d. Frequently re-triaging patients
6. **The _____ simplifies communication among disaster responders:**
 - a. Emergency Response System
 - b. Incident Command System
 - c. Emergency Response Network
 - d. Disaster Preparedness System
7. **Using the START method, triage evaluation should take:**
 - a. 15 seconds
 - b. 30 seconds
 - c. One minute
 - d. Up to two minutes
8. **During disaster triage, if a patient does not start breathing after simple airway maneuvers:**
 - a. Immediately move patient to secondary care facility
 - b. Tag as red/immediate and move on
 - c. Tag as black/dead and move on
 - d. Call for assistance
9. **Which scenario has the greatest casualty potential?**
 - a. A terrorist attack on a major city
 - b. A natural disaster
 - c. A nuclear power plant meltdown
 - d. A pandemic disease outbreak
10. **What was the greatest pandemic in US history?**
 - a. Spanish Flu
 - b. Avian (Bird) Flu
 - c. West Nile Virus
 - d. SARS

Disasters Follow No Rules: Preparing Your Hospital – questions cont.

11. **What is a hospital's first response to a disaster scenario?**
 - a. Postpone all elective surgeries
 - b. Divert all EMS units not arriving from disaster scene
 - c. Place hospital under security lockdown
 - d. All of the above

12. **Surging in a place does not involve**
 - a. Rapidly discharge existing patients
 - b. Canceling scheduled elective procedures
 - c. Hiring more support personnel
 - d. Increasing the number of patient-care staff

13. **A key reason for hospitals losing money is:**
 - a. Increasing cost of energy
 - b. Underfunding of Medicare and Medicaid
 - c. High costs of updating equipment
 - d. Personnel salaries

14. **The National Implementation Plan does not include:**
 - a. Preparedness and communication
 - b. Initiating an emergency response alert
 - c. Surveillance and detection
 - d. Response and containment

15. **Natural disasters do not include:**
 - a. Hurricanes
 - b. Mine cave-ins
 - c. Floods
 - d. Earthquakes

16. **A Mass casualty event is defined as:**
 - a. An incident that produces a sufficient number of casualties to disrupt normal functions
 - b. An event that affects more than one million people
 - c. An occurrence that is the result of terrorism
 - d. An event that involves only facilities

17. **The most important mission in a disaster response scenario is:**
 - a. Communicating the location
 - b. Alerting the national guard
 - c. Triage
 - d. Alerting evacuation teams

18. **Disaster triage excludes:**
 - a. Providing the greatest good for the patient
 - b. Response teams prioritizing the casualties
 - c. Orderly treatment
 - d. Best use of equipment

19. **___ identifies a patient who will not survive without immediate treatment.**
 - a. Black
 - b. Red
 - c. Yellow
 - d. Green

20. **Which triage color is used to identify "walking wounded" patients?**
 - a. Green
 - b. Yellow
 - c. White
 - d. Orange

Disasters Follow No Rules: Preparing Your Hospital – questions cont.

21. ____ provides a common organizational structure and language to simplify communication.
- START method
 - Incident Command System
 - Emergency Medical Response
 - Decompressing
22. Small aircraft evacuation can be characterized by:
- Simple and generally available
 - More efficient
 - High cost and complexity
 - Removal of critical resources
23. More patients' lives can be saved through:
- Temporizing damage-control surgery
 - Definitive surgery
 - Long-lasting surgical intervention
 - Use of sophisticated technology
24. ICS is built around:
- Command/Operations
 - Planning/Logistics
 - Administration/Financial
 - All of the above
25. ____ is when hospitals incorporate the ICS into their emergency preparedness plans:
- Triage
 - HEICS
 - Definitive medical care
 - SARS
26. Definitive medical care is provided in:
- An existing hospital
 - Mobile facility
 - A and B
 - None of the above
27. ____ determines the organizational hierarchy of the ICS:
- Job titles
 - Seniority
 - Academic degree
 - Functional requirements
28. ____ infected 2-0-40 percent of the world's population
- SARS
 - Saran
 - Spanish Flu
 - Bubonic Plague
29. The Spanish Flu caused death by:
- Bacterial pneumonia
 - Massive hemorrhages
 - Edema in the lungs
 - All of the above
30. A pandemic outbreak can result in:
- Economic downturn
 - Mass quarantine
 - Overwhelmed medical community
 - All of the above

Pain Management for Patients with a Substance Abuse History

1. Health care workers should be cautious when prescribing opioids to ____.
 - a. Transplant recipients
 - b. Cardiac patients
 - c. Diabetic patients
 - d. Recovering addicts
2. One component of pain is _____.
 - a. Physical
 - b. Pre-existing
 - c. Pain scale
 - d. Recovering addicts
3. The emotional components of pain include:
 - a. Anger
 - b. Sadness
 - c. Depression
 - d. All of the above
4. Acute pain in postoperative surgical patients is due to:
 - a. Emotional distress
 - b. Preexisting disease
 - c. Surgical procedure
 - d. A combination of B and C
5. _____ leads to a rise in heart rate, increased oxygen consumption and overall cardiac workload.
 - a. Opioid prescription
 - b. Unrelieved pain
 - c. Arterial blockage
 - d. Intoxication
6. ____ is a chronic, relapsing and treatable disease characterized by lack of control over consumption and compulsive use despite harmful consequences.
 - a. Addiction
 - b. Diabetes
 - c. Crohn's
 - d. Arthritis
7. The most important step in proper postoperative pain management is:
 - a. Administration of prescription drugs
 - b. Maintaining the dopamine pathway
 - c. Proper preoperative assessment
 - d. Understanding and treating a patient's addiction
8. An example of a pain assessment tool is a:
 - a. Numerical scale
 - b. Visual analog scale
 - c. Picture scale
 - d. All of the above
9. A patient's altered level of consciousness in the acute postoperative phase of care due to intraoperative anesthetics makes it hard to successfully administer:
 - a. An IV drip
 - b. Oral analgesics
 - c. A pain assessment
 - d. All of the above
10. Physical indications of pain in the acute postoperative setting include;
 - a. Sweating
 - b. Elevated heart rate
 - c. Trouble moving/taking deep breaths
 - d. All of the above

Pain Management for Patient's with a Substance Abuse History – questions cont.

11. **One way to help ensure postoperative pain management for a patient with a history of opioid addiction is:**
- Obtain a preoperative substance abuse history
 - Consult an addictionologist
 - Administer frequent pain scale tests
 - Begin a preoperative pain management regimen
12. **Which of the following is not an alternative pain treatment?**
- Electric shock therapy
 - Local and regional anesthesia
 - Epidural blocks
 - Local pain pumps
13. **Postoperative fears for opioid-dependent patients may include:**
- Being judged by the care giver
 - Suffering a relapse into drug use
 - Not receiving enough pain medication
 - All of the above
14. **Blocking the action of cyclooxygenase and inhibiting prostaglandin production can be accomplished with:**
- Steroid treatment
 - A Clonidine patch
 - NSAID therapy
 - All of the above
15. **___ is a synthetic narcotic used to treat opioid addiction.**
- Heroin
 - Clonidine
 - Methadone
 - Prednisone
16. **Methadone is used in the treatment of addiction to:**
- Opiates
 - Alcohol
 - Methamphetamines
 - All of the above
17. **Side effects of Methadone use include:**
- Impairs cognitive functions
 - Debilitating drowsiness
 - Liver damage
 - Methadone has no serious side effects
18. **Opiates provide a flood of ___, which causes the euphoric high associated with drug use.**
- Epinephrine
 - Dopamine
 - Endorphins
 - Morphine
19. **The preoperative assessment for a substance abuser should include:**
- The patient's drug history
 - The patient's recovery history
 - A full physical
 - All of the above
20. **Patients who take opiates in large doses have a higher ___.**
- Pain threshold
 - Drug-seeking behavior
 - Tolerance
 - B & C

Gangrene: Recognizing and Treating Cellular Necrosis

- 1. Which is not the one of the three most common variations of gangrene?**
 - a. Gas
 - b. Dry
 - c. Internal
 - d. Wet
- 2. Fournier's gangrene affects the ____.**
 - a. Fingers
 - b. Genitals
 - c. Feet
 - d. Hands
- 3. The best treatment for gangrene is ____.**
 - a. Revascularization
 - b. Amputation
 - c. Maggot debridement therapy
 - d. Antibiotic therapy
- 4. Gangrene occurs when a body part ____.**
 - a. Becomes infected
 - b. Loses its blood supply
 - c. Is diseased
 - d. Loses feeling
- 5. What disease often contributes to the occurrence of dry gangrene?**
 - a. HIV
 - b. High cholesterol
 - c. Smoking
 - d. Arteriosclerosis
- 6. Symptoms of gangrene include ____.**
 - a. Swelling of the affected area
 - b. Discoloration of affected tissue
 - c. Decreased heart rate
 - d. All of the above
- 7. ____ can occur if a bacterial infection from gangrene spreads throughout the body.**
 - a. Septic shock
 - b. Necrosis
 - c. Ischemia
 - d. Decompression
- 8. The tissue becoming dry, shrunken and blackened describes ____ gangrene.**
 - a. Wet
 - b. Gas
 - c. Dry
 - d. Internal
- 9. Which of the following are symptomatic of wet gangrene?**
 - a. Swelling
 - b. Blistering
 - c. Pungent odor
 - d. All of the above
- 10. Burns, frostbite and wound infections can result in ____ gangrene.**
 - a. Wet
 - b. Gas
 - c. Dry
 - d. Internal

Gangrene : Recognizing and Treating Cellular Necrosis - questions cont.

11. Gas gangrene should ___ be treated as a medical emergency.
- Always
 - Sometimes
 - Never
 - Depends on the patient
12. A hernia, or a twist in the gastro-intestinal tract can result in ___ gangrene
- Wet
 - Gas
 - Dry
 - Internal
13. X-ray technology can be helpful in diagnosing ___ gangrene.
- Wet
 - Gas
 - Dry
 - Internal
14. Sweating, difficulty breathing and convulsions can be signs of ___.
- Bacterial infection
 - Oxygen toxicity
 - Fournier's gangrene
 - Bacteriostasis
15. The primary function(s) of MDT is/are:
- Clean the wound
 - Disinfect the wound
 - Speed the rate of healing
 - All of above
16. ___ larvae are the preferred species for MDT.
- Horse fly
 - Greenbottle fly
 - Fruit fly
 - All of the above
17. Medical maggots are generally left in the wound for ___ days.
- 1-2
 - 2-3
 - 304
 - 4-5
18. The risks associated with MDT include:
- There are no inherent risks
 - Larvae attacking living tissues
 - Larvae burrowing into the wound and breeding
 - b and c
19. It has been reported, though unproven in clinical studies, that maggots can:
- Improve blood clotting ability
 - Stimulate the production of granulation tissue
 - Remove bacteria from the blood
 - All of the above
20. Medical grade maggots are:
- Sterile
 - Safe
 - A legitimate treatment option
 - All of above

Answers CE CREDIT PKG 10A: 22 CONTINUING EDUCATION CREDITS

Certified Member

AST Member No: _____

Name: _____

Certification No: _____

Address: _____ City: _____ State: _____ Zip: _____

Telephone: _____ Email: _____

CE Credit PKG 10A: 22 CONTINUING EDUCATION CREDITS

The fee is \$37. This package is only available to AST & ASA members.

Check Enclosed Yes, I want to pay by Credit Card: Visa MasterCard AmEx

Card# _____ Expiration Date _____ Signature _____

Repeat Cesarean Section

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

Off- pump Coronary Artery Bypass Grafting

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

Sterilization – Killing Prehistoric Beast

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

When Unexpected Complications Arise During Surgery

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

Blood Pressure

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

Safety Concepts in the Surgical Setting

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

Necrotizing Fasciitis

a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d			
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	13.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	19.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	14.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	20.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	15.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	16.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	17.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	12.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	18.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

Treatment of War Casualties

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

