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Ethics in the O.R. Setting:

The Other Side of Professional Practice

by Ann Marie McGuiness, CST, MSEd, CNOR

PART 1

Editor's Note: This article will be continued in next month's issue. The author will complete her discussion of medical ethics by providing practical examples of ethical situations that surgical technologists may face in the operating room.

In today's health care practice, technological advances permit the use of interventions and advanced practices that have blurred what once were clear lines of distinction between life and death, and between treatment and non-treatment. There was also clear division between medical decisions dictated by the physician "for the good of the patient" as opposed to patient-directed care. Today's health care consumers are better educated and often knowledgeable about the various treatment options available to them. While these advances have improved the overall quality of health care and have extended the normal lifespan, accompanying these changes are the issues of a lack of inexhaustible resources to support these costly treatments and equitable access to these sometimes limited resources. From these dilemmas has risen the field of health care ethics.

An ethical dilemma arises when there is no clear-cut right or wrong solution or where there is a no-win situation for all parties involved. It is important, therefore, that the surgical technologist has a working knowledge of what health care ethics entails, some of the considerations that need to be evaluated when making ethical decisions, and some of the more commonly encountered ethical situations found in today's medical and/or surgical setting.

Definitions

Ethics, in general, is the field of philosophy that studies the morality of human conduct. It is the science of morals: the philosophic and spiritual disciplines that systematically examine the values of good or bad, right or wrong, and justice or injustice in human conduct. Ethics also involves the study of the cultural, religious, and professional impact of these values on society. In the health care field, ethical and moral principles provide the basis for the development and implementation of professional standards, such as the Association of Surgical Technologists' Standards of Practice and the AST Code of Ethics (see page 15).

The deontologic approach is the guiding principle most commonly used in health care practice in the United States today, where we see virtually open access to medical care for all individuals, regardless of any obstacles related to that access.

Clinical medical ethics is the discipline that provides a systematic and structured approach to identifying, analyzing, and resolving the ethical problems of a particular patient population. The most common guiding principles used to formulate ethical views today involve the concepts of utilitarianism versus deontology.

Utilitarianists, also referred to as consequentialists or teleologists, believe that the good of society outweighs the benefit to any one individual. They judge the "rightness or wrongness" of a decision based upon the predicted outcome that what is right is also beneficial to the greatest number of individuals within society. Under the principles of utilitarianism, the need to spend resources on developing vaccines against communicable diseases would take precedence over the expense of providing medical support and resources to one patient in need of a liver transplant.

Deontologists believe that decisions should be based on a moral obligation to each member of society, regardless of the impact to the group as a whole. Deontology uses the principle of autonomy, or self-rule, and supports the patient's right to self-determination. Using the previous example, a deontologist would view the rights of the patient to have access to the care and procedures required to perform a liver transplant equally as important as the right to access vaccines to prevent disease. The deontologic approach is the guiding principle most commonly used in health care practice in the United States today, where we see virtually open access to medical care for all individuals, regardless of any obstacles related to that access.

Primary bioethical principles in health care

The health care profession, by its nature, is a caring profession, dedicated to assisting patients in attaining and maintaining an optimal level of wellness. The care provided by health care practitioners is commonly guided by two basic principles. Today, these two bioethical principles continue to be used to establish criteria for evaluating and implementing all other bioethical decisions.

Beneficence

The principle of beneficence is the first overriding and compelling paradigm utilized for determining patient care in the surgical setting. The principle of beneficence upholds that all interventions should ultimately benefit the patient and that the intent of any action undertaken on the patient's behalf has the overall goal of helping the patient more than causing harm. The action should promote good and prevent or remove evil. In medicine, rarely is any intervention totally beneficent. There are generally some negative consequences associated with most

actions, such as the pain associated with starting an intravenous line to administer pain medication or the making of a surgical incision to access a diseased organ. While the overall outcome of the actions is positive, the patient will have to undergo a pain-inducing procedure as one step in the pain-relief process.

Non-maleficence

The principle of non-maleficence is the second overriding and compelling paradigm used as the basis for all patient care. The overall goal of any medical or surgical intervention should be to do no harm or that any harm done should not outweigh the overall benefit to the patient. The creation of a surgical incision, outside of the operating room setting and without the patient's informed consent, would constitute assault and battery with a dangerous weapon. The incision, though, is an integral step in the removal of an abscessed appendix. Failure to remove the diseased appendix would cause greater harm than that caused by the surgical incision and subsequent removal of the pathology.

Secondary bioethical principles in health care

Prior to the 1970s, the focus of health care was on the preservation of life, no matter the cost. The paternalistic model of physician as both care provider and "sage" has given way to consumer demands for the right to self-determination in regard to health care. Technological advances have permitted the extension of "life" beyond the limits of a quality existence, and the dilemmas resulting from this situation have spawned the field of bioethics, including the identification and consideration of the secondary bioethical principles that impact the delivery of health care in today's society.

Autonomy

The principle of autonomy, or self-determination, states that a competent person has the right to determine the course of his or her medical care, even when that choice is viewed as negative or "unacceptable" and may even result in death. This determination includes the ability to make decisions based on the provision of valid and pertinent information determined without constraints or coercion, the power to have those decisions supported and implemented by caregivers, and the expectation that the decisions that have been determined will be respected and carried out by the caregivers to the best of their abilities.

In 1972, the American Hospital Association (AHA) published the *Patient's Bill of Rights*. This document supports and enforces the right of the patient to access respectful care, to obtain accurate information, to be provided with continuity of care, to have confidentiality maintained, and to have the right to self-determination.

AST CODE OF ETHICS

- To maintain the highest standards of professional conduct and patient care
- To hold in confidence, with respect to patient's beliefs, all personal matters
- To respect and protect the patient's legal and moral right to quality patient care
- To not knowingly cause injury or any injustice to those entrusted to our care
- To work with fellow technologists and other professional health groups to promote harmony and unity for better patient care
- To always follow the principles of asepsis
- To maintain a high degree of efficiency through continuing education
- To maintain and practice surgical technology willingly, with pride and dignity
- To report any unethical conduct or practice to the proper authority
- To adhere to the Code of Ethics at all times in relationship to all members of the health care team

Under the AHA Patient's Bill of Rights, the patient has the right to make decisions regarding the nature and extent to which interventions will and will not be performed. These decisions are based on factual information usually provided during the course of obtaining informed consent. Informed consent should be obtained when the individual is able to sort through information and options in a logical and rational manner. These "rights" also carry over into periods of time when the patient may be incapable of verbalizing and monitoring those decisions, such as during a surgical intervention. It is during these periods, when the patient is unable to speak for himself and the invocation of a living will or durable power of attorney is instituted, that the principle of autonomy must be safeguarded and support for the patient's decisions regarding care must be honored.

Assessing the needs of the patient and supporting them in a manner that shows caring and respect are actions that are as much a part of the job description of a surgical technologist as are scrubbing, gowning, and gloving.

Justice

The principle of justice refers to the concepts of equity and fairness. In today's democratic society within the United States, each person is entitled to equal access to health care, regardless of such variables as social status or ability to pay for such services. While in principle justice is a worthy goal, today's health care crisis has been precipitated, to a degree, by this concept. In reality, access to health care in the US is not completely equitable. Factors such as urban living versus suburban living, the cost of health care, medical technology resources, and medical personnel resource limitations impact the concept of equitable health care for all. The recent focus on the desire to implement a national health care system to provide a more equitable distribution of medical resources is an attempt to provide greater justice and equity to health care consumers.

Morality

Morality refers to that part of human behavior that can be evaluated in terms of right and wrong. In relation to ethics, morals are the behaviors demonstrated by the professional group that support ethical behavior and practice. Morals are the values about what is good, right, and just. They are developed based upon the belief system adopted through cultural, religious, or professional beliefs and values. Common morality is the communal consensus of a society or culture regarding norms of human conduct and human rights. Within health care, there are various professional groups who share a core moral code of support for the patient along with the four basic principles of ethics – as beneficence, non-maleficence, autonomy, and justice.

Moral guides in health care

Confidentiality

The concept of confidentiality involves the maintenance of patient privacy. During the course of care delivery, it is critical that the staff have access to patient information. Knowing that a patient has a history of drug abuse may impact the types of anesthetics and postoperative pain medications used for this patient. Other, less necessary, information may also be included in the medical record accessible by the health care staff, such as a prior suicide attempt by a patient during adolescence that has subsequently been resolved.

The professional surgical technologist has a moral obligation to the patient to treat any personal information as "privileged" information to be used only in the direct care of the patient. Student surgical technologists also need to be

aware of the importance of maintaining patient confidentiality in the preparation of educational journals, when sharing information during clinical seminars, and during other educational situations. While it is permissible to discuss procedures and patient issues with instructors and fellow classmates under the domain of education, for the purposes of learning, it is important that patient confidentiality be addressed and maintained.

Copies of patient documents should have the patient's name and identifying information removed or disguised. The patient should be referred to in a "generic" fashion, eliminating the use of patient names. Journaling should contain factual information, such as "the patient was a 39-year-old female who presented with the diagnosis of pelvic pain…." All information obtained during the course of externships or clinical seminars must be held in confidence. Discussing details of surgical cases without the intent to educate or provide care for that patient is a breach of confidentiality. This breech can give rise to legal action on the grounds of invasion of privacy.

Fidelity and loyalty

Fidelity and loyalty both involve the act of promise-keeping on the part of the health care practitioner. Every profession has a scope of practice that governs those procedures and responsibilities assigned to each team member. Some of these responsibilities overlap between professional groups, but professional codes of ethics dictate that health care practitioners, in general, support the desires of the patient, regardless of personal views or opinions. When a practitioner can not support a patient's personal decision regarding medical care, the practitioner has an obligation to provide a substitute caregiver.

This precedence is seen today in the operating room when a patient chooses to undergo elective termination of a pregnancy. If personal views are not supportive of this procedure, you, as a professional, can not simply choose to abandon a patient who does not share your moral or ethical view. Instead, you have an obligation to notify your supervisor or nurse manager of the issue in a timely manner, so that substitutions in scheduling can be made to accommodate the needs of the patient.

Integrity and veracity

Integrity, the practice of being honest, and veracity, the act of telling the truth, are important moral tenets in the health care profession and are mutually supporting. A positive relationship needs to exist between the patient and the health care practitioners in order for optimal wellness to be achieved. Patients must be willing to enter into a trust relationship with people whom they do not know intimately. They must feel "comfortable" in entrusting these individuals with the information and feedback needed to guide their care during the critical time and events surrounding a surgical intervention. The professional health care practitioner must be willing to foster and support the development of such a relationship by providing accurate information during the process of informed consent without overwhelming patients and by demonstrating a caring and respectful attitude toward them and their decisions regarding care. Professional moral conduct compels health care professionals to provide patients with information and care that is both accurate and truthful in nature and with treatments that promote wellness and well-being.

Respect for persons and for the sanctity of life

Aeger primo, the patient first, and *Primum non nocere*, first—do no harm, are basic tenets of health care in general and the profession of surgical technology specifically. The focus of many surgical interventions is primarily therapeutic, providing a cure for disease or illness. There are also procedures in which the focus is either palliative, a procedure performed to provide better quality of life without curing the disease, or interventive, a procedure performed to halt the progression of a process. Whether therapeutic, palliative or interventive in nature, the overall intent of any procedure should be to assist the

patient in achieving a desired quality and quantity of wellness through the means determined by the patient to be in his or her best interest.

The Golden Rule (the rule of reciprocity)

"Do unto others as you would have done unto you" is an excellent guideline for health care practitioners to use when determining moral ethical practice. How would you want to be treated? Would you want the surgical team members to focus on you lying on the operating room bed, or would you want to hear about "last night's date" or "the fight so-and-so had with their spouse this morning"? Would you want to be denied information because the team thought you couldn't handle it? We would be appalled if treated in such a manner; yet one can find just such behavior occurring daily in operating rooms across the country.

The recent focus on the desire to implement a national health care system to provide a more equitable distribution of medical resources is an attempt to provide greater justice and equity to health care consumers.

Patients entrust the health care practitioner with their care, in some cases their very lives. Practitioners, in turn, have a professional and moral obligation to fulfill that duty to the best of their abilities. Assessing the needs of the patient and supporting them in a manner that shows caring and respect are actions that are as much a part of the job description of a surgical technologist as are scrubbing, gowning, and gloving.

Compassion and solidarity (respect for community)

Compassion and solidarity are moral principles that address equity of care, regardless of whom the patient is or the patient's life circumstances. Compassion, the desire to alleviate patient distress, and solidarity, the desire to deliver quality, professional patient-centered care regardless of other intervening variables, are desirable qualities commonly identified in health care providers. The homeless person deserves the same consideration and level of care as does the CEO of a giant corporation. The moral principles of compassion and solidarity erase discrimination based on anything other than the urgency of the patient's medical condition and the team's ability to act in a professional manner to assist the patient in returning to an optimal level of wellness.

Professional integrity, honesty, and efficiency

The surgical patient has every right to expect and receive high-quality care from those professionals who make up the surgical team. Patients are in a most vulnerable position during surgical intervention, and they may place blind faith in the skills and knowledge of those caring for them. The surgical technologist, then, has the obligation to provide the highest level of patient care possible. Patients have the right to know that each and every team member will advocate for them when they are unable to advocate for themselves. This requires that the O.R. team be knowledgeable and supportive of the needs and issues of each surgical patient. This advocacy can take many forms, from providing protection and a safe environment in which the surgical intervention can take place, to ensuring that competent individuals provide care. If the surgical technologist on a procedure is unfamiliar with the equipment being used, the tech with the knowledge base has the duty and obligation to remain scrubbed for as long as the equipment is in use. Just because it is 3 pm and time for relief does not mean that the surgical technologist can leave a patient in the care of someone who does not have the proper knowledge base. The sense

of professional integrity possessed by health care practitioners in the surgical setting mandates that they stay and care for the patient.

Currency

Currency in one's knowledge base is the responsibility of each and every surgical technologist. The operating room is an area where the knowledge base is extremely dynamic, changing sometimes as frequently as every three months. While the basics of practice stay relatively unchanged, the introduction of new technology and methods demands that the O.R. team undertake continuous education to stay abreast of these changes. The surgical technologist owes the maintenance of a current and solid knowledge base to themselves, the team, the profession, and most importantly, the patient.

Surgical conscience

During the course of any surgical case, there are multiple opportunities for undetected errors to occur. "No one is looking…" or "No one called it…" are empty platitudes to keep a surgical technologist who does not possess a strong sense of surgical conscience from feeling "guilty" when breaks in aseptic technique occur or errors are made. Unfortunately, these sayings are erroneous in that the person who made them has, indeed, identified that an error has occurred and has gone uncorrected. Again, the standard of the "significant other" needs to be the moral guide of the surgical technologist – if that happened to someone you loved, would you find that behavior acceptable? Despite the aggravation, the added efforts, or the extra work required to remedy the issue, being able to "look in the mirror with your head held high" is the standard of care the professional surgical technologist should deliver in each and every instance.

About the Author

Ann Marie McGuiness, CST, MSEd, CNOR, is program director of the surgical technology program at Lock Haven University—Clearfield Campus in Clearfield, Pennsylvania, offering both campus-based and on-line entry-level surgical technology education ***(www.lhup.edu)***. She has been a Certified Surgical Technologist since 1977. Ann has presented at numerous forums, workshops and conferences and has served on various committees for AST, ARC-ST and LCC-ST, where she currently chairs the LCC-ST Exam Review Committee.

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Ethical Conflicts *in the* O.R. Setting

by Ann Marie McGuiness, CST, CNOR, MsEd

PART 2

Editor's Note: This article is the second of two parts. The first half of this article appeared in last month's issue of The Surgical Technologist. *In that issue, the author presented an in-depth, comprehensive overview of the bioethical principles, morals, and ethics that form the foundation of our health care system.*

In this issue, the author continues this discussion with practical examples of ethical conflicts that surgical technologists may face.

In the operating room, the surgical technologist is primarily involved with assisting the patient in undergoing a therapeutic intervention to remove or correct a pathology. Providing the surgical technologist with an opportunity to investigate and examine some of the ethical issues that can and do occur in the operating room allows the examination of one's personal value system in relation to the moral and ethical positions commonly espoused in today's health care profession. While these values may differ, it is important that the surgical technologist be able to embrace the values of health care and be willing to support the patient and surgical teams in ways that conform to established societal norms.

The list of ethical issues in health care expands on a daily basis. Technology has provided the means to extend the life cycle beyond points that were once thought to be finite. People are able to survive under conditions that previously would not have supported life. Along with these incredible and far-reaching changes have come many challenges to beliefs and practices that were previously clear-cut.

When faced with an ethical dilemma, there are two approaches commonly used to determine the best options for that given situation. Under the utilitarianism system of ethics, one would describe the issue, list the possible solutions, and then choose the solution that benefits the greatest number of people. Under the deontological system of ethical decision-making, one would describe the problem, list the solutions, and compare the solution with the underlying principles of self-autonomy and self-determination. Patients would base their decisions on their needs, desires, and requests, regardless of any external factors or impact on others.

It is important that the surgical technologist be able to embrace the values of health care and be willing to support the patient and surgical teams in ways that conform to established societal norms.

Both of these approaches have benefits and drawbacks when applied to any given situation. A combination of both approaches, with the application of the concept of the reasonably prudent person—that action that another practitioners of equal education and preparation would undertake in the same situation under the same circumstances, is used in the health care profession to establish recommended standards of practice in ethical situations.

The following summary of ethical conflicts that the surgical technologist may encounter during practice is by no means comprehensive or exhaustive. Each clinical practice site will present its own unique ethical challenges. The purpose of this section of the article is to briefly touch on ethical topics that may be encountered when practicing in the surgical setting. It is also designed to assist you in examining the ethical issue and assessing the potential impact that a scenario involving this topic would have on you and your practice. Each topic, in and of itself, contains many more facets and details than can be contained in this article. Additional research and review may be required to clarify the concepts and concerns that should be considered when making ethical decisions.

Elective abortion

Elective abortion involves the deliberate termination of a pregnancy without medical indication. In the United States, first trimester (within the first 13 weeks of pregnancy), second trimester (between the 14th and 27th weeks of pregnancy), and even third trimester abortions are available upon request by the pregnant female. In some states, minors may also obtain elective abortion without parental consent.

First trimester abortions are performed by dilatation and curettage. The cervix is dilated, and a vacuum curette is used to evacuate the products of conception. Second trimester abortions involve either the dilation of the cervix and evacuation of the products of conception or the injection of concentrated saline solution into the amniotic sac, causing fetal death and expulsion of the products of conception. Third trimester abortions are commonly performed as dilation and extraction, where the fetal body is delivered, with the exception of the head. A sharp object is inserted into the back of the fetus' head, and a vacuum tube is used to extract the brain. The remainder of the fetal tissues is then delivered.

The ethical debate over elective abortion hinges on what individuals determine to be the fetal "point of viability"—that point in fetal development when a fetus can live independently of the mother, albeit with outside technical support. Many health care practitioners feel that viability is not reached until 20 weeks of gestation and is questionable up until the 27th week

of gestation. Others feel that life begins at conception and that any unnatural act that forces early death or delivery of the fetus constitutes murder. The ethical debate becomes complicated by today's technology, where neonatal intensive care units daily address the issues of premature infant survival for infants as young as 22-24 weeks of gestational age.

Surgical technologists need to examine their ethical positions on elective abortion prior to employment. Many institutions offer staff the option of not participating in elective abortions, provided that there is alternate staff available to provide services to the patient. The performance of elective abortions and the ability to choose elective participation are issues that are best discussed during the job interview process or prior to accepting a position as a surgical technologist.

Therapeutic abortion

Therapeutic abortions are those semi-elective procedures performed to terminate a pregnancy when the continuation of the pregnancy has a significant potential of leading to maternal injury or death. Many of these abortions are performed during the second and third trimesters of pregnancy. The ethical considerations surrounding these abortions may be different from those of elective abortion, in that the risk to the mother may provide moral support to practitioners, supporting their performance and participation under these types of circumstances.

Elective sterilization

Elective sterilization is a procedure that can be performed on either the male or female patient. Male patients usually elect to undergo vasectomy, the removal of a segment of the vas deferens, effectively preventing the migration and ejaculation of sperm during sexual intercourse. For the female patient, sterilization can be achieved through occlusion of the fallopian tubes, removal of the ovaries, or removal of the uterus. The basic underlying principle of all of these methods is the prevention of contact between sperm and ova, thereby preventing conception.

Tubal occlusion and/or vasectomy, while not foolproof, are highly effective methods of birth control. Some religions, though, view any artificial interference with procreative abilities to be morally wrong.

On rare occasions, a court-ordered sterilization may be performed as part of a judgment in a legal case. The patient may not consent to

the procedure or may not be deemed competent to make decisions regarding self-determination.

Artificial fertilization

Today's modern reproductive technology allows for the fertilization of stored human eggs, sperm, and embryos, with subsequent implantation into a uterus for growth and development for the purpose of establishing a pregnancy. Genetic coding may soon permit us to manipulate human genes and change the course of human evolution by eliminating genetic diseases. Ironically, this technology also permits the conception of a "designer baby"—one with desirable features and attributes selected from a "pool" of embryos.

IVF, in vitro fertilization, involves the use of expensive medications and interventions. In the face of rising health care costs and dwindling economic resources, should this procedure only be available to those who can afford to pay for these services, or is every person entitled to avail themselves of this technology? Is the right to bear a child, regardless of the cost to society, more compelling than the more equitable allocation of monetary resources to meet basic health needs?

In the face of rising health care costs and dwindling economic resources, should in vitro fertilization only be available to those who can afford to pay for these services, or is every person entitled to avail themselves of this technology?

Human experimentation

Each day, in operating rooms throughout the United States, experimentation on humans is occurring. While non-human trials of new medications and medical devices are undertaken before human trials are permitted, the actual outcome and long-term consequences of the use of these investigational agents remain unknown until in vivo human testing is done. In the 1980s, one example involved the implantation of intraocular lenses (IOLs), which were used to correct blindness caused by surgical aphakia. Patients had to sign special consent forms, and follow-up documentation had to be submitted to the FDA following the implantation of each of these devic-

es. It was only through human trials that the need to redesign lenses with laser ridges and to place lenses in the posterior rather than anterior chamber was identified and verified. The knowledge and insight gained from these early "experiments" permitted modification of designs and materials, permitting a wider application of this technology to a greater number of candidates. Without the "human" factor, this information may not have been detected as rapidly or effectively. Is it ethical, then, to use humans as "guinea pigs"?

Animal experimentation

Monkeys, pigs, and mice have all been used to predict the effect of products, devices, and concepts for use in the human body. While some people condone the use of animals for experimentation and learning, at what point does experimentation become animal cruelty? The administration of lethal doses and pouring toxic levels of substances into delicate animal tissues have all been performed in the name of scientific progress. Yet lives are saved daily by the knowledge gained by performing experimental surgeries on animals, many of whom die as a consequence of testing.

Organ donation/transplantation

The technology to support organ transplantation has developed dramatically to the point where many organs can now be successfully transplanted from donor to recipient. The demand for organ donations far exceeds the supply. The resources, both fiscal and tangible, needed to support one transplant patient are significant. The procedure, in and of itself, is costly, let alone the medical follow-ups and the lifetime supply of anti-rejection medications required. Anyone who has received a kidney, liver, heart, lung, or pancreas tells of the "double-edged sword"—death is exchanged for a life of chemicals used to keep the implanted organ from being destroyed by the body's own immune system.

Another area of controversy surrounding the ethics of organ transplantation is the determination of who will receive the organ. If you can pay for it, can you get an organ earlier than someone without the financial means to pay for it? While the buying and selling of organs is illegal in the United States, there are countries that will sell organs on the black market. Will genetic engineering permit the "growth" of human organs for transplantation? And if so, can society afford to support a population that will demand a significant portion of allocated health care dollars?

Substance abuse/recreational drug use

While it is acknowledged that the operating room is a high-stress environment in which to work, and that health care practitioners are susceptible to alcohol and drug abuse, an impaired practitioner has no place in a critical care setting. Even recreational use of these substances will lead to behavioral issues, such as avoidable errors and poor decision-making. Professional ethics dictate that practitioners be free of chemical substances that could impair judgment or functioning.

While some people condone the use of animals for experimentation and learning, at what point does experimentation become animal cruelty?

The operating room also presents opportunities for the procurement of controlled substances. While controlled substances are usually secured, there exists opportunities for health care workers to obtain controlled substances illegally. This procurement is both illegal and immoral.

While "whistle blowing" can lead to personal repercussions, the surgical technologist has an obligation to report known substance abuse. The duty of non-maleficence states that decisions must be made based on preventing patient harm. More significant, though, is the fact that the

health care worker has now become a "patient" and is in need of the same intervention and care rendered to anyone with a disease.

Gender reassignment surgery

Gender reassignment surgery involves procedures that change a patient's biological sex. It is performed for the condition known as gender dysphoria, a psychological condition in which the individual believes that he or she is psychologically and emotionally the opposite sex. Gender dysphoria is diagnosed by a therapist or psychiatrist who is experienced in gender issues. Some individuals with gender dysphoria elect to undergo sexual reassignment surgery. Gender reassignment is also performed for individuals with ambiguous sexual characteristics and genitalia, commonly referred to as hermaphrodites.

Sexual reassignment surgery (SRS) involves the primary and secondary sex tissue development. Male-to-female SRS consists of the removal of the penis and the construction of a vagina and labia. Although surgical techniques differ among surgeons, generally the tissue of the penis is kept intact and fashioned into a clitoris, so that the patient can experience orgasm. Female-to-male SRS consists of a bilateral mastectomy and removal of the ovaries. A penis can be created using a surgical technique called phalloplasty.

Many individuals with gender dysphoria and ambiguous sexual characteristics live a life riddled with discrimination based on their issues of sexuality. The care of these patients in the operating room setting should not differ from that given to any patient presenting for surgical intervention.

Care of the HIV/AIDS patient

Acquired immunodeficiency syndrome (AIDS), first identified in the human population in 1982, infects an estimated 33 million people around the world. Individuals with AIDS require routine medical and surgical care as well as interventions to address the numerous infections that can result from an altered immune system. With reports of patients taking up to 17 years to seroconvert from HIV-negative to HIV-positive, it is imperative that health care providers protect themselves from accidental inoculation with HIV-infected bodily fluids.

The operating room, like many other professional arenas, carries an inherent risk of disease transference from patient to staff. You can not tell if a patient has AIDS by looking at them, by their age, or by any other external factors. Patients are not required to reveal their AIDS status, nor can

hospitals require AIDS testing for patients or staff. The treatment of HIV-positive and AIDS patients in the operating room should not differ from the care delivered under the established policies and procedures defined in the Centers for Disease Control's Standard Precautions. If standard precautions are followed without exception, health care workers will be provided with the maximum amount of protection possible against contracting this terminal illness.

Severely disabled newborns

The birth of a child is commonly a joyous occasion for many parents. When a baby is born with severe birth defects, such as anencephaly, the dream of a "perfect child" gives way to the reality that such babies are either delivered stillborn or die soon after birth. This tragedy affects not only the involved family; it extends its sense of loss and grief to the surgical team as well. Surgical deaths leave an indelible impression on the health care practitioner, whether preventable or not.

The health care team must address the needs of both the family and the neonate during this very stressful period. Time to bond, detach, and grieve may need to be provided in the O.R. suite. On those occasions when organ harvesting for donation can occur, the O.R. team needs to contain their own grief and move to provide for the issues associated with organ procurement.

Quality vs quantity of life

When is death preferable to life? This situation usually occurs when a patient has developed a terminal disease, and the pain associated with it turns each day into an "existence" rather than a life. Self-determination permits patients to choose which medical interventions they wish to have implemented during such situations. While some patients are compelled by religious or philosophical beliefs that death by any unnatural means is murder, others feel that life without meaning is nothing more than mere existence. In our society, suicide and assisted suicide are illegal. In the health care setting, though, individuals have the right to refuse treatments when the sole purpose of the treatment is to prolong life.

Refusal of treatment

Provided for in the AHA Patient Bill of Rights is the right to refuse treatment. A patient may choose to refuse any aspect of care, even that care that will bring about cure from disease. Patients may also choose to continue engaging in health-endangering activities. If the ethical duties of the health care conflict with the patient's desires, the O.R. team may feel that the patient is making "poor decisions." The ethical obligation of the health care team, though, is to support the patient in their decision, to the best of their abilities.

If you can pay for it, can you get [a donated] organ earlier than someone without the financial means to pay for it?

DNR orders in the surgical setting

Patients have the right to determine which, if any, extraneous measures will be instituted should they not be able to make these determinations at the time of the event. Do Not Resuscitate orders that were traditionally suspended in the operating room, due to the nature of the life support technologies commonly associated with general anesthesia administration (eg endotracheal intubation, use of a ventilator, use of medications to regulate blood pressure, etc), are re-evaluated at the time of surgery. While the compelling focus of our care is the preservation of life and the omission of harm, standing back and watching as a patient who chose DNR status undergoes cardiopulmonary failure and death can be emotionally and professionally taxing. Every death in the operating room setting is disquieting for the staff, due to the ethical conflict of medicine's

primary moral and ethical doctrine of nonmaleficence.

As surgical technologists, our professional responsibilities to the surgical patient extend beyond the instruments, equipment, and environments to the promotion of health and wellness. Our responsibilities extend to assuring the rights of our patients to expect and receive quality, equitable, and appropriate care, with respect to the patients' desires and wishes. We owe it to our patients to be an integral part of all aspects of their health care.

About the author

Ann Marie McGuiness, CST, CNOR, MsEd, is program director of the surgical technology program at Lock Haven University—Clearfield Campus in Clearfield, Pennsylvania, offering both campus-based and online entry-level surgical technology education *(www.lhup.edu)*. She has been a certified surgical technologist since 1977. Ann has presented at numerous forums, workshops and conferences and has served on various committees for AST, ARC-ST and LCC-ST, where she currently chairs the NBSTSA Exam Review Committee.

As surgical technologists, our professional responsibilities to the surgical patient extend beyond the instruments, equipment, and environments to the promotion of health and wellness.

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Safety Concepts
in the Surgical Setting

Ann M McGuiness, 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 development 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 bronchcoscopy 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 anesthetic gases, such as inhalation agents
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 eyewear 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 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 include[3]:

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 tissues 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 alignment 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, MEd, 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.

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Necrotizing Fasciitis

Valentin Rodriguez

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

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

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 bacterium 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 *Streptococcal 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 contacting 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 *S. 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 mysitis, 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 hospitals 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.

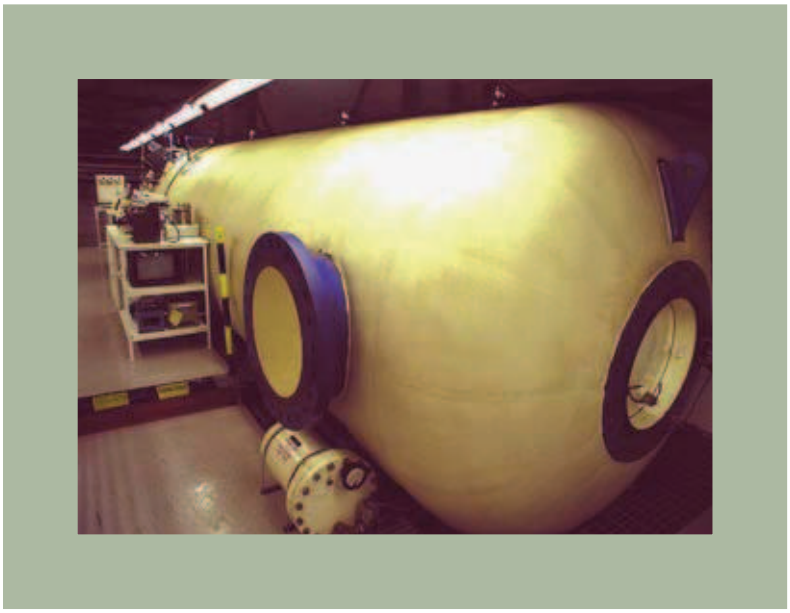
In a Minneapolis study, two groups of patients were compared; one group was comprised of individuals who contracted community-associated MRSA infections, and the other was composed of individuals who experienced community-associated methicillin-sensitive *S. aureus* (MSSA) infections. The latter population 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 underlining 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 underwent two surgical 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 debridements as well as intense antibiotic therapy. When these were not successful, 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 hydrosponge, 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 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, symtoms 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 as 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 are[15]:

- 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 Rodriguez lives in Fresno, California and is a a student at San Joaquin Valley College, in Fresno. He 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 on to remain calm and help the surgeon with every step. He 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.

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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.

FEMA

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 safety[1]

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

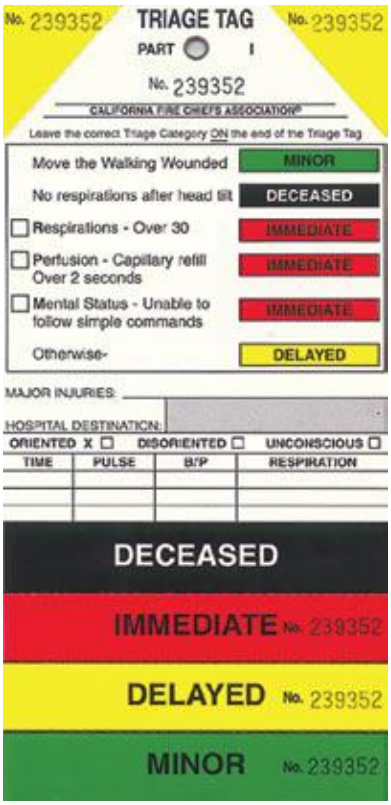

Figure 1.
Triage tag.

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]

Methods of Evacuation

Method	Cost/Benefit Ratio
Ground	• Simple and generally available • Inefficient (low transport capacity) • May remove critical resources
Small Aircraft	• High cost and complexity • Inefficient (low transport capacity) • Difficult to provide advanced care • Aircraft may be better-utilized in disaster area
Large Aircraft	• 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]

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-

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:

n **Minor**	Delayed care/can delay up to three hours
n **Delayed**	Urgent care/can delay up to one hour
n **Immediate**	Immediate care/life-threatening
n **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.

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U.S. Coast Guard Petty Officer 2nd Class Nyso Lynn Cangemi

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.

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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]

Alan Kim, The Roanoke Times

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.

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

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.

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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

Free Press newsboys don protective masks during the 1918 pandemic. While widely used, the masks had no protective effect against the virus.

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

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, causing 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.

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- Stockpile minimal personal protective equipment: $400,000
- Stockpile basic supplies: $240,000
- Total: $1 million[3]

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.***

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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.

> 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.

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

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 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]

X-ray of a foot presenting with gas gangrene.

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]

> 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.

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 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 impeding 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.

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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.

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.

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 species 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 plastic 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

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.

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1. The bioethical principle of _____ states that patients have the right to self-determination.
   a. integrity c. veracity
   b. autonomy d. reciprocity

2. The bioethical principle of _____ states that practitioners will be honest.
   a. veracity c. integrity
   b. solidarity d justice

3. The bioethical principle of _____ states that pratitioners will monitor and correct beaks in aseptic technique.
   a. loyalty c. veracity
   b. surgical conscience d. respect for life

4. The bioethical principle of _____ states that all patient information be kept private.
   a. confidentiality c. reciprocity
   b. efficiency d. compassion

5. The bioethical principle of _____ states that all interventions should help the patient more than cause harm.
   a. fidelity c. non-malficence
   b. justice d. beneficence

6. The bioethical principle of _____ states that practitioners will maintain an up-to-date knowledge and skills base.
   a. effeciency c. currency
   b. solidarity d. loyalty

7. The bioethical principle of _____ states that patients have the right to be told the truth during the process of making decisions regarding their healthcare.
   a. integrity c. veracity
   b. autonomy d. reciprocity

8. The bioethical principle of _____ states that practitioners will tell the truth.
   a. fidelity c. respect for community
   b. solidarity d. justice

9. The bioethical principle of _____ states that professionals will strive to alleviate patient suffering.
   a. currency c. reciprocity
   b. autonomy d. compassion

10. The bioethical principle of _____ states that the degree of harm caused during an intervention should not outweigh the benefits derived from the care.
    a. confidentiality c. autonomy
    b. justice d. beneficence

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a. Is cost-effective
b. Provides for individual autonomy
c. Benefits the greatest number of people
d. Considers the concept of self-determination

2. **Deontological ethics involves choosing a solution that:**
a. Meets the individual's needs and wishes
b. Allocates resources equitably
c. Benefits all members of society
d. Does not consider the concept of self-determination

3. **Ethical considerations associated with elective abortion include:**
a. Maternal complications and risk factors
b. Fetal "point of viability"
c. Patient out-of-pocket cost
d. Patient age

4. **Elective sterilization is:**
a. Supported by all religions
b. A means of preventing conception
c. Effective only on male patients
d. Often ordered by judges in criminal cases

5. **Medical experimentation is:**
a. Rarely done on humans
b. Only performed on animals
c. A necessary part of scientific research
d. Usually done without patient consent

6. **Some of the ethical issues associated with organ donation include:**
a. Black market buying and selling of organs
b. The cost of surgery, follow-up care, and anti-rejection medications
c. Selecting organ recipients
d. All of the above

7. **Drug and substance abuse by health care workers violates the principle of:**
a. Self-determination c. Veracity
b. Non-maleficence d. Fidelity

8. **The condition where one perceives themselves to be psychologically and emotionally the opposite sex is termed:**
a. Gender dysphoria c. Phimosis
b. Sexual dimorphism d. Hermaphrodism

9. **The surgical patient has the right to refuse treatment under the Patient's Bill of Rights developed by:**
a. AORN c. AAMI
b. AST d. AHA

10. **The concept where that action that another practitioner of equal education and preparation would undertake in the same situation under the same circumstance is called the doctrine of:**
a. Reasonably Prudent Person
b. Forseeability
c. Res Ipsa Loquitor
d. Master-Servant

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3	❑	❑	❑	❑	8	❑	❑	❑	❑
4	❑	❑	❑	❑	9	❑	❑	❑	❑
5	❑	❑	❑	❑	10	❑	❑	❑	❑

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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 device delivers the current to the patient?**
   a. Active electrode
   b. Inactive dispersive 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. **An anesthetized 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

294 JUNE 2008 2 CE CREDITS

Safety concepts in the surgical setting

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Mark one box next to each number. Only one correct or best answer can be selected for each question.

CEExam

295 JULY 2008 2 CE CREDITS

Necrotizing faciitis

Earn CE credits at home

You will be awarded continuing education (CE) credit(s) for recertification after reading the designated article and completing the exam with a score of 70% or better.

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Note this exam awards two continuing education credits.

Members: $12, nonmembers: $20

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. **Bacteriodes often reside in the**
a. Liver
b. Lungs
c. Intestine
d. Mouth

4. **When bacteria invades parts of the body where they are usually not found, the infection is called:**
a. Toxic shock syndrome
b. Invasive GAS disease
c. Hepatitis C
d. Chickenpox

5. **_____plays a critical role in the transmission of NF.**
a. History of alcoholism
b. Open wound
c. Hygiene
d. Diabetes

6. **Factors that help the spread of NF include:**
a. Cancer
b. Alcoholism
c. Hepatitis C
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 flu
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

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295 JULY 2008 2 CE CREDITS

Necrotizing faciitis

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2	☐	☐	☐	☐	7	☐	☐	☐	☐
3	☐	☐	☐	☐	8	☐	☐	☐	☐
4	☐	☐	☐	☐	9	☐	☐	☐	☐
5	☐	☐	☐	☐	10	☐	☐	☐	☐

Mark one box next to each number. Only one correct or best answer can be selected for each question.

11. **Which of the following microbiological staining methods can be used to determine whether a type I or type II infection is present?**
a. Acid-Fast
b. Gram
c. Simple
d. Negative

12. **In patients with an allergy to penicillin, the surgeon may prescribe**
a. methicillin.
b. benzathine.
c. amoxicillin.
d. clindamycin.

13. **A common region of the body in which group A hemolytic streptococcus may be found is the**
a. colon.
b. lungs.
c. skin.
d. liver.

14. **The gaseous toxin of *streptococcus pyogenes* is released**
a. when cell death occurs due to invasion by bacteriophages.
b. from the bacterial cell wall.
c. when antitoxins invade causing cellular lysis.
d. when the cell binds to the plasma membrane of an organ.

15. **Which of the following antibiotics is ineffective against *Peptostreptococcus?***
a. metronidazole
b. chloramphenicol
c. penicillin G
d. ampicillin

16. **Routine X-rays are not considered a reliable method for diagnosing NF because the**
a. contrast medias are ineffective in aiding in the diagnosis of NF.
b. detection of gas can be due to many other factors.
c. radiographs cannot adequately show the fascial planes.
d. infection is superficial and will not appear on the radiographs.

17. **Mechanical debridement is not often used due to**
a. the removal of healthy tissue.
b. inadequate removal of dead tissue.
c. contributing to the spread of the bacteria to healthy tissue.
d. time inefficiency allowing spread of the bacteria.

18. **_____of adult reported cases of NF report toxic shock and multi-organ failure.**
a. 12%
b. 25%
c. 37%
d. 50%

19. **Which of the following bacteria is increasingly causing NF?**
a. *Helicobacter pylori*
b. *Staphylococcus aureus*
c. *Escherichia coli*
d. *Pseudomonas aeruginosa*

20. **The number of reported cases of GAS disease in the U.S. is _____the number of strep throat cases.**
a. equal to
b. more than
c. less than
d. variable as compared to

295 JULY 2008 2 CE CREDITS

Necrotizing faciitis

	a	b	c	d		a	b	c	d
11	❑	❑	❑	❑	16	❑	❑	❑	❑
12	❑	❑	❑	❑	17	❑	❑	❑	❑
13	❑	❑	❑	❑	18	❑	❑	❑	❑
14	❑	❑	❑	❑	19	❑	❑	❑	❑
15	❑	❑	❑	❑	20	❑	❑	❑	❑

Mark one box next to each number. Only one correct or best answer can be selected for each question.

CE Exam

298 OCTOBER 2008 3 CE CREDITS

Disasters

Earn CE credits at home

You will be awarded continuing education (CE) credit(s) for recertification after reading the designated article and completing the exam with a score of 70% or better.

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Note this exam awards three continuing education credits.

Members: $18, nonmembers: $30

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 patients 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 seriously-injured casualties
   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

298 OCTOBER 2008 3 CE CREDITS PART 1 OF 3

Disasters

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	a	b	c	d		a	b	c	d
1	❑	❑	❑	❑	6	❑	❑	❑	❑
2	❑	❑	❑	❑	7	❑	❑	❑	❑
3	❑	❑	❑	❑	8	❑	❑	❑	❑
4	❑	❑	❑	❑	9	❑	❑	❑	❑
5	❑	❑	❑	❑	10	❑	❑	❑	❑

Mark one box next to each number. Only one correct or best answer can be selected for each question.

11. **What is a hospital's first response to a disaster scenario?**
a. Surge in place
b. Cancel all elective surgeries
c. Divert all incoming non-disaster patients
d. Place the hospital under secure lockdown

12. **Surging in 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 fatalities

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. **After the critically injured are treated, the _____ tagged patients are seen.**
a. Yellow
b. Green
c. White
d. Orange

Disasters

	a	b	c	d		a	b	c	d
11	❑	❑	❑	❑	16	❑	❑	❑	❑
12	❑	❑	❑	❑	17	❑	❑	❑	❑
13	❑	❑	❑	❑	18	❑	❑	❑	❑
14	❑	❑	❑	❑	19	❑	❑	❑	❑
15	❑	❑	❑	❑	20	❑	❑	❑	❑

Mark one box next to each number. Only one correct or best answer can be selected for each question.

21. _____provides a common organizational structure and language to simplify communication.
a. START method
b. Incident Command System
c. Emergency Medical Response
d. Decompressing

22. Small aircraft evacuation can be characterized by:
a. Simple and generally available
b. More efficient
c. High cost and complexity
d. Removal of critical resources

23. More patients' lives can be saved through:
a. Temporizing damage-control surgery
b. Definitive surgery
c. Long-lasting surgical intervention
d. Use of sophisticated technology

24. ICS is built around:
a. Command/Operations
b. Planning/Logistics
c. Administration/Financial
d. All of the above

25. _____is when hospitals incorporate the ICS into their emergency preparedness plans:
a. Triage
b. HEICS
c. Definitive medical care
d. SARS

26. Definitive medical care is provided in:
a. An existing hospital
b. Mobile facility
c. A and B
d. None of the above

27. _____determines the organizational hierarchy of the ICS:
a. Job titles
b. Seniority
c. Academic degree
d. Functional requirements

28. _____infected 20-40 percent of the world's population.
a. SARS
b. Saran
c. Spanish Flu
d. Bubonic Plague

29. The Spanish Flu caused death by:
a. Bacterial pneumonia
b. Massive hemorrhages
c. Edema in the lungs
d. All of the above

30. A pandemic outbreak can result in:
a. Economic downturn
b. Mass quarantine
c. Overwhelmed medical community
d. All of the above

Disasters

	a	b	c	d		a	b	c	d
21	❑	❑	❑	❑	26	❑	❑	❑	❑
22	❑	❑	❑	❑	27	❑	❑	❑	❑
23	❑	❑	❑	❑	28	❑	❑	❑	❑
24	❑	❑	❑	❑	29	❑	❑	❑	❑
25	❑	❑	❑	❑	30	❑	❑	❑	❑

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CE Exam

300 DECEMBER 2008 2 CE CREDITS

Gangrene

Earn CE credits at home

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Note this exam awards two continuing education credits.

Members: $12, nonmembers: $20

1. Which is not 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. Which of the following contribute to dry gangrene?
a. Arteriosclerosis
b. High cholesterol
c. Smoking
d. All of the above

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

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300 DECEMBER 2008 2 CE CREDITS PART 1 OF 2

Gangrene

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3	❑	❑	❑	❑	8	❑	❑	❑	❑
4	❑	❑	❑	❑	9	❑	❑	❑	❑
5	❑	❑	❑	❑	10	❑	❑	❑	❑

Mark one box next to each number. Only one correct or best answer can be selected for each question.

11. Gas gangrene should _____ be treated as a medical emergency.
a. Always
b. Sometimes
c. Never
d. Depends on the patient

12. A hernia, or a twist in the gastro-intestinal tract can result in _____ gangrene.
a. Wet
b. Gas
c. Dry
d. Internal

13. X-ray technology can be helpful in diagnosing _____ gangrene.
a. Wet
b. Gas
c. Dry
d. Internal

14. Sweating, difficulty breathing and convulsions can be signs of _____.
a. Bacterial infection
b. Oxygen toxicity
c. Fournier's gangrene
d. Bacteriostasis

15. The primary function(s) of MDT is/are:
a. Clean the wound
b. Disinfect the wound
c. Speed the rate of healing
d. All of the above

16. _____ larvae are the preferred species for MDT.
a. Horse fly
b. Greenbottle fly
c. Fruit fly
d. All are used

17. Medical maggots are generally left in the wound for _____ days.
a. 1-2
b. 2-3
c. 3-4
d. They crawl out on their own

18. The risks associated with MDT include:
a. There are no inherent risks
b. Larvae attacking living tissues
c. Larvae burrowing into the wound and breeding
d. b and c

19. It has been reported, though unproven in clinical studies, that maggots can:
a. Improve blood clotting ability
b. Stimulate the production of granulation tissue
c. Remove bacteria from the blood
d. All of the above

20. Medical grade maggots are:
a. Sterile
b. Safe
c. A legitimate treatment option
d. All of the above

Gangrene

	a	b	c	d		a	b	c	d
11	❑	❑	❑	❑	16	❑	❑	❑	❑
12	❑	❑	❑	❑	17	❑	❑	❑	❑
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15	❑	❑	❑	❑	20	❑	❑	❑	❑

Mark one box next to each number. Only one correct or best answer can be selected for each question.

Answers CE CREDIT PKG 6: 12 CONTINUING EDUCATION CREDITS

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CE CREDIT PKG 6: 12 CONTINUING EDUCATION CREDITS
The fee is $19. This package is only available to AST members.

☐ *Check Enclosed* *Yes, I want to pay by credit card:* ☐ Visa ☐ MasterCard ☐ AmEx

Card # _____ Expiration Date _____ Signature _____

Ethics in the O.R., Part 1

	a	b	c	d		a	b	c	d		a	b	c	d		a	b	c	d
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2.	☐	☐	☐	☐	5.	☐	☐	☐	☐	8.	☐	☐	☐	☐					
3.	☐	☐	☐	☐	6.	☐	☐	☐	☐	9.	☐	☐	☐	☐					

Mark one box next to each number. Only one correct or best answer can be selected for each question.

Ethics in the O.R., Part 2

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1.	☐	☐	☐	☐	4.	☐	☐	☐	☐	7.	☐	☐	☐	☐	10.	☐	☐	☐	☐
2.	☐	☐	☐	☐	5.	☐	☐	☐	☐	8.	☐	☐	☐	☐					
3.	☐	☐	☐	☐	6.	☐	☐	☐	☐	9.	☐	☐	☐	☐					

Mark one box next to each number. Only one correct or best answer can be selected for each question.

Safety Concepts in the Surgical Setting

	a	b	c	d		a	b	c	d		a	b	c	d		a	b	c	d
1.	☐	☐	☐	☐	4.	☐	☐	☐	☐	7.	☐	☐	☐	☐	10.	☐	☐	☐	☐
2.	☐	☐	☐	☐	5.	☐	☐	☐	☐	8.	☐	☐	☐	☐					
3.	☐	☐	☐	☐	6.	☐	☐	☐	☐	9.	☐	☐	☐	☐					

Mark one box next to each number. Only one correct or best answer can be selected for each question.

Necrotizing Faciitis

	a	b	c	d		a	b	c	d		a	b	c	d		a	b	c	d
1.	☐	☐	☐	☐	7.	☐	☐	☐	☐	13.	☐	☐	☐	☐	19.	☐	☐	☐	☐
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3.	☐	☐	☐	☐	9.	☐	☐	☐	☐	15.	☐	☐	☐	☐					
4.	☐	☐	☐	☐	10.	☐	☐	☐	☐	16.	☐	☐	☐	☐					
5.	☐	☐	☐	☐	11.	☐	☐	☐	☐	17.	☐	☐	☐	☐					
6.	☐	☐	☐	☐	12.	☐	☐	☐	☐	18.	☐	☐	☐	☐					

Mark one box next to each number. Only one correct or best answer can be selected for each question.

Disasters Follow No rules

	a	b	c	d		a	b	c	d		a	b	c	d		a	b	c	d
1.	☐	☐	☐	☐	9.	☐	☐	☐	☐	17.	☐	☐	☐	☐	25.	☐	☐	☐	☐
2.	☐	☐	☐	☐	10.	☐	☐	☐	☐	18.	☐	☐	☐	☐	26.	☐	☐	☐	☐
3.	☐	☐	☐	☐	11.	☐	☐	☐	☐	19.	☐	☐	☐	☐	27.	☐	☐	☐	☐
4.	☐	☐	☐	☐	12.	☐	☐	☐	☐	20.	☐	☐	☐	☐	28.	☐	☐	☐	☐
5.	☐	☐	☐	☐	13.	☐	☐	☐	☐	21.	☐	☐	☐	☐	29.	☐	☐	☐	☐
6.	☐	☐	☐	☐	14.	☐	☐	☐	☐	22.	☐	☐	☐	☐	30.	☐	☐	☐	☐
7.	☐	☐	☐	☐	15.	☐	☐	☐	☐	23.	☐	☐	☐	☐					
8.	☐	☐	☐	☐	16.	☐	☐	☐	☐	24.	☐	☐	☐	☐					

Mark one box next to each number. Only one correct or best answer can be selected for each question.

Gangrene: Recognizing and Treating Cellular Necrosis

	a	b	c	d		a	b	c	d		a	b	c	d		a	b	c	d
1.	☐	☐	☐	☐	7.	☐	☐	☐	☐	13.	☐	☐	☐	☐	19.	☐	☐	☐	☐
2.	☐	☐	☐	☐	8.	☐	☐	☐	☐	14.	☐	☐	☐	☐	20.	☐	☐	☐	☐
3.	☐	☐	☐	☐	9.	☐	☐	☐	☐	15.	☐	☐	☐	☐					
4.	☐	☐	☐	☐	10.	☐	☐	☐	☐	16.	☐	☐	☐	☐					
5.	☐	☐	☐	☐	11.	☐	☐	☐	☐	17.	☐	☐	☐	☐					
6.	☐	☐	☐	☐	12.	☐	☐	☐	☐	18.	☐	☐	☐	☐					

Mark one box next to each number. Only one correct or best answer can be selected for each question.

Directions: Complete all 6 answer keys for the exams. Include your check or money order made payable to AST or complete credit card information with the appropriate amount and mail to Members Services, AST, 6 W Dry Creek Circle, Ste 200, Littleton, CO 80120-8031. If paying by credit card, you can fax in the answer keys and credit card payment to AST at 303-694-9169.