CHAPTER 1

HISTORY OF EMBALMING AND RESTORATIVE ARTS

(3 CE Hours)

Learning objectives

- Discuss some of the reasons different cultures have embalmed their dead.
- Describe the process and materials used to embalm the dead in ancient Egypt.
- Discuss the historical changes affecting the embalming policy from the Dark Ages through the Renaissance.
- Explain how the Civil War changed the history of embalming.
- List three noted early American embalmers and their contributions to the field.
- Name three inventions that significantly changed embalming techniques in the 1800s and 1900s.
- Name the first well-known "demisurgeon" whose restorative techniques were a sensation in the early 1900s.
- Discuss the findings from the recent National Cancer Society research, published in November 2009, and how this may affect the use of formaldehyde in embalming.
- Explain the risks of arsenic in old cemeteries and embalmed bodies and how to protect yourself from exposure to arsenic.

Introduction

This chapter is presented in two parts. The first part of the chapter discusses the history of embalming, introducing significant practitioners and authors, the invention of innovative devices and techniques, and the subdiscipline of restorative techniques. The second part of the chapter discusses possible risks of embalming, including those associated with formaldehyde exposure highlighted in recent research findings, and the hidden danger of arsenic in historic cemeteries.

PART I: Embalming – a long history

Men and women have practiced human preservative methods and restoration art since early times, to restore and maintain bodies free from decomposition and return the body to its natural lifelike appearance. The reasons for the practice are varied and distinct to each culture. The ancient Egyptians practiced their embalming and mummification techniques to meet religious goals involving the afterlife. In more recent times, the practice was a matter of necessity; the early study of anatomy and the technique of dissection, for example, necessitated some method or material that would allow the corpse to be studied for longer periods in warm as well as cold weather. Not least significant, embalming and restorative methods became critical for transportation or viewing associated with funeral and memorial celebrations, to display the body as is the tradition in many cultures and faiths, and provide a sense of peace and closure to family members and friends.

This section highlights some of the significant individuals, inventions and techniques in the history of embalming, from ancient through modern times, describing the incredible range of materials and methods used to make tools and embalming fluids. It also reviews a history of modern restorative art, which emerged as an important subdiscipline in the early 1900s.

Embalming defined

Embalming refers to the preservation of the dead human body by specific actions conducted by human beings. It is "man-made," in that it requires specific types of intervention and treatment of the body that necessitates human action. In some parts of the world, elements of the climate, such as extreme cold or dry heat, act as a natural preservative, creating corpses that do not decompose and maintain their form for great lengths of time. These natural processes do not require human intervention and are not considered embalming.

Humans around the world and throughout history have developed scores of fascinating methods and materials for preserving dead bodies. Ancient Sicilians had a method that used heat; ancient Egyptians used evisceration and immersion in their special solution; arsenic and mercury were popular for a while, and, more currently in this country, arterial injection and cavity treatment became the norm.

Historical periods

Embalming history is composed of a number of distinct periods. Our earliest knowledge of embalming is that which occurred in Egypt over 5,000 years ago. It continued, with variation in practices and materials over time and location, for almost 4,000 years, ending in about 650 ACE. Egyptian embalming was a religious practice, as preservation of the body was a necessary precursor to resurrection in the afterlife. As Christianity became more dominant in the area, the practice was suppressed as a pagan ritual, and Arab conquerors also rejected the practice of embalming. Still, Egyptian methods recorded by historians of the day would emerge many years later, influencing embalming in other parts of the world.

The second main epoch of embalming history is the period of the Renaissance in Europe, a period in which embalming techniques were primarily used to preserve the dead for purposes of dissection and study.

The third distinct period is modern history, from 1861, the start of the Civil War, to the present day. During the Civil War, embalming became more common (at least among Northern officers), initially required by public transportation services before they would take a corpse to its final resting place from the battlefield location. It became an invaluable means for maintaining corpses of prominent military officials, whose bodies might travel to a number of locations for memorial services. Additionally, embalming allowed viewing of the body without showing all the ravages of war. In this third, and current period, embalming is available to nearly everyone who requests it, where once it was only available to nobility or the wealthy.

Ancient Egypt

Well over 5,000 years ago, Egyptians did not embalm their dead. Instead, they prepared the dead by folding the arms and legs of the body and placing the body in the fetal position, wrapped in a simple cloth or fiber mat, and buried on its side in a shallow grave in the desert. The location was specific: west of the Nile River, in some cases with pottery or other items. Because the body was surrounded by hot, porous sand in an area with virtually no precipitation, the climate acted as a preservative, extracting all moisture from the body.

By about 5,000 years ago, Egypt had become a bustling hub with a growing population and increasing wealth. Those with titles and wealth wanted more than a simple burial. Because one's body and certain organs in it (but not all), as well as specific possessions, would be required in the afterlife, it was problematic to just leave a body in the sand to dry, as it could easily be uncovered by winds and exposed or be robbed of the items buried with it. To ensure that they entered the afterlife with their body and possessions intact, the wealthier Egyptians requested deeper graves that could be sealed or lined with materials that would keep sand away from the body and grave robbers away from personal items, such as buried jewelry and even furniture that the upper class might want buried in their container.

Even with sealed containers, grave robbers of the day, knowing that valuable jewelry and personal objects were being buried with a body, would find ways to open the containers and steal the items, usually leaving the body in a position where it was no longer protected and no longer preserved. Once discovered, bodies might be decayed or even reduced to a skeleton, which was shocking to family members. Unaware of the process of decomposition, the Egyptians initially thought that burying loved ones in tightly built stone coffins would preserve them. When they found that the soft tissues would disappear even in a stone casket, they coined the term "sarcophagi," which refers to a type of bronze or copper casket, but literally means "flesh eater." In order to keep the body from decay in the warm Egyptian climate, they had to construct a method to preserve body tissues over time.

While we do not know exactly how it began, it is likely that methods common at the time for preserving meat, fowl or fish probably suggested a clue for early techniques. One might bleed a fish, for example, then preserve it by salting, smoking, sun drying or otherwise heating it to prevent decomposition and store it for a later time. By the time of the very earliest documentation of the process of embalming (in about 500 BCE), it had become a sophisticated technique that had been evolved over hundreds of years. Embalming methods varied by era as well as by individual embalmers. Additionally, a number of different services were usually available to the customer, ranging in price according to materials and time involved. In most historical accounts, there are three options provided family members of the deceased, distinctly defined as low to high quality.

To demonstrate each tier of service, the embalmers would show three wooden models of corpses that were distinct from one another by the way the body was incised (or if it was not incised), the number of steps involved, and the materials used. The most expensive (over $1,000, by current monetary standards) required incision and removal of internal organs, as well as the insertion of aromatic powders and perfumes, such as myrrh, frankincense and cinnamon, before the incision was sewn up. A less expensive method (less than $100) utilized an injection of cedar oil into the gut or anus, while the cheapest included little more than washing and salting the body for a lengthy period. In most cases, the desirable processing time was a period of 70 days.

Our knowledge of the process comes primarily from descriptions written about 500 BCE by the famous Greek historian, Herodotus. Nearly 500 years later, in 45 BCE, Siculus, another historian, would write about the process – still the three tiers of service, but materials and processes had changed slightly. Here are some of the characteristics that were common to both accounts.

Egyptian embalming procedure

The first step for the ancient Egyptian embalmer was the removal of the brain, typically with the use of a metal hook or spoon, inserted through the nostrils into the brain, or less commonly, through the eye socket. Some mummies did not have the brain removed.

Incision and evisceration was not always used, but became more common in later periods. The earliest incisions were made in the left side, from the ribs to the crest of the ilium, measured about 5 inches, and were usually made with a black flint knife blade. The angle of the incision shifted over time, then turned oblique, with the cut extending from the crest of the ilium toward the pubic bone. Very late in the tradition, bodies might be incised at the anus. In cases of evisceration, all the viscera except the kidneys and heart were removed and cleansed, then immersed in a container of palm wine and packed in natron.

Natron is a salt found in dry lake beds of the desert in that area that is composed of sodium carbonate decahydrate (a kind of soda ash) and baking soda, along with small quantities of household salt. Like other salts, it is highly corrosive. Egyptian embalmers found it necessary to tie fingers and toenails to each digit using a little metal wire or thimble, or the nail would disappear in this step of the process. The body was immersed in a high concentration of natron for 20 days. After that, it was rinsed with water and dried in the sun.

The next steps were spicing and wrapping the body. The body surface and cavity would be coated with resin (tree sap), or resin mixed with fat, and the skull was packed with bandages made of linen and soaked in resin, rolled up and placed in the cranium. Sometimes the skull was filled with resin that was heated and poured into the skull using a funnel.

The viscera removed from the body might be returned to the body or placed in four special jars, perhaps one to two feet in height and 4 inches across, and made of a variety of materials, from clay to alabaster. The top of each container depicted a face of one of the four children of Horus, the Egyptian god of the sky, who had the body of a man and the head of a falcon. Each child resembled a different species, having the face of a human, jackal, hawk or ape, with each container dedicated to a specific body part: the jar with the human face contained the liver; the face of a jackal held the stomach, an ape held the lungs and the hawk, the intestines. The jars were typically housed in a wooden box near the body, while miniature copies of each of the four containers were placed within the body cavity. The cavity was then packed with straw, resin-soaked linen or moss.

If the actual organs were returned to the body cavity, they would be wrapped in material that also depicted the appropriate child of Horus. In the earliest days of embalming, the incision was not sewn closed, but the edges were pulled together, or attached to one another with wax or resin. Embalmers began to sew the incision closed as early as 1700 BCE. Looking at the stitches today, one is struck by how much they look like the familiar embalming stitches used in modern times. Finally, the incision would be covered by a plate made of metal or wax depicting the eye of the Egyptian god of the dead.

In the most expensive method, treatment would approximate this schedule:

- Day 1 through16: Evisceration and washing of the body.
- Day 16 through 36: Immersion in natron.
- Day 36 through 68: Spicing and wrapping with bandages.
- Day 68 through 78: Body placed in a coffin.

Wrapping started rather simply and became a very complicated affair, with individuals specializing in the wrapping of toes, for example or another body part. Each finger and toe was wrapped individually, followed by wrapping of each of the limbs. The face would be covered with a bandage and the body with a simple cloth garment, then spiral bandaging would begin. The body would be padded in places or bandaged with extra material to maintain the body's natural shape. Other items might also be bound between the bandages, including the name of the deceased or lotus flower petals.

The amount of bandages required was great, and people may have saved pieces of linen their whole lives to have sufficient wrapping for their mummification. Bandages might be over 3,000 feet in length and were imprinted with hieroglyphics identifying the person.

Ancient Egyptians did get what they paid for, in some cases, as the more expensive methods of embalming preserved the body better, but only about 10 percent of mummies were preserved this way. The majority of people were embalmed using cheaper methods, where the body was coated with natron or heated resin, for example, which preserved the body but tended to destroy facial features, fingers, toes and hair. Some of the success of Egyptian preservative methods could likely also be attributed to a hot, dry climate that discouraged bacterial growth.

Originally, Egyptian embalming was simply about preservation; keeping the body from decaying. Only if a body was properly embalmed and mummified would the individual be able to be part of the afterlife.

Given the prominence of death rituals and the fact that the quality of the embalming directly affected one's chance in the afterlife, embalmers were treated with great honor and respect, often accompanying priests at the temple in the role of holy men. In fact, during embalming, the head embalmer would wear a costume depicting Anubis, the half-human, half-jackal god of funerary and embalming, who protects the dead for their journey to the afterlife.

In the last 1,000 years these methods were practiced, the external appearance of the wrapped body became increasingly important. Wrapping patterns became more and more elaborate, with plaster added to create a surface that could be easily decorated to depict the individuals' life. A lifelike portrait of the individual was painted and placed over the mummy's head, with great care taken to make the face as close to the way it was in life.

Wrapped mummies were placed in a "cartonnage," a kind of envelope of about 25 sheets of linen or papyrus soaked in resin, plaster of Paris or gum acacia and placed over the body when still wet. This material would be pulled together and cinched in the back create a tight fit that dried to create a hard surface that would be covered with a thin layer of plaster that was painted with a human head or other images. The body within the cartonnage would also be surrounded by a number of wooden boxes made of cedar or sycamore. The position of the body in the coffin also changed with time. Initially, bodies were place in the coffin on their sides, with a pair of eyes painted on the outside of the coffin to signify the position of the body inside. The final external container for the mummy varied according to the fashion of the day. Early on, the outermost wooden case might be shaped like a house with a roof for a cover in one era. Later, it was more likely to be shaped like a human form (called mummiform).

Ancient Egyptian restorative art

The ancient Egyptians were already practicing a range of restorative techniques as early as 1200 BCE. To "round out" emaciated facial features, such as hollowed cheeks, the inside of the mouth might be packed with sawdust. Eyelids were stuffed using linen or eyes might be replaced with stone. Material was also packed into the body through incisions into areas like the back, which could not otherwise be easily reached. Later, the temples and cheeks would be filled with warm resin administered through a funnel into the ears, where it could be molded into the right position. Common padding materials included long pieces of linen, sand or mud, sawdust, and fat. Both the face and the body were contoured to approximate the individual's original features and shape.

If the individual had a broken leg or other obvious disability or injury, it would also be tended to. Bed sores were packed with resin-soaked linen and covered with animal hide. Broken legs would be supported with a splint. A crooked spine might be straightened.

Important or wealthy people's bodies might be painted with a thin layer of gold (gilded). The gold might cover the whole body, or, more commonly, portions of the body, such as the face, fingers, toenails and genitals. After this, the body would be covered with a sticky paste of fat mixed with resin, and bandaging would begin.

Other ancient embalming traditions

While many ancient civilizations embalmed their dead, only a small number are mentioned here to touch upon the great diversity of methods and materials used.

Populations of the Tigris-Euphrates River Valley, including the Persians, Syrians and Babylonians, submerged recently deceased individuals of importance in a container of honey or wax to preserve the body, especially for a long journey. Alexander the Great was likely treated this way to preserve his body after his death in battle in 323 BCE.

The ancient Ethiopians eviscerated and dried their dead much like the Egyptians. They also practiced restorative art, applying layers of plaster to the skin to round out the body in natural contours. Then, the plaster was painted and covered with a thin clear coating. Its composition remains something of a mystery, but may be a type of liquefied amber.

Perhaps as early as 900 BCE, the Guanche lived in the Canary Islands, a small cluster of islands in the Atlantic Ocean. Fabled to be the descendents of Atlantis, the lost continent, the Guanche embalmed only the most important members of their society, using a flint knife to cut the lower abdomen and take out the intestines, which were cleansed and returned to the body along with salt and herbs, which also covered the cavity. The body would be covered with fat, resin powder and pumice, and dried in the sun or placed by a heat source, with arms positioned according to the body's gender; men's arms down at the sides, and women's across the stomach. Guanche embalmers were also gender-specific – only male practitioners could attend to men's corpses, and female practitioners to women's corpses.

In some cases, the body was dried in the same manner described above, but, additionally, a corrosive substance, likely the juice of a local plant, was inserted into the wall of the abdomen or poured down the throat, producing a special type of mummy called "xaxos," the knowledge of which may have originally come from Egypt. These mummies were distinct from others as the flesh of their bodies appeared perfectly preserved – wrinkled and a deep tan color, but forming a hard, dry, unmovable surface. Xaxos bodies show no sign of decay, very minimal shrinkage in body size, and are incredibly light. A body measuring about 5½ feet in length might weigh only 7 or 8 pounds. Guanche embalmers were responsible for watching the body and protecting it from vultures during the drying period of a little over two weeks. After the drying was complete, the family would take the body with them and sew it a cover made from animal skin. Nobility were placed in hollowed out juniper logs, which served as coffins, and which were housed in special caves. Unlike Egypt, where embalmers had enjoyed high status, Guanche embalmers were paid well but suffered the taint of personal pollution by the nature of their work. Their touch was considered contaminating, and they lived far from the rest of the community.

Some indigenous North American populations (Native Americans) who preserved the corpses of their leaders after death used a singular process in which the skin was removed all in one piece. The procedure began with an incision in the back, followed by removal of the flesh from the bones, leaving the skeleton intact, with the sinews still connected to the bones. All the flesh was removed from the bones, and dried thoroughly in the sun. The bones and skin were also dried in the sun, but the skin was painted with fat first to reduce shrinkage. After drying in the sun, the skin was placed on a mat and housed in a special building on a high shelf where it remained clean and undisturbed until the funeral. At that time, the bones were replaced in the skin and a powdery white sand was used to fill in the natural contours of the body. Once the skin was sewn up, the body was said to look much as it did in life, according to witnesses. The flesh that had been taken off the body and dried was sewn into a basket and placed at the feet of the corpse.

More than 100 years ago, the people of the Aleutian Islands and Kodiak Archipelago preserved their dead by removing the internal organs though an incision in the pelvic area, with the resulting cavity filled with dry grass. The body was placed in a cold stream where the icy water stripped the body of fatty tissues. The corpse would be manipulated into the fetal position, with the knees immediately under the chin, and the arms wrapped about the legs. In some cases, bones had to be broken to achieve this posture. Once formed into this shape, the body was dried in the sun and wrapped in animal skins.

Embalming during the Renaissance

During the Dark Ages (also called the Middle Ages), a historical period lasting from about the 5th to the 15th Century ACE, the law had typically prohibited medical schools from acquiring corpses for anatomical study and dissection. What was little known at the time is that cases of embalming, while few in number, did occur. Most of the people preserved were royalty or held another elite status, such as members of the clergy. The information was kept secret, not known by the typical European nor publicized in any way. The methods used were very similar to the ancient Egyptian methods (and were likely taken from ancient descriptions in historical documents), except that the process was speeded up considerably. It was generally done to preserve the body for burial purposes, and was typically performed where the death occurred. A pope, bishop, countess, and princess were among the elite group of individuals embalmed during the Dark Ages, but this was not generally known until the 1500s.

Within this period, from 1095 to 1291 ACE, the Christian nations of Europe launched a bloody campaign, known as the Crusades, in an attempt to capture the Holy Land, initiating a series of military campaigns against Moslems and many other religious and cultural groups. It was a time when many, many members of nobility and military leaders died in battle, far from their homes. As preservative methods were unknown to the vast majority of people, bodies of importance would be disemboweled, and the flesh cut off. Bones were boiled until soft tissues came off the bones, and the bones would be dried and wrapped in animal hide, to be returned to their home nation by couriers.

The Renaissance, the historical period that emerged from the Dark Ages, marked a period of increasing freedom in the study of anatomy and medicine, historically indicated when Frederick II, a Sicilian king in the early 1300s, granted authority for dissections to be carried out and even delivered a number of executed criminals to a medical school in Bologna, Italy, for the procedure. In those days, dissection had to be a speedy process, typically performed outdoors in the cold in front of a large group of anatomy students or other spectators. The supply of bodies for study, however, never matched demand, and medical students, along with many other culprits, were known to steal bodies from cemeteries or the gallows and work with them for the short time before they were too decayed to be useful.

In 1300, Pope Boniface VIII issued an order that prohibited corpses being cut into pieces for transport or burial, warning that those who broke the rule would be excommunicated. Now, those killed in battle needed to find a new way home, at the same time that anatomy students needed a preservative that would allow a more careful and lengthy examination of a body without the worry of decomposition.

It was clear that some form of drying the body would be necessary, and there had already been some experimentation exposing cadavers to the heat of the sun and ovens. It was also discovered that warm air pushed through the blood vessels would clean them out and dry the tissue surrounding them. Additionally, practitioners had been experimenting with the injection of different substances into the body, which was facilitated by the invention of better injection tools. Anatomy students learned to inject substances into body cavities to make blood vessels more visible for study, and in the early 1300s, in Italy, a colored solution that hardened in the body was developed. Others experimented with injecting warm water, ink, mercury and wax.

The first instruments used for injection included a bladder, which held the solution, attached to a cannula made from a straw, the quill of a feather,

and later, a glass tube. The tubelike section would be inserted in a body opening, and the liquid would be pressed out of the bladder and into the body. Tools approximating a modern hypodermic syringe were manufactured as early as the 1500s. By the end of the century, the first continuous-flow syringe was developed.

Early European embalmers and embalming methods

Ambroise Pare, who lived in the 1500s and was the Royal Military surgeon for two French kings, was best known for devising a method of embalming that become the most commonly used of the era. Like most surgeons of the day, he was responsible for embalming the bodies of military men killed in battle or by natural causes, but he was also well known for developing a technique for controlling bleeding after amputations and his ability to design far better artificial limbs than had previously existed.

The embalmer treating soldiers killed in battle would first remove the heart, which would be embalmed separately, then presented to the relatives, as was the custom of the day. The skull was cut with a saw and the brain removed, and deep incisions were made along the limbs and back and buttocks, where the larger veins and arteries are located, to empty the blood, which was further pressed out. The body was washed with a sponge soaked in aqua vita and vinegar boiled with wormwood, salt and other ingredients. All the incised areas would be filled with an aromatic, powdery mixture of spices and herbs including chamomile, balsam, menthol, lavender, marjoram, thyme, absinthe, myrrh and sandalwood. The incisions would be sewn closed, and the entire body would be covered with turpentine and rose and chamomile oil, then layered again with the aromatic powder. The body would be wrapped in linen, and placed in a lead coffin, filled with dry sweet herbs. If the herbs were not available, a powder of lime and ashes of oak wood could also be used. It was said this procedure would preserve a body for as long as was necessary.

In the 1600s, two Dutch practitioners developed the method of arterial injection to introduce a preservative substance into the vascular system. **Jan Swammerdam** was trained in medicine but dedicated his career to the examination of insects and small animals. He experimented widely with different substances, finally finding that a mixture of alcohols, turpentine and wax created an effective preservative.

Swammerdam's technique was applied to humans by **Frederick Ruysch,** who used it to preserve entire bodies or parts of bodies, typically for use as teaching aids, but also, in some cases, to restore high status individual's bodies for funeral purposes. His skills were required, for example, when a famous British admiral was killed at sea near Holland and not recovered from the water immediately. There was much concern that his badly decomposed body could not be preserved for travel or restored to a presentable appearance for the viewing at the funeral, but Ruysch was said to have done a masterful job restoring the body to a natural appearance and color. His refinement of Swammerdam's techniques remains something of a mystery, and it is suspected that he may have used some amount of arsenic in his formula.

Stephen Blanchard, also Dutch, published a book about dissection, extolling on this new method of preservation called "embalming" in a 1688 text that mentions the use of spirits of wine and turpentine as preservatives, with diagrams of the necessary instruments for introducing the liquid into the body. His first step in one of the descriptions requires that the intestinal tract be flushed with water forced into the mouth and out through the anus, followed by spirits of wine, which are blocked from flowing out the rectum and maintained in the body. Large veins and arteries were also opened and blood was flushed out with water, then also injected with spirits of wine. This the first written account of a technique that includes the injection of the blood vessels for embalming purposes.

Secret formulas for embalming fluids were not uncommon. A successful Flemish embalmer named **Ludwig De Bils** was particularly secretive and concerned about his competitors stealing his formula. Unbeknownst to him, one of these competitors, a German physician named **Gabriel Clauderus**, visited De Bils' anatomical museum and touched one of the preserved bodies with a moistened finger. Later, he tasted it, and found it had a salty flavor, suggesting a large portion of the formula might be salt. De Bils never did disclose his methods, and Clauderus went on to publish a method of embalming that did not require evisceration but used a mixture of "ashes of tartar" and "sal ammoniac" dissolved in water, a potion he called "balsamic spirit." He would inject the fluid into all the body cavities and immerse the cadaver for a period of up to two months, then finish treatment by drying the body in the sun or other heating source.

The British Isles

The British Isles developed different techniques than those most popular in the Netherlands. The Company of Barber-Surgeons, the medical association of the day, was given the sole authority to embalm and perform anatomical dissection in England, but others also engaged in the practice.

William Hunter was born in Scotland but found success as an obstetrician in London, where he was appointed physician-extraordinary to Queen Charlotte of England in the mid-1700s. His most critical advice for students was to begin the embalming process within eight hours of death in the summer and 24 hours in the winter. He taught the following embalming method for purposes of funeral viewing and anatomical study:

> The first step was injection of the femoral artery with a combination of "oil of turpentine," "Venice turpentine," chamomile and lavender oil, and vermilion dye, used until the skin took on a rosy appearance. The body would remain untouched for a few hours, after which the thoracic and abdominal cavities were opened, the viscera removed, and the liquid pressed out of them. The viscera itself would be injected and immersed in camphorated spirits of wine, then returned to the body along with a powder made of camphor, resin and niter. This powder would also be inserted into the eyes, ears, nose and other cavities. The skin of the entire body was rubbed with rosemary and lavender oil and the body was placed on a bed of plaster. Bodies used for anatomical study would be placed in a box for a period of about four years and checked for decomposition. If some was noted, the body was placed on a bed of gypsum.

Both Hunter's brother and nephew were also prominent embalmers. The nephew, **Matthew Baillie,** modified the methods used by his uncles to provide comparable preservation in a shorter period of treatment. He used the same solution, similarly injected into the femoral artery, then left undisturbed a few hours. At that point, however, he made a small incision in the bowel and introduced water through a small tube to wash out the contents of the bowels. He also ligated the rectum and small bowel and filled the intestinal tract with camphorated spirits of wine. The lungs were also filled by way of the trachea. The bladder was emptied and refilled with a powder of camphor, resin and niter, and it was layered on the viscera before closing the incision. The eyeballs were pierced and emptied, then packed with the powder mixture, along with the mouth and ears, then the skin rubbed down as above.

In the mid-1800s, **John Morgan**, a professor of anatomy at the University of Dublin in Ireland, formally established two principles for producing the best embalming results: injection of the solution into the largest artery possible and use of pressure to push the solution through the blood vessels. He also was among the first to make use of a pre-injection solution as well as a controlled drainage technique. Morgan's method required that the body be opened so the heart was visible, then an 8-inch pipe was inserted into the left ventricle or aorta. The pipe was connected to yards of tubing ending in a fluid container hung above the corpse. The force of gravity acting on the liquid above the body would exert about 5 pounds of pressure, adequate to the purpose of permeating the body.

By the later 1800s, a number of embalming methods were becoming more common in other parts of Europe. In Italy, the practitioner **Tranchina**, from Naples, used and promoted solutions using arsenic, which he injected into the arteries for funeral viewing and anatomical study. He typically used 1 pound of arsenic mixed with 5 pounds of an alcoholic wine, some of which would be injected into the femoral artery without any previous removal of blood. In some cases, he injected the fluid into the right common carotid artery so that the solution would permeate the head as well as the body. The lungs were filled by way of the trachea. He would also incise the abdomen to empty the bowel and moisten the area with the preservative solution. According to records, the body would be completely dried in six weeks.

Gerolamo Segato of Florence, Italy, was said to have turned a human body to stone by introducing silicate of potash into the body tissues, followed by immersion of the body in a weak acid solution. The specific details are unknown, but the story appears to have a factual base.

Jean Nicolas Gannal, who began his career as a pharmacist's assistant, became a highly revered inventor and expert in the field of chemistry. In 1831, it was requested that he find an effective way to preserve bodies for anatomical study. After much experimentation, he found a formula of 6 quarts of a solution of aluminum acetate, administered through the carotid artery, preserved the body without the need to drain blood or eviscerate. In some cases, the bodies would be immersed in this solution until they could be dissected. When used for funeral presentation purposes, the process was the same, except that Gannal would add a small amount of arsenic and carmine to the original solution, about 2 gallons of which would be injected upward, then downward, in the carotid artery. A number that were disinterred over a year later were said to be in exactly the same state as on the day of burial.

Gannal worked on a number of famous cases for the Paris police, preserving murder victims so that some information about the death or the murderer might be discovered. He was also associated, indirectly, with the passage of the first law prohibiting arsenic in preservative materials, which occurred in 1846 when his use of arsenic become a complicating factor in a high-profile murder case in which arsenic was thought to be the poisoning agent. Additionally the medical community was concerned about the potential risk of poisoning to people handling the body.

In the mid-1800s, **J.P. Sucquet** advocated the use of zinc chloride as a preservative, using about 5 quarts of a 20 percent solution in water, which he introduced into the body through the popliteal artery and the abdomen. Rights to this very successful method, proven to keep a buried body in excellent condition for at least two years, were sold to two Americans, **Charles D. Brown** and **Joseph Alexander.**

Richard Harlan, an American medical doctor who met Gannal, and was presented with his book, "History of Embalming," was so taken with it that he requested permission to publish the book in English in the United States. Embalming practices traveled relatively quickly from Europe and the United Kingdom to the United States, in part due to the publishing of Gannal's book in Philadelphia in 1840, and in another part due to the fact that Sucquet's embalming methods and materials had been purchased as a business venture by two savvy doctors from New York – Brown and Alexander. Most significantly, however, the history of embalming in the United States was changed by the onset of the Civil War, in the year 1881, which increased the demand for an effective way to preserve bodies for funeral purposes.

Early American embalmers and embalming methods

At this time, in the U.S., there was almost no embalming of the dead for funeral purposes. Preservation of the body typically meant the use of ice, which required cold weather. At the beginning of the Civil War, no plans were provided for returning the fallen to their homes. In previous battles against the Native Americans and during the Mexican-American War (1846-48), the military dead were buried where they fell in battle. In the early days of the war, family members were able to claim the deceased by themselves by going to the hospital or battlefield and bringing the body home for burial. When battles were far from the troops' homes, the process of returning the body to the family became far more difficult. In some cases, the remains would be returned to family members if they had formerly requested it and could arrange the transportation of the remains back to the troop's home state, but this was often a very difficult thing to accomplish.

At the same time, there was great concern about the dangers of contact with dead bodies and fear of contamination. People who worked with decomposing bodies in cemeteries and churches became ill, but no one understood the mechanism by which this occurred. Embalming, it was thought, would make handling corpses a much safer venture. Concerned with these issues, President Lincoln directed the troops to use embalming to allow the return of the Union dead to their homes. As it never became a policy in the South, virtually all those embalmed during the Civil War were Northerners.

Initially, the process for embalming called for arterial embalming when possible, usually injecting the femoral or carotid, without drainage or any cavity treatment. If the nature of the wounds or degree of decomposition made arterial embalming impossible, the trunk would be eviscerated (if necessary) and refilled with sawdust or powdered charcoal or lime. Then the body would be placed in a coffin entirely filled with sawdust for transport home.

Embalmers of the time utilized a variety of methods and solutions and manufactured all their own chemicals, including arsenic, zinc chloride, bichloride of mercury, aluminum salt, sugar of lead, and a variety of salts, alkalis and acids. To make zinc chloride, practitioners would immerse sheets of zinc in hydrochloric acid until the necessary solution was achieved.

Dr. Thomas Holmes, born and educated in New York, became one of the most well known names in the field through his experience in the war. As a coroner's physician in the 1850s, he had experimented with a variety of different chemicals and embalming techniques. He developed a very effective solution (which he later marketed as "Innominata"), that he used to embalm the first prominent military figure killed in the war (in 1861), a young colonel named Elmer Ellsworth. Funeral services were held in three different cities, requiring that the body travel a lengthy distance before burial in a fourth city. His appearance was discussed favorably in the press, providing a good introduction of embalming to a previously uninformed public.

This series of viewings of the body became something of a tradition, and was repeated with other war heroes, culminated with slain President Abraham Lincoln. Holmes also embalmed the next colonel who died in the war. His body also toured the country to be viewed with great publicity before the funeral. By 1864, all deceased patients at the Washington, D.C., Military Hospital, Holmes' headquarters, were routinely embalmed and the grave marked so that the body could be disinterred and sent to the family, if desired.

In all, it is estimated that Holmes prepared more than 4,000 bodies during the war.

After the war, Holmes turned to business, selling "Innominata," his embalming solution, to interested undertakers. While he found that undertakers were intrigued by the preservative qualities of his product, they did not have the surgical skills required for common embalming techniques. Holmes, followed by others in the field, found that they could sell more of their product by emphasizing its disinfection qualities, the fact that it could be used for external applications, such as washing the body and face, and could also be easily poured into the mouth and nose to permeate the lungs and stomach. Holmes also patented many embalming-related inventions, such as a canvas corpse removal bag that was coated in rubber, and an innovative injection method that improved on the hypodermic syringes currently available that needed constant refilling. In some cases, a pump that provided continuous flow would be used, but it was rare during this time.

Dr. Richard Burr became famous as the embalmer photographed by Matthew Brady in front of an embalming tent near the battlefield. Despite this claim to fame, Burr had not been happy with Brady's presence, even accusing him of accidentally setting fire to the embalming tent. Unfortunately, Burr, along with a number of other embalmers employed by the military, also gained a reputation for poor service and inflated costs, according to many complaints. In response, Gen. U.S. Grant ordered that all embalmers be excluded from military areas until he had come up with a reasonable set of rules and regulations, which became the first step toward the licensing of embalmers and undertakers.

A U.S. Army General order stated that only those with special licensing by the army would be able to remove bodies from the field or embalm. Those who wanted to work as embalmers for the military had to post a performance bond and had to furnish a list of prices for materials and labor to the appropriate military officials. Applicants for license were also required to describe the process and materials used as well as the length of time the preservative would be effective, and documentation or evidence to support their claims.

In some places, specific prices were dictated. For example, in Tennessee and Alabama, the following fees applied:

> "Embalmers must post a bond of $1000 guaranteeing skillful performance of work. Disinterment (only between the middle of October and the middle of May) for a price of $15. Furnish metal burial cases, marked and dropped off for express service for a price of $75. Zinc coffins an additional $40."

The following men are a small number of the many innovators who contributed to the evolution of embalming around this time:

- **Daniel Prunk** went to college and medical school in Ohio, practiced medicine for a number of years, then signed up for service as an assistant surgeon for the Volunteer Infantry in 1861. Licensed by the army in 1865 to practice embalming and undertaking, he set up locations in Tennessee, Georgia and Alabama. Prunk's embalming formula used zinc chloride, to which he added arsenious acid, which was injected warm with no dilution or blood drainage. Prunk wrote one of the earliest descriptions of cavity treatment that advised puncturing the stomach to allow gases to escape, especially important, he noted, when shipping a corpse a long distance. He also recommended that an individual with a large abdomen and discolored bowel have fluid introduced into the peritoneal cavity, and described an ingenious method of using a silk string like a drawstring to close the cavity once injection was complete.
- **Benjamin Lyford** was an embalmer during the Civil War who patented a complicated embalming system in 1871 that required that the body be enclosed in a sealed container that would be emptied of air by a pump. He was one of the first embalmers to recommend that cosmetics be used to normalize the facial features.
- **G.W. Scollay** patented a method of embalming just after the Civil War that involved the use of gaseous compounds injected through the vascular system, and was one of the earliest proponents for a gaseous rather than liquid preservative.

The early profession

The Civil War and assassination of President Lincoln had familiarized the general public with the concept and appearance of an embalmed body, but embalming was still comparatively rare. The profession was poorly organized, had no formal schools or training programs, with little uniformity in embalming techniques. Patents for chemical embalming fluids showed that many used mercury and arsenic.

Most companies employed traveling salesmen who also demonstrated the products they were selling. The man who sold you preservative fluids would also instruct you in the technique of arterial embalming. They might sell other items also. Here is a list of prices for embalming tools and materials from 1877:

- Rubber gloves – $2 pair.
- Anatomical syringes with three cannulas in a case – $22.
- Surgical instruments in cases – $5.
- Wax eyecaps and mouth closers – $1 each.
- Embalming fluid – $5 for 12 pint bottles (might also be available in 10-gallon kegs at $3 per gallon).

Noted embalmers and publications

Until the early 20th century (the 1900s), embalming usually occurred in the deceased's home, or perhaps at the hospital. But as early as the 1870s, two professional journals, The Sunnyside, established in 1871, and The Casket in 1876, highlighted funeral homes that had morgues with appropriate facilities for embalming, including running water and cooling rooms. These magazines, which also presented advertisements for embalming products and tools as well as articles of interest to those in the funerary business, depicted the funeral home of the future as one that would meet a range of needs, a place for preparation of the body, viewing, services and burial.

Renouard

Dr. August Renouard, a regular contributor to The Casket and eventually renown as an embalming expert, was originally a bookkeeper for a furniture store and undertaking establishment in Colorado. Renouard was responsible for the transportation of bodies back east and south for burial and soon saw the need for an effective way to preserve bodies. He requested permission of his employer to arterial embalm the bodies before shipment, and his work received instant acclaim from the undertakers around the country receiving the bodies, which, it was said, appeared to be sleeping. Renouard was not shy about marketing his chemical formulas and methods, and it was not long before undertakers around the country were happily purchasing his products.

Renouard developed a popular correspondence course and provided personal instruction in embalming, but no instructional textbook of undertaking and embalming was yet widely available in the U.S. Because of his expertise and public acclaim, the management of The Casket asked him to write a book that could be used as a practical guide. "The Undertakers Manual," published in 1878, was a detailed 230-page compendium of anatomy, chemistry and embalming information, with instructions on practice and descriptions of available instruments and equipment.

In 1880, Michigan became the first state to form an undertakers association. In 1881, it changed its name to the Funeral Directors Association, and other states followed, organizing similarly under the same name. In 1882, representatives from all the state associations met in Rochester, N.Y., and formally founded the National Funeral Directors Association, a significant step in the professional growth of the field. Renouard himself provided demonstrations of embalming at the first national convention, which set the precedent for embalming demonstrations at state and national meetings afterward.

In 1894, Dr. Renouard moved to New York City and founded the U.S. College of Embalming. The school was unusual in that each student would remain enrolled until he was able to embalm with what were considered sufficiently professional skills. Renouard's son, also an embalming instructor, worked at the training school for many years.

Renouard's special embalming fluid, it was advertised, would not harden the body, but would make it firm and preserve features in a lifelike manner, providing a natural color to the face. Further, it was noted, the solution was not affected by freezing, would not injure the hands, was a powerful antiseptic and disinfectant, and contained no arsenic, mercury, zinc or formaldehyde.

Clark and Sullivan

Joseph Henry Clark, born in Indiana in 1840, was initially employed as a casket salesman who began to sell embalming fluids as a sideline. He found sales were greatly facilitated by a demonstration of embalming methods, as it helped end-users understand how to properly utilize the materials to get the desired effects. He enrolled in an anatomy course in Cincinnati to begin learning the necessary information, working closely with a Dr. C.M. Lukens, and eventually founded the Clarke School of Embalming at Cincinnati in 1882. Initially, the school was more like a traveling show, as Clarke traveled most of the year, providing instruction around the country. In 1899, the school's name was changed to the Cincinnati College of Embalming, and Clarke became a permanent lecturer at that location. He was considered an excellent instructor and writer, and held a number of patents associated with embalming.

Felix Sullivan, born in Canada, was the son of an undertaker who came to the United States to enlist in the New York Calvary during the Civil War. Deserting service near the end of the war, Sullivan worked for a number of casket companies in New York, eventually becoming a funeral director and studying anatomy, then a skilled embalmer. Sullivan saw how successful Clarke's course had become, and enrolled in it in 1882, then proceeded to create his own course of instruction patterned after it, which also sold successfully. He became Clarke's greatest rival.

Sullivan was never in one place of employment long and was known to have a volatile temper, but became famous as an expert embalmer in a number of famous and difficult cases. A "mad bombing" in Chicago that took a number of lives required Sullivan to restore members of the police and one of the bombers, who had had a dynamite cap explode in his mouth. The other bombers were hung, and all the dead were prepared by Sullivan, who was highly praised for their natural appearance. Sullivan lectured and demonstrated embalming before large classes in

many cities, but was censored for a period after he was found in a compromising situation with a woman who was not his wife, and was charged with wife and child desertion. After treatment for alcoholism, he returned to a successful career.

Clark and Sullivan disliked each other intensely, at one point becoming enmeshed in a heated conflict regarding Ulysses S. Grant's embalming. Clarke had been contacted to handle the embalming by the undertaking company arranging the funeral, but was ill on the day of the death and bedridden for a number of weeks. Another member of the undertaking company completed the embalming instead, using Clarke's proprietary embalming chemical. After the body was embalmed, Gen. Grant's clergyman and Felix Sullivan arrived and insisted the body be re-embalmed. Sullivan claimed to pull out all the fluid previously injected and replace it with the fluid made by the company he represented. Sullivan was also called in to re-embalm President Garfield after the first procedure was considered inadequate.

The Dodge family

Two brothers, **George and A. J. Dodge**, originally in other businesses, found themselves the owners of the Egyptian Embalming Chemical Co., in repayment of a debt owed them. They took to the new venture with interest, studying anatomy and chemistry, then deciding to go to Boston to learn embalming. Both became practitioners, with A.J. becoming particularly well known as an embalmer, teacher and author of embalming texts.

In 1839, both brothers resigned from the Egyptian Chemical Co. and purchased the Oriental School for Embalming, a traveling school with headquarters in Boston. Two years later, the Oriental school was renamed the Massachusetts College of Embalming. A.J. eventually left that institution to found the New England Institute of Anatomy, Sanitary Science, and Embalming, a nonprofit educational institution.

A.J.'s previous training in chemistry made him aware of the importance of research, and he was always thinking of ways to improve existing products and techniques. In 1921, his company began publishing an industry journal called The Dodge Magazine. Dodge seminars soon became important parts of many funeral director and embalmers' educations, and introduced the idea of a full-service funeral home. A.J. Dodge's son, Walter, opened the Dodge Chemical Co. in Detroit at the same time his father was opening one in Boston. A younger son joined as a salesman, and the company expanded, branching into all parts of the U. S. as well as Canada. By 1982, it existed in Mexico, Europe, Australia, New Zealand and Japan.

Other noted embalmers

The early 1900s saw the first significant move toward creating systematic treatments for unsightly injuries or disease. Around this time, a New York embalmer named **Joel E. Crandall** developed a restorative art technique specific to head trauma that was adopted into some embalming program curricula. He will be discussed further in the section, "Restorative Art," below.

Carl Lewis Barnes was born in Pennsylvania to an undertaking family. He manufactured embalming chemicals, studied medicine and eventually opened an embalming school, but is probably best known for his invention of a number of embalming tools, including the "handless injector" system. This contraption consisted of a collapsible rubber fluid bag, hung in such a way that gravity would force fluid into the artery or vein, and pressure could be increased further by pressing the bag. He also developed the "Kant Slip Arm Plate," a tube holder and shut-off device in one, which strapped to the arm below the point of incision to hold the arterial nozzle and rubber tubing in place.

While women were much less likely to be employed outside the home in this era, embalming was not an uncommon profession for women, with a number reaching great prominence in the field. The Bernard School of Embalming in New Jersey was founded by **Mrs. E.G. Bernard**; **Linda D. Odou** founded the Odou Embalming Institute in New York City; and **Lena R. Simmons** founded the Simmons School of Embalming in Syracuse, N.Y.

Modern inventions

Since the development of arterial injection of the blood vessel in late 17th century, little else has proven more effective to prepare the body. There have, however, been experiments with a great variety of methods and materials. In one "shocking" method, electric current was applied to a corpse in attempts to mimic the effect of lighting. It was not a success as a corpse apparently does not effectively conduct an electrical current and therefore cannot produce the contraction of small muscles that might restore normal color to discolored areas or prevent further blood coagulation, as was hoped.

A machine that vibrated the body to facilitate the removal of blood was a sensation for a short time, but sometimes had the disadvantage of moving the body from one end of the table to the other, or shaking instruments so violently that they could not be useful.

Early in the days of modern embalming, with the advent of arterial injection, there was some concern about the trunk viscera. Should it be removed and preserved separately, then replaced? This typically required immersion of the organs in a preservative powder or liquid, and additional powder or liquid placed in the cavity after replacement of the organs. The alternative method was to keep the trunk intact and treat it with the same preservative solution, introduced directly into the trunk cavity as well as through immersion of the body in the solution.

In the mid-1870s, the invention of the trocar by Samuel Rodgers helped to usher in a new system for treatment of the cavities. The trocar was patented in two forms, with the latter issued specifically for a system of embalming that included the introduction of the trocar into the naval so that a preservative could be distributed to all the organs of the trunk simultaneously. Rodgers also suggested the cavity treatment be followed by injections into the limbs, also using the trocar. The trocar's ease of use made it appealing to those who felt uncomfortable performing arterial embalming, which required more anatomical knowledge and dexterity. For a brief time, there was some conflict between the "bellow punchers" who treated the cavity with the trocar, and "throat cutters" who chose to embalm arterially. Unfortunately, both systems might fail singly, but would successfully work together, so, eventually, the two systems were combined, with initial arterial injection followed by treatment of the cavity.

As more embalming was performed in the funeral home, more professional devices became widely available. The vast majority of embalming pumps or injectors in the late 1800s utilized gravity. One popular device was the gravity bowl, which utilized a container hung above the body and connected to the arterial tube with rubber tubing, with the height of the bowl determining the amount of pressure exerted. Unlike the hand pump, which required constant manual pumping, the gravity bowl could be continuously filled, and therefore did not require the constant attention of the embalmer or an assistant. By the mid-1930s, electric-powered injection machines were popular, with the fluid often gravity-fed to the pump. These machines were increasingly substantial, often made of metal and culminating in the "Porti Boy," in 1939, the most popular injection machine in history, only to be surpassed in the 1960s by extreme high-pressure injection machines, such as the Sawyer.

New embalming equipment, such as a battery-powered electric pump that injected embalming chemicals, a jaw closer, and a plastic screw-like device called a trocar button were invented in the first few decades of the 1900s. The trocar button successfully provided a waterproof seal for trocar punctures or more exotic wounds, such as bullet holes.

As embalming in funeral homes become more common, more were designed with a reliable water source that could be used to create the necessary suction for aspiration. In many cases, a trocar was connected to rubber tubing that was attached to a sink faucet. In the 1950s, these methods were abandoned in favor of electric aspirators that provided more reliable suction and pressure than water, which might lose pressure in periods of high water use.

The pros and cons of formalin

The use of highly poisonous chemicals with attractive characteristics has long been debated in the field of embalming, with many choosing to expose themselves to an unknown degree of risk. At the end of the 1890s, embalming fluid advertisements were introducing the ingredient formalin, a saturated solution of formaldehyde combined with other ingredients.

While not wholeheartedly welcomed, it became the standard, while other preservatives with appealing but dangerous qualities, like mercury and arsenic, were prohibited.

Certainly, formalin formulas had drawbacks: Formalin-based fluids, embalmers soon learned, required special handling and use to provide the desired results. For example, blood had to be removed and washed out of the body before injection of the preservative. Also, they found, it was critical that the body be properly positioned before the injection, as hardening made it very difficult to model the hands or limbs into a natural position. In cases of jaundice, formalin might react with bile to produce green skin.

The primary criticism of formalin fluids, however, was the concern associated with inhalation of formaldehyde fumes, which commonly caused mucosal irritation, or formaldehyde absorption though the skin, which was known to cause skin irritation. Other potential risks were relatively unknown at the time, but it was assumed that environmental management of the workplace (better ventilation, use of gloves, masks, and so on) could reduce known risks to a reasonable level.

As embalming moved from the bedroom to the funeral home, there were better ventilation systems and more refined formaldehyde solutions to address some of these early problems. Increasingly, specific formulas of preservative were developed for specific uses. In the 1980s, a number of national organizations developed regulatory guidelines for the embalming industry. The Federal Trade Commission (FTC) and Occupational Safety and Health Administration (OSHA) adopted rules regarding embalming procedures, and OSHA provided regulatory guidelines outlining necessary protection for funeral home personnel. The Environmental Protection Agency (EPA) also regulated the industry, issuing rules concerning the use of formaldehyde by embalmers. Because of the potential risk of formaldehyde to the safety of those who work with it, there is a long history of investigation into other materials or methods that preserve as well. While a number of companies claim to have found alternatives to formaldehyde that are equally effective, none appear to have taken its place.

A recent study published in the Journal of the National Cancer Society reviews new data regarding formaldehyde exposure and is currently prompting all the regulatory agencies listed above to review and revise their guidelines for formaldehyde exposure in the workplace (see Part II: Is Embalming Dangerous?).

A formal curriculum

As funeral services became more encompassing and funeral homes more common, commercial companies developed to meet the new needs of embalmers and funeral directors. The research in this subject area was typically referred to as "mortuary science," with the discipline developing to such a degree that by the end of the 1800s, trade journals with technical and marketing information were surprisingly widespread. Chemical companies employed lecturers and demonstrators as salesman, and, throughout the 1800s, many undertakers who wanted to learn to embalm did so by taking a period of a few days to attend sessions of traveling schools, sponsored by these embalming chemical companies. These courses typically covered only the most basic skills, given the short amount of time. Many undertakers also turned to home-study courses.

After the Civil War, training often occurred in funeral homes through a type of assistantship or apprenticeship. Each funeral home might experiment with its own materials, tools and techniques, passing down what worked in a system of trial and error, with many unique systems. To ensure safety in the profession as well as satisfaction for the bereaved, standardization in materials and techniques became a priority. By the early 1900s, schools of mortuary science were just beginning to develop a common standard for coursework and examination. It was also about this time that the first dedicated embalming schools opened.

In 1927, the first mortuary school accreditation was created by the Conference of Funeral Service Examining Boards, a collection of the existing state licensing boards. The National Council on Mortuary Education was established in 1942 by the National Funeral Directors Association and the National Association of Embalming Schools and Colleges. Basic course content for anatomy and embalming and the mortician's oath were initially drafted in 1948. The development of standard curricula was complicated by the fact that each individual, trained in a different manner, might complete a task in a different fashion with different tools and materials. Review is ongoing to assure to the greatest extent possible that only the safest, most effective products and methods are used. The American Board of Funeral Service Education continues to review and amend the required course content.

Modern restorative art

Modern restorative techniques (renamed "restorative art," in the 1930s) became an important sub-discipline of aftercare services in the early 1900s, filling a critical need in cases where the body exhibits obvious signs of trauma or disease, or battle wounds from war. Modern restorative art plays a role in comforting the bereaved by presenting family members with a loved one who appears as familiar in death as in life.

In 1912, the subject gained a name and a formal progenitor in an issue of the New York Sunnyside, a popular trade journal of the day. Joel E. Crandall, a well-known embalmer, introduced "demisurgery," which he described as "the art of building or creating parts of the body which have been destroyed by accident, disease, decomposition or discoloration, and making the body perfectly natural and lifelike."

Increasingly, the science of demisurgery became a necessary part of the funeral professional's toolkit. Five years after Crandall introduced the service in the Sunnyside, another professional journal, The Casket, noted the necessity of making bodies "presentable" as an integral part of the responsibilities of the embalmer and referred to Joel Crandall as the only person competent to teach the necessary techniques.

Initially, Crandall was simply a traditional embalmer, albeit a highly skilled one. In his early 30s, he began to record his experimental methods in repairing mutilated bodies, techniques he had refined over the past decade. Initially, he had used materials common to funeral sciences at the time, such as plaster of Paris, but found it inadequate for his needs. While it could be used to fill deep underlying areas close to bone, it could not be used as he wanted, to fill in damaged or missing skin. Instead, Crandall learned to create waxy putties and concealing cosmetic preparations to mimic the look of intact healthy skin.

His early work focused on bodies mutilated so beyond recognition that family members and undertakers usually felt they could not be viewed. Largely by trial and error, Crandall addressed the problems encountered in mutilated bodies with solutions that are used, with some adaptation, to this day. One of his learning methods made use of plaster "heads" that were damaged and repaired, a practice adopted by embalming school laboratories and used until quite recently.

While Crandall may not have been the first to use hidden stitches to close cuts or remove pieces of skin or other tissues that interfered with the natural presentation of the face or body, he was among the first to formally include such methods in the category of restorative technique. Part of his skill was due to his manufacture and development of innovative instruments and materials, including a demisurgical grip that included a set of basic instrument and brushes as well as cosmetic preparations, false hairpieces (including prefabricated mustaches and eyelashes), and preformed wax facial features that could be modified by less skillful embalmers or technicians.

Crandall's first step in restorative work was always to study a recent photograph of the deceased. One of his most famous cases was Col. Jacob Astor, a passenger on the Titanic. He and others pulled from the sea in 1912 were taken by way of Nova Scotia to New York for burial services. Given the amount of time the body was in the water and the delay in treating the corpse, the job was substantial. Crandall was able to restore Astor's discolored face to a natural appearance with the use of cosmetics, allowing the casket to be open for viewing.

By 1913, Crandall owned a demisurgical supply company, a school in New York City and an undertaking company in New Jersey. Over the next decade, he lectured on the subject of demisurgery at the Demisurgical Institute of New York and developed a correspondence course. In 1917, some of Crandall's restorative techniques were filmed to be shown at conventions for teaching purposes. This led to a popular lecture

circuit. Unfortunately, much of this information has been lost or was never formally published.

A number of embalming schools at the time claimed to teach aspects of restorative arts, and some argued that Crandall was not the founder of the science of demisurgery, as he claimed when he opened the Demisurgical Institute of New York in 1918. Schools in Boston, Cincinnati and New York stated that the subject was a part of their curricula for years, although, if it was covered, it was not promoted in any of the advertising or published list of subjects covered until 1912. By that year, Crandall was already an established leader in the field, lecturing on demisurgical techniques at the New York State Embalmers Convention.

Called names including "dermasurgery," "plastic surgery," "plastic work," "derma sculpture" or "artistic embalming" ("demisurgery" was too closely associated with Crandall's empire), many prominent embalming schools began to teach courses on restorative techniques, providing information on decoloration and specific postmortem surgical procedures. Not everyone in the field of funeral services agreed. C.A. Renouard, for example, felt, as a matter of principle, that cosmetics and, in many cases, surgical procedures should not be used. Many years later, however, near the end of his life, he changed his mind, even recommending courses in restorative art to students and colleagues.

While specific details of Crandall's techniques are incomplete, it is likely his influence that spurred many embalming schools to incorporate some type of restorative art into their curriculum, as it became more expected and desired by consumers. By 1918, effects of World War I were causing people to ask whether demisurgery had applications for U.S. war casualties. Crandall felt that all war dead should be embalmed as soon after death as possible, so they could be restored later at the necessary time and place for a memorial service.

One of the most striking impacts Crandall made in the field was his use of before and after photographs, showing his repair of mutilated bodies. Numerous cases were quite severe, requiring substantial reconstruction. While an inspiration to many in the field, showing just what could be achieved, there were also those who found the results so impressive that competitors accused him of doctoring the photos. Crandall was incensed by this accusation, requiring all individuals involved with the restoration (including family members, lawyers, the undertaker and photographers, among others) to sign affidavits attesting to the authenticity of the photographs.

Crandall's other great contributions to the field were his confident knowledge that a great many "unpresentable" cases could be restored to viewing condition, as well as his innovations in materials and techniques. The first half of the 20th Century saw a growth in the number and types of products and equipment available, sold by innovative marketing techniques such as before-and-after photos, as well as demonstrations and lectures, like those that had been used to promote embalming decades before. Many in traditional embalming considered the subdiscipline a new art form, and interest in demisurgery, its tools, materials and especially cosmetics soared.

Sales of prefabricated (usually wax) features and assistive materials and tools boomed in the late 1920s and '30s, with a number of companies vying for Crandall's business. These products, such as Eckel's "molding masks," included generic prefabricated eyes or noses that required the individual responsible for the body to do some shaping based on a photo. In the late 1940s, a dental plastic surgeon and instructor of restorative science suggested that a better match for many features could be achieved through the use of family members' features. In other words, siblings or parents who resembled the deceased could be used to create molds. It was as close to a custom fit as could be achieved, given the very similar size and shape of features in most families.

Some methods developed early in the 1900s are still used today, while others became outdated almost immediately. Methods that once suggested great promise, such as skin grafting from one part of the body to another, never worked as well as hoped. In 1926, the Montez Manufacturing Co. in Michigan developed an electric-heated spatula meant for smoothing and modeling wax and reducing body swelling that held great promise but failed on both counts. It not only tended to make the skin surface too shiny, it also was ineffective in reducing swelling tissues. Most practitioners went back to their previous method, which required a bowl of hot water and an alcohol lamp to heat the spatula to the desired temperature. This too had drawbacks, as it became hard to control when it cooled, which would cause wax to roll and lose its adhesive ability.

The majority of prominent figures in the field in these early days agreed on only a few basic points. Most recommended use of a highly concentrated fluid and completed basic restoration before arterial injection, and taught that a significant waiting period was necessary between the completion of arterial treatment and final cosmetic application. The field was still highly experimental and flexible, with virtually no standardization.

Due to the prevalence of jaundice in the early 1900s for a period of about a decade, there was much in the literature about the difficulty in preparing a body with jaundice. The most commonly used arterial fluids were formalin-based, and turned the body from the original jaundiced tone of yellow to green once embalmed. While there may still be complications with a jaundiced body even today, the issue has been addressed a number of ways, with more or less success. Bleaching solutions such as phenol and chlorine have been tried, but one of the few early successful treatments (according to some) was a treatment by J.H. De Normandie of New York in 1924, who used a secret solvent injected into the carotid artery combined with a topical ointment and the use of hot moist towels on the face. The formula was never revealed.

Famous names, publications, and inventions in early restorative art

In 1915, **Albert Worsham** demonstrated the use of cotton and collodion to fill shallow cavities and build facial features, all of which would then be covered with a layer of wax. Worsham's claim to fame was the restoration of a mangled lion tamer in 1917, in which he had to recreate ears, much of the facial features and both arms, as well as close the ripped-open abdomen. The same year, C. O. Dhonau developed a treatment for addressing swollen or black eyes by pressing out the collected blood using a slit on the underside of the lids, then applying a 50 percent phenol mixture to lighten the area and shrink swelling.

By the mid 1920s, articles on restorative art appeared frequently in professional journals associated with embalming, those of chemical manufacturers and other vendors. A number who contributed to the technical literature were **C.F. Callaway**, who, starting in 1927 wrote many articles, lectured on and demonstrated restorative techniques, as well as **William G. Collier,** who invented restorative wound fillers and wrote articles for The Casket and Sunnyside. Collier's topics addressed facial cancers, loss of limbs, common procedures and cosmetic techniques. A.O. Spriggs (who worked for the Champion Co.), contributed a series entitled "The Art of Plastic Surgery" that discussed such topics as hidden suturing methods, restorative techniques for gunshot wounds, and the correct injection of fluids. All the articles were eventually compiled into a textbook, published in 1934, called "Champion Restorative Art."

Clarence G. Strub published over a thousand articles and two texts, "The Principles of Restorative Art," a 32-page practical textbook, and "The Principles and Practice of Embalming." Both are the model for modern books on the study because of their clarity and simplicity, and both became primary texts for colleges of mortuary science. Another seminal work, published in the early 1930s, is **C.O. Dhonau** and **G. Joseph Praeger's** "Manual of Restorative Art," which was also updated in 1955.

In the 1930s,Worsham designed a course including about 30-40 hours of laboratory work that employed mutilated human heads previously used in anatomy and dissection courses. Between classes, these items were stored in preservative fluids, providing real conditions for practice in filling cavities, forming facial features and applying cosmetics. Almost two decades later, in 1948, lab materials had evolved, with the Postgraduate Institute of Restorative Art of Chicago using specially created "mutilated heads" crafted from rubber and plastic, which allowed students to suture, apply wax and cosmetics in a realistic way.

Increasingly, institutions of mortuary science provided more hours of restorative art, but

special schools devoted to cosmetic preparation and restorative art also became more common. In 1937, for example, The Embalmers Graduate College in Chicago offered a 30-hour course of restorative techniques and cosmetic application. Along with legitimate programs such as the Chicago college came less authentic educational opportunities. In 1926, Dhonau, a noted expert in the field of restorative arts, called it a scandal that fluid manufacturers were issuing diplomas for demisurgery to individuals who simply attended their free clinics, in the same way that decades earlier, fluid manufacturers were criticized for issuing diplomas to those who had viewed their embalming seminars. Dhonau and others in the field called for professionalism and high standards in restorative art education.

There were still cases in these days of bodies embalmed in the family home without the use of gloves or other protective measures. In some cases, family members attended. The potential risk associated with casual treatment of a dead body became a critical issue for **Edward C. Johnson**, a funeral service professional who became infected during an embalming and nearly had to have a finger amputated. He recovered, and eventually became very well known in the field of restorative art, writing scholarly articles on the history of embalming and funerals in the United States, and founding the Postgraduate Institute of Restorative Art in 1948 in Chicago. Professor Johnson, his wife, Gail, and daughter Melissa – all of whom were licensed funeral directors and embalmers – coauthored his publications and traveled the world with him presenting embalming and restorative art lectures and demonstrations. The family was also critical in transporting the American victims of the Jonestown, Guyana, suicides that shook the world in 1978.

New products introduced in the 1930s helped to revolutionize restorative techniques. There had always been a problem with application of cosmetics over a wax surface, an issue addressed in part by the invention of the airbrush or power sprayer as early as 1911. These devices were originally powered by carbon dioxide cylinders, then, in 1934, by a manually operated spray applicator sold with its own specific cosmetic set. A few years later, an industrial and artistic airbrush equipment manufacturer created an airbrush kit designed especially for embalmers. The Paasche Co. kit contained an electric air compressor, an airbrush applicator for restorative art wax, a set of cosmetic tools, and a number of preformed facial features. Also at the time, the Dodge Chemical Co. introduced a needle injector and needles that were fashioned for securing the mouth, also offering instruments, cosmetics, wax and chemicals used for restorative art.

In 1943, **Sheridan Mayer** published "Restorative Art," a basic text in many educational institutions that was revised a number of times. He also wrote the "Workbook on Color and Mortuary Cosmetology," published a few years later, and the textbook "Color and Cosmetics" in 1973. His background was unusual in the field; trained as an artist and sculptor, he was also employed as a theatrical cosmetician and makeup expert. Perhaps his greatest contribution to restorative art was his encouragement of a uniform curriculum and standards for instructional and testing purposes. While not an embalmer, he prepared sample syllabi and curricula as well as examination questions that became standards in the field of study.

By the mid-century, the two major trade journals, The Casket and Sunnyside, both published a monthly article that ran for 14 years. Called "Restoration Clinic," it described treatments for specific difficulties, with before and after photos to show results.

Gladys P. Curry, author of the 1947 "Textbook of Facial Reconstruction," became internationally known for her ability to identify dead bodies after infamous disasters, such as a fire in a night club that killed more than 500 people, or the bodies of decomposing crewmembers of a submarine lost in 1939. Her book provides useful illustrations and photographs that break down reconstruction into a series of steps, rebuilding each layer of the face from the bare skull to the muscles, to the soft tissues of the face and neck, eventually refining the skin surface and adding hair to achieve the most natural look. The Curry system was used for years by embalmers to assist law enforcement agencies in identifying skeletal remains. While the book is dedicated specifically to reconstruction of the soft tissues of the head and neck with clay or wax and does not discuss restorative difficulties or the use of embalming with reconstruction, it is an excellence reference on modeling techniques and restorative techniques for purposes of identification.

Education in restorative methods was facilitated by the introduction of visual aids, such as photographs and film, which could show the sequence and results of each technique or step. The earliest known film example is **Joel Crandall** in 1912, but other filmmakers followed, such as Worsham and Renouard, using black and white film, before the 1920s, and **K. Angstadt**, filming in color, in the 1930s. Angstadt was a skilled restorative artist from Pennsylvania who demonstrated techniques in silent film with subtitles. His excellent technique and skill were evident in a number of complicated restorations, including replacing a jaw that had been removed, reducing swelling of the face and hands, and replacement of eyelids and lashes that had been ravaged by infection. In the 1940s, two educational color films were produced. One, from the Los Angeles College of Mortuary Science, shows how to create plaster masks that can be used for practicing restoration techniques and describes modeling methods that are very effective in producing natural facial features.

It might be said restorative art formally "arrived" as a discipline in 1945, when it was the subject of the address at the National Funeral Directors Association Convention in Chicago, with content stressing the value and necessity of these procedures.

Infamous cases of early modern restorative art

John Dillinger, Bonnie Parker and Clyde Barrow ("Bonnie and Clyde") were killed by law enforcement agents in the summer of 1934. Dillinger, taken to the Cook County Morgue in Chicago, was met there by an instructor from Worsham's College, who was requested to make a death mask of Dillinger for the FBI. Bonnie and Clyde were embalmed in Louisiana, after which Clyde's body went to Dallas, where his head, which was shattered by over 100 bullets, was restored, while Bonnie, who had received more than 50 bullet wounds, was taken to a different funeral home in Dallas. Extensive restorative work was completed on both, and both were viewed by an estimated 50,000 individuals.

PART II: IS EMBALMING DANGEROUS?

This section discusses risks associated with embalming, highlighting recent findings associating long-term exposure to formaldehyde to a higher risk of myeloid leukemia among embalmers. These findings, as well as recent OSHA investigations showing violations in workplaces that use formaldehyde, emphasize the potential risk – to one's safety and one's business – that can occur without proper attention to formaldehyde regulations. These findings are followed by a review of proper ventilation for funeral home preparation rooms, and an article discussing health risks associated with older cemeteries or contact with corpses embalmed from around the time of the Civil War until the early 1900s, when arsenic was commonly included in embalming fluids.

National Cancer Institute findings

The November 2009 Journal of the National Cancer Institute published some disturbing new findings about exposure to formaldehyde. In this recent study, researchers at the National Cancer Institute investigated the relation of mortality to work practices and formaldehyde exposure levels among a number of professionals, including embalmers. In a case-control study among funeral industry workers who had died between 1960 and 1986, researchers compared those who died from lymphohematopoietic malignancies and brain tumors with those who died from other causes. Lifetime work practices and exposures to formaldehyde were obtained by interviews with next of kin and coworkers.

This study was the first epidemiological investigation, to the authors' knowledge, to relate cancer risk to duration of employment, work practices and estimated formaldehyde exposure levels in the funeral industry.

The study found that death from myeloid leukemia increased with increasing years of embalming experience. There was an almost fourfold increased risk of death from myeloid leukemia among persons who performed embalming for more than 34 years. There was a threefold risk of death from myeloid leukemia in persons performing more than 3,068 embalming procedures. There was also a threefold risk for those estimated to have

exposures exceeding 9,253 parts per million-hours. However, they did not find a statistically increased risk for mortality from brain tumors or other lymphohematopoietic malignancies.

So what is the current status of formaldehyde use in the embalming profession?

Funeral professionals and organizations responsible for protecting their welfare continue to monitor the international, federal and state regulatory landscape for changes or limits on the use of formaldehyde for embalming purposes in the United States.

The National Funeral Directors Association (NFDA) has performed a preliminary analysis of the report that will likely be updated after further review. The NFDA has published two articles regarding the recent formaldehyde study results, which can be found on its website at these links. The first reviews the most recent research findings regarding cancer and formaldehyde, and the second outlines best management practices for workplaces using formaldehyde, including appropriate ventilation standards (which are also presented in the next section):

- http://www.nfda.org/additional-tools-embalming/1901-formaldehyde-understanding-the-newest-study-on-cancer-and-exposure-in-funeral-service.html
- http://nfda.org/additional-tools-embalming/1749-formaldehyde-best-management-practices.html

The NFDA is also completing a ventilation study to evaluate prep room ventilation systems to ensure they are providing the maximum protection for embalmers from formaldehyde exposure during embalming.

Given that the International Agency for Research on Cancer (IARC) has declared formaldehyde a carcinogen and the federal Environmental Protection Agency (EPA) is reviewing the recent data regarding formaldehyde exposure and leukemia, it is expected that both the EPA and OSHA will propose new regulations limiting the use and exposure limits for formaldehyde based on all these studies.

Workplace violations

Given the widespread knowledge that formaldehyde exposure can be dangerous, there is surprising laxity regarding storage and use of the product. In October 2009, the OSHA cited a large Massachusetts company for 41 alleged violations of workplace safety and health standards at its Cambridge production plant. The embalming fluid manufacturer faces $138,000 in fines for inadequate safeguards involving formaldehyde stored and used in manufacturing processes at the plant as well as for various chemical, mechanical and electrical hazards identified during comprehensive OSHA inspections conducted over the past several months.

OSHA found that the plant lacked a process safety management (PSM) program and procedures to proactively assess and address hazards associated with processes and equipment using large amounts of formaldehyde and that the plant also lacked controls and other safeguards to reduce the levels of formaldehyde to which some workers were overexposed.

OSHA also identified numerous deficiencies in the plant's respiratory protection, emergency response, hazardous energy control, chemical hygiene and chemical hazard communication programs.

Ventilation requirements

Although ventilation requirements for preparation rooms may be changing in the near future, be sure your workplace meets minimum safety standards according to the following guidelines.

Ventilation guidelines and calculations for funeral home preparation rooms[1]

Ventilation guidelines

Ventilation requirements for funeral home preparation rooms are not specifically addressed in current OSHA guidelines. However, the National Mechanical Code of the Building Officials and Code Administrators (BOCA) and the Heating, Ventilation, and Air-Conditioning Handbook of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) specify ventilation criteria for autopsy rooms. These criteria for autopsy rooms can serve as useful guidelines for effectively ventilating funeral home preparation rooms.

- BOCA requires a minimum of 12 air changes per hour for autopsy rooms. The BOCA Code also requires that the air shall be exhausted to the outdoors, at an approved location on the exterior of the building.
- ASHRAE recommends a minimum of 12 air changes per hour be supplied to autopsy rooms, and that at least two of the air changes per hour be outdoor air. ASHRAE also specifies that the room be negatively pressurized in relation to adjacent areas.
- The National Funeral Directors Association recommends, as an accepted industry practice, no fewer than 10-15 air changes per hour for preparation rooms.
- A source of makeup air should also be provided in preparation rooms to prevent excessive negative pressurization and to improve air mixing within the room.

Ventilation calculations

Air changes per hour (ACH) – To determine the number of air changes per hour occurring in an existing preparation room:

1. Calculate volume of preparation room:
   - □ Length (ft) x width (ft) x height (ft) = room volume (ft^3).
2. Calculate exhaust vent area in ft^2:
   - □ If rectangular: length (in) x width (in) = vent area (in^2).
   - □ If circular: 3.141 x [radius (in)]^2 = vent area (in^2).
   - □ Vent area (in^2) x 0.00694* = vent area (ft^2).
     - (* = factor for converting in^2 to ft^2).
3. Calculate volumetric airflow of exhausted air in cubic feet per minute (CFM):
   [NOTE: This will require airflow measurements using a velometer or equivalent instrument to determine average air velocity in feet per minute (ft/min) across the face area of the preparation room exhaust vent. More sophisticated measurement methods, such as duct static pressure, may also be used. Alternatively, a volumetric airflow hood can be used to directly obtain CFM.]
   - □ Air velocity (ft/min) x vent area (ft^2) = CFM (ft^3/min).
4. Convert CFM to cubic feet per hour (CFH):
   - □ CFM (ft^3/min) x 60 (min/hr) = CFH (ft^3/hr).
5. Calculate air changes per hour (ACH):
   - □ CFH (ft^3/hr) I room volume (ft^3) = ACH (air changes per hour).
   - □ Sample calculation for air changes per hour (ACH).
     - Preparation room is 30 ft. long x 20 ft. wide x 10 ft. high with an 18-inch-diameter circular exhaust fan vent having an average face velocity of 860 FPM.
     - Room volume = 30 ft x 20 ft x 10 ft = 6,000 ft^3.
     - Vent area = 3.141 x (9 in)^2 = 254.4 in2 x 0.00694 = 1.77 ft^2.
     - CFM = 860 FPM x 1.77 ft^2 = 1,522 CFM (ft^3/min).
     - CFH = 1,522 CFM x 60 min/hr = 91,320 CFH (ft^3/hr).
     - ACH = 91,320 CFH I 6,000 ft^3 = 15.2 ACH.

Ventilation system capacity – To determine the ventilation system capacity in cubic feet per minute necessary to obtain a desired number of air changes per hour.

1. Calculate volume of preparation room:
   - □ Length (ft) x width (ft) x height (ft) = room volume (ft^3).
2. Calculate cubic feet per hour (CFH) needed:
   - □ VOLUME (ft^3) x ACH (desired) = CFH (needed).
3. Convert to cubic feet per minute (CFM) needed:
   - □ CFH I 60 (min/hr) = CFM (needed).

Sample calculation for ventilation system capacity

Preparation room is 26 ft. long x 18 ft. wide x 9 ft. high and it is necessary to determine the number of cubic feet per minute that must be exhausted to obtain 15 air changes per hour.

- 4,212 ft^2 x 15 ACH = 63,180 CFH (ft^3/hr).
- 63,180 CFH I 60 min/hr = 1,053 CFM (ft^3/min).

Calculation of the outside supplied air changes recommended by ASHRAE can be performed in the same manner as those for exhausted air.

Hidden dangers

The following article cautions those working near old burial sites or treating embalmed bodies from certain periods, particularly the Civil War, to protect themselves from risk of exposure to arsenic through contact with the embalmed bodies and possible contamination of ground

water and soil. Please pass the information along to anyone you feel might benefit from it.

Old cemeteries, arsenic, and health safety[2]

Embalming human remains for burial has taken a long road to its present state as an art that now minimizes health and environmental concerns of burials. Along the way, health and safety were not always considerations. From the Civil War until about 1910, arsenic was the main ingredient in the embalming fluids used widely throughout the country. Although effective, arsenic is toxic and persistent, and elemental arsenic will never degrade into harmless byproducts.

Progress in embalming practices during the late 1880s has left a legacy that can potentially harm the health of archeologists or cemetery workers, and impact the environment. Awareness of this potential problem is the first step in alleviating any real damage that might occur.

Arsenic embalming began as a sanitary practice and a practical means to preserve the body until burial or for transport. Considering that the alternative was ice, arsenic embalming seemed like a significant improvement. What the embalming practitioners or undertakers did not consider were the long-term effects of placing significant amounts of arsenic in concentrated burial areas – cemeteries.

The arsenic that endures today can pose significant danger to forensic archeologists, cemetery workers, or individuals that may be utilizing potentially contaminated groundwater supplies.

In the U.S., the widespread use of arsenic in embalming fluids began in the Civil War period. Dr. Thomas Holmes, the "father of American embalming," was engaged by the medical department of the Union Army to set up battlefield embalming stations to enable the bodies of Union dead to be returned home. Numerous embalmers were trained in these new techniques, which included preparation of embalming fluids. Although fluid composition was often a trade secret, arsenic was the primary embalming agent because it effectively killed or halted the microorganisms responsible for decomposition. Other embalming compositions were used less frequently and contained similar toxic materials, such as mercury or creosote.

At the end of the Civil War, successful embalmers returned to their hometowns and took their craft with them. This expansion of arsenic-based embalming gradually came to encompass all areas of the country.

From 1856 to 1873, six patents were issued for fluids that contained arsenic, from as little as four ounces to as much as 12 pounds of arsenic per body. Individual embalmers could also create their own formulas by going to the local pharmacy to get the necessary quantities of arsenic. The 1878 publication, "The Undertaker's Manual," contained several embalming fluid formulas, the majority of which were arsenic based. A popular formula of the time contained about four ounces of arsenious acid (an arsenic trioxide) per gallon of water, with two or more gallons of fluid recommended for proper embalming.

Chemical embalming spread most rapidly in the 1880s, when fluids were compounded and sold commercially. Fluid compounders sent salesmen on the road to demonstrate fluid use and broaden their customer base. The salesmen provided at least rudimentary instruction in embalming techniques and helped continue the growth of chemical embalming.

The demand for chemical embalming stimulated the creation of embalming institutes or schools. Some of the earliest were the Rochester (New York) School of Embalming and the Cincinnati School of Embalming. Correspondence courses overcame geographic barriers and embalming practitioners began providing services in every state. For example, chemical embalming in Iowa began about 1879. An enterprising young undertaker from Iowa City, Dr. William Hohenschuh, took a correspondence course from Dr. Auguste Renouard, founder of the Rochester School of Embalming. Dr. Hohenschuh spread the technique to his fellow undertakers, and by 1899 there were at least 240 registered embalmers in Iowa.

Burial practices during this time also have a bearing on problems associated with the release of arsenic. Initially, burials were primarily in wood coffins that were placed directly in the ground. Throughout the latter 1880s, use of metal burial containers, such as the Fisk metallic burial case and combination metal and wood caskets, increased. In either case, no burial vaults that enclosed the coffin were used. Embalming and metal containers added cost to funeral arrangements, and were generally only used by those who could afford them. In many cases, burial of non-embalmed persons in wooden caskets was still the only viable option. Yet embalming became increasingly affordable and popular.

Both wooden and metal caskets will eventually degrade and begin to allow contact of the embalmed remains with the environment. Arsenic, a basic element, will not change or degrade, but must remain with the remains or move into the environment. As the containers corrode, water moving downward through the soils of cemeteries can dissolve arsenic from the burials and move arsenic into the soil or groundwater. This slow spread of arsenic from numerous sources in an old cemetery can lead to serious environmental and health problems.

To understand the potential impact, assume a hypothetical cemetery in a modest-sized town. It is reasonable for the period 1880 to 1910 to assume that 2,000 people died in that time period.

If half of those were embalmed with arsenic, using six ounces of fluid per person, the cemetery contains 380 pounds of arsenic. If the embalmers in the area used more arsenic, such as three pounds per person, then the cemetery would contain over one ton of arsenic. In either case, this is a significant amount of a potent, toxic material to find in the ground at one location.

In the early 1900s, arsenic use was banned from embalming. The driving force for the ban was the concern for health of embalming practitioners and interference with autopsies after embalming had occurred. Today, arsenic is prevalent in or near old cemeteries. Some of the most compelling evidence is the recent analysis of the remains of an embalmed Civil War soldier. The tissue sample revealed that arsenic was present at a concentration of 28,000 parts per million, or 2.8 percent. This is firm documentation that arsenic embalmed remains can carry the arsenic residue for many years.

Evidence of elevated levels in the environment near old cemeteries is only now beginning to emerge. Limited sampling of old hand-pump wells that still exist at many smaller cemeteries has been conducted in Iowa. These wells typically access the shallow groundwater aquifer, and if still functional, can provide an initial indication of arsenic presence. One problem with these old wells is that they are often located up gradient or peripheral to the burial area of interest and do not provide the ideal groundwater sample.

Fourteen hand-pump wells at a variety of Iowa cemeteries were sampled for arsenic. The U.S. Geological Survey staff in Iowa City did not expect detectable levels of arsenic in shallow groundwater samples. Two of the samples contained arsenic at 30 parts per billion, above the new proposed drinking water standard for arsenic.

Installing groundwater monitoring wells near cemeteries can provide a better indication of the impact of arsenic. In one study at Hamilton College in Clinton, N.Y., up-gradient and down-gradient wells were installed outside of the college cemetery, which contains at least 68 graves from before 1910. Samples from the wells indicate elevated levels of arsenic down-gradient from the cemetery. Zinc, copper and lead also increased down-gradient.

What significance does the presence of arsenic have for archeologists, cemetery workers and others that may come into contact with contaminated soil or human remains at old burial sites or cemeteries? Because the main routes of exposure are ingestion, inhalation and skin contact, there can be important health and safety implications for personnel working at sites where arsenic is present in sufficient concentrations.

Acute arsenic poisoning by ingestion can occur as the result of hand contact with dusts or objects containing arsenic compounds, and subsequent hand-to-mouth contact. Another common mechanism includes the dust settling on objects that later have contact with the mouth, including the tops of soda cans, cigarettes in a shirt pocket or eating utensils. The smallest recorded fatal dose is 130 mg, although recovery has occurred after much larger doses.

Most ingested arsenic is quickly absorbed through the stomach and intestines and enters the blood stream. A common effect of arsenic ingestion is irritation of the digestive tract, leading to pain, nausea, vomiting and diarrhea. Other effects characteristic of oral exposure

include abnormal heart function and impaired nerve function, causing a "pins and needles" sensation in the feet and hands.

The inhalation route of exposure may be operative at dry, dusty sites, or during the handling of objects coated with dust. Inhalation exposure to arsenic can produce the same types of systemic health effects as oral exposure, although symptoms and effects are usually milder. The current Occupational Safety and Health Administration Action Level for arsenic inhalation exposure is 0.005 mg/cubic meter.

Direct dermal contact with arsenic compounds may result in mild to severe irritation of the skin (dermatitis), as well as irritation to the mucous membranes of the eyes, nose and throat. Dermatitis of the face and eyelids is sometimes accompanied by conjunctivitis, with redness, swelling and pain.

Due to the level of toxicity associated with arsenic, it is important to take precautionary measures when working in and around burial sites that may contain arsenic-embalmed remains. Protective measures include using protective work clothing and equipment, housekeeping and hygiene practices. Individual project requirements may differ; Occupational Safety and Health Administration standards, in particular 29 CFR 1910.1028, can give further guidance on proper procedures. Protective work clothing would include coveralls or similar full-body work clothing, gloves and shoes or shoe coverlets. Face shields or vented goggles should be worn when necessary to prevent eye irritation. Protective clothing and equipment should be replaced at least weekly, and preferably on a daily basis. Disposable clothing is preferred because laundering clothing and gloves can result in additional exposure problems.

Disposal of arsenic-contaminated materials must comply with federal, state, and local hazardous waste regulations. Engineering controls, such as exhaust ventilation, will not be available to control dust exposure in many applications. In that case, respiratory protection should be used to control dust exposures within acceptable limits. The minimum level of respiratory protection would be a half-mask air-purifying respirator equipped with high efficiency filters. Efforts must be taken to keep the inside of the respirator free of dust, and filters should be changed frequently, usually at least daily. Surfaces should be kept as free from dust as practical. Use of compressed air, sweeping or brushing should be avoided, because these methods will increase ambient air dust levels. Vacuuming is an effective method; however, special high-efficiency equipment should be used.

Smoking, eating or drinking should not be allowed in any work areas where arsenic may be present. Hands and face should be washed prior to eating, drinking or smoking. Protective clothing must be removed and handled carefully to avoid the generation of dust. A separate area for storage of street clothes should be available, and a shower should be taken at the end of each work period. These general guidelines are a starting point for protective measures needed to work at old cemeteries or with materials from old cemeteries that may contain arsenic embalmed remains. It is recommended that a certified industrial hygienist be consulted before beginning a project for specific measures.

Without an extensive review of public agency or private funeral establishment records, accurate determinations of the number and location of arsenic-embalmed bodies present in the nation's graveyards is impossible. Even if records were made available, they may not contain sufficient information to verify use of arsenic and the effort to obtain such information would be enormous.

The best opportunities to ascertain the presence and impact of arsenic in old cemeteries can come through cooperative efforts of forensic and other archeology experts with environmental scientists. Opportunities to collect and analyze soil and groundwater samples from excavations should be utilized. Not only will this provide information on the dangers to the environment, it will also provide critical information needed for proper protection of those engaged in archeological endeavors that could expose them to arsenic.

Endnotes

1. *http://www.state.nj.us/health/surv/documents/fuhomevent.pdf; http://www.nj.gov/health/surv/documents/fuhomevent.pdf*

2. John L. Konefes and Michael K. McGee; Additional assistance by Melissa Johnson Williams; http://crm.cr.nps.gov/archive/19-10/19-10-6.pdf

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Notes

HISTORY OF EMBALMING AND RESTORATIVE ARTS

Final Examination Questions

Select true or false for each question and complete your test online at **www.elitecme.com.**

1. Our earliest knowledge of embalming is that which occurred in the Canary Islands among the Guanche.

   True False

2. The first step for the ancient Egyptian embalmer was the removal of the brain, typically with the use of a metal hook or spoon inserted through the nostrils into the brain, or less commonly, through the eye socket.

   True False

3. Some of the success of Egyptian preservative methods could likely also be attributed to a hot, dry climate that discouraged bacterial growth.

   True False

4. Populations of the Tigris-Euphrates River Valley, including the Persians, Syrians and Babylonians, submerged recently deceased individuals of importance in a container of plaster to preserve the body, especially for a long journey.

   True False

5. Guanche embalmers were gender-specific – only male practitioners could attend to men's corpses, and female practitioners to women's corpses.

   True False

6. Xaxos bodies show very minimal shrinkage in body size and are quite heavy.

   True False

7. By 1864, all deceased patients at the Washington, D.C., Military Hospital were routinely embalmed and the grave marked so that the body could be disinterred and sent to the family, if desired.

   True False

8. In the mid-1870s, the invention of the trocar by Samuel Rodgers helped to usher in a new system for treatment of the cavities.

   True False

9. At the end of the 1890s, embalming fluid advertisements were introducing the ingredient formalin, a saturated solution of formaldehyde combined with other ingredients.

   True False

10. OSHA has issued ventilation guidelines for funeral preparation rooms for at least two decades.

    True False