

# What is Embalming?

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*“Embalming, one of humankind’s longest practiced arts, is a means of artificially preserving the dead human body” (Mayer p.23).*

## What is Embalming?

**Embalming**, or mortuary science, is concerned with achieving a state of preservation, sanitation and restoration of the deceased human body through a process of chemical treatment which inhibits the growth of micro-organisms, temporarily interrupts organic decomposition and restores a physical appearance of natural form and colour.

The objectives of embalming are accomplished through vascular and cavity injections of aqueous solutions of soluble, germicidal chemicals, together with various other supplementary techniques and procedures. Such chemical treatment of the deceased human body during embalming achieves these goals by acting upon bodily proteins and enzymes, while destroying the bacterial micro-organisms that would otherwise break down those proteins. Embalming solutions convert proteins to a longer lasting substance by forming cross-linkages and destroying their reactive centres that normally hold water needed for decomposition. Likewise, the enzymes, which break down protein, are inactivated and the protein bodies of pathogenic bacteria are also destroyed. The art of embalming is performed in modern times for three main reasons:

### 3. Preservation

The most obvious and commonly known purpose of embalming is **preservation**, which serves to retard or arrest the unpleasant consequences of organic decomposition. Influenced by custom and religion since embalming began with the rise of Egyptian civilisation over 5000 years ago, preservation today is generally required to allow long delays between the death and the funeral. Even during the average refrigerated delay of approximately three days before a funeral in Australia, signs of decomposition still usually become evident because decomposition is only slowed with refrigeration, rather than being arrested by embalming.

The process of embalming preserves and sanitises the deceased human body by ‘converting’ or ‘inactivating’ proteins and enzymes to resist putrefaction. Proteins are transformed in this way when an embalming solution alters their ‘*colloidal*’ state from solution to suspension, to a more firm and stable condition that is resistant to decomposition by enzymes and unusable as food for bacteria. A more practical analogy of this conversion is when the egg white of a raw egg changes from its transparent, gel-like form to a firm and stable opaque white when cooked. The egg’s *proteins* are “*converted by the heat to a more stable form of protein*”. (Mayer, p 14-16). The hydrophilic, gel-like proteins of the body, once changed into this inactive and longer-lasting compound, can no longer hold water and cannot be decomposed by bodily enzymes or bacteria. During this process the proteins of these enzymes and bacteria are also inactivated and any disease-causing micro-organisms are concurrently destroyed.

Natural Preservation is known to occur in certain situations when decomposition of a body and its proteins is halted by one of a number of naturally arising processes. Generally, this occurs from a lack of moisture or by temperatures that are too cold for putrefactive agents to survive in. Desiccation in a climate of dry heat produces naturally preserved mummies by taking away the much needed moisture from these putrefactive agents. Also, similar to today’s refrigeration, bodies can be preserved in extremely cold conditions such as glaciers and snow-capped mountains. Also,

natural mummification is known to have occurred with the flow of a dry, cold air current, such as on St. Bernard mountain, Switzerland, as well as in the earth of some burial sites containing tannin or high levels of certain salts.

## 2. Sanitation

While preservation has been the sole reason for embalming in the past, changes in customs and socio-religious beliefs, as well as advances in pathology and bacteriology, have brought about additional advantages for the practice of embalming. The purpose of **sanitation** is to inhibit or destroy pathogenic organisms and their products. The knowledge of diseases and the risk of public infection from dead bodies assisted the realisation of the importance of sanitation, possibly to the point of surmounting that of preservation. The necessity for sanitation for public health protection through embalming continues today with the growing presence of such diseases as AIDS and Hepatitis B and C.

*“Embalming fluids are similar to the types of chemical germicides that have been tested and found to completely inactivate HIV” (Mayer p.450).*

By reducing the presence and growth of micro-organisms within the body, embalming effectively protects funeral workers and viewing family members alike from a wide range of potential hazards. Beyond the increasing prevalence of blood borne pathogens, all bodies must be considered as potentially infectious due to the translocatable bacterial and microbial agents that are naturally found within the intestines. Because bacteria does not die with its host and continues even with refrigeration, sanitation becomes highly important in eliminating the risks that refrigeration fails to. As extensive contact with the deceased prior to the funeral is a normal part of Australian funeral service, the disinfection and sanitation of the deceased through embalming is an invaluable safeguard.

## 3. Restoration

**Restoration** in embalming centres around the physical presentation of the deceased and aims to recreate a naturalness of form and colour. Due to the evolution and refinement of funeral customs throughout the world, restoration has in recent times become a powerful reason for embalming. The increasing demand for viewings and the fact that studies have shown the importance of a positive viewing experience for the grieving process also reinforces its importance.

Incomparable to other methods of preparing the deceased for viewing, embalming effectively removes the unpleasant changes caused by death and the traces of disease and suffering. Often dehydrating and discolouring the body, refrigeration can often have the reverse effect. Should no other advantage of embalming be accepted, then the greatly improved appearance of the deceased for a viewing is reason enough. While refrigeration is helpful and practical to a certain extent, there is no substitute for the value of embalming in a modern, professional and complete funeral service that is capable of meeting the needs of clients through such a difficult time.

*“The eyes of the dead must be gently closed and the eyes of the living must be gently opened.” (Jan Brugler from Mayer p. Xi)*

## The History of Embalming

As the ages and various methods of embalming have changed, so too have the reasons for its practice. When embalming began with the Ancient Egyptians around 3200BC, the sole reason for embalming was preservation, mainly for religious reasons, as they believed it necessary for resurrection. The earliest recorded account of Egyptian embalming was made in 484BC by the famous Greek historian, Herotodus. The process featured the evisceration\* (see Glossary) of internal organs, covering them in a salt called natron for 20 days, coating the body with resins and fat and then wrapping and spicing it for mummification (Mayer, p.27).

During the second period of embalming history, from 650 AD to 1861, preservation was done mainly to allow “*anatomical dissection and study*”, as it was termed the ‘Period of the anatomists’ (Mayer, p 24). During most of this time, very little was known about disease and so no concern was given to public health or sanitation, and it is believed that there was also little consideration given to the restoration and appearance of the remains, particularly in Egyptian times. While restorative art was believed to be practiced prior to the Christian Era in other ways, the true value of restoration in fully arterially embalmed bodies was not recognised as a purpose for embalming until much later.

## **The Process of Death**

The death of a human “*is a process and not a moment in time*” (Mayer p.103). It is a series of stages that can be categorised into two basic types, being **somatic** death and **cellular** death. Somatic death refers to the death of the body as a whole and functioning unit and Cellular death refers to the ultimate death of all individual bodily cells. The stages of death that the human body goes through span an undefined period of time, proceeding the irrevocable stoppage of the three essential organs. Referred to as the ‘Tripod of Life’, these organs are the brain, heart and the lungs. The failure of one of these leads to a ‘mechanism of death’, such as Coma, Syncope and Hypoxia respectively.

There are three stages of ‘Somatic’ death. Firstly, **clinical** or **legal** death which involves the cessation of function of one of the heart, brain or lungs. It begins a 5 or 6 minute period within which life can be restored via CPR without permanent damage. Secondly, **brain or functional** death, in which the highly specialised cells of the brain and nervous system, begin to die from anoxiation, or oxygen starvation. Without the functions of the lungs to produce oxygen or the heart to pump it to the brain, cells in different parts of the brain begin to die in stages. Thirdly, **biological** death, which represents the death of the body as a whole and marks the irreversible death of the body’s organs and tissues and the point at which the more resistant cells begin to die.

Following the three stages of ‘Somatic’ death, the final stage of the process of death is **Cellular** or **Molecular** death. Although the biological death of a person may have irretrievably passed, the complete death of all individual cells occurs much later. Muscle cells can survive up to around 3 hours and up to 6 hours for cells of the cornea and blood. These cells are able to survive after biological death because of the trapped oxygen and nutrients they are capable of storing, which are then gradually depleted over varying amounts of time, depending on the rate of post-mortem metabolic activity. These metabolic processes which continue after somatic death continue to produce heat without the functions of respiration and circulation that allow heat loss, causing a temporary rise in body temperature known as post-mortem caloricity

## **Rigor Mortis**

Rigor mortis is an inevitable and temporary post-mortem chemical change concerning a movement in the body's pH balance which temporarily contracts both voluntary and involuntary muscles. Also known as cadaveric rigidity, this change naturally occurs and disappears due to the various chemical responses to death within the muscle cells. After death the metabolic process of carbohydrates being broken down into pyruvic and lactic acids continues, although supplies of oxygen and adenosine triphosphate (ATP) have diminished, these acids, normally converted into carbon dioxide and water, begin to accumulate within muscle fibres. Such a build up leads to the body's pH to become temporarily acidic and causes the coagulation and stiffening of muscle juices and proteins to cause what is known as rigor mortis.

A closely related analogy to this is the stiffness a person feels the day after strenuous exercise. In this case the body's stores of oxygen and ATP were temporarily depleted and a short period of anaerobic muscle activity occurred. Unable to cope with the metabolic workload, carbohydrates are converted into lactic acid rather than energy, which builds up in the muscles and causes a stiffness similar to rigor mortis.

Usually beginning within 2 to 4 hours of death and lasting between 36 and 72 hours, rigor mortis interferes with the distribution of fluids during embalming in the form of extravascular pressure. Therefore, it is necessary to relieve rigor mortis prior to embalming via the gentle manipulation and massage of the body's joints and muscles. Relieving rigor mortis before embalming reduces extravascular resistance and increases the body's reception of preservative.

Rigor mortis naturally disappears once the body's pH balance gradually returns to a neutral and then alkaline state. The acid state created in rigor mortis itself contributes to the breakdown of muscle proteins that is responsible for releasing the strongly alkaline chemical, ammonia. Lactic acid is then neutralised, freeing the contracted fibres and insoluble proteins from their state of rigor, and the process of decomposition begins.

## **Decomposition**

Beginning after rigor mortis has passed, **decomposition** involves the action of autolytic and bacterial enzymes which disintegrate the structure of bodily cells and is the most positive indication that death has occurred. Usually beginning in the caecum of the large intestine due to high concentrations of bacteria, decomposition causes the breakdown and separation of bodily compounds into simpler substances through proteolysis – the decomposition of proteins. This occurs via bacterial and autolytic enzyme activity on cells once the supply of nutrients and oxygen has been exhausted. These enzymes, designed to breakdown nutrients during metabolism to a digestible form, continue their catalytic task after death upon cells and proteins.

**Autolytic** enzymes are self-destructive and activate without microbial assistance. Once nutrients are exhausted, they begin to attack the cells that produced them, producing amino acids, sugars, fatty acids and glycerol which contribute further to decomposition as food sources for microorganisms. Originally functioning to breakdown nutrients to a digestible state, **bacterial** enzymes begin to destroy other cells through bacterial or microbial action once their food supplies are depleted. Both processes disintegrate bodily structures, including the vascular system, and produce ammonia products which can neutralise the effect of preservatives.

## **The Embalming Procedure**

The embalming procedure begins with the topical disinfection and washing of the body and the setting of features. Following this an ongoing case analysis begins to determine what conditions are present within the body and what techniques and chemicals should be employed to address these conditions. The stages of embalming, being **arterial** and **cavity**, then begin with the aim of gaining the maximum possible level of *preservation, sanitation and restoration*.

**Arterial** embalming, also known as capillary embalming, refers to the phase in embalming in which an arterial solution is distributed throughout the body by injection into one or more of the body's arteries. Following the course that is usually taken by blood during life, the preservative moves through the body's arteries, into the smaller arteriole, through the contacting tissue spaces, into capillaries and then into the veins. As the preservative must displace blood, one or more veins are used for drainage. As fluid passes through tissue spaces, it comes in contact with the body's cells for conversion. Among the most common arteries that are used for the injection of embalming solutions are the Common Carotid, the Femoral and the Axillary. Generally it is the corresponding vein that is used for drainage. Smaller vessels, although sometimes used as secondary injection sites, are not normally selected as injection points because of their lesser size and strength.

The second stage in the procedure is called **Cavity** embalming in which a cavity fluid is distributed throughout the mostly hollow organs of thorax and abdomen, which receive little preservative during arterial embalming. Cavity embalming, therefore, is necessary to remove gases and neutralise the problematic contents of the cavities to achieve the proper level of preservation and sanitation. This process also serves to arrest potentially contagious bacterial growth within the body as a hygienic measure that helps prevent gas formation, purge and decomposition.

Following the completion of these two stages of embalming, the body is again washed and then dried and the features are readjusted if necessary. The person is then dressed in the clothing provided and placed in a coffin or casket and prepared for the viewing.

## **The Distribution of Preservative Chemicals**

During embalming, different areas of the body can be seen to be receiving arterial solution through the observation of one or more indicators of distribution and diffusion. These indicators can be divided into three stages of arterial fluid distribution: *The general distribution of fluid, the presence of fluid in particular body areas and the diffusion of fluid into the tissues*.

**General distribution** of arterial solution is exhibited by the distension of superficial vessels and by good blood drainage. **Distribution in particular body areas** is indicated by the presence of an active dye, the clearing of intra and extra-vascular blood discolourations and the leakage from IV punctures. **The diffusion of fluid into the tissues** is evidenced by a loss of elasticity of the skin, the rounding of fingers, lips and toes, and the firming, drying and bleaching of the tissues.

Although many factors such as rigor mortis, decomposition and coagula contribute to negative forms of resistance to the distribution of arterial solution, certain moderate forms of natural and artificially induced resistance can actually enhance the distribution and diffusion of arterial fluid. Once general distribution of preservative is achieved various chemical processes take place to assist the diffusion of the fluid throughout the tissue spaces. Diffusion is the process of fluid passing through the minute, semi-permeable membranes of the capillaries to come in contact with the tissues for the conversion of proteins. Becoming extravascular, the fluid moves between and into the cells due to a number of physical of passive transport mechanisms:

**Osmosis, Pressure Filtration** and **Dialysis** occur as fluid passes through the walls of capillaries. It mixes with the intercellular fluid, the medium through which the preservative comes in contact with individual cells, via **Diffusion** and **Gravity Filtration**. The preservative and intercellular fluid then passes through the semi-permeable cell walls via the transport mechanisms of **Osmosis, Absorption** and **Dialysis**, to bring about cellular conversion.

## Embalming Chemistry

When Embalming began with the Egyptians, the chemistry of embalming comprised mostly of natron salts, palm wine, myrrh, frankincense, cinnamon, oil of cedar, fat and various resins. During the second era of embalming in the period of the anatomists, it was primarily arsenic and other poisons that were used for embalming. Around 1897, the practice of embalming was revolutionised by the introduction of formalin products – aqueous solutions of the gas formaldehyde. Despite initial difficulties and criticisms, largely concerning the fumes and strong firming effects, these new formalin solutions gradually improved and prevailed.

**Formaldehyde** is a toxic, colourless and pungent gas with a chemical symbol of HCHO. Despite its disadvantages, the use of formaldehyde has been greatly improved with various supplementary and co-injection chemicals which reduce its adverse effects, maintain its stability, extend its shelf life, enhance its distribution and increase its preservative effect. It is a very powerful and highly reactive germicidal and bactericidal chemical that quickly converts body proteins to insoluble resins which stops decomposition. **Formalin** is the saturated aqueous or liquid solution of formaldehyde that is formed when dissolved in water with methyl alcohol and has a density slightly higher than water. Formalin generally contains 40% formaldehyde, water and approximately 7% of methyl alcohol – a stabiliser that prevents it from falling out of solution into a powder called paraformaldehyde.

**Paraformaldehyde** is a polymer or solid form of the preservative gas formaldehyde. Paraformaldehyde is an insoluble, white powder that can contain between 85% to 99% of pure formaldehyde. **Gluteraldehyde** is a five-carbon, straight-chain dialdehyde developed commercially in the 1950's. It is a better disinfectant than formaldehyde and can convert body proteins over a larger pH range. **Phenol**, or carbolic acid (C<sub>6</sub>H<sub>5</sub>OH), is a colourless, crystalline, coal-tar derivative that is generally restricted to cavity fluids due to discolouration problems.

Many supplementary chemicals are used in conjunction with the main preservative. **Water conditioners** are used as a surfactant to stabilise and soften the effect of certain minerals found in water. **Anti-coagulants** are used to minimise coagulation problems associated with formaldehyde. **Modifying agents** and **Buffers** can be included to stabilise solutions and pH levels. **Humectants** are used to prevent dehydration of body tissues by increasing their ability to hold water. And active **Dyes** are used to give an internal cosmetic or colouring effect during embalming (Mayer, p129-141).

Mayer, R.G. (1990). Embalming: History, Theory and Practice. Appleton & Lange: California.