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## **Implantable Medical Devices and Their Management for Burial and Cremation**

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There can be no doubt that medical science has advanced at a tremendous rate and that technology has evolved to overcome more and more challenges. As technology has developed, equipment has become smaller and more targeted and this is no more so, than in the case of implantable medical devices. These advances place more pressure on funeral and bereavement service professionals, as we have to adapt and react to the problems that these devices create once the patient has died, and we prepare for funeral services and final disposal by burial or cremation.

Cremation is a particular area of concern as some of these medical implants pose a risk of explosion when exposed to the high temperatures generated during the process. This potential for explosion risks damaging the internal structures of the cremation equipment generating expensive repair costs and can pose a risk to the safety of the technical staff. Burial however must also be considered. Some of these devices feature materials of a high value and with limited resources. Is it sensible that these items are buried, when they could be removed and sent for reprocessing, recycling and redeployment?

Some reading this may not be aware of the construction of cremation equipment, or the costs associated with it. The internal refractory brickwork of the cremator makes two or in the case of some older machines three chambers, referred to as the primary, secondary and tertiary combustion chambers. The coffin, containing the deceased is placed or charged into the primary or main chamber where it is burnt and reduced to decalcified bone which is later ground down to become what is known as the ashes or cremated remains. The gasses from this combustion then pass through a port in the primary combustion chamber into the secondary chamber where they are mixed with air and burnt again. This process of secondary combustion helps to reduce emissions from each cremator. Older machines may feature a tertiary combustion chamber, but with advances in combustion engineering and the installation of abatement and filtration equipment there is little need for this set up in newer machines. The internal refractory brickwork of a cremator is very intricate and can take a skilled refractory engineer considerable time to build, inside the shell of the machine. There are estimates that the cost of a 'reline' or replacing all of the refractory inside a cremator can cost between £ 35,000.00 and £ 45,000.00, depending on the type, style and size of the cremator.

Understanding the intricate nature of a cremator and the costs associated with its maintenance and repair make it easier to understand why crematorium authorities may ask for potentially damaging medical devices to be removed from the deceased human body prior to its cremation. That having been said, as some of these devices are developed and refined, they are getting smaller and some medical manufactures state on their paperwork and supporting documents that the devices are safe or compatible with cremation.

If we look at the most up to date cremation regulations, The Cremation (England & Wales) Regulations 2008 (updated March 2020) there is a list of battery powered and other implants that could cause problems during the cremation of human remains. This list includes the following:

Therapeutic Patches

Pacemakers, Defibrillators (ICD's) and Cardiac Resynchronisation Devices (CRTD's)

Implantable Loop Recorders

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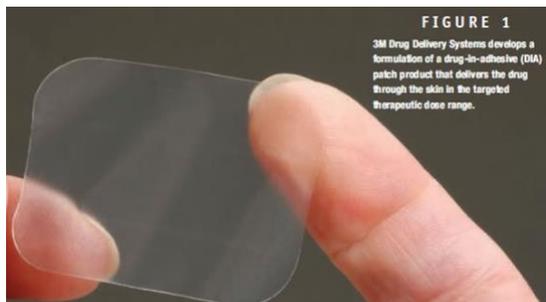
Ventricular Assist Devices (VAD's) Left Ventricular Assist Devices (LVAD's), Right Ventricular Assist Devices (RVAD's), or Biventricular Assist Devices (BiVAD's)  
Implantable Drug Pumps including Intrathecal Pumps  
Radioactive Implants (Brachytherapy)  
Fixation Nails  
Implantable (including for Pain, Bone Growth & Functional Electrical Stimulation) Stimulators  
Hydrocephalus Programmable Shunts  
Micra Transcatheter Pacemakers

Considering these devices, it is important to have some understanding of when and where they are used, what they do, and how they may be removed from the dead human body.

### **Therapeutic Patches:**

Therapeutic patches are a drug delivery system that attach directly to the skin. These patches have been used for a long time and are most commonly associated with treatment of addiction support (Nicotine Patches) but have been developed to deliver hormones and medications into the blood stream. They may now be used for pain relief and also the treatment of Angina. Angina patches are known to contain Nitro Glycerine and this poses a risk when subjected to cremation. Angina Patches should be removed prior to cremation and ideally should be returned to the hospital of issue for proper disposal. The operator can simply remove the patch from the skin of the deceased body using a suitable pair of forceps, while undertaking preparation or embalming of the remains.

In cases where the deceased is to be buried, one must ask the questions as to whether it is correct to bury the body with the patch in question in place and also whether the decomposition of this patch in the ground would have any effect on the soil or on the water table.



Therapeutic Patches can be placed in any location on the body. When carrying out any type of preparation, the operator should make a thorough check for all patches and remove everything present.

### **Pacemakers and Defibrillators:**

A pacemaker is typically used to treat abnormal cardiac rhythms and will shock the heart if it detected an abnormal rhythm. A defibrillator is used to monitor heart rhythms and provide a shock if a dangerous rhythm is detected. Typically, but not always, a pacemaker will have one pacing lead coming from it and running into the heart. The defibrillator will typically have two pacing wires running from the unit to the heart. These units contain a larger battery which poses a risk of explosion when subjected to the intense heat of the cremation process. The unit is relatively simple to remove however in the case of a defibrillator, checks should be made to ensure that the unit has been

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deactivated prior to removal. If not deactivated prior to removal and the defibrillator detects activity from the removal procedure, it may generate a shock which could physically harm the person trying to remove it. If in any doubt, check, check and check again.

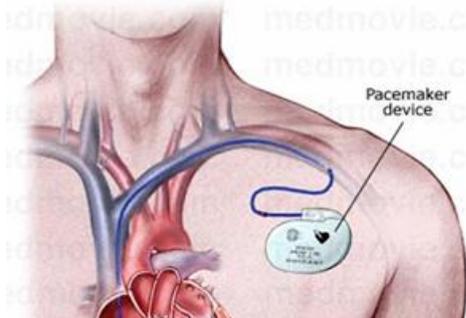


Diagram Showing Pacemaker

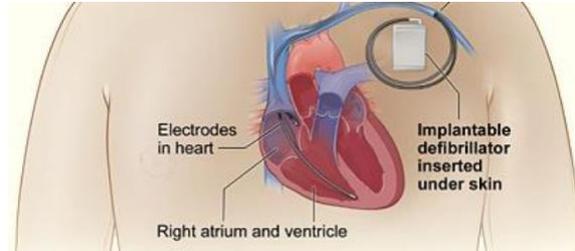


Diagram showing Defibrillator

To remove either a pacemaker or defibrillator, firstly identify what the unit is and ensure it is safe to remove. Make an incision over the device and expose it and the tissue pocket that has been created by the surgical team. Withdraw the device from the body and depending on the device cut one wire at a time. It is best to use a pair of insulated wire cutters for this procedure as these will help to protect the operator. The incision made can be treated with embalming sealing powder and then it is sutured closed with tight sutures, to form a leak proof seal. The device should then be cleaned and disinfected before being placed in a sealable plastic bag, labelled with the name of the deceased and the date of removal if possible. This should then be returned to the cardiac unit of the hospital that fitted the device. If this is not possible, there are recycling programs that have been rolled out and more information can be found by contacting your local crematorium authority or by contacting the Institute of Cemetery and Crematorium Management or the Federation of Burial and Crematorium Authorities.

### **Implantable Loop Recorders- AKA Insertable Cardiac Monitors:**

These are a small device, about the size of a standard USB stick or packet of chewing gum. They are placed under the skin, in the thoracic or chest region, just like a pacemaker or defibrillator and used to monitor the heart function and record abnormal heart function, high heart rates and abnormal rhythms. They monitor the cardiac activity of the patient who may ultimately need a pacemaker or defibrillator fitting. These devices contain a battery, which poses a risk of exploding when subject to cremation and so need to be removed prior to cremation. They can be removed in the same way as a pacemaker or defibrillator prior to cremation. Once removed, these units should be cleaned, disinfected and placed into a sealable plastic bag with the name of the patient and the date of removal and returned to the hospital who fitted the implant.

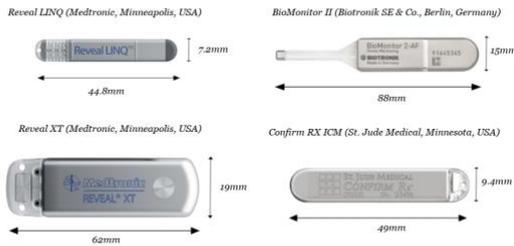
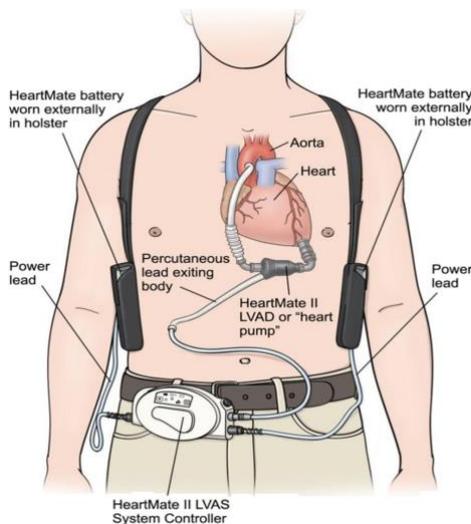


Diagram of different Cardiac Loop Recorders

### Ventricular Assist Devices:

The Ventricular Assist Device is a mechanical pump and is fitted to people with weakened hearts to support blood flow. Blood is taken from the left or right ventricle of the heart and pumped either to the lungs or to the body and vital organs. These devices can be referred to as left or right Ventricular Assist Devices (LVAD OR RVAD) or Biventricular Assist Devices (BiVAD). These terms refer to where the pump is located in and on the heart. They are used when transplantation is not an option or when the heart needs additional support before transplantation or event to support the heart following on from surgery to allow it time to repair following surgical intervention or myocardial infarction. The battery packs for VAD's are worn externally by the patient and should be checked and removed when the patient is prepared for burial or cremation. The implantable unit may be safe to undergo the cremation process however, this should be checked with the manufacture and implanting hospital as well as the medical referee of the Crematorium Authority in question.



If the pump component of the VAD needs to be removed and the deceased person is to be embalmed, removal is best done after the arterial injection of the deceased is completed, but before cavity aspiration and embalming is carried out. A midline incision is required to expose the sternum, which should be removed as if an autopsy were being performed. The heart can be exposed, once the sternum is removed and the device can be removed before reconstruction takes place. The removed



device should be cleaned and disinfected and then placed into a sealable plastic bag, with the name of the deceased, the date of death and date of removal labelled on the bag. Where possible, the VAD should be returned to the hospital where it was implanted. Once removal is completed, the sternum should be replaced and the incision sutured closed with tight sutures, to prevent leakage, prior to cavity aspiration and treatment being performed. The next of kin or person arranging the funeral should be informed if this type of procedure is required and should ideally give their consent in writing prior to removal.

### **Implantable Drug Pump:**

These pumps are typically used for targeted pain management and most frequently are used in cases of Chronic Pain. The unit itself comprises a pump unit with a drugs reservoir and a delivery system. The unit is placed under the skin, usually in the region of the abdomen, although sometimes the gluteal region is favoured. These units contain a battery and there is a risk of explosion when exposed to the temperatures generated during exposure. To remove this device, the same procedure for the removal of a pacemaker or defibrillator is followed. The incision is made over the device, which is then withdrawn, and the delivery leads cut. Once removed, the incision is treated with sealing powder and sutured tightly to form a leak proof seal. The device is then cleaned and disinfected, prior to being sealed in a bag labelled with the patient's name and the date of removal. As always, where possible the unit should be returned to the implanting hospital for disposal.

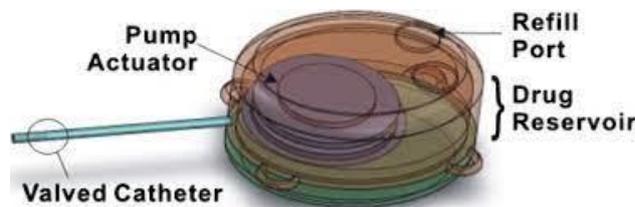


Diagram of Implantable Drugs Pump

### **Radioactive Implants: (Brachytherapy)**

Radioactive Iodine 125 seeds are used in the treatment of various types of cancer. These radioactive seeds are usually placed within or next to the area requiring treatment. They offer a continuous low dose of radiation to kill cancerous cells and also help to stop the reproduction of cancerous cells. Brachytherapy has been shown to be effective in the treatment of cervical, prostate, breast and skin cancer and is most commonly used in the treatment of prostate and cervical cancer. The radiation in the seeds typically lasts for up to 12 months and should the patient die within this time, the seeds will need to be removed. Following a period of 12 months, the seeds can remain in place and should pose no problems for anyone handling the deceased or for burial or cremation. Further information on brachytherapy can be obtained from the Department of Nuclear Medicine of the hospital implanting the seeds. Guidance should be sought from this department and the medical referee of the cremation authority concerned. If removal is required, the implanting hospital will need to be consulted.

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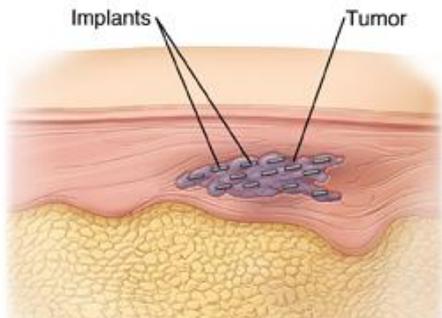


Diagram of Brachytherapy seeds

### **Fixion Nails:**

These nails are typically made from surgical Titanium and inserted into the medulla or marrow cavity of a long bone, most often the Femur. This is usually done following breakage or loss of bone density owing to conditions such as Osteoporosis. The steel rod or nail is hollow and once inserted into the bone cavity is pressurised by the injection of a sterile saline solution. Owing to the pressure of the saline within the hollow tube, there is a significant risk of explosion when subjected to cremation. The fixation nail should be depressurised by releasing the saline, by drilling or cutting.

There is some debate as to how easy it is to depressurise these nails and some embalmers have developed their own ways of dealing with them. Some have used metal drills and others have cut through the femur and the nail using a reciprocating or oscillating saw. Another technique is to make an incision into the thigh to allow access to the femur, remove a segment of the upper part of the femur to expose the nail and then remove a two-inch section of the nail. The cut part of the femur is then glued back into place and the incision in treated with sealing powder and sutured tightly closed to prevent leakage. This gives a good cosmetic effect and provides a segment of the nail, which can be cleaned and disinfected and presented to the medical referee if required, to prove depressurisation.

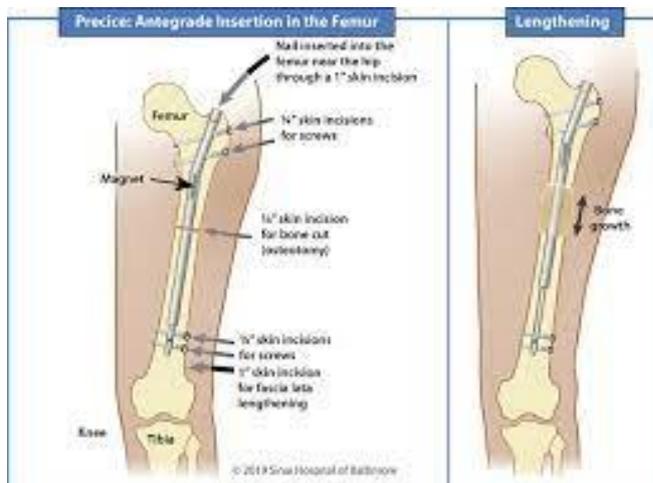


Diagram to show Fixation Nail

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### **Implantable Stimulators:**

These devices are used to manage chronic pain and wires from the unit are connected to the epidermal space, near the spine. The device is roughly the size of a pocket watch and is implanted under the skin of the abdomen or in some cases, in the gluteal region. The unit contains a battery, similar to that in a pacemaker and is at risk of explosion when subject to cremation. The removal of this unit is similar to that of a pacemaker and once removed, should be washed, disinfected, labelled with the details of the patient and returned where possible to the implanting hospital.

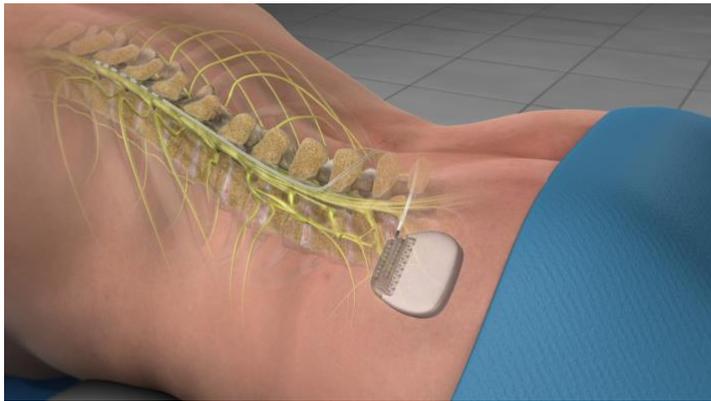


Diagram Showing Implantable Stimulator

### **Hydrocephalus Programable/ Non-Programable Shunts:**

These shunts are used to drain an excess of cerebral spinal fluid from the chambers within the brain. The excess CSF is diverted from the brain into the body where it is reabsorbed to help control the internal pressure within the brain. There are two types of shunts that can be used, programable and non-programable shunts. The programable shunts can be adjusted once they have been implanted into the patient, using a hand-held device, which is held over the unit. The non-programable shunts cannot be adjusted once they have been implanted. Both types of devices use a valve which is pre set to react to a change in the pressure of the CSF. As the pressure rises, the valve opens and excess CSF is drained. As the pressure falls, the valve closes and fluid stops draining.

Typically, these devices do not contain a battery, however they are detailed in the Ministry of Justice 'The Cremation (England & Wales) Regulations 2008, as being at risk of exploding when subject to cremation. Therefore, they are likely to need to be removed. Guidance should be sought from the Medical Referee of the local crematorium authority.

Should one of these shunts need to be removed, the device can usually be located behind either the left or right ear of the deceased. A small incision can be made over the device, which is then withdrawn and the tubes running from it can be cut. The device is then cleaned, disinfected and placed in a bag labelled with the details of the patient, so that it can be returned to the implanting hospital. The incision is then treated with sealing powder and the sutured closed with tight sutures, to prevent leakage. The hair of the deceased can then be washed, dried and styled to hide the incision.

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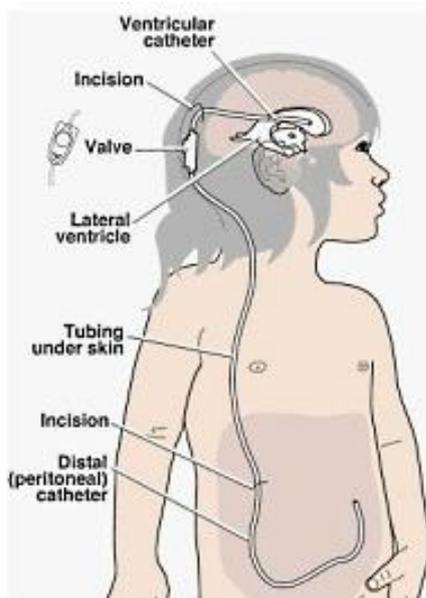


Diagram to show Implant and Use Hydrocephalus Programable/ Non- Programable Shunt

### **Transcatheter Systems:**

The latest advance in implantable medical devices is the Micra Transcatheter Pacemaker. The Micra Transcatheter Pacemaker is 93% smaller than a traditional pacemaker and is implanted directly to the wall of the ventricle of the heart and is leadless. The unit features an ultra-low power system which is designed to offer a lifespan of up to 12 years, depending on usage and is fully compatible with MRI Scanning. These pacemakers are minimally invasive to implant and are placed using a venous catheter which is fed up to the heart from either the left or right femoral vein. Following successful implantation, the patient should not require an overnight hospital stay and should fully recover a day or two after the procedure. Should the unit need to be replaced, up to three of the Micra Transcatheter Pacemakers can be sited on the Ventricular Wall of the heart before a redundant unit needs to be removed. These units can also be used in conjunction with traditional pacemakers or defibrillators, meaning that a patient could have a Micra Transcatheter Pacemaker and a more traditional unit in situ.

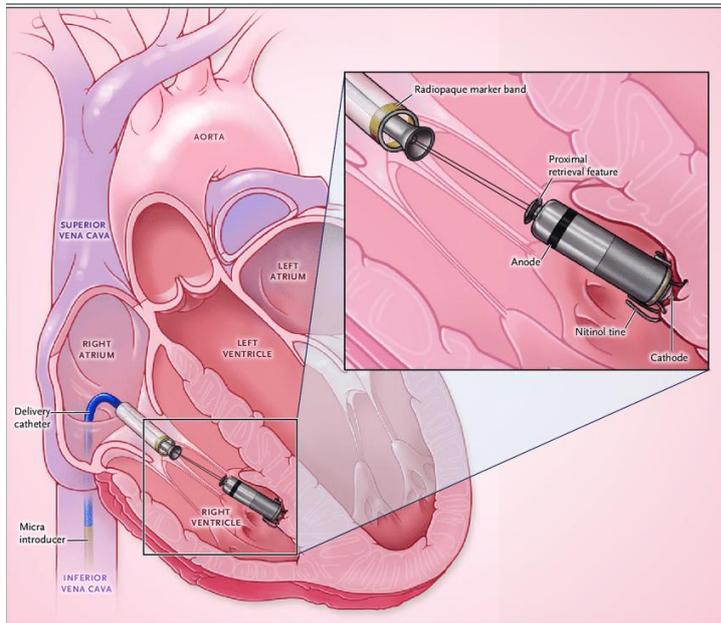
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Documentation from the manufacturers of these devices along with tests from some of the major manufacturers of cremation equipment show these devices to be compatible with cremation. Each individual crematorium authority or company will have their own directions as to whether these newer types of pacemakers need to be removed or not prior to cremation and if in any doubt at all, clarification should always be sought from the manager and medical referee. Those arranging a funeral should satisfy themselves as to what type or number of implants may be in place and seek clarification regarding this as necessary.

There has been much discussion as to how these devices can be removed, given that the device is so small and is implanted directly into the wall of the heart. One approach is to make a midline incision, similar to that of an autopsy to expose the sternum. The ribs are cut through at the point of the cartilaginous joint to allow removal of the sternum and the operator can access the heart. The left ventricle is palpated to locate the unit, which can then be exposed through an incision into the wall of the heart to allow access. In a case where embalming is to be carried out, this should be done after the arterial injection of the deceased, but before cavity aspiration is performed. There is a risk that aspiration could dislodge the device and make it more difficult to retrieve. For this reason, it is also suggested that vein drainage be performed, instead of atrial drainage, which poses a risk of dislodging the unit. Once removed, the unit can be cleaned, disinfected, bagged and labelled for return to the implanting hospital. The sternum is then replaced, the incision treated with sealing powder and closed with a tight suture to provide a leak proof finish. This procedure is very invasive and may take some time to complete.

An alternative procedure is to make an incision between 2 and 5 inches long, along the underside of the 5<sup>th</sup> rib. Once incised, the rib can be separated from the sternum by cutting through the cartilaginous joint and then pushed to one side, to allow access to the apex of the heart. The heart is palpated to feel for the device, which is then removed through an incision into the ventricle. The removed device is cleaned, disinfected, bagged and labelled for return to the implanting hospital and

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the heart and rib replaced in their normal anatomical position. The incision is treated with sealing powder and closed with a tight suture to prevent any leakage. If the deceased is not to be embalmed, this procedure can be carried out at any time, however if embalming is to take place, the procedure should be performed after arterial injection but before cavity aspiration and vein drainage should be used in place of atrial drainage. This is still invasive, but not to the same degree as the first procedure. Whatever procedure is used, the person arranging the funeral should be informed and written consent obtained.

Medical science will continue to advance as newer and better ways are found and developed for overcoming a variety of illness, conditions, and problems. Those of us working in the bereavement services will need to find newer and better ways of meeting the challenges these advancements have on the care and preparation of the deceased as well as care and support that we provide to the bereaved. We all have seen many changes in our work and what we are required to know and do. Professionally speaking, if we have a desire to learn and share the benefits of our experience with our colleagues, there isn't much that we cannot overcome.

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