G76 The Pathologist's Role in Preserving Implanted Pacemakers and Cardiac Defibrillators or How Not to Get Shocked!

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After attending this presentation, attendees will understand the standardization of techniques for safe and effective explantation of implanted electric cardiac devices such as pacemakers, defibrillators, and leadwire systems.

This presentation will impact the forensic science community by demonstrating how careful adherence to recommended procedures by medical examiners will minimize damage to retrieved implanted cardiac devices (pacemaker, ICD, CRT-D and leads), and will facilitate postmortem device analysis and cause of death determination. In addition, appropriate pre-extraction planning of methods for removing implanted defibrillator leads will reduce risk of electrical shock for personnel.

Permanent implantable electrical cardiac devices such as Pacemakers, Implanted Cardiac Defibrillators (ICDs), and Cardiac Resynchronization Therapy-Defibrillators (CRT-D) are common therapies. On occasion, the function or malfunction of such devices has been suspected in patient deaths, especially in view of recent large recalls. It is possible to determine what role, if any, an implanted cardiac device could have played in a patient's death from postmortem examination of a retrieved device, interrogation of stored memory, and additional testing even several years after death. It is very important that implanted electrical devices and associated leads be considered for retrieval as a system. The goals for removal of pacemakers/ICDs/CRT-Ds are: (1) keep as much of the total system together and intact as possible, (2) identify the components for the device and how it was implanted before retrieval, (3) document throughout the retrieval process, and (4) keep explanting personnel safe.

Before attempting removal of any implanted electrical device system, it is advisable to familiarize yourself with how it is implanted, and possible risks. Whenever possible, review any x-ray or imaging that shows the device and lead(s). Pacemakers, ICDs and CRT-Ds are surgically implanted in a similar manner, in a prominent palpable subcutaneous pocket located usually on the left chest or abdomen. Electrical leadwires (leads) are attached to a pacemaker, ICD, CRT-D by screws in a "header." Leads are usually tunneled together upwards through the left chest and into the medial left subclavian vein and then to the appropriate areas of the atrium and ventricles.

The lead carries electric current to the electrode attached to the patient's heart and carries sensed electrical information to the pacemaker/ICD/CRT- D. These signals are processed by an on-board computer and software for interpretation and delivered therapy. The treating physician has prescribed desired device performance by programming the device. An electrical lead is made of an outer layer of plastic insulation, an often intricate inner metal wire core for carrying current, a terminal electrode attached to the heart's surface, and an attachment to the device's header. Lead failures are known to account for approximately 50% or more of implanted electrical system failures. Therefore, it is vital that we attempt to optimize lead retrieval during postmortem examinations. Also of note, additional unattached leads may be found because when leads are replaced in patients often times original leads are simply abandoned—and often it is the abandoned leads that are of interest. Therefore, whenever possible both the pacemaker/ICD/CRT-D and the attached lead should be extracted as a single device system, along with careful extraction of any abandoned leads.

The pacemaker/ICD/CRT-D subcutaneous pouch should be documented by sketches or photographs looking for pre-mortem burns or charring of the walls, type and amount of fluid present, or evidence of fluid ingress into the plastic header or metal pacemaker/ICD/CRT-D case. All findings and clinical impressions about explanted lead(s) and attachment to pacemaker/ICD/CRT-D header should be documented for the record and photographed.

ICDs and CRT-Ds are about the same size as pacemakers and are implanted in a similar manner, but because defibrillators use high energy, they represent a significant safety issue. ICD/CRT-D leads have a special terminal electrode attachment for defibrillation. For retrieval of ICD or CRT- Ds which remain switched on, personnel must be aware to avoid inadvertent contact with the lead's terminal defibrillation electrode. The ICD/CRT-D terminal electrodes resemble springs or coils and are attached to the end of the lead attached to the heart, and must be assumed to be "hot" even after a patient's death. Retrieval procedures can induce electrical signals in to the ICD/CRT-D that, while artifact, may set the device up to deliver a shock. If an ICD/CRT-D is known to be implanted in a patient, prior to starting an autopsy or retrieval, identification of the make and model of the device and consultation with a cardiologist can help ensure the unit is switched to "off" to reduce the risk of shock. A patient's chart can also be examined to determine if the unit was switched to "off" prior to death. However, it is always best to handle a retrieved terminal electrode from a defibrillator as if it is still "hot" and capable of delivering an electrical shock.

Brief background information on pacemakers and ICDs with appropriate references will be presented, along with a detailed suggested extraction protocol.

Implantable Cardioverter Defibrillator, Cardiac Resynchronization Therapy Defibrillator, Pacemaker

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