ANAESTHETIC MANAGEMENT OF PATIENTS WITH PACEMAKERS AND IMPLANTABLE CARDIOVERTER DEFIBRILLATOR.

The number of patients with cardiac implantable electronic device (CIED) has continued to grow at an astounding rate over the years. However, the comfort level of most anaesthesiologists in delivering anaesthesia and postoperative care to these patients has remained at a very low level although periodic reviews have appeared in literature at regular intervals. It is also not clear whether patients with pacemakers or implantable cardioverter defibrillators (ICD) have an increased perioperative morbidity / mortality. Magnet application still appears to be the standard management of such patients. While magnet application may be appropriate in many instances, blind magnet application without knowing its limitations and complications is nothing more than acquiring a false sense of security.

The American Society of Anesthesiologists (ASA) came out with a practice advisory on the management of patients with CIED in 2005 (1). Practice advisories should not be considered as guidelines as they are not supported by robust literature as when guidelines are generated. Thus, practice advisory is not a standard of care and the readers can follow, reject or modify the suggestions based on their experience and judgment. However, practice advisories do aid in decision making to ensure safety of patients. This ASA advisory was further updated in 2011(2). There are no new management recommendations in the 2011 advisory but what is enlightening is i) emphasis being now placed on individualized approach to patient management ii) effective multi-disciplinary approach before the procedure iii) team approach throughout the perioperative period and iv) a reduced reliance on individuals from the industry (Industry Employed Allied Health Professional (IEAPs) to independently manage patients CIED patients in the absence of physician direction. It is now accepted that an IEAP can assist in the implementation of a program but cannot independently recommend perioperative management (2).

Basis of pacemakers.

Pacemakers are indicated in any patient with symptomatic sinus bradycardia, atrio-ventricular (AV) block of any etiology, documented periods of sinus arrest more than 3 seconds and following catheter ablation of the AV node. Pacemakers can be temporary or permanent. They can be instituted as external pacing pads, transvenous insertion of temporary pacing wires through a central venous line or permanent implantation of a sophisticated pulse generator.

Pacing can take place in a single chamber (atrium or ventricle), dual chambers (atrium and ventricle) or multiple chambers (bi-ventricular pacing). Pacemakers can employ bipolar or unipolar leads although in the last 15 years there has been a tendency to use bipolar leads. In bipolar leads, both the anode and the
cathode are present on the same lead (and thus the distance between them is minimal), whereas in unipolar leads the pulse generator acts as the anode (lead tip is the cathode) and therefore the distance between them is longer. The clinical relevance of this is that bipolar leads are less susceptible to electromagnetic interference (EMI).

Pacemaker devices can be implanted in the atrium, ventricle or as in dual chamber devices, in both atrium and ventricle. Depending on the programming, in a single chamber device, the device can sense the intrinsic electrical activity and either “trigger” or “inhibit” pacing of that chamber. Devices are programmed for specific “escape intervals”. If an electrical activity is not sensed during the programmed time interval, the device will trigger depolarization of that chamber. If an electrical activity is sensed within the preset time interval, the device will inhibit itself and wait for a subsequent depolarization during the next preset interval.

Dual chamber pacing, a very “physiological” pacing technique is capable of sensing both chambers and either trigger or inhibit pacing in or both chambers. The mode is considered physiological as ventricular systole is preceded by atrial contraction and the atrial rate is the same as the ventricular rate. Dual chamber pacing optimizes left ventricular (LV) filling, AV synchrony and ultimately improves cardiac output (CO). Dual chamber pacing also minimize AV valve regurgitation that occurs with isolated ventricular pacing and retrograde atrial depolarization. More than doubling of CO has been demonstrated with atrial pacing for the treatment of AV junctional rhythm in patients with ischemic cardiomyopathy.

**Pacemaker coding**

The North American Society for Pacing and Electrophysiology (NASPE) and the British Pacing and Electrophysiology Group (BPEG) has adapted a generic code for antibradycardia, adaptive rate and multisite pacing (3). The code has been universally adopted to reduce confusion and improve communication between different practitioners caring for patients with pacemakers.

The first letter denotes the chamber paced (A for atrium, V for ventricular and D for dual (both) chambers), the second letter describes the chamber being sensed (A, V or D as described earlier and an additional O when pacemaker discharge is not dependent on sensed activity). The third letter denotes the response to sensed events. Here the letter O indicates no response to electrical signal and is related to the absence of a sensing mechanism whereas “T” or “I” represents either a triggered electrical activity or inhibition to a sensed response. This has resulted in designations like AOO, VVI or DDD. It is important to understand these terms to understand the pacing behavior of the device. In AAI, the device is programmed to pace the atrium at a set rate only if there is no sensed activity during the set escape
interval. If an activity is sensed by the device during this period, the device inhibits itself, thus the letter “I” in the third position of the designation. AAI is generally useful in patients with sinus bradycardia with normal AV conduction.

VVI is usually used in patients with atrial fibrillation with slow ventricular rates. The ventricle is paced at a preset rate if no activity is sensed in the preset escape interval. Patients with impaired AV conduction but with normal sinus function will require a device in VAT mode. Each sinus beat should be followed by a corresponding ventricular contraction. In VAT mode; the device senses the atrial activity and triggers a ventricular response if there is no sensed activity in the escape period. This will also allow increased heart rate in response to exercise. However, this mode is not appropriate for patients with atrial arrhythmias. DDD is considered the “smart” mode as it is capable of sensing and subsequent triggering or inhibition of both atrium and ventricles.

Pacing modes that preserve AV synchrony are AOO, AAI, DOO, DVI, DDI and DDD. Those that sense atrial activity and trigger ventricular activity are VDD, VAT and DDD. Asynchronous modes (AOO, VOO DOO) are usually used for temporary pacing activities.

**Fourth and fifth position of NASPE codes.**

The fourth position of the code indicates the presence or absence of rate responsive pacing while the fifth position indicates the presence or absence of multisite pacing.

*Rate modulation.*

Rate modulation allows the pacemaker to increase the heart rate in response to increase physical activity or physiological needs. Physiological determinant that primarily determine sinus node function (circulating catecholamines or autonomic activity) is still in developmental stages. Secondary classes of sensors that detect physiological consequences of exercise (reduction in venous pH, shortening of QT interval, increase in minute ventilation or respiratory rate or increase in right ventricular stroke volume) have been developed but is still not very relevant clinically. A third group of sensors and perhaps the most commonly used clinically are sensors that detect external changes in response to exercise; like body movement. It is important to consider the type of sensor used to detect rate modulation in relation to the site of surgery. Operative movement in close proximity to such generators can stimulate unwanted tachycardia. Similar precaution should also be taken in patients in whom rate adaptive response is dependent on minute ventilation, as large tidal ventilation has been shown to interfere with these devices.

*Multisite pacing.*

*Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators*
Position V in the code indicates the presence or absence of multisite pacing. This indicates the presence of more than one lead in a single cardiac chamber or biventricular pacing. The former refers to the presence of more than one lead in the atrium in attempts to suppress atrial fibrillation but this is still in its infancy. On the other hand, biventricular pacing (also called cardiac re-synchronization therapy (CRT)) is well established and clinically very relevant. CRT is achieved through an additional lead (in addition to the atrial and right ventricular lead) placed transvenous though the right atrium and coronary sinus to stimulate the lateral wall of the LV.

Chronic heart failure is accompanied by conduction defects due to sinus node and AV nodal dysfunction as well as interventricular and intra-ventricular conduction delays resulting in incomplete RV and LV systole. QRS duration of > 170 msec is associated with high mortality from sudden cardiac deaths. CRT utilizes atrial synchronized bi-ventricular pacing where LV and RV activation is timed to synchronize RV and LV ejection. The aim of bi-ventricular pacing is to optimize segmental electrical excitation, timing of contraction and relaxation and consequently cycle efficacy (4, 5). In CRT, in addition to AV sequential pacing of the RV, the LV is also paced and its contraction is carefully timed to improve the synchrony between the RV and LV ejection. This also results in overall improvement in LV systolic contraction. CRT is currently indicated for reduction in symptoms of moderate to severe heart failure (NYHA 111 or 1V) in patients who remain symptomatic despite adequate medical therapy with a LV ejection fraction < 30% and QRS duration of > 130msecs. In some patients biventricular pacing can increase the QT interval producing torsades-de-pointes. Thus access to rapid defibrillation should be present in such patients (6).

**Implantable Cardioverter Defibrillator**

ICD’s are devices that are capable of detecting a ventricular arrhythmia and delivering a defibrillator shock. Since the first implantation in 1980, the pulse generator which was then implanted in the abdomen, has become progressively smaller and is now implanted in a subcutaneous pectoral pocket. The present generation ICD’s can terminate 98% of ventricular fibrillation (VF) episodes. All such devices now incorporate sophisticated pacemaker technology in case a defibrillator shock results in ventricular asystole and to deliver anti-tachycardia pacing to terminate ventricular tachycardia (VT).

The NASPE/BPEG has also approved a four code description for ICD’s. The first letter denotes the chamber in which the shock is delivered (A-atrial, V-ventricle, O-none or D for dual), the second letter denotes the chamber in which anti-tachycardia pacing is delivered (also coded O, A, V or D). The third letter denotes the mechanism by which tachyarrhythmia is detected, either with an intra cardiac electrocardiogram (ECG) or by hemodynamic means (H). It is assumed that hemodynamic monitoring
includes ECG. The fourth position is the three to five letter codes for the pacemaker capability of the device. Thus an ICD device may have a code which reads like VOH-VVIR.

In patients with cardiomyopathy and reduced LV function, large clinical trials have shown clear survival benefit with the prophylactic use of ICD’s as compared to medical therapy. This benefit is seen in ischemic cardiomyopathy as well as non-ischemic cardiomyopathy primarily due to prevention of sudden cardiac deaths. Thus, ICD’s have become a definitive therapy for patients with malignant arrhythmias. ICD’s use an RV lead to sense electrical activity and deliver a shock if necessary. They may use a single lead (RV chamber), dual leads (atrial and ventricular leads) or three leads (CRT device). Devices are programmed to identify different types of malignant arrhythmias and deliver an appropriate therapy. Identification of different arrhythmias is based on different zones of heart rates programmed into the device taking into consideration the specific pathology and risks in a given patient. When a fast ventricular rhythm of sufficient duration is sensed by the device, a tachyarrhythmia is declared. Based on the rate, programming and duration of arrhythmia, the device begins a sequence of therapies. Generally slower ventricular rates are considered as VT and managed with over drive pacing. If this does not terminate the arrhythmia, then a defibrillatory shock is delivered. If the initial rate falls into a higher zone, then a direct defibrillatory shock is delivered. An additional sensing electrode in the right atrium helps distinguish true ventricular tachycardia from conducted supraventricular tachycardia and avoid unnecessary, unpleasant and potentially deleterious ICD discharges.

**Perioperative preparation of patient.**

It is clear that precise information about a patient’s CIED and recommendation from the CIED team for the day of surgery can be very helpful. Failing this, the presence of an IEAP or knowledgeable colleague with a programming device will be helpful to ensure device function. Unfortunately, such ambitions cannot always be guaranteed as patients can come in for emergency procedures at odd hours of the day. In such situations, it is left to the anaesthesiologists to gain key information and understand what can cause problems with a CIED. Anesthesiologists are also expected to take recommended measures as suggested by ASA practice advisory to avoid these problems.

Adverse outcomes to be avoided during the perioperative period are:

i) Damage to the device, leads or site of lead implantation
ii) Failure to deliver pacing or defibrillation
iii) Changes in pacing behavior
iv) Inappropriate delivery of a defibrillatory shock

*Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators*
v) Inadvertent electrical reset to backup pacing modes

Any of these unfortunate events may lead to hypotension, arrhythmias, myocardial damage and ischemia of the heart or other vital organs. The most common problem that the anesthesiologist is going to face in the perioperative period is electromagnetic interference (EMI)

**Electromagnetic interference.**

Any device that emits radiofrequency waves between 0 and $10^9$ Hz can generate EMI and therefore interfere with pacemaker/ICD function. Thus electrocautery, magnetic resonance imaging (MRI), extracorporeal shock wave lithotripsy, electroconvulsive therapy, radiofrequency ablation, shivering, fasciculation’s and large tidal volumes may create problems in patients with these devices. Higher frequency waves (X-rays, γ rays, infrared and ultra violet rays) are unlikely to cause interference with CIED.

EMI interference in pacemakers and ICD’s can result in:

i) Inappropriate inhibition or triggering of a paced output

ii) Asynchronous pacing (which may compete with a regular rhythm and can precipitate an arrhythmia)

iii) Reprogramming (usually into a back up mode, often this is VVI or VOO) s

iv) With ICD’s EM can result in inappropriate delivery of a defibrillatory shock

Prolonged EMI may result in the device going into a noise reversion mode or noise suppression mode in which asynchronous pacing will occur till the noise stops. The major disadvantage of this is that this may result in loss of AV synchrony and hemodynamic imbalance. In addition, current can be induced down the leads resulting in an inappropriate electrical discharge to the myocardium that can result in arrhythmias or burns. Damage to the circuitry can also occur. Unrecognized EMI should be suspected if pacing modes tend to change intermittently or suddenly on the ECG monitor.

The susceptibility of modern pacemakers to EMI has decreased considerably over the years. This primarily because of the availability of bipolar leads although unipolar leads are still used in pediatric population, in epicardial placed leads in adults who require them for optimal function. Bipolar leads are considered safer because of the short distance between the anode and cathode (both placed near the tip of the leads) resulting in a short circuit distance. The larger distance between the cathode, at the tip of the lead and the anode which is the pulse generator results in a longer distance where EMI can occur. In addition, modern circuits are also protected by components like filters and circuit shields.

*Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators*
Magnets and pacemakers.

It is interesting to note that magnets were never intended to treat pacemaker emergencies or prevent EMI effects. Pacemakers have magnet activated switches to produce pacing behavior that demonstrates remaining battery life and sometimes pacing threshold safety factors. Application of a magnet over a pacemaker converts it into an asynchronous mode and protects for the effects of EMI. However, not all magnets have to convert into the asynchronous modes and this behavior has to be confirmed with the manufacturer. The asynchronous mode obtained depends on the remaining battery life, programming of the device and defaults that vary by the manufacturer. Normal asynchronous modes used include AOO, VOO or DOO and depends on the programming configuration of the device. Once a magnet is applied, asynchronous pacing persists as long as the magnet remains in place over the pulse generator. Applying the magnet does not always solve problems as it can result in competitive pacing. This occurs when the magnet induced asynchronous pacing competes with patients own heart rate, which may fall on a vulnerable period and induce risk of arrhythmia.

Magnets and ICD.

A magnet placed over an “ICD only” device will suspend its anti-arrhythmia function and prevent accidental discharge. This is specifically in situations where the device does not have pacemaker function. In some devices (Medtronic, St Jude), it is essential that the magnet remains over the device to keep it inactivated. In others (Boston Scientific), magnet deactivation is different, as magnet application will result in audible R-wave detection tones. If the R-wave detection tone continues beyond 20-30 seconds, then tachyarrhythmia function will be suspended as long as the magnet remains over the device. Once the magnet is removed the anti-tachyarrhythmia function will restart. If the tone changes to a solid tone after 30 seconds, then it indicates that the device is permanently deactivated and the magnet can be safely removed. Re-activation will occur when the magnet is replaced over the device for 30 seconds when the R-wave tone reappears.

In modern ICD devices where combined ICD with pacemaker function is available, the standard magnet will inactivate the anti-tachyarrhythmia function but the pacing behavior will not change to an asynchronous mode. Thus, in a patient with combined ICD with pacemaker, if it is desired to protect a pacemaker dependent patient from the effects of intraoperative EMI, re-programming of asynchronous mode will have to be performed by an IEAP.

Preoperative evaluation.

Key principles in the preoperative evaluation of a patient include:

*Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators*
i) Determining that a CIED is present in a patient

ii) Defining the type of device

iii) Determining whether the patient is dependent on the anti-bradycardia pacing

iv) Determining whether the device is functioning as intended

Although there are no clinical trials, anecdotal case studies have shown that incomplete evaluation prior to surgery can result in intraoperative problems. ASA recommendations state that comprehensive evaluation of the device be performed by a knowledgeable consultant using appropriate manufacturer’s programming device (2). However, the Task Force also acknowledges that this is not always possible. The presence of a CIED can be accessed from a complete history and physical examination of the patient. Further information can be obtained from an information card that the patient is expected to carry always. Occasionally the patient may give adequate information about the indication and functional capability of the device but this is rather unusual and rare. Thus, it is up to the anaesthesiologist to gather information from all available sources to give a picture of the functional capability of the device implanted.

The chest X-ray can give useful information about the device. Most modern devices use an X-ray code that can be used to identify the manufacturer of the device. The chest X-ray also gives information about the lead configuration and thus whether it is a single or dual chamber pacemaker, a biventricular device or an ICD. Anesthesiologist will be able to identify the number and location of the leads. Generally the RV lead of an ICD device will have two thick radio opaque sections representing the high voltage coil for delivery of a defibrillatory shock and terminals in the RV. A biventricular system will have an RA lead, another lead passing through the coronary sinus to the left side of the heart and a third lead in the RV with two thick radio opaque coils indication an ICD device. Evaluation of the X-ray may also show whether any of the leads is broken indicating faulty functional capacity.

Finally, if one can get any information on the manufacturer, further information can be obtained from calling up a cardiologist or an IEAP personal.

Next, it is essential to understand the pacemaker dependency of the patient on the CIED. If a knowledgeable consultant is available, the device can be re-programmed to a VVI mode at the lowest possible rate and see whether the patient is generating spontaneous ventricular activity. If this is not possible, further information can be obtained by quizzing the patient for history of symptomatic bradycardia or syncopal attacks or a history of AV nodal ablation as possible reasons for implantation of the device. The ECG should be closely examined. If every P wave or QRS complex is preceded by a
pacing spike the likelihood is high that the patient is pacemaker dependent and dependency should be the assumption.

Provocative maneuvers to elicit bradycardia (prolonged Valsalva maneuver, small dose of edrophonium, esmolol or adenosine) can help identify effective sensing, pacing and mechanical capture. However, this is not recommended by ASA practice advisory. Such maneuvers should only be carried out after assuring that a backup plan for emergency pacing is already in place.

**Preoperative preparation.**

This includes:

i) Determining whether EMI is likely to occur during the planned procedure

ii) Determining whether preoperative re-programming of the CIED pacing function to an asynchronous mode or disabling any special function including rate adaptive function is needed

iii) Suspending anti-tachyarrhythmia function if present

iv) Advising the person performing the procedure to consider use of bipolar electrocautery or consider using harmonic (ultrasonic) scalpel to minimize potential EMI effects on the pulse generator and leads

v) Assuring the availability of temporary pace making and defibrillation equipment

vi) Evaluating the possible effects of anesthetic techniques on CIED function and patient CIED interactions.

It is important to identify whether EMI is likely to occur during a planned intervention. Electro cautery, magnetic resonance imaging (MRI) and radiofrequency ablation has been shown to be associated with significant EMI. In patients who are dependent on the pacemaker for their anti-bradycardia function, it is advisable to change over to an asynchronous mode. This is best achieved by application of a magnet over the device in case of a pacemaker. It is also advised by the ASA that special functions including rate adaptive function should be suspended during the procedure. This can also be achieved by application of a magnet over the device or re-programming the device. The use of a magnet has the advantage that removal of the magnet immediately restores the previous settings. Magnet is not indicated in patients who are not pacemaker dependent for their ventricular rate (Fig 1).
The Task force does not routinely recommend application of a magnet over an ICD. However, the anti-arrhythmia function should be suspended if present (Fig 2). There are a couple of caveats to be considered here. For many ICD’s there is no reliable means to detect appropriate magnet placement. Placement of a magnet over an ICD will suspend the anti-arrhythmia function but does not convert this into an asynchronous mode. Moreover, it is equally important to understand whether the device has been programmed to ignore the magnet application. If a patient is dependent on the device for its anti-bradycardia function, then the device has to be re-programmed to the asynchronous mode before the procedure. The major advantage of using a magnet in an ICD patient is that temporary suspension of its anti-arrhythmia function is achieved with the magnet which can be rapidly restored in an emergency or at the end of the procedure.

For all CIED patients, it is important for the personnel doing the procedure to consider using a bipolar cautery or ultrasonic (harmonic) scalpel when applicable. Equally important as having the magnet induced deactivation of a pacemaker or a re-programmed ICD, is the need for appropriate monitoring and availability for temporary pacing and external defibrillation.

Anesthetic techniques or anaesthetics does not interfere with CIED function, However, the physiological consequences of anaesthetic techniques can create occasional problems. The most common of these is the induction of hyperventilation which will rapidly induce hypokalemia. Fasciculation’s, shivering and large tidal volumes can result in micro-potentials and are possible sources of EMI. Myocardial ischemia and high lactate levels can increase electrophysiological thresholds but are not very relevant clinically.

Intraoperative considerations.

The primary responsibilities during this period includes:

- Monitoring the operation of the device
- Preventing potential CIED dysfunction
- Performing emergency defibrillation, cardioversion or heart arte support.

The ECG as well as monitoring of the peripheral pulse (palpation of the pulse, auscultation of heart sounds, pulse plethysmography from oximeter or intra-arterial blood pressure tracing) should be continuously monitored during the surgery. The ECG should be displayed, as per ASA standards, through the course of surgery and if necessary continued into the postoperative period. These standards (ECG and pulse monitoring) should apply to all patients with CIED undergoing general anesthesia (GA), regional
Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators

Anaesthesia (RA) or monitored anesthesia care (MAC). Peripheral pulse monitoring is mandatory as pulseless electrical activity can go unnoticed in these patients.

Procedures during which EMI, MRI, radiofrequency ablation, radiation therapy can interfere and damage CIED function and need special attention

*Electrocautery interference:* The present recommendation regarding the use of electrocautery in patients with CIED include: i) positioning the cautery tool and the cautery return pad, so that the current pathway does not pass through or near the CIED system ii) avoiding proximity of the cautery electrical field to the pulse generator and leads, including avoidance of waving the activated electrode over the generator. iii) using short, intermittent and irregular bursts at the lowest possible energy levels, as well as using more “cutting” than “coagulation” current iv) using bipolar electrocautery systems or harmonic scalpel when possible.

*Radiofrequency ablation.* The risk of EMI from radio frequency ablation can be avoided by avoiding direct contact between the radio frequency catheter and the pulse generator and leads as well as keeping the radio frequency current path (from tip of catheter to current return pad) as far away from the pulse generator and leads.

*Lithotripsy:* The current recommendations regarding the use of lithotripsy in patients with CIED include: i) avoid concentrating the lithotripsy beam near the pulse generator ii) If the lithotripsy system triggers on the R wave, then atrial pacing might have to be de-activated before the procedure.

*MRI:* An MRI is generally contraindicated in patients with MRI. If an MRI is suggested for a patient with CIED, then a cardiologist as well as manufacturer of the device should be contacted.

*Radiation therapy.* The Task Force believes that radiation therapy can be safely conducted in patients with CIED. The device must be outside the field of radiation. This may require some pulse generators to be surgically relocated before starting radiation therapy. Most manufacturers insist on device verification before and after completion of the radiation therapy.

*Electroconvulsive therapy.* The Task Force believes that electroconvulsive therapy can be given to a patient without significant damage to the CIED device that has been disabled. All CIED’s should have comprehensive evaluation before the procedure. ICD function should be disabled before shock therapy during ECT. CIED dependent patients may have a temporary pacing system to preserve cardiac rate and rhythm during shock therapy. Also, the CIED may require programming to asynchronous mode to avoid myopotential inhibition of the device in pacing dependent patients.

*Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators*
Emergency defibrillation or cardioversion. During the procedure emergency cardioversion or defibrillation may be necessary. The primary concern is to minimize the amount of current passing through the pulse generator or leads. Before attempting defibrillation in a patient with ICD or pacemaker which is magnet disabled, all potential sources of EMI should be terminated and the magnet removed so as to enable anti-tachycardia therapies. The patient should then be observed for appropriate therapy. For the CIED patient whose anti-arrhythmia function has been disabled through programming, attempts should be made to re-program the anti-arrhythmia function. If the above steps do not improve the situation, proceed with emergency defibrillation.

Over-riding all the above suggestions is the need to follow the ACLS guidelines for resuscitation and defibrillation. If life threatening arrhythmias continue, follow ACLS guidelines for energy level. If possible reduce the amount of energy passing through the pulse generator and lead systems by i) positioning the defibrillation paddles as far away as possible from the pulse generator ii) positioning defibrillation paddles perpendicular to the major axis of the CIED pulse generator and leads, to the extent possible by placing them in an antero-posterior location. A clinically appropriate output should always be used irrespective of the presence of the CIED.

Postoperative management.

Cardiac rate and rhythm should be continuously monitored during the postoperative period. Back-up pacing facility and cardioversion defibrillation equipment should be available at hand. The CIED device should be evaluated for restoration of function in all cases. This is one of the more controversial decisions of the Task Force, as not all bodies agree with this recommendation. However, complete evaluation is primarily meant for the greatest safety of the patient although this may not turn out to be practical in all cases. If the interrogation reveals that the CIED functions are inappropriate, then re-programming the device is mandatory. For ICD, the anti-tachyarrhythmia function should be re-established at the earliest. Consultation with a cardiologist or IEAP may be necessary.

Summary.

1. Anesthesiologists should be fully aware of the functional capabilities of pacemakers and ICD’s

2. Magnet application over pacemaker devices converts it into an asynchronous mode.

3. Magnet application over ICD inhibits its anti-arrhythmia function but does not convert it into an asynchronous mode. If the pacemaker function should be retained then the device has to be reprogrammed.
4. The greatest threat during surgery is EMI from electrocautery. MRI is contraindicated in patients with CIED.

5. Primary principles to avoid EMI during surgery should be known and followed in the operating room. Harmonic scalpel or bipolar electrocautery should be used when possible.

6. ECG and peripheral pulse should be continuously monitored intraoperatively and postoperatively.

7. Facilities for emergency defibrillation should be available in the operating room. Before delivering an external defibrillatory shock, removal of magnet and observation for inherent anti-tachyarrhythmia function of ICD should be observed. ACLS guidelines should be followed. Energy levels and paddle position should be adjusted to minimize injury to the device and leads.
References.


Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators
Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators

Fig. 1 Shows flow chart for patients with pacemakers undergoing any procedure
Fig 2. Shows a flow chart of management of patients with ICD
Anaesthetic management of patients with pacemakers and implantable cardioverter defibrillators