Perioperative Management of Cardiac Implantable Devices

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Goals and Objectives

- Understand differences in types of cardiac implantable electronic devices
- Understand the perioperative management of CIEDs
- Understand the limitations and cautions with CIEDs
- Recognized the complications of perioperative management of CIEDs and how to avoid them
- Determine what is appropriate for outpatient surgicenter care with no backup, what is not appropriate for outpatient surgicenter care and how can you optimize your patients for safety and efficiency

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ABA: Always Blame Anesthesia

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Audience Poll

- 86 year old with CHF, Biventricular ICD, pacemaker dependent scheduled for knee replacement: this patient needs:
- A) Magnet placed over their ICD no interrogation after needed
- B) Rep or EP to come in and reprogram device before and after surgery
- C) Magnet applied during procedure and rep or EP to come in and interrogate after procedure while in PACU
- D) No intervention needed

4

Poll Results

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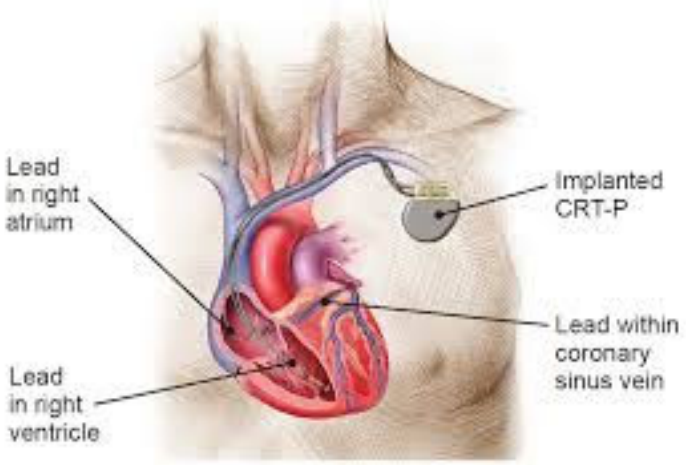
Pacemakers

- Single chamber, dual chamber and biventricular (3 lead devices)



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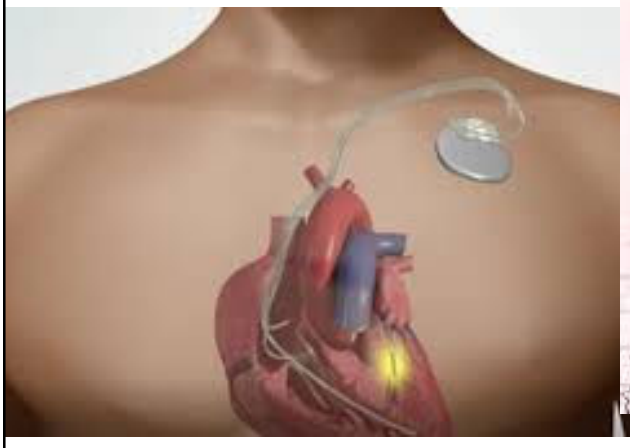

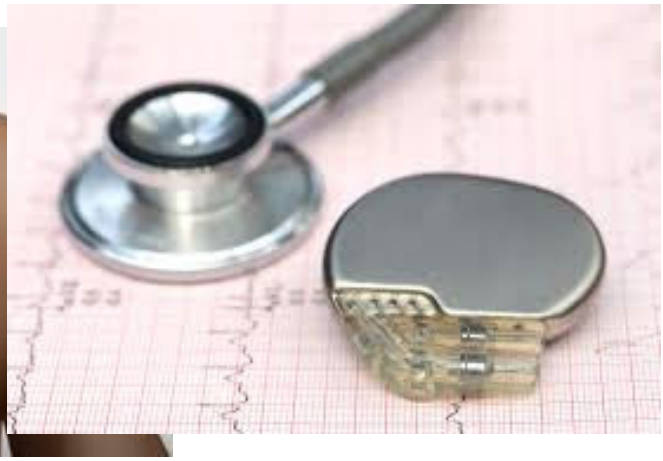

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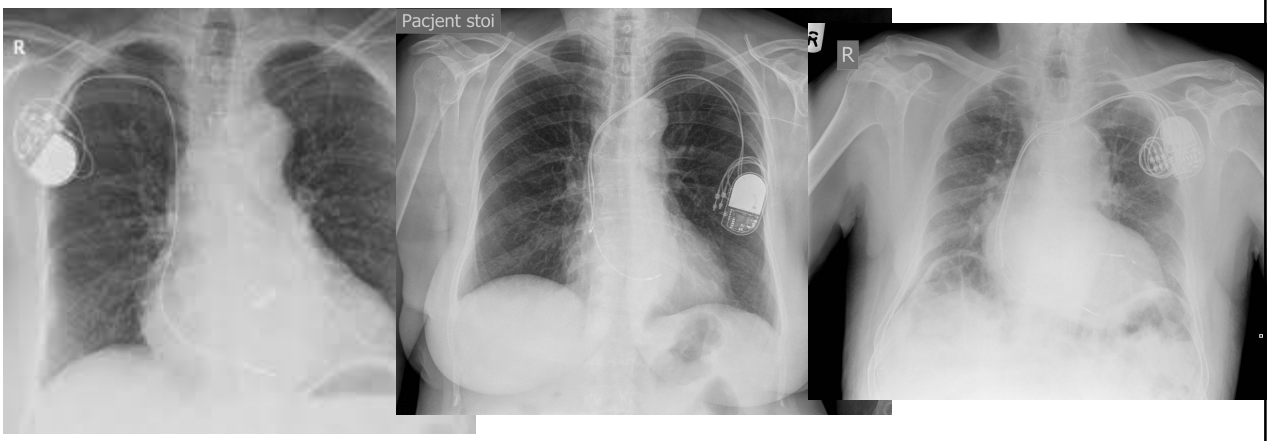
Pacemaker CXR



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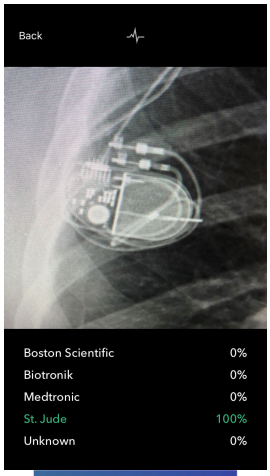
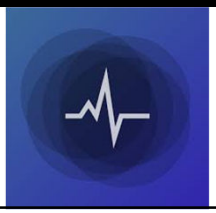
How can you find out the manufacturer?

- All patients are given a card when implanted: 10% still have the card in their possession when they come for their procedure
- You need to know which manufacturer made their device to call the manufacturer if you need reprogramming
- Medtronic 1-800-Medtronic
- Boston Scientific 1-800-Cardiac
- St Jude/Abbott 1-800-456-1477
- Biotronik 1-800-547-0394
- OR: download the PACEMAKER-ID app for your phone





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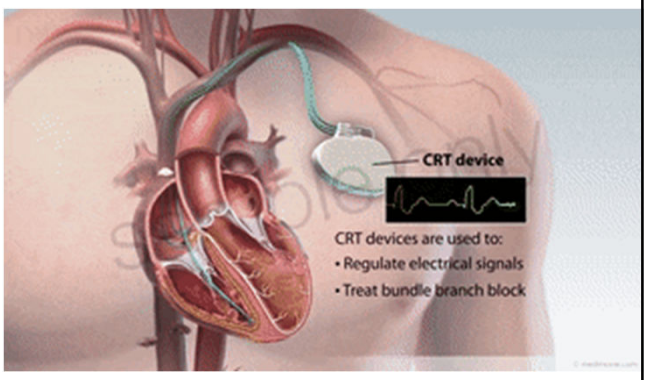
How do pacemakers work?

- Basic function of a pacemaker is to sense if there is native electrical activity in each chamber: if there is no native activity the pacemaker will pace the heart by generating an electrical impulse that will then depolarize the myocardium and generate mechanical systole: heart squeezes



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What does a bovie or plasmablade do to a pacemaker

- Pacemaker will detect electrocautery and will interpret that as intrinsic electrical activity: pacemaker thinks 'great news, the native conduction has returned, I can sit in the background and do nothing'
- If a patient is pacemaker 'dependent': meaning is they are using their pacemaker a significant amount then the pacemaker will be inhibited and there may be a significant pause if the patient does not have an intrinsic escape rhythm

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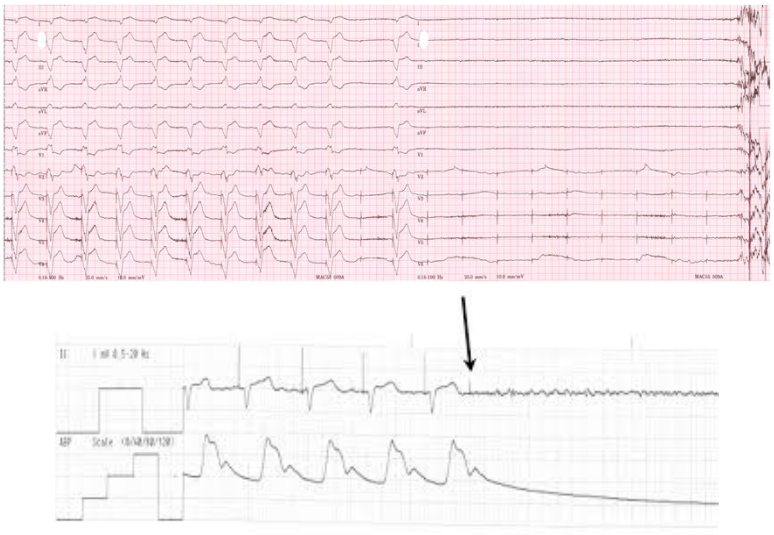
What a pacemaker does when it sees bovie



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What's a little asystole between friends?

- Short bursts will not cause long term or short term damage
- Can be asystolic for many seconds and patient will have no recollection 'Felt like I was asleep'
- Rare concern of 'long short' sequences: induction of asystole can rarely cause long short escape sequences that induce ventricular fibrillation (not ideal)
- Instruct your surgeon to limit the bovie or plasmablade to short bursts

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How short do the bursts need to be to prevent cerebral malperfusion (when do you lose consciousness)? How long is too much bovie?
-2 seconds
-4 seconds
-6 seconds
-10 seconds
-30 seconds

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Poll Results

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Archives of Neurology and Psychiatry (1943) 50 : 510-528

ACUTE ARREST OF CEREBRAL CIRCULATION IN MAN

LIEUTENANT RALPH ROSSEN (MC), U.S.N.R.*
HERMAN KABAT, M.D., PH.D.
BETHESDA, MD.
AND
JOHN P. ANDERSON
RED WING, MINN.

Numerous investigations have been concerned with the effects of acute arrest of cerebral circulation in animals. The earlier workers [1] studied the effects of ligation of the cerebral arteries. More recently, observations have been made on the effects of temporary occlusion of the chief cerebral arteries [2] and of temporary cessation of the heart beat.[3] Using the method of occlusion of the chief cerebral arteries, Sugar and Gerard [4] measured the survival time for different regions of the cat brain by the persistence of spontaneous action potentials. A careful study of the changes in function and structure of the brain of the cat resulting from temporary occlusion of the pulmonary artery was reported on by Weinberger, Gibbon and Gibbon.[5] These methods involved one or another of the following complications: anesthesia; surgical procedures at the time of arrest of circulation in the brain; incomplete arrest of circulation as a result of failure to occlude the anterior spinal artery; arrest of circulation in vital organs outside the central nervous system, and difficulty of determination of the exact moment of cessation of the heart beat.

For quantitative study a technic was utilized which produced sudden complete arrest of blood flow in the brain of the unanesthetized animal without the per-

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From the Hastings State Hospital, Hastings, Minn., and the Anderson Institute for Biologic Research, Red Wing, Minn.

1. Cooper, A.: Some Experiments and Observations on Tying the Carotid and Vertebral Arteries, Guy's Hosp. Rep. **1**:465, 1836. Kussmaul and Tenner: Untersuchungen über Ursprung und Wesen der fallsuchartigen Zuckungen, Untersuch. z. Naturl. d. Mensch. u. d. Thiere **3**:3, 1857. Hill, L.: On Cerebral Anemia and the Effects Which Follow Ligation of the Cerebral Arteries, Phil. Tr. Roy. Soc., London, s.B **193**:69, 1900.

2. Pike, F. H.; Guthrie, C. C., and Stewart, G. N.: Studies in Resuscitation: IV. The Return of Function in the Central Nervous System After Temporary Cerebral Anemia, J. Exper. Med. **10**:490, 1908. Gildea, E. F., and Cobb, S.: The Effects of Anemia on the Cerebral Cortex of the Cat, Arch. Neurol. & Psychiat. **23**:876 (May) 1930.

3. Boehm, R.: Ueber Wiederbelebung nach Vergiftungen und Asphyxie, Arch. f. exper. Path. u. Pharmakol. **8**:68, 1877. Batelli, F.: Le rétablissement des fonctions du coeur et du système nerveux central après l'anémie totale, J. de physiol. et de path. gén. **2**:443, 1900. Crile, G., and Dolley, D. H.: On the Effects of Complete Anemia of the Central Nervous System in Dogs Resuscitated After Relative Death, J. Exper. Med. **10**:782, 1908. Heymans, C.; Bouckaert, J. J.; Jourdan, F.; Nowak, S. J. G., and Farber, S.: Survival and Revival of Nerve Centers Following Acute Anemia, Arch. Neurol. & Psychiat. **38**:304 (Aug.) 1937.

4. Sugar, O., and Gerard, R. W.: Anoxia and Brain Potentials, J. Neurophysiol. **1**:558, 1938.

5. (*a*) Weinberger, L. M.; Gibbon, M. H., and Gibbon, J. H., Jr.: Temporary Arrest of the

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are the studies on recovery from attempted suicide by hanging [15] and resuscitation after cardiac arrest.[16]

All these investigations on acute arrest of circulation in the human brain were limited almost entirely to patients with various disorders, such as hypersensitive carotid sinus reflex, orthostatic hypotension and Stokes-Adams disease. Many of these patients were in the older age group and suffered from arteriosclerosis, hypertension or heart disease. The experiments were difficult to control, and much variation was noted, which limited the accuracy of quantitative observations. Furthermore, there is reason to believe [13] that the syncope resulting from stimulation of a hypersensitive carotid sinus reflex is complex and bears a closer relation to an epileptiform seizure than to syncope from cerebral anemia.

In order to study the effect of acute cerebral anoxia in man, a new technic was devised, which used the Kabat-Rossen-Anderson apparatus. This procedure is essentially an adaptation to the human subject of the method devised by one of us [6] for producing arrest of cerebral circulation by means of a cervical pressure cuff. Acute arrest of circulation in the human brain was studied in 11 schizophrenic patients and in 126 normal young male subjects. No deleterious effects were observed from repeated tests on these subjects.

ANATOMY AND PHYSIOLOGY

Arterial blood is supplied to the human brain chiefly through the internal carotid and the vertebral arteries, but to some extent by anastomotic connections of branches of the external carotid and the subclavian artery. In addition, some blood reaches the brain through the small spinal arteries.

The common carotid artery is readily occluded by external cervical pressure, blood flow to the brain through the internal carotid artery and branches of the external carotid artery being thereby eliminated. The ascending branches of the subclavian artery, with the exception of the vertebral artery, are also readily occluded by a circular cervical pressure cuff.

The vertebral artery is a branch of the first part of the subclavian artery. In the lower portion of the neck, the first part of the vertebral artery runs upward and backward between the scalenus anticus and the longus colli muscle to enter the foramen in the transverse process of the sixth cervical vertebra. The second part of the vertebral artery passes upward, entering the series of foramens in the transverse processes of the vertebrae from the sixth cervical to the atlas. The third part of the vertebral artery enters the skull and joins the vertebral artery of the opposite side at the base of the brain to form the basilar artery. It is impossible to occlude the third part of the vertebral artery by cervical pressure. The second portion is difficult to occlude by external pressure because the artery can be compressed only where it passes through muscles between the transverse processes. The first portion of the vertebral artery may be occluded readily by external pressure

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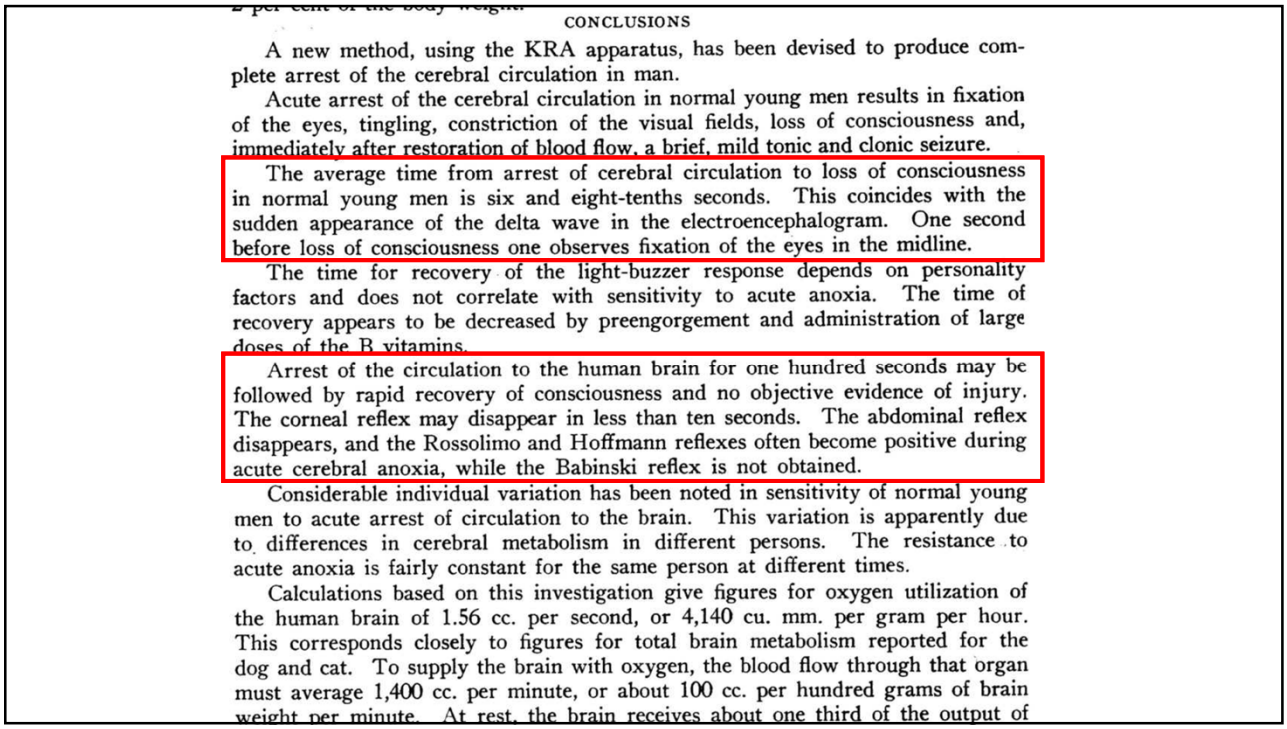

CONCLUSIONS

A new method, using the KRA apparatus, has been devised to produce complete arrest of the cerebral circulation in man.

Acute arrest of the cerebral circulation in normal young men results in fixation of the eyes, tingling, constriction of the visual fields, loss of consciousness and, immediately after restoration of blood flow, a brief, mild tonic and clonic seizure.

The average time from arrest of cerebral circulation to loss of consciousness in normal young men is six and eight-tenths seconds. This coincides with the sudden appearance of the delta wave in the electroencephalogram. One second before loss of consciousness one observes fixation of the eyes in the midline.

The time for recovery of the light-buzzer response depends on personality factors and does not correlate with sensitivity to acute anoxia. The time of recovery appears to be decreased by preengorgement and administration of large doses of the B vitamins.

Arrest of the circulation to the human brain for one hundred seconds may be followed by rapid recovery of consciousness and no objective evidence of injury. The corneal reflex may disappear in less than ten seconds. The abdominal reflex disappears, and the Rossolimo and Hoffmann reflexes often become positive during acute cerebral anoxia, while the Babinski reflex is not obtained.

Considerable individual variation has been noted in sensitivity of normal young men to acute arrest of circulation to the brain. This variation is apparently due to differences in cerebral metabolism in different persons. The resistance to acute anoxia is fairly constant for the same person at different times.

Calculations based on this investigation give figures for oxygen utilization of the human brain of 1.56 cc. per second, or 4,140 cu. mm. per gram per hour. This corresponds closely to figures for total brain metabolism reported for the dog and cat. To supply the brain with oxygen, the blood flow through that organ must average 1,400 cc. per minute, or about 100 cc. per hundred grams of brain weight per minute. At rest, the brain receives about one third of the output of

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6 seconds

- To syncope in an awake patient
- Bis will go to zero
- Pulse ox will go to zero
- Tell surgeon ‘stop bovie’
- Unlikely permanent damage: concern for long short induced VF: monitor pulse ox/telemetry/arterial line
- If had ventricular fibrillation then code cart, apply pads and defibrillate

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What does a Defibrillator and what does it do?

- A Defibrillator is programmed to detect ventricular arrhythmias: they are primarily programmed to detect ventricular fibrillation: ventricular rate of >250 beats per minute
- An implantable cardioverter defibrillator (ICD) has programmable parameters for detection of ventricular arrhythmias and then has instructions on what to do if an arrhythmia is detected (will apply therapies: will give a shock to terminate the arrhythmia).
- Transvenous defibrillators may also act as a pacemaker if the heart rate becomes too slow

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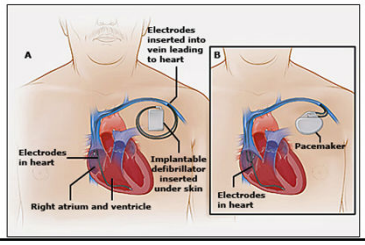
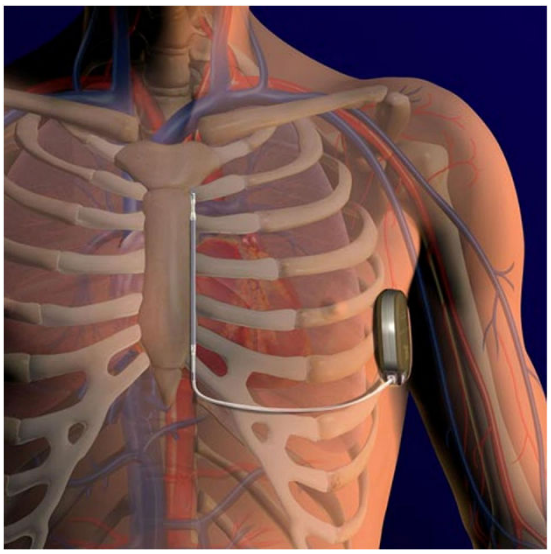
What is a subcutaneous defibrillator

- Subcutaneous ICDs have no pacing capability
- They are 'shock box only'
- No pacing support
- Sense bovie the same as ventricular arrhythmias





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Sizes and shapes of implantable devices

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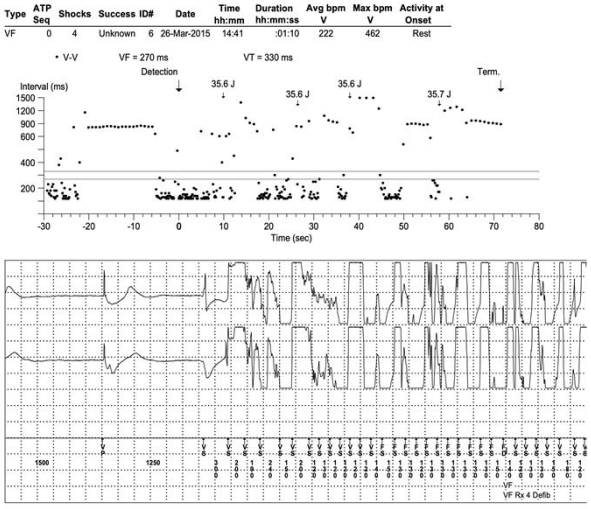
How does a defibrillator interpret electrocautery; bovie or plasmablade?

- Device sees rapid electrical activity and interprets 60 hz electricity as ventricular fibrillation
- Once it meets detection then will charge itself and deliver therapies: give ICD shock
- 40J delivered therapy is equivalent to 8000 Volts



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What does application of a magnet do to pacemaker and defibrillator?

- Magnet will cause a pacemaker to pace 'asynchronously'
- Asynchronous pacing means that a pacemaker will pace at a predetermined rate 'blindly': will pace at 70 bpm continuously until the magnet is removed
- A magnet placed over a defibrillator will disable tachy therapies (will not detect VF or shock) – magnet applied to an ICD **DOES NOT AFFECT PACING THERAPIES**
- When the magnet is removed pacemakers and defibrillators will immediately return to their previous programming and do not need to be interrogated

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Does the body part having surgery affect how much interference the device will see?

- Yes: the pacemaker is most sensitive in the immediate vicinity of the pacemaker can and the leads then the electric field will dissipate with exponential function as bovie is moved farther away
- Most likely to sense interference with chest/abdominal and head and neck surgery
- Unlikely for the device to sense any interference below the waist
- Interference for leg surgery is still possible if the grounding pad is placed on the chest or back rather than the opposite leg

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Grounding Pad Placement

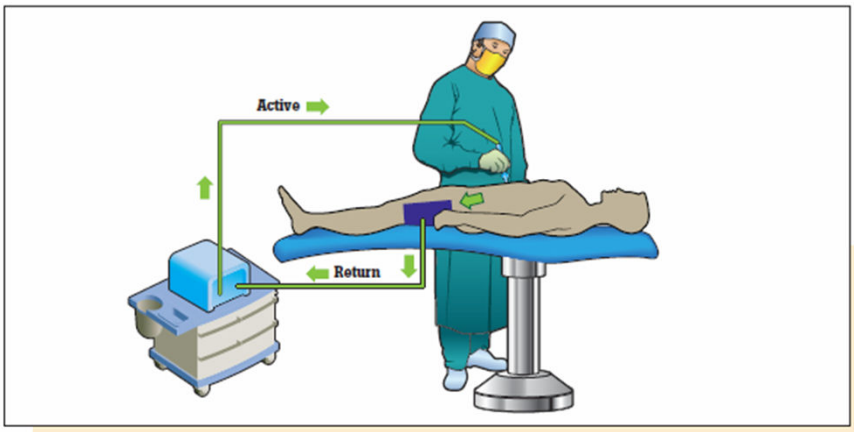

Figure 1: Monopolar electrosurgery

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Grounding pad placement

- Should be placed away from device
- Contralateral thigh for lower extremity surgery is optimal
- Grounding pads placed on chest or back will risk sensing of electrocautery by device

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Preprocedure checklist

- What surgery is being done?
- What type of device do they have: pacemaker, defibrillator, manufacturer (Medtronic, Boston Scientific, St Jude, Biotronik)
- Should a magnet be placed over device if electrocautery is needed– are they pacemaker dependent (are they using their device: if >95% ventricular pacing then would consider them 'dependent')
- Is a magnet possible to maintain sterility or positioning: left breast surgery or prone positioning for spine surgery – if not possible then need to call rep in advance for reprogramming of device and need to have someone reprogram the device when the procedure is complete
- If pacemaker dependent and has a defibrillator and decision is made to use a magnet: make surgeon aware to use short bursts (<6 seconds of bovie at a time) to prevent prolonged asystole

29

Ms. Jones Preop left mastectomy

- Per patient has 'pacemaker'
- Cardiology 'clearance' note says 'medium risk ok for surgery'
- History of afib and AVJ modification
- Moderate to severe aortic stenosis
- Pa pressure on last echo of 65mmHG
- Patient reports had 'pacemaker surgery two months ago to make my heart work better'

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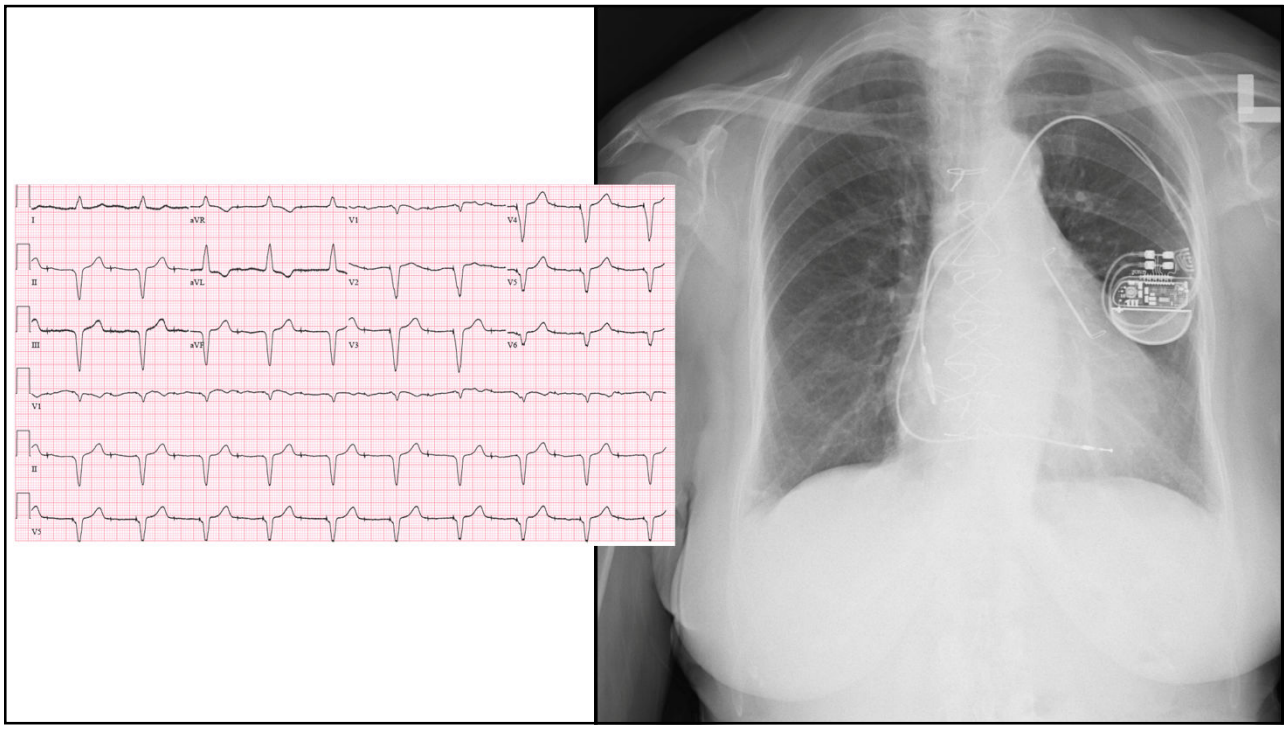
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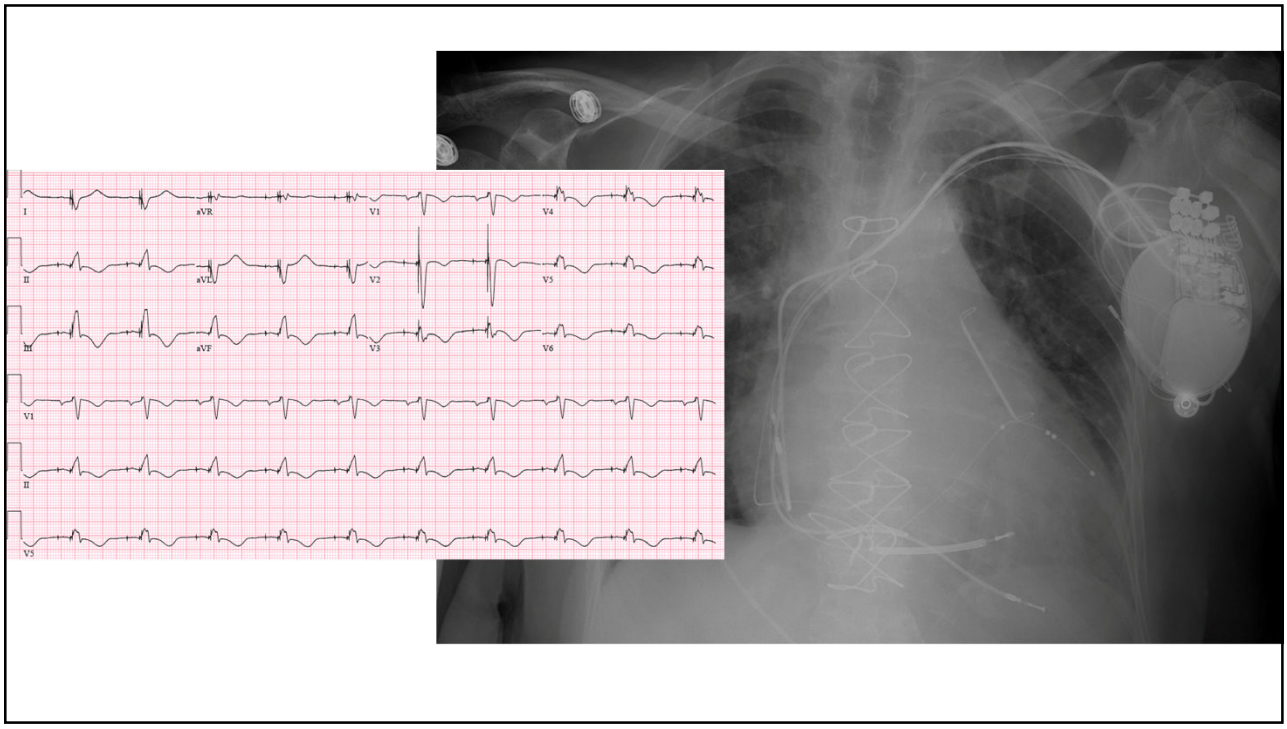
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From limited data we know

- Had boston scientific dual chamber pacemaker
- Upgraded to boston scientific Biv ICD
- Is ventricular pacing: assume pacemaker dependent
- If magnet used sterility may be an issue
- If reprogrammed small chance could have spontaneous ventricular tachycardia/ventricular fibrillation – need to be aware of where external defibrillator is located

33

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- History of afib and AVJ modification
- Moderate to severe aortic stenosis
- Pa pressure on last echo of 65mmHG, EF 20%
- Patient reports had ’pacemaker surgery two months ago to make my heart work better’
- Would try to schedule this at a hospital with cardiology and EP available – would cancel this on day of surgery if was to be done at surgicenter

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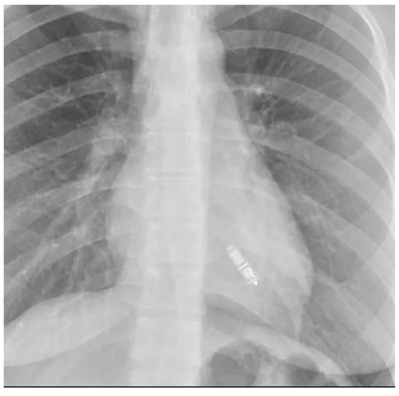
Mr. Smith presents for spine surgery

- I have one of those new pacemakers that you can’t see
- They put it in my leg



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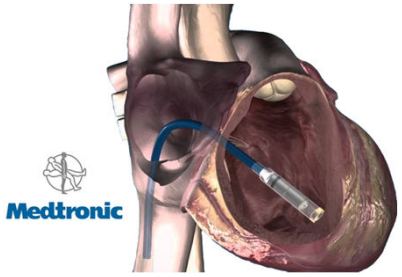
Leadless pacemaker

- FDA approved for past 4 years
- Device is deployed into the right ventricle via the femoral veins
- Battery lasts 12-15 years
- Benefits of lower rates of complications, no risk of lead fracture/dislodgement



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Poll: Pacemaker management for this patient

- A) Place magnet over left posterior back over site of where device is posterior
- B) Tape magnet over device anterior left chest and remove when procedure complete
- C) No intervention is needed – communicate with surgeon if asystole
- D) Rep to reprogram the device before and after procedure

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Poll Results

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Mr. Ford is having a right port removed(malfunction) and new port placed on the right

- Patient with EF 20% NICM after chemo
- Has left chest ICD
- Interventional radiologist plans to use electrocautery to free adhesions
- Overly nervous anesthesiologist places radial art line given EF
- Magnet application is recommended and case starts

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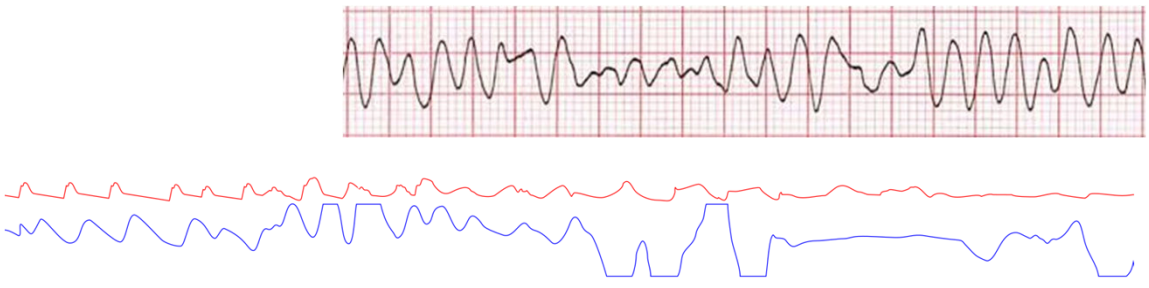
Small amount of sedation is given; wire placed in the IJ and as advanced you see:



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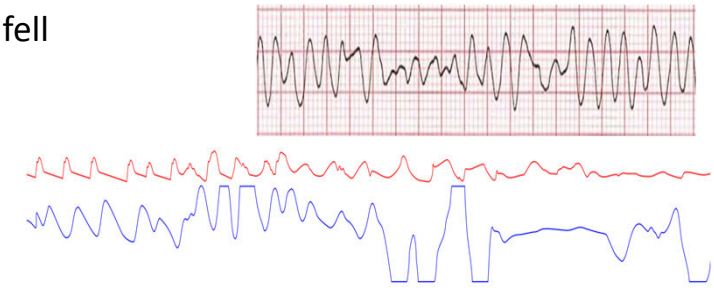
Next step is

- Look for pulse ox – likely fell off finger
- Push amiodarone
- Push lidocaine
- Intubate
- Remove magnet
- Externally defibrillate
- Chest compressions



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Poll Results

44

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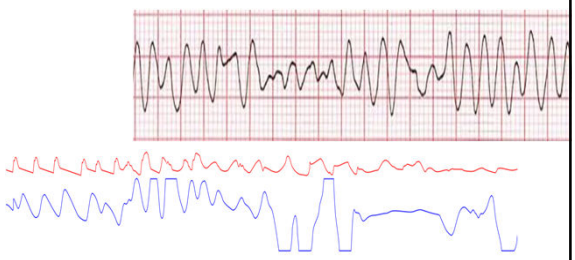

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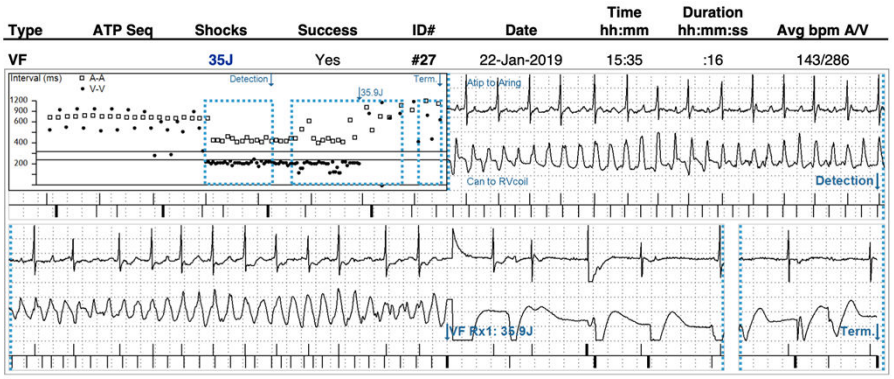
Ventricular fibrillation

- Removal of magnet will allow device to recognize VF, charge and terminate VF with a shock



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Mr. Smith scheduled for abdominal surgery, per patient has a pacemaker: management?

- Place 3 magnets: one over each device
- Have rep come in and disable each device
- No intervention is appropriate

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Poll Results

48

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- Place 3 magnets: one over each device
- Have rep come in and disable each device
- No intervention is appropriate

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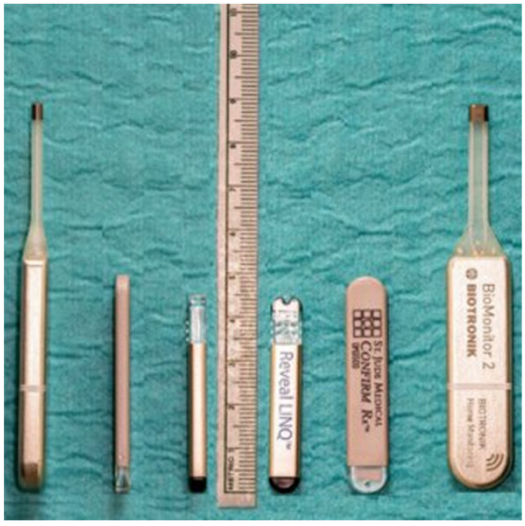
Implantable loop recorders

- Used to monitor long term for arrhythmias
- Do not pace or have any function other than record
- They will record noise during electrocautery but does not matter: nothing that needs to be done perioperatively



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Goals and Objectives

- Understand differences in types of cardiac implantable electronic devices
- -Transvenous pacemakers, leadless pacemakers, Trasnvenous defibrillators, subcutaneous defibrillators, loop recorders
- Understand the perioperative management of CIEDs
- -use checklist: depends on surgery location, type of CIED and if pacemaker dependent
- Understand the limitations and cautions with CIEDs
- -all are 'fooled' by electrocautery: pacemakers will inhibit pacing and defibrillators will give an inappropriate shock if they sense electrocautery

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Goals and Objectives 2

- Recognized the complications of perioperative management of CIEDs and how to avoid them
- -magnet application, recognition when magnet not appropriate (breast surgery, prone positioning, leadless pacemaker) communication with surgeon "they are asystolic while you bovie"
- Determine what is appropriate for outpatient surgicenter care with no backup, what is not appropriate for outpatient surgicenter care and how can you optimize your patients for safety and efficiency
- -if you think to yourself this guy sounds sick maybe we shouldn't do this here: don't do it here. Elevated PA pressure, CHF, biv ICD with recent VT therapies all predict should be done somewhere with support in case there is a problem

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