Invasive and Implanted Medical Devices: Rehabilitation Therapeutic and Diagnostic Interventions and Their Contraindications

Douglas P. Stevens, MS, MD
Norton Healthcare
Norton Neuroscience Institute
Louisville, KY

Medical Director,
SCI&D and PACT Clinics;
Electro-diagnostician
Louisville VAMC

(over 15 years)
Disclosures

- I have read Lord of the Rings three times
- I enjoy karaoke
- I like the Beatles and Elvis (in that order)

CME Staff Disclosures
Professional Education Services Group staff have no financial interest or relationships to disclose.

- Douglas P. Stevens, MS, MD
  - Physician Advisory Board, Hill-Rom Inc., The Vest
Obtaining CME Credit

• If you would like to receive CME credit for this activity, please visit: http://www.pesgce.com/PVAsummit2011/

• This information can also be found in the Summit 2011 Program on page 8.
Objectives

At the conclusion of this activity, the participant will be able to:

A. list common implanted and invasive medical devices.

B. discuss the changing clinical environment of increasingly providing therapeutic and diagnostic rehabilitation.

C. verbalize the contraindications in providing specific rehabilitation interventions to patients with specific medical devices.
Objectives

• The participant will be able to list common implanted and invasive medical devices.

• The participant will be able to discuss the changing clinical environment of increasingly providing therapeutic and diagnostic rehabilitation.

• The participant will be able to verbalize the contraindications in providing specific rehabilitation interventions to patients with specific medical devices.
What You Should Learn

**Big Picture**

- The ‘categories’ of devices
- Therapeutic interventions
- Diagnostic interventions
- What it is that goes ‘wrong’
- What is safe, and what is dangerous
NO DEAD PATIENTS

Don’t order short-wave diathermy
What You Should Learn

Big Picture

• The ‘categories’ of devices
• Therapeutic interventions
• Diagnostic interventions
• What it is that goes ‘wrong’
• What is safe, and what is dangerous
IMPLANTRAT IS NOT AMUSED
Implanted & Invasive Device ‘Categories’

- Space-occupying (implants)
- Electrical (pacers, stimulators)
  - Passive receivers (Bladder/phrenic stim)
  - Pulsed generators (cardiac pacer, DBS)
- Hydraulic / Mechanical (pumps)
Space-occupying Devices

- Penile implant
- Breast implants
- Orthopedic implants
- Tissue expanders
Breast Implants

At risk from mechanical trauma
Orthopedic Implants
Implanted & Invasive Device ‘Categories’

- Space-occupying (implants)
- Electrical (pacers, stimulators)
  - Pulsed generators (cardiac pacer, DBS)
  - Passive receivers (bladder/phrenic stim)
- Hydraulic / Mechanical (pumps)
$18.00 Giant Power Heidelberg Electric Belt

For only $18.00 we offer the genuine 80-gauge current Heidelberg Alternating, Self Regulating and Adjusting Electric Belt as the highest grade, very finest electric belt ever made, as the only successful electric belt treatment, as the most wonderful relief from all chronic and nervous diseases, all diseases, disorders and weaknesses peculiar to men, no matter from what cause or of how long standing.

$18.00 is our low price, for this highest grade electric belt, a superior belt to those usually sold at $8.00 to $10.00. Our $18.00 Giant Power Belt is the result of years of scientific study and experiment, it is the very highest grade, a belt that has all the best features of other electric belts without their disadvantages and discomforts, with exclusive and distinctive features that are not found in other makes. Positively wonderful in its quick cure of all nervous and physical disorders arising from any cause, whether natural weakness, excesses, indigestion, etc. The nerve building, health giving, vigor restoring current penetrates and permeates the affected parts; every nerve, tissue and fiber responds at once to the healing, vitalizing power, health, strength, superior manliness, youthful vigor in the result.

Our Giant Power
The Giant Power Giant Heidelberg Alternating Electric Belt at $18.00 will do you more good in one week than six months of doctoring. The Heidelberg Electric Belt for disorders of the nervous system, stomach, liver and kidneys, for weakness, diseased or inflamed condition of the sexual organs from any cause whatever, is worth all the drugs and chemicals, pills, tablets, washes, injections, and other remedies put together. Healing power in electric current is magical—never before equaled.

Have you perhaps written to some quack, so called institute or self-styled man’s physician, have you tried various so called remedies for your particular trouble without success, without getting any help, perhaps not even temporary relief. Perhaps you are discouraged; maybe hopeless. Don’t give up. Don’t despair, Power Giant Heidelberg Electric Belt is just what you need. Just what you should wear. Send for our Giant Power 80-gauge Current Heidelberg Electric Belt at $18.00, wear it according to directions. In a day you will feel a difference, in two days there will be a marked change for the better, in three days your condition will be a week or two weeks your system will be filled with the grand health giving current, in a month you will be a new man.

Our Giant Power 80-Gauge Heidelberg Electric Belt at $18.00 comes complete with the finest stomach attachment and most perfect, comfortable electric sack suspensory ever produced. The lower illustration shows the suspensory forms part of the circuit. The electric current must pass through the innumerable nerves and fibers. Every wearing brings the current in contact with the organs; every wearing means that part of the organ is traversed countless times and strengthened with the strengthening current; means a living, healthy, powerful, vigor induced, tone returned, a joy restored that thousands of dollars’ worth of medicine and doctors’ prescriptions would never give.

Don’t Suffer in Silence; for our Giant Power 80-Gauge Current Giant Heidelberg Electric Belt it will enable you to face the world anew. $29.00 will bring to you and strength, vigor, manliness and happiness, a bigger measure for your money, a greater organ than you ever possibly secure in any other purchase.

Are you in doubt? Have you tried so called remedies without avail and fear to take advantage of this great offer? Do you hesitate because some surgeon or doctor took advantage of you? With you can run no possible risk. Let us send you one of our genuine Giant Power 80-gauge Heidelberg Electric Belts under the liberal conditions of our offer. We will send the belt, then after ten days’ fair trial if you have any reason to be dissatisfied, if you are not greatly benefited, bring the belt to us and we will refund your money.

How the 80-Gauge Heidelberg Electric Belt is made. 80-Gauge Electric Belt of the Heidelberg make is the finest belt that can be manufactured.
Electrical Devices

- Cardiac pacer / defibrillator
- Diaphragm pacers
- Vagus nerve stimulator
- Deep-brain stimulators
- Spinal cord stimulator
- Gastric stimulator
- Bladder-stimulator (Vocare)
- Free-hand system

Pulsed Generators

Passive Receivers

- Phrenic nerve
Schematic of Pacemaker

The most commonly encountered device

Lead →

Pulsed Generator

Constant Desire
Phrenic Nerve Stimulator

Intermittent desire
Diaphragm Pacer

- **lungs**
- **diaphragm**
- **electrodes**
- **pacing unit**

**External Pulse Generator**
Diaphragm Pacer
Phrenic nerve pacer
Bladder Stimulator
Bladder stimulator

Passive Receiver in InterStim
Bladder (and bowel) stimulator
Hydraulic/Mechanical Devices

When automobile speeds at fifty miles an hour motorcycle cop (A) starts in pursuit - motorcycle hits cat (B) causing it to fall on button (C) which sets off cannon (D) - cannon ball (E) hits ivory dome of barber (F), bouncing off and knocking neck off bottle of strong acid (G) - acid drops on gold nugget (H) dissolving it - weight of kernels of corn (J) lowers board (I) and fall into flower pot (K) - corn grows till it reaches height (L) - can (M) of lima beans (N) jumps at corn on account of the natural affinity for succotash - string on end of can pulls lever (O) which pushes pointer (P) into paper tank (Q) half filled with water in which sardine (R) is swimming - pointer punctures paper tank, water runs out and sardine catches severe cold from exposure - sardine contracts a very high fever that finally sets fire to paper tank and lights cigar (S).
Implanted & Invasive Device ‘Categories’

• Space-occupying (implants)
• Electrical (pacers, stimulators)
  • Pulsed generators (cardiac pacer, DBS)
  • Passive receivers (bladder/phrenic stim)
• Hydraulic / Mechanical (pumps)
Implanted Hydraulic Devices

- Intra-thecal pumps

- Ventricular-assist device (VAD / LVAD)
Intrathecal Pumps
New Pump

![New Pump Image]
Old Pump vs. New Pump
Intrathecal Pumps

www.medtronic.com

<table>
<thead>
<tr>
<th>Devices or Procedures</th>
<th>Potential Patient Injury</th>
<th>Potential Pump Damage</th>
<th>Change in Pump Flow</th>
<th>No Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defibrillation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Diathermy, Therapeutic</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Electrocautery</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>High Magnetic Field Devices</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>High-Output Ultrasonic Devices/Lithotripsy</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>MRI</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Radiation Therapy</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Theft Detector/Security Devices</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Ultrasound, Diagnostic</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>X-ray, Diagnostic</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>TENS (Transcutaneous External Neurostimulator)</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Home Environment (e.g., microwave ovens)</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Occupational Environment (e.g., arc welding, electrical substations, industrial equipment)</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
Baclofen flow rate as a function of temperature (hyperbaric will reduce)

Figure 10
Flow Rate Accuracy as a Function of Temperature
Implanted Hydraulic Devices

- Intra-thecal pumps
- Ventricular-assist device (VAD / LVAD)
Ventricular-assist device

External Pulse Generator

Blood pumped to aorta

Blood from left ventricle flows into LVAD

LVAD

Pump

Connector between control unit and LVAD

Battery

Control unit
Invasive Devices

- PICC line
- Peripheral IV
- Chest tube
- Gastric/nasogastric tube
- Tracheostomy tube / Ventilator
- Insulin pump
- Ventricular-assist device (VAD or LVAD)
- Diaphragm pacer
Objectives

• The participant will be able to list common implanted and invasive medical devices.

• The participant will be able to discuss the changing clinical environment of increasingly providing therapeutic and diagnostic rehabilitation.

• The participant will be able to verbalize the contraindications of specific rehabilitation interventions to patients with specific medical devices.
What You Should Learn

Big Picture

• The ‘categories’ of devices
• Physio-therapeutic interventions
• Diagnostic interventions
• What it is that goes ‘wrong’
• What is safe, and what is dangerous
Therapeutic Interventions

- Functional electrical stimulation / TENS
- Therapeutic ultrasound / phonophoresis
- Iontophoresis
- Diathermy (short-wave)
- Topical heat / cold
- Infra-red light therapy
- Massage
Therapeutic Interventions

- Body-weight support systems
  - harness with Therastride and Lite-Gait
  - Lokomat
- Treadmill-training (ABT=Activity-based therapy)
- Aquatic therapy
- Lithotripsy
- Electroconvulsant therapy
- Transcranial magnetic stimulation
- Hyperbaric treatment
TENS / FES / ELECTRODIAGNOSIS

- should not be used in patients with a defibrillator or pacemaker (especially of the demand type) (RELATIVE)

- caution in any pulse-generator device
Safety of nerve conduction studies in patients with implanted cardiac devices.

We conclude that routine NCS is safe in patients with implanted cardiac pacemakers with bipolar sensing configurations and defibrillators.
CONTRAINDICATIONS WITH DEVICES

- Orthosis not adapted for the body (lower limbs)
- Body weight greater than 135 kg
- Fixed contractures or hip, knee, ankle arthrodesis
- Bone instability
- Cardiac contraindications
- Severe cognitive deficits
- Mechanical ventilation
- Severe vascular disorders of the lower limbs
- Open skin lesions in the area of lower limbs and torso
- Circulatory problems

NO absolute contraindications

Relative contraindications of mechanical compression

LOKOMAT Contraindications
Objectives

• The participant will be able to list common implanted and invasive medical devices.

• The participant will be able to discuss the changing clinical environment of increasingly providing therapeutic and diagnostic rehabilitation.

• The participant will be able to verbalize the contraindications of specific rehabilitation interventions to patients with specific medical devices.
What You Should Learn

Big Picture

• The ‘categories’ of devices
• Therapeutic interventions
• Diagnostic interventions
• What it is that goes ‘wrong’
• What is safe, and what is dangerous
Diagnostic Interventions

- Magnetic resonance imaging (MRI)  YES
- Diagnostic ultrasound
  - Neuromuscular  NO
  - Musculoskeletal
- Computerized-tomography (CT)  NO
- Positron-emission tomography (PET)  NO
- Electrodiagnosis  RELATIVE

CONTRAINDICATIONS ?
Ultrasound


What You Should Learn

Big Picture

- The ‘categories’ of devices
- Therapeutic interventions
- Diagnostic interventions
- What it is that goes ‘wrong’
- What is safe, and what is dangerous
Impact of the Intervention (what goes wrong)

• Electrical interference (Electromagnetic induced currents)
• Excess heat (Elongated metal; i.e. LEAD TIPS)
• Migration of device and/or leads (Negligible, ‘BUT’)
• Magnetic interference (Magnetic components)
• Hydraulic (flow) interference (Temperature & pressure)
• Mechanical compression
Practically speaking

- Of what is the device made?
- Does it have a 'lead'?
- Is anything within it ferromagnetic?
- How is the device damaged?
- How is the patient injured?
- Is it electrical?
- Are they burned?
- Is there a magnet within it?
- Are they 'stimulated'?
- Is it 'shorted out'?
- Are they deprived of device intent?
- Is it 'frozen' (stopped)?
DEAD PATIENTS
KEY POINTS
What You Should Learn

Big Picture

• The ‘categories’ of devices
• Therapeutic interventions
• Diagnostic interventions
• What it is that goes ‘wrong’
• What is safe, and what is dangerous
Infrared-light Therapy
Superficial heat & cold
Ultrasound

May be used over or near:
• Any part of the body - including the spine
• Metal implants, plates, pins and screws
• Pacemakers
• Defibrillators
MRI Contraindications

- Cardiac pacemakers
- Neurostimulators (DBS, Vagus, Phrenic)
- Penile implants Duraphase & Omniphase
  - the only 2 out of 13 tested
- Gastric stimulators
- Programmable VP shunts
OK with MRI

- Vocare bladder system (1.5 T)
- Freehand system (1.5 T)
- Heart valves
- Coils, filters, stents (if non-ferromagnetic)
  - if weakly ferromagnetic, wait 6-8wks
- Breast implants; most penile implants
- Orthopedic implant
- Intrathecal pumps
- Passive receivers (conditional & 1.5 T)
www.MRIisafety.com
THE END
THANK YOU

QUESTIONS?