New Opportunities and Challenges in FES and Neural Prostheses

Lecture 10: EE 546 Winter 2020

Howard Jay Chizeck
Other Types of Neural Prostheses

- **Cochlear Implants** (convert sound to electrical signals, for hearing)
  - Commercial success
  - Different products using different coding methods
- **Neural Prostheses for Vision**
  - Close to clinical deployment
Other Types of Neural Prostheses

- **Pacemakers**
  - Commercial success
  - Many different products
  - Some have adaptive capability
  - Security issues
  - Data to cloud?

- **Implanted Defibrillators**
  - Widespread use
Other Types of Neural Prostheses

- Neural Prostheses for respiration
  - Diaphragm pacing – usually using phrenic nerve
  - For high level SCI patients—can replace ventilator
Other Types of Neural Prostheses

- FES for sleep apnea
  - Stimulate muscles of tongue to prevent obstruction of breathing
Other Types of Neural Prostheses

- FES for Tissue Conditioning/Prevention of Pressure Sores
  - Stimulation to prevent long duration contact damage, facilitate blood flow
Other Types of Neural Prostheses

- Electrical Stimulation to Control Pain
  - Various possible mechanisms (TENS, EMS, PNT)
  - Different stimulation sites (surface, implants)
Other Types of Neural Prostheses

- Electrical Stimulation to Control Epilepsy
  - Vagus Nerve Stimulation
  - Cortical Stimulation
    - Neuropace
Status of FES Systems--2020

- Good progress in understanding and implementing functional electrical stimulation has been achieved in the past few decades by researchers in many countries.
Status of FES Systems

The clinical application of FES remains quite limited—in terms of numbers of patients and range of applications.
Status of FES Systems

- Most FES devices have not achieved widespread clinical or patient acceptance
  - Exceptions: cochlear implants, pacemakers, defibrillators, DBS for Essential Tremor and Parkinsons, pain control
Status of FES Systems

Many of the small companies that have focused on developing FES systems have been unsuccessful.

Large corporations more successful
What is the Problem?

- There are technological limitations of various kinds that restrict the performance, reliability, safety or economic feasibility of FES systems.
Limitations

- Some are technical
- Some are economic
- Some are limits of knowledge
Each Patient is Unique

- In most of these applications, every patient is different
- This is a critical complicating factor in design and economics
System Level Issues

- Ease of Use
- Training Requirements
- Cosmesis (physical and functional)
- Performance
- Reliability
- Maintenance and Support
- Cost, Market Size, Economic and Investment Considerations
Conclusions

- Is the glass half empty or half full?
- Need to coordinate new technologies, practitioners and economic players in the development of neural prostheses
- Exciting new opportunities for research and development