Objectives

- History of neurorehabilitation
  - The influence of the military in its creation/development
- Blast injuries
  - Incidence
  - Signs/Symptoms
  - TBI versus PTSD
- Neurorehabilitation, non-pharmacological management
- Neurorehabilitation, pharmacological management

Neurotrauma & rehabilitation: a historical perspective

- 1917: MAJ Frank Granger, USA, MC: Director of physiotherapy service of the reconstruction division
  - Units in 35 general hospitals and 18 base hospitals
  - American College of Radiology & Physiotherapy
- 1938: Radiology & Physiotherapy separated
  - Physiotherapy physicians – Society for Physical Therapy Physicians
  - Dr. John Coulter (Northwestern Univ), Dr. Frank Krusen (Mayo Clinic), Dr. Walter Zeiter (Cleveland Clinic)
- 1939: Dr. Krusen ‘Physiatrist’
Neurotrauma & rehabilitation: a historical perspective (2)

- 1939-1941: Rapid development of Physiatry, primarily because of military needs
  - Army physicians sent to Mayo Clinic to train under Dr. Krusen
- 1943: LTC Howard A. Rusk, USA, MC (WWII) established rehabilitation program in the U.S. Army Air Corps
  - Recognized the importance of early ambulation and physical activity rather than prolonged bedrest
  - 7 convalescent hospitals

Neurotrauma & rehabilitation: a historical perspective (3)

- 1945: AMA established a Physical Medicine & Rehabilitation section
- 1947: American Board of Physical Medicine (ABPM) established
- 1949: Changed to American Board of Physical Medicine & Rehabilitation (ABPM&R)
- 1954: Vocational Rehabilitation Act
- 1990: Americans with Disabilities Act
- 1990: National Center for Medical Rehabilitation at the National Institutes of Health
  - 1992: First NCMRR grants
  - Its goal is to support rehabilitation, health, and well-being of individuals with physical disabilities

Neurotrauma & rehabilitation: a historical perspective (4)

Brain injury in...
- Vietnam War: 12-14%
- Persian Gulf War: 8%
- OIF/OND/OEF*: 22%

*OIF = Operation Iraqi Freedom
OND = Operation New Dawn
OEF = Operation Enduring Freedom
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US & UK casualties in Iraq & Afghanistan
- US Statistics:
  - Iraq (OIF) March 19, 2003-August 31, 2010
    - Fatalities: 4,421 US Troops
    - Wounded: 31,921 US Troops
  - Afghanistan (OEF)
    Oct 2001-Sept 2011
    - Fatalities: 1,749 US Troops
    - Wounded: 13,669
- Approximately 8% of US Troops leave theater with a diagnosis of TBI

- UK Statistics:
  - Iraq (Op TELIC) January 1, 2003-July 31, 2009
    - Fatalities: 179 UK Military & Civilian
    - Wounded: 537 UK Military & Civilian
  - Afghanistan (Op HERRICK) October 1, 2001-September 15, 2011
    - Fatalities: 381 UK Military & Civilian
    - Wounded: 2,326 UK Military & Civilian

Accessed on September 6, 2011
http://www.mod.uk/DefenceInternet/FactSheets/
Accessed on October 2, 2011

Blast related TBI: incidence
- Approximately 20% of all deployments
- Approximately 28% of all service members medically evacuated out of Iraq/Afghanistan
- Approximately 88% of all service members medically evacuated to WRAMC
- Up to 97% of injuries are blast related (data from 1 unit)
  - 53% involved head & neck
- The number of Iraqi and Afghan civilian casualties is even greater
- Increasing number of civilian blast injuries worldwide

Blast injuries: incidence
- Increase in neurological symptoms in blast versus non-blast injuries
  - 1303 victims of explosive munitions:
    - 51% suffered primary blast injury
      - 30% blast injured = persistent neurological symptoms
      - 4% non-blast injured = persistent neurological symptoms

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Blast injuries: incidence (2)

- Medical Characteristics (incidence)
  - Pulmonary embolism: 28 patients (6.8%)
  - CSF leak: 35 patients (8.6%)
  - Early seizure: 50 patients (12.3%)
  - Systemic infection: 188 patients (46.1%)
  - CSF infection: 37 patients (9.1%)
  - Spinal cord/column injury: 40 patients (9.8%)
  - Vascular injury: 111 patients (27%)

Blast injuries: incidence (3)

- Post-traumatic aneurysms 35%
- Post-traumatic vasospasm 47%

Blast injuries: incidence (4)

- Blast induced TBI is the “signature wound” of the current conflicts in the Middle East
- It is estimated that 20% of deployed service members sustain at least a mild TBI secondary to blast
- TBI versus PTSD
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Signs & symptoms

• Major injury/trauma
  ▪ Penetrating wounds
    – Amputations
    – Neurovascular damage (peripheral nerve injury)
  ▪ Internal organ injury (chest, lung, abdomen); shock
  ▪ Fractures
  ▪ Prolonged loss of consciousness; post-traumatic amnesia
  ▪ Tetraplegia, paraplegia, hemiplegia
  ▪ Ocular injury
  ▪ Hearing loss; tympanic membrane rupture

Signs & symptoms (2)

• Minor injury
  ▪ No (or brief) loss of consciousness
  ▪ Pain
  ▪ Headaches
  ▪ Dizziness; vertigo; imbalance
  ▪ Weakness (mild or peripheral nerve distribution)
  ▪ Visual changes (especially blurry vision; difficulty focusing)
  ▪ Nausea/vomiting
  ▪ Fatigue; sleep disturbances
  ▪ Cognitive impairment
  ▪ Changes in behavior/personality
  ▪ Nightmares; flashbacks

TBI vs. PTSD

• High degree over overlap in persons exposed to blast/bombings
  ▪ The environment/situation is one in which one could experience PTSD even without TBI
  ▪ Symptom overlap
    – Somatic symptoms
      ▪ Nausea, dizziness/vertigo, fatigue, insomnia
    – Emotional
      ▪ Anxiety, depression, irritability
    – Cognitive
      ▪ Attention, memory, processing speed
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TBI vs. PTSD (2)

- Lack of overlap
  - Abnormal neuro-imaging
  - Headaches
  - Seizures
  - Focal neurological deficits

TBI vs. PTSD (3)

- Post-concussive symptoms
  - Most resolve within 3 months
  - Prolonged Post-Concussion Syndrome
    symptoms often are associated with PTSD
    - Also consider other psychological issues (e.g. depression),
      legal, secondary gain and undiagnosed neurological injury
      (e.g. diffuse axonal injury)

Neurorehabilitation: non-pharmacological

- Amputations
  - Weakness: physical therapy/occupational therapy
    for strengthening, range of motion/stretching, positioning,
    prevention of contractures, edema control
  - Pain: tapping, massage
- Peripheral nerve/muscle damage
  - Weakness: physical therapy/occupational therapy
    for strengthening, gross/fine motor control
  - Splinting
  - Functional electrical stimulation (FES)
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Bioness® H-200 upper extremity functional electrical stimulation for hand paralysis

Walkaide® lower extremity functional electrical stimulation for foot drop

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Neurorehabilitation: non-pharmacological

• Traumatic Brain Injury/Spinal Cord Injury
  • Inpatient rehabilitation
    – Physical therapy
      • Strengthening, range of motion, balance, gait
      • Assistive devices (cane, walker, wheelchair etc.)
      • Body weight support gait/balance (e.g. Zero-G, Alter-G)
      • Casting
      • Spasticity management
      • Pain management; modalities (heat, ultrasound, e-stim)

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Neurorehabilitation: non-pharmacological

• New technology
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Neurorehabilitation: non-pharmacological

- Occupational therapy
  - Upper extremity strengthening, range of motion, fine/gross motor skills
  - Splinting
  - Adaptive equipment (reachers, transfer devices, flatware handles, pen/pencil grips, elastic shoeaces, shoe horns, unilateral buttoning, tub bench etc.)
  - Pain management; modalities (paraffin; contrast baths; e-stim)
- Vocational/educational skills
- Cognitive assessment/therapy
- Vision assessment/therapy
- Driving evaluations

Neurorehabilitation: non-pharmacological

- Speech Language pathology
  - Swallowing evaluation/treatment
  - Speech (dysarthria) therapies
  - Language (aphasia) therapies
  - Cognitive therapies

Neurorehabilitation: non-pharmacological

- Neuropsychology
  - Capacity evaluations
  - Cognitive remediation
  - Emotional assessments & support

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Neurorehabilitation: non-pharmacological
• Therapeutic recreation
  • Avocational activities
  – Community activities (public transportation)
  – Leisure activities
  – Sports

Neurorehabilitation: non-pharmacological
• Medical/Nursing Issues
  • Respiratory care
  – Monitoring respiratory status, tracheostomy management
  • Skin care
  – Turning, inspection, wound management
  • Neurogenic bladder
  – Timing
  – Catheterization
  • Neurogenic bowel
  – Timing
  – Suppositories
  – Digital stimulation

Neurorehabilitation: non-pharmacological
• Medical/neuropsychological issues
  • Agitation
  – Environmental
  • Structured unit
  • Quiet; reduce stimulation
  • Natural light; non-fluorescent light
  • Aroma therapy
  • Staff education
  • Mood disorders
  – Psychotherapy/hypnotherapy
  – Electroconvulsive therapy (ECT)
Neurorehabilitation: non-pharmacological
- Medical issues
  - Sleep dysfunction
    - Environment, including lighting
    - Monitor sleep (sleep log, actigraph)
    - Sleep hygiene
    - Assess for sleep apnea

Neurorehabilitation: pharmacological
- Pain
  - Non-narcotic pain medications
    - Anticonvulsants
    - Tricyclic antidepressants
    - Alpha agonist
  - Narcotic pain medications
  - Intrathecal pumps
  - Nerve blocks
  - Epidural steroid injections

Neurorehabilitation: pharmacological
- Agitation
  - Beta blockers
  - Mood stabilizers
    - Anticonvulsants
    - Antidepressants
  - Atypical antipsychotics
  - Antipsychotics/benzodiazepines
Neurorehabilitation: pharmacological

- Mood disorders
  - Antidepressants
    - SSRI
    - Bupropion
    - SNRI
  - Anticonvulsants
  - Tetracyclic antidepressants

Neurorehabilitation: pharmacological

- Headaches
  - Abortive
    - Non-steroidal anti-inflammatory drugs (NSAIDs)
    - Acetaminophen
    - Narcotics, short acting
    - Triptans
  - Prophylaxis
    - Anticonvulsants
    - Beta blockers
    - Calcium channel blockers
    - Botulinum toxin injections
    - Tricyclic antidepressants

Neurorehabilitation: pharmacological

- Seizure management
  - Prophylactic x 7 days after TBI
    - Phenytoin
    - Levetiracetam
  - Long-term use
    - Minimize side effects
    - Ease of use/compliance
    - Co-morbidity treatment
Neurorehabilitation: pharmacological

- Sleep dysfunction
  - Melatonin
  - Ramelteon (melatonin receptor agonist)
  - Tetracyclic antidepressants
    - Trazodone, mirtazapine
  - Tricyclic antidepressants
  - Other antidepressants if depression related insomnia
  - Antipsychotics
  - Anxiolytics (rare)
  - Other sleep aids (e.g. eszopiclone, zaliplon, zolpidem)

Neurorehabilitation: pharmacological

- Fatigue
  - Neurostimulants
  - Modafinil, armodafinil
  - Caffeine

Neurorehabilitation: pharmacological

- Cognitive dysfunction
  - Attention
    - Neurostimulants
      - Methylphenidate
      - Dextroamphetamine/Amphetamine
      - Atomoxetine
  - Modafinil/armodafinil
  - Selective serotonin reuptake inhibitors (SSRI)
  - Memory
    - Cholinesterase inhibitors
Neurorehabilitation: pharmacological

- Spasticity
  - Baclofen (oral and intrathecal)
  - Tizanidine
  - Dantrium
  - Benzodiazepines (with caution)
  - Botulinum toxins

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Neurorehabilitation: pharmacological

- Post-TBI or Post-stroke Parkinsonism
  - Carbidopa-levodopa
  - Amantadine
  - Bromocriptine

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Neurorehabilitation: pharmacological

- Arousal
  - Amantadine
  - Dopamine agonists
  - Neurostimulants
  - Avoidance of sedating medications

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Neurorehabilitation: pharmacological

- Neurogenic bladder
  - Anticholinergic agents (detrussor hyperreflexia)
    - Propantheline, dicyclomine, hyoscyamine
  - Antispasmodic drugs
    - Oxybutinin, tolteradine, solifenacin, darifenacin
  - Tricyclic antidepressants
    - Imipramine, amitriptyline

Monitor for UTI, including signs/symptoms of autonomic dysreflexia in SCI

Neurorehabilitation: pharmacological

- Neurogenic bowel
  - Stool softeners
  - Laxatives
  - Electrolyte solution (e.g. polyethylene glycol)
  - Oral
  - Suppositories
  - Enemas

Thank you!

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