Adult Neurogenic Bladder: Current Evaluation & Advances in Clinical Management

W38, 16 October 2012 14:00 - 17:00

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<th>Start</th>
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| 14:00  | 14:45 | Introduction, Neuro-Anatomy and Neurophysiology, Neuro-pathophysiology, Voiding Dysfunction | • Angelo Gousse  
• Stephen Kraus  
• Hari Siva G R Tunuguntla |
| 14:45  | 15:30 | Urodynamics and Neurogenic Voiding Dysfunction                         | • Stephen Kraus                                |
| 15:30  | 16:00 | Break                                                                 | None                                          |
| 16:00  | 17:00 | Treatment of Neurogenic Bladder                                         | • Angelo Gousse  
• Hari Siva G R Tunuguntla                      |

**Aims of course/workshop**

Aims and objectives of this workshop include:
1. To correlate the various types of detrusor and sphincter dysfunction with the location of the nervous lesions
2. To present the contemporary evaluation (including applied urodynamics) of neurogenic bladder conditions
3. Comprehensive discussion on the current management of clinically significant neurogenic bladder syndromes based on the type of dysfunction and individual comorbidities
4. Presentation of evidence based current therapeutic strategies

**Educational Objectives**

Knowledge gained from the workshop will be of immense benefit to the practicing Urologists, Neurologists, Internists & Geriatricians with special interest in neurogenic bladder dysfunction, Urology/Urodynamic nurses and continence advisors in the day to day evaluation and management of commonly encountered neurogenic bladder conditions. Participants will be able to correlate the type of voiding dysfunction with the location of nervous lesions and learn the role of urodynamic evaluation in the overall management. Participants will have a comprehensive understanding of therapeutic strategies as practiced in 2011-2012 including pharmacological and surgical treatments (endoscopic, minimally invasive, and open options). Participants will gain knowledge regarding the effect of deep brain stimulation on voiding function. Additionally, neurosurgical, perioperative, and anaesthetic management of these patients will be discussed.
### W38, Adult Neurogenic Bladder: Current Evaluation and Advances in Clinical Management (Advanced)

**Tuesday – 16 October 2012; 14:00 – 17:00 Hours**

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<td>14:00</td>
<td>14:45</td>
<td>1. Introduction</td>
<td>Hari Tunuguntla</td>
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<td>2. Neuro-Anatomy and Neurophysiology</td>
<td>Stephen Kraus</td>
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<td>3. Neuro-pathophysiology and Voiding Dysfunction</td>
<td>Hari Tunuguntla</td>
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<td></td>
<td>a. CVA, Brain tumor, Brain Injury, Deep brain stimulation, Multiple Sclerosis</td>
<td>Hari Tunuguntla</td>
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<td>b. Parkinson’s disease</td>
<td>Angelo E. Gousse</td>
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<td>c. Spinal Cord Injury, spina bifida, spinal cord tumor</td>
<td>Stephen Kraus</td>
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<td>d. Other: herniated disk, HIV</td>
<td>Hari Tunuguntla</td>
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<td>4. Clinical Evaluation</td>
<td>Hari Tunuguntla</td>
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<td>15:00</td>
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<td>1) Urodynamics and Neurogenic Voiding Dysfunction</td>
<td>Stephen Kraus</td>
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<td>a. Before the urodynamics</td>
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<td>b. Autonomic dysreflexia</td>
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<td>c. Problems of storage(bladder)</td>
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<td>i. Detrusor overactivity</td>
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<td>ii. Impaired compliance</td>
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<td>d. Problems of storage (outlet)</td>
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<td>i. Incompetent outlet-neurogenic vs SUI</td>
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<td>ii. Hyporeflexia</td>
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<td>ii. BPH</td>
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<td>16:15</td>
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<td>1) Treatment of Neurogenic Bladder</td>
<td>Hari Tunuguntla</td>
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<td>a. Tube drainage</td>
<td>Hari Tunuguntla</td>
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<td>b. Pharmacotherapy (improve storage)</td>
<td>Angelo E. Gousse</td>
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<td>c. Intravesical therapy (improve storage)</td>
<td>Angelo E. Gousse</td>
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<td>d. Pharmacotherapy (improve emptying)</td>
<td>Hari Tunuguntla</td>
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<td>e. Botulinum toxin</td>
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<td>ii. sphincter</td>
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<td>f. Surgery</td>
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<td>ii. Incontinence</td>
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<td>iii. other</td>
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<td>g. Role of Neurostimulation &amp; Neuromodulation</td>
<td>Hari Tunuguntla</td>
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<td>h. Closing</td>
<td>Hari Tunuguntla</td>
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Aims of course/workshop
Neuroanatomy and neurophysiology of the lower urinary tract will be briefly discussed initially followed by neuropathophysiology of the cerebral, spinal, and peripheral lesions correlating the same with the clinical symptomatology. This will be followed by clinical evaluation including classic urodynamic findings of various forms of neurogenic voiding dysfunction. In the last part of the workshop, current evidence based therapeutic strategies and advances in the management of adult neurogenic voiding dysfunction will be discussed.

Educational Objectives
Having participated in this course, which will also include case presentations to illustrate the points, you should have an advanced knowledge on the pathophysiology, current evaluation and management of adult neurogenic lower urinary tract dysfunction. In addition, you should become familiar with what can now be offered to the individual patient in your clinical practice.
Adult Neurogenic Bladder: Current Evaluation & Advances in Clinical Management (Advanced)

Introduction, Neuroanatomy & Pathophysiology

Workshop Faculty

Hari Tunuguntla, MD, MS, MCh (Program Chair and Faculty)
Assistant Professor, Section of Neuro-Urology, Female Pelvic Medicine & Reconstructive Surgery, UMDNJ-Robert Wood Johnson Medical School, New Brunswick, NJ, U.S.A.

Stephen R. Kraus, MD MS FACS (Faculty)
Professor and Vice Chair Head, Section of Female Urology, Neuro-Urology and Urodynamics UT Health Science Center, San Antonio, TX, U.S.A.

Angelo E. Gousse, MD (Faculty)
Bladder Health & Neurogenic Bladder Institute Miramar, FL, U.S.A.

Neurogenic Bladder

- Abnormal bladder function secondary to central nervous system (CNS) injury or neurologic disease
  - Detrusor muscle overactivity: sustained high bladder pressure; characterized by involuntary detrusor contractions during the filling phase, which may be spontaneous or provoked
  - Detrusor muscle areflexia: detrusor underactivity resulting in urinary retention
  - Sphincter-detrusor dyssynergy: inappropriate timing of sphincter contraction

Current Advances in Evaluation & Management of Adult Neurogenic Bladder (NGB)
Workshop - Aims & Objectives

The attendee should be familiar with:
- Classification and epidemiology of neurogenic bladder (NGB)
- Neuroanatomy/neuropathophysiology of NGB Evaluation and treatment
- Understand specific issues associated with NGB treatment in patients with:
  - Central nervous system abnormalities
  - Parkinson's disease
  - Spinal cord injury
  - Multiple sclerosis

Classification & Epidemiology

Neurogenic Detrusor Overactivity:
Defined as overactivity due to a relevant neurological condition
- Examples of Neurological Conditions:
  - Multiple sclerosis
  - Parkinson's disease
- Approximately 4.4 million Americans with a neurologic condition (MS, SCI, PD, and stroke) have DO
- Approximately 2.6 million Americans with a neurologic condition (MS, SCI, PD, and stroke) have UI

Symptoms:
- Urgency
- Frequency
- Incontinence

Sequela:
- Higher intravesical pressures
- Poor bladder compliance
- Recurrent febrile urinary tract infections
- Stones
- Vesicoureteral reflux
- Hydroureter
- Renal failure
- Autonomic dysreflexia

Impact of Bladder Symptoms on Daily Activities From Patient Perspective

Symptoms
- Intimacy
  - Avoidance of sexual contact and intimacy
- Physical
  - Limitations or cessation of physical activities
- Psychological
  - Grief/depression
  - Loss of self-esteem
  - Fear of a lack of bladder control
- Domestic
  - Planning travel around toileting
- Occupational
  - Absence from work
  - Decreased productivity

Clinical Presentations of NDO

- Antidepressants
- Anticholinergics
- Beta-blockers
- Alpha-blockers
- Detrusor myotomy and neurolysis
Why Should We Worry???

- Potentially detrimental to upper tracts
  - Hydronephrosis
  - Renal failure
- Urinary incontinence
  - Social
  - Skin care
- Other urological issues
  - UTIs
  - Stones

Normal Micturition Physiology

- Storage
- Evacuation
- Role of Central Nervous System

Keep these components in mind during GU tract w/u and management of NGB

Normal Micturition Physiology

- Storage
  - Accommodate urinary volume without bothersome sensation
  - Maintain continence
  - Maintain low intravesical pressures
  - Protect upper tracts
  - Provide appropriate warning & sensation
- Evacuation
- Role of Central Nervous System

Normal Micturition Physiology

- Storage
- Evacuation
  - Coordinated event
  - Voluntary control
  - Sustained detrusor contraction of appropriate duration & strength to allow complete emptying
- Role of Central Nervous System

Micturition Reflex

- Very coordinated neuromuscular event
- First - sudden, complete striated sphincter relaxation.
- Second - simultaneous detrusor contraction with urethral relaxation.
- Requires integration of the autonomic (parasympathetic, sympathetic) and somatic nervous systems.
Spinal Cord Centers

- Sympathetic Input - T10 - L2 cell bodies form the hypogastric nerve
- Sacral Micturition Center - S2 - S4
  - Parasympathetic Nucleus - cell bodies form the pelvic nerve
  - Pudendal Nucleus (Onuf) - cell bodies form the pudendal nerve

Peripheral Nerves

- Hypogastric - sympathetic fibers, chain ganglia, to pelvic plexus
- Pelvic - S2 - S4 ventral roots to the pelvic plexus
- Pudendal - S2 - S4 ventral roots leave the pelvis through Alcock's canal to innervate the striated urethral and anal sphincters
- All are mixed motor and sensory nerves

Neurogenic Bladder: Assessment

- Physical Examination1,2
  - Detailed patient history
  - General/Medical exam
  - Abdominal exam
  - Pelvic/rectal exam
  - Focused neurological exam

- Bladder/Sphincter Function Tests Can Include3-4
  - Post-void residual (PVR)
  - Urinalysis
  - Urinary diary
  - Ultrasound of urinary tract
  - Urodynamics
  - Sphincter Electromyography (EMG)
  - Voiding cystourethrogram (VCUG)
  - Urethral pressure profiles

Work up for the Patient with NGB

- Upper tract evaluation
- Lower tract evaluation
  - Remember concept of filling & emptying
- Labs

Pathophysiology Related to Neurogenic Disease

- Afferent Pathways5,6
- Efferent Pathways
- Both afferent and efferent modifications are believed to potentially contribute to detrusor overactivity

Upper GU Tract Evaluation

- Imaging
  - Renal sonogram & KUB
  - Nuclear renal scan
  - IVP
  - Cross sectional imaging
- Renal Function
  - 24 hr creatinine clearance
  - Nuclear renal scan (total and split function)
  - Serum creatinine unreliable

Lower GU Tract Evaluation

- Voiding/catheterization diary
- Urodynamic evaluation
- Cystoscopy
- Imaging
  - Fill and voiding cystourethrogram
  - Can be done simultaneous with UDS
Tethered Cord Syndrome

- Impediment of cephalad migration of conus medullaris during vertebral growth
- Associated with short filum terminale, lipoma, adhesions, esp. after repair of dysraphism
- Mitochondrial anoxia and axonal injury
- Lower extremity weakness, spastic gait
- Bowel & bladder dysfunction
- May occur in adulthood
- UDS mandatory


Tethered Cord Syndrome

- Detrusor areflexia in 60%1
- Recovery after cord release2
- Overactivity in up to 30%3
- Early, aggressive surgical correction4


Spina Bifida
### Myelomeningocele

- Nerve roots/spinal cord with meningeal covering protrudes through posterior vertebral bony arch
- Deficit depends on neural structures affected
- Detrusor may be areflexic; compliance poor 50%
- Bladder neck classically open - incontinent
- Non-relaxing external sphincter - high storage pressure
- These patients are wet but in danger of renal damage

### Sacral Agenesis

- Absence of part or all of 1 or more sacral vertebrae (caudal regression syndrome)
- Neurogenic lower urinary tract dysfunction with 2 or more vertebral bodies affected
- 1% children born to IDDM mothers (terato?)
- M=F
- Normal cord but conus ends abruptly
- Nerve rootlets embedded in dense fibrous tissue

### Spinal Stenosis

- 90% of the population will report back pain
- Acquired lumbar stenosis over 65 yrs: 1 per 1000
- Chronic and substantial pain limits activity

### Cerebrovascular Accident

<table>
<thead>
<tr>
<th>US Incidence/Prevalence</th>
<th>Estimated 7,000,000 Americans ≥20 years of age have had a stroke1</th>
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<tr>
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<td>As estimated 795,000 people experience a new or recurrent stroke annually1</td>
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<td>Someone in the US has a stroke every 40 seconds, on average1</td>
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<tr>
<th>Bladder Dysfunction</th>
<th>In a pooled meta-analysis of 18 studies evaluating a total population of 727 patients who had a stroke, 56% were found to have OIS2.3</th>
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<tbody>
<tr>
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<td>In another pooled meta-analysis of 93 studies evaluating a total population of 24,108 patients who had a stroke, 50% were found to have OIS4.5</td>
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<td>Lower extremity observed in up to 29% of patients (n=64) within 4 weeks after a first ischemic stroke6</td>
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<th>Progression</th>
<th>Among ischemic stroke survivors ≥ 65 years at age (n=108), 50% had some hemiparesis, 31% were unable to walk without assistance, and 26% were institutionalized in a nursing home at 6 months after stroke6.7</th>
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| Life Expectancy | Median survival time after first stroke is 13.3 years for men and 7.8 years for women aged 55 to 64 years of age8.9 |

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2. Data on file, Allergan, Inc.
**Cerebrovascular Accident**

- 83/100,000 Americans, hemorrhage or infarction
- Location and size determines effect on the lower urinary tract
- Generally, decreases inhibitory control over the voiding reflex
- Initial retention is common
- Urinary frequency, urgency, urge incontinence

**Fun Facts: CVA**

- Incidence: 2.6% (Noninstitutionalized)
  - Male > Female
  - Increases with age (8.1% if 65 years old)
  - >500,000 CVA occur annually in US
  - 3<sup>rd</sup> most common cause of death
- LUT problems - Varies depending on time point
  - 53% during acute stage
  - 32% at 12 months
- UI has long term predictive value
  - Acute stage (7 days) UI: 4x higher risk of institutionalization @1 year
  - UI within first week: 50% mortality at 6 months
  - 2x worse impairment in level of disability in nursing home residents

**CVA: Types of Bladder Dysfunction**

- Neurogenic Detrusor overactivity
- Detrusor Hyperactivity with impaired contractility
- Alterations in sensation
- Detrusor areflexia
- Sphincter should function normal
  - Level of pathology precludes causes of DESD
  - Question of “uninhibited sphincter relaxation”
  - Pseudo-dyssynergia is possible
- “Normal” pathology
  - BPH
  - DAB
  - SUI

**Fun Facts: TBI**

- Most commonly results from MVA
- Male to female: 5 to 1
- Mechanism
  - Diffuse axonal shearing injury
  - Severe gray matter from white matter & other brain regions
  - Essentially isolates cortex from rest of the brain
- Results in variety of deficits
  - Cognitive
  - Physical
  - Emotional
  - Behavioral
- Urinary incontinence is most common urologic problem
- Most likely loss of inhibitory control (similar to CVA)

**NGB in Cerebrovascular Accident**

- Incontinence rate as high as 51% - 1st year
- Detrusor Hyperreflexia - most common
- Although variable, sensation usually intact
- Pseudodyssynergia - voluntary attempt to hold off a bladder contraction
- Synergistic void - above the Pontine Center
- Consider coexisting pathology - BPH
Parkinson’s Disease

US Prevalence
150,000 persons currently living in US with PD.

Bladder Dysfunction
A degenerative disorder associated with loss of dopaminergic neurons in substantia nigra.

Type of Disease
A movement disorder associated with loss of dopaminergic neurons in substantia nigra.

Age of Onset
Average age of onset is 60 years, and incidence increases with age.

Progression
Symptom progression may take 20 years or more.

Life Expectancy
Average life expectancy generally similar to those without PD.

2. Data on file, Allergan, Inc.

Parkinson’s Disease

• Degenerative disorder - loss of dopamine containing neurons in the substantia nigra and locus ceruleus
• Bradykinesia, tremor, skeletal rigidity
• Common cause of voiding dysfunction - detrusor hyperreflexia with sphincter bradykinesia (impaired relaxation)
• Up to 75% have voiding symptoms - LTIS (57%), LTOS (23%)

Shy-Drager Syndrome

• Uncommon degenerative disorder - atrophy in cerebellum, brainstem, peripheral autonomic ganglia and spinal cord sympathetic neurons
• Orthostatic hypotension, anhydrosis, impotence, Parkinson’s like symptoms, voiding and bowel dysfunction.

Shy-Drager Syndrome

• Bladder neck open at rest, detrusor overactivity & denervation of striated sphincter
• Frequency, urgency, urge incontinence or retention may herald the onset of Shy-Drager syndrome.
• Work-up similar to Parkinson’s

Multiple Sclerosis

Multiple Sclerosis (MS)

- Focal inflammatory/demyelinating lesions
- Ages 20-50; temperate climate
- Plaque formation of brain and cord may have autoimmune etiology
- Voiding dysfunction in 90% of MS patients: frequency, urgency, urge incontinence, hesitancy, intermittency, poor stream

Progression of Multiple Sclerosis

- Bladder symptoms worsen with increasing MS disease duration and disability
- Bladder dysfunction in MS patients may become more complicated due to worsening of DO, worsening paraparesis, recurrent UTIs, spasticity, reduction in general mobility, and cognitive impairment

Spinal Cord Injury (SCI)

- Voiding symptoms/ neurological findings do not correlate with UDS results
- Detrusor hyperreflexia in up to 78%
- Hyperreflexia associated with DESD in 50%
- Up to 40% patients-impaired contractility (areflexia)
- 55% MS patients may change urodynamic behavior


US Incidence and Prevalence

12,000 new cases each year
293,000 (range 220-365,000) in 2010

Bladder Dysfunction

- In a pooled meta-analysis of 20 studies evaluating a total population of 1228 patients with SCI, 49% were found to have DO
- In another pooled meta-analysis of 12 studies evaluating a total population of 2773 patients with SCI, 36% were found to have UI

Type of Disease

- Leading causes are motor vehicle crashes, followed by falls and acts of violence

Age of Onset

- Average age at injury is 40.7 years

Life Expectancy

- Related to severity of injury

2. Data on file, Merck Inc.
Traumatic Spinal Cord Injury

Lower urinary tract function varies depending on stage of recovery from SCI

- Spinal Shock:
  Detrusor areflexia, Flaccid paralysis,
  Reflexes absent below the level of the lesion
- Recovery: Return of reflex detrusor activity
- Stable

Stable Phase

- Absence of further somatic neurorecovery
- Unchanging urodynamic behavior
- Level of lesion MAY correlate w/ expected function
  Upper level SCI: TH+DES
  Lower level SCI: Areflexia
- Need to diagnose and treat patients effectively to preserve renal function

Remember: The enemy of the upper tracts is sustained elevation of intravesical pressure

Traumatic Spinal Cord Injury

- Objectively evaluates detrusor & sphincter behavior
- Essential to establish management plan
- Do not treat SCI patients symptomatically
- Do not base treatment on supposition
- Remember: Enemy of the upper tracts is sustained elevation of intravesical pressure

NGB in Spinal cord injury

- Incidence: 12,000 newly diagnosed cases every year*

Brain Tumor

- Both primary and metastatic tumors may cause voiding dysfunction
- The area(s) and level(s) of brain affected will determine the pattern of dysfunction
- Like CVA, most lesions cause disinhibition of the pontine micturition center
- Detrusor overactivity with sphincter synergy is common

Glioma
Normal Pressure Hydrocephalus

- Triad - **Gait disturbance, Dementia, Urinary Incontinence**
- Normal intracranial pressure
- Frequency, urgency, urge incontinence, even nocturnal enuresis
- Detrusor overactivity most common finding
- Recovery with shunt may be dramatic, not in all cases

Cerebellar Ataxia Syndromes

- Cerebellar disease causes a variety of motor abnormalities
- Acute forms - tumor, viral, vascular, toxic,demyelinating
- Chronic form - Friedrich’s,corticocerebellar degeneration
- Poor coordination, decreased DTR’s, dysarthria, dysmetria
- Overactivity to areflexia, DESD in 37%

Alzheimer’s Dementia

![Image](image1)

Dementia

- Incontinence approaches 90% in literature
- Atrophy of both white and gray matter
- Although detrusor overactivity may be found, not always the case
- 2/3 with or without cognitive impairment with incontinence were found to have detrusor overactivity (instability)

NGB in Dementia: Detrusor Overactivity - cerebral effect

- Blok et al (Brain 1997)
  - Ant Cingulate, Gyrus
  - Increased during void
  - Decreased during storage
  - Implies area for “control”
- Griffiths (Behav Brain Res 1998)
  - Decreased perfusion frontal (esp. Right) in institutional demented
  - Genuine urge incontinence with reduced sensation

Pelvic Plexus Injury

- May occur with any major pelvic surgery
- Pelvic fracture or tumor
- **Neural effect:**
  - **hypogastric - sympathetic:** incomplete bladder neck closure
  - **pelvic – parasympathetic:** impaired detrusor contractility
  - **pudendal – somatic:** external sphincter
Pelvic Plexus Injury

- Up to 80% will resolve within 6 months
- Best evaluated with UDS
- Beware the development of decentralization
- Silent hydronephrosis risks upper tract damage

Abdominoperineal Resection

- Incomplete emptying (retention) up to 90%
- Pelvic plexus injury impairs contractility
- Treat retention initially with CIC
- Sympathetic defect decreases bladder neck tone, ejaculation
- Sphincter weakness results in incontinence

Abdominoperineal Resection

- Up to 40% may have coexisting BPH
- Voiding dysfunction may be transitory
- Pudendal nerve damage: external sphincter dysfunction may be permanent
- For retention: UDS helps determine
  - BOO vs. impaired contractility
  - Sphincter function

Radical Hysterectomy

- Many develop vesicourethral dysfunction
- Effect similar to APR
- Parasympathetic disturbance should be decreased
- Risks increased with cardinal ligament excision
- May develop poor compliance
- Best to monitor upper tracts and storage pressure

Autonomic Neuropathy

- Results from decreased myelinization
- Sensory fibers affected primarily (diabetes)
- Parasthesias, decreased DTRs
- Vasomotor, alimentary tract Sx, diaphoresis
- Acontractile/hypocontractile detrusor
- Positive denervation sensitivity test
- Tx underlying problem will help GU Symptoms

Diabetic Neuropathy

- Voiding symptoms classically after 10 years
- Segmental demyelination & axonal degeneration
- Classic understanding:
  - Sensory impairment
  - Decreased contractility
  - Distention myopathy worsens voiding dysfunction
- Up to 55% diabetics have detrusor hyperreflexia
- 33% impaired contractility or areflexia*
- Urodynamics essential in diabetic voiding dysfunction

* Kaplan, Tc, Blaivas J Urol 153:342,
Herpes Zoster

- Varicella affects dorsal root ganglia
- May progress to anterior horns
- Sensory neuropathy
- May progress to somatic and visceral motor neuropathy
- Urinary retention may occur
- Usually self-limited

Transverse myelitis

- Uncommon inflammatory condition of the cord
- Grey and white matter involved
- Affects both children and adults
- Bilateral sensory/motor deficits sudden/progressive
- Bowel & bladder dysfunction - incontinence or retention
- 7 autoimmune etiology - seasonal clustering
- DA or DH (+DESD)
- Complete recovery from 3 to 18 months
  Residual deficit common

* Berger, Blaivas, Oliver J Urol 144:103, 1990

Amyotrophic Lateral Sclerosis

- Progressive neurodegeneration of neurons
  - spinal cord
  - Brainstem
  - Cerebral motor
- Upper and lower motor neuron lesions
- May be associated with dementia
- Juvenile forms affect those <30 yrs
- Results in paralysis, respiratory failure
- UMN may have overactivity with sphincteric function preserved

Voiding Dysfunction in AIDS

- Up to 40% AIDS patients - consider other GU pathology
  (stricture, BPH, prostatitis, calculi)
- HIV encephalitis, Viral meningitis 2nd CMV, herpes, Varicella
- Cryptococcus, Coccidiomycosis, Aspergillus, Mycobacterium
- Opportunistic CNS infxn - Toxoplasmosis 37%
- Symptoms variable, depending on site of lesion.
  - 36% areflexia
  - 27% hyperreflexia
  - 18% BOO
  - 19% Normal


Spinal Cord Tumor

- Weakness:
  - Upper motor neuron: lesion in precentral gyrus down to lateral corticospinal tracts
  - Lower motor neuron: lesion in ventral horn cells, neuromuscular junction, or muscles
  - Mixed: upper+lower weakness
- Sensory disturbances
- Autonomic disturbances (sweating, sexual, bowel, etc)

NGB in spinal cord tumors

- Weakness:
  - Upper motor neuron: lesion in precentral gyrus down to lateral corticospinal tracts
  - Lower motor neuron: lesion in ventral horn cells, neuromuscular junction, or muscles
  - Mixed: upper+lower weakness
- Sensory disturbances
- Autonomic disturbances (sweating, sexual, bowel, etc)
Voiding Function Following Deep Brain Stimulation

• A small device, similar to a pacemaker, is surgically implanted to deliver electrical stimulation to targeted areas of the brain
• Opinion on the effect of DBS on voiding function in PD is divided between improvement and deterioration
• Thalamic deep brain stimulation resulted in an earlier desire to void and decreased bladder capacity, suggesting a regulatory role of the thalamus in lower urinary tract function*

Adult Neurogenic Bladder: Current Evaluation & Advances in Clinical Management (Advanced)
Urodynamics in Neurogenic Voiding Dysfunction

Workshop Faculty
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Asst Professor & Director, Section of Neuro-Urology, Female Pelvic Medicine & Reconstructive Surgery, Voiding Dysfunction, and Urodynamics
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Classification of Neurogenic Bladder

• Urologic/Urodynamic
  – Failure to Store
  – Failure to Empty

• Neurologic
  – “Upper” vs “Lower”
  – Central vs Peripheral
  – “Anything can go”

Rationale for Urodynamic Evaluation

• Baseline functional assessment of LUT
• Identify NGB with risk of complications & may need early intervention
  – High fill pressure/poor compliance
  – DESD
• Assist in developing treatment plan
• Tool for identifying change neuro-pattern

Urodynamics

• Storage
  – Sensation
  – Capacity
  – Compliance
  – Stability
  – Continence
• Emptying
  – Flow rate
  – Detrusor pressure
  – Straining?
  – Outlet relaxation
  – PVR

Urodynamic Testing:
ICS Standard Nomenclature

• Acontractile Detrusor
  – Old nomenclature: Areflexia - Atonic, Flaccid
• Detrusor Overactivity (old: Bladder Instability)
  – Neurogenic DO
  – DO Incontinence
• Dyssynergia - Bladder/Sphincter discoordination
  – Internal urethral sphincter: smooth bladder neck
  – External urethral sphincter: striated Rhabdosphincter

Common Confusion
Leak Point Pressures

• Valsalva or Abdominal Leak Point Pressure- the intravesical pressure at which urine leakage occurs due to increased abdominal pressure in the absence of a detrusor contraction
• Detrusor Leak Point Pressure- the lowest detrusor pressure at which urine leakage occurs in the absence of either a detrusor contraction or increased abdominal pressure
**Leak Point Pressures**

**Valsalva Leak Point Pressure**
- Measures Outlet
  - Measure of SUI
- Low (0-60cmH20),
- Gray (60-100cmH20)
- Normal (>100cmH20)

**Detrusor Leak Point Pressure**
- Measures Compliance
  - Measure of bladder ability to safely store urine
- >40cmH20: Risk of damage to upper urinary tract

McGuire 1993
McGuire 1983

**Valsalva Leak Point Pressure**
- Cough Manuever
  - Higher pressure
  - Difficult to localize when leak occurred
- Valsalva Manuever
  - Slower rise
  - Allows more exact determination of pressure when leak occurred.

**Detrusor Leak Point Pressure**
- DLPP > 40 cm H20
  - Risk of Upper tract deterioration
  - 68% Vesico-ureteral reflux
  - 81% Hydronephrosis


**Detrusor Leak Point Pressure**
- Risk of Upper tract damage?

**Detrusor Leak Point Pressure**
- What is the DLPP?
- Does this pose a risk?

Pt performs self cath for volumes <500 cc

**Detrusor Leak Point Pressure**
- What is the DLPP?
- Does this pose a risk?
Detrusor Leak Point Pressure

- What is the DLPP?
- Does this pose a risk?

Pt performs self cath for volumes >225 cc

Classification of Neurogenic Bladder Failure to Store

- **Detrusor Cause**
  - Detrusor overactivity
  - Loss of Detrusor Compliance
- **Sphincter Cause**
  - Denervation
  - Ablation
  - Fixed sphincter (ISD?), open scar

Classification of Neurogenic Bladder Failure To Empty

- **Detrusor function**
  - Is detrusor contraction of significant magnitude to achieve emptying?
    - Areflexia, hypocontractility
    - Hyperactivity with impaired contractility
- **Sphincter function**
  - Is sphincter creating excessive outlet resistance?
    - Detrusor sphincter dyssynergia
    - Mechanical obstruction
    - Fixed sphincter

Urodynamic Patterns of NGB

- Detrusor Areflexia
- Detrusor Overactivity
  - Detrusor-External Sphincter Dyssynergia
  - Detrusor Hyperactivity with impaired Contractility
- Hostile Storage
  - Loss of compliance
  - High DLPP
- Don’t forget about non-neurogenic void dysfunction
  - SUI, Bladder outlet obstruction

Acontractile Detrusor

- Variant: Impaired contractility
- Absent/diminished detrusor contraction
- Storage capacity often increased
- May have diminished sensation
- Assuring storage pressure < 40 cm H2O safeguards upper tracts
**Detrusor Areflexia**
Decentralized Bladder

- Adrenergic overgrowth
- Progressively decreased compliance
- Need to follow DA patients with DLPP
- Upper tract imaging helpful
- Ensure low pressure storage

**Acontractile Detrusor**

**Normal compliance**

**Impaired Compliance**

**Poor compliance with leak**

**Non-compliant bladder with reflux**
Detrusor Overactivity

Normal Cystometrogram

Cystometrogram in patient with detrusor instability

Detrusor Overactivity

Detrusor External Sphincter Dyssynergia

A. At rest
B. Synergia (normal)
C. Internal sphincter dyssynergia (proximal)
D. External sphincter dyssynergia (distal)
E. Combined sphincter dyssynergia

Detrusor External Sphincter Dyssynergia

Detrusor External Sphincter Dyssynergia (DESD)
Adult Neurogenic Bladder: Current Evaluation & Advances in Clinical Management (Advanced)

Treatment of Neurogenic Bladder

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18/06/2012

Current Management of Neurogenic Bladder

3 major categories:

- Behavioral/non-pharmacologic interventions1,2
  - Lifestyle interventions
  - Fails, portable units
  - CIC/CISC, condom or Foley catheterization for patients with incomplete bladder emptying

- Pharmacotherapy1,4
  - Anticholinergic agents are the standard therapy

- Surgery1,4
  - Reserved for those who fail conservative therapy
  - Urinary Diversion
  - Bladder Reconstruction

1 CIC=clean intermittent catheterization; CISC=clean intermittent self catheterization

Accessible Exam Room

NGB: Conservative Treatment

- Stress incontinence due to sphincter incompetence
  - Behavioral
  - timed voiding
  - external appliances

- Detrusor overactivity with detrusor sphincter dyssynergia:
  - intermittent catheterization (CIC)
  - bladder relaxants
  - indwelling catheter + bladder relaxing drugs

- Detrusor overactivity with negligible post void residual & no DESD:
  - Behavioral
  - bladder relaxants
  - CIC
  - triggered voiding (if urodynamically safe)
  - External appliances
  - indwelling catheter + bladder relaxants

- Detrusor underactivity with post void residual:
  - CIC; alpha blockers; intravesical electrical stimulation
  - bladder expression (if urodynamically safe)

Pharmacotherapy (improve storage)

- To improve storage (oral, transcutaneous, and intravesical)
- To improve emptying (oral)

Surgical Management

- Suprapubic tube drainage
- Augmentation Cystoplasty
- Continent Urinary Diversion
- Incontinent Urinary Diversion
- Others
Failure to Store

- **Detrusor Cause**
  - Detrusor Hyperreflexia
  - Loss of Detrusor Compliance
- **Sphincter Cause: Incompetent outlet**
  - Denervation
  - Ablation
  - Fixed, open scar

Pharmacologic Therapy for Failure to Store

- Anticholinergic agents
- Musculotropic agents
- Tricyclic antidepressants
- Alpha-adrenergic agonist

Musculotropic Relaxants

- **Oxybutinin chloride** - 5mg TID
  - Oral as well as transdermal
  - Can also use intravesically
- **Tolterodine SA** - 4 mg Qday
- **Solifenacin** - 5-10 mg Qday
- **Darifenacin** - 7.5-15 mg Qday
- **Trospium XR** - 60 mg Qday
- **Fesoterodine** 4-8 mg Qday

Anticholinergics in NGB

Meta-analysis

- Compared with placebo, anticholinergics result in better patient-reported cure/improvement
- Higher incidence of adverse events (dry mouth)
- No difference in withdrawal of treatment due to adverse events
- None of the different agents/dosages assessed was superior to another.
- Treatment associated with a reduction in maximum detrusor pressure, which can be beneficial for long-term renal function

Surgery for Failure to Store

- Denervation procedures
  - Central - subarchnoid blocks
  - Peripheral - sacral rhizotomy
  - Perivesical - bladder denervation
- Bladder augmentation
- Urinary Diversion


Botulinum Toxin Type A

- For bladder & sphincter

Botulinum Toxin

- Most potent bio toxin known to man
  - 1897 van Ermengen, outbreak of sausage poisoning
  - Clostridium botulinum (Gram + Anaerobe)
  - 7 distinct toxins (A-G)
- Blocks presynaptic release of acetyl-choline from cholinergic nerve terminals
- Two chains (light and heavy)
  - 150 kDa (100 kDa connects to 50 kDa via disulfide bond)
  - Heavy chain binds molecule to target cell membrane (nerve terminal)
  - Light chain internalized and inhibits neurotransmitter release

Smith, JU, 2005
Rackley CUR 2004

Presynaptic Release of AcetylCholine

- Vesicle with ACH
- SNAP Complex
  - Inside presynap
  - Binds vesicle
  - Exocytosis of vesicle and release of ACH

Smith, JU 2005

Botox Inhibits Presynaptic Release of ACH

- Heavy chain gets light chain toxin inside presynaptic cell
- Light chain binds up SNARE complex
- Vesicle unable to exocytose

Smith, JU 2005

Preparations

<table>
<thead>
<tr>
<th>Preservative</th>
<th>BTX-A (Botox)</th>
<th>BTX-A (Replas)</th>
<th>BTX-B (Myobloc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyaluronidase</td>
<td>400 kDa</td>
<td>400 kDa</td>
<td>700 kDa</td>
</tr>
<tr>
<td>Package (u)</td>
<td>100</td>
<td>500</td>
<td>1/400/5/100/1/100</td>
</tr>
<tr>
<td>Neutrophil protein</td>
<td>0.5</td>
<td>1.25</td>
<td>25/50/100</td>
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<tr>
<td>pH</td>
<td>3.0</td>
<td>7.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Year of FDA approval</td>
<td>1989</td>
<td>1999</td>
<td>2000</td>
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</table>

<table>
<thead>
<tr>
<th>Preparation</th>
<th>My preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100 units (DQ/DAB)</td>
</tr>
<tr>
<td></td>
<td>200-300 for NGB</td>
</tr>
<tr>
<td></td>
<td>30 mL volume</td>
</tr>
<tr>
<td></td>
<td>30 injections</td>
</tr>
<tr>
<td></td>
<td>Collagen inject scope</td>
</tr>
</tbody>
</table>

| Problems   | Invasive |
|           | Temporary requires repeat cystoscopy and injections |
|           | "Feel" for the inject |
|           | Too deep: inject in serosa or outside bladder |
|           | Too shallow: waste into lumen |

Rackley, CU 2005

Intravesical injection of Botulinum Toxin technique

- My preparation
  - 100 units (DQ/DAB)
  - 200-300 for NGB
  - 30 mL volume
  - 30 injections
  - Collagen inject scope
- Problems
  - Invasive
  - Temporary requires repeat cystoscopy and injections
  - "Feel" for the inject
  - Too deep: inject in serosa or outside bladder
  - Too shallow: waste into lumen
**Botulinum Toxin Type A**

*side Effects: rare*

- Lethal dose 2800 unit (40 unit/kg in 70 kg)
  - Detrusor doses well below
- Allergic reactions
- Flu like symptoms
- Avoid other agents that impair neuromuscular transmission
  - Curare like compounds
  - Aminoglycosides
  - Myasthenia Gravis (relative)

**Cost an Issue**

"I was very ill and my HMO wouldn't pay for human parts."

Smith, Nature/Urology 2004

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**Smith, JU 2005**

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**Kuo YC et al. Int J Urol 2012**

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**Cruz F, et al. European Urology 2011; 60: 742-750**

---

**Table 1**

| Therapeutic effects of urethral soman (SOM) A injections in different voiding dysfunction |
|---------------------------------|-----|-----|-----|
| Disease                        | n   | No. effective | No. improved | No. fail |
|---------------- -------------- |----|------------|-------------|----------|
| Detrusor dysfunction            | 10 | 9 (90.0)    | 0           | 1 (10.0) |
| Detrusor neuropathy             | 15 | 13 (86.7)   | 2 (13.3)    | 0        |
| Detrusor events/loss            | 30 | 27 (90.0)   | 3 (10.0)    | 0        |
| Detrusor dysautonomia           | 10 | 9 (90.0)    | 1 (10.0)    | 0        |

**Table 2**

<table>
<thead>
<tr>
<th>Therapeutic effects of LDF (laser) to the bladder neck</th>
<th>Patients</th>
<th>Cause of bladder neck obstruction</th>
<th>Patents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detrusor dysfunction</td>
<td>100</td>
<td>Nonobstructive urethral stenosis</td>
<td>100</td>
</tr>
<tr>
<td>Detrusor neuropathy</td>
<td>100</td>
<td>Difficult voiding or relaxation</td>
<td>100</td>
</tr>
<tr>
<td>Detrusor dysautonomia</td>
<td>100</td>
<td>Nocturnal incontinence</td>
<td>100</td>
</tr>
</tbody>
</table>

*From current patients presenting with symptoms of autonomic dysfunction at baseline.*

---

**Study**

<table>
<thead>
<tr>
<th>Design</th>
<th>Outcomes</th>
<th>Evidence level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonsurgical bladder</td>
<td>Open n=27 (BTA)</td>
<td>1 Bladder capacity increased</td>
</tr>
<tr>
<td>Open n=27 (BTA)</td>
<td>2 Bladder pressure decreased</td>
<td>16</td>
</tr>
<tr>
<td>Rode and Schieltz et al.</td>
<td>Open n=50 (BTA)</td>
<td>1 Bladder capacity increased</td>
</tr>
<tr>
<td>Open n=50 (BTA)</td>
<td>2 Bladder pressure decreased</td>
<td>16</td>
</tr>
<tr>
<td>Kuo YC et al.</td>
<td>Open n=10 (BTA-A)</td>
<td>1 Bladder capacity increased</td>
</tr>
<tr>
<td>Open n=10 (BTA-A)</td>
<td>2 Bladder pressure decreased</td>
<td>16</td>
</tr>
<tr>
<td>Non-nonsurgical bladder</td>
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</tr>
<tr>
<td>Open n=10 (BTA)</td>
<td>2 Bladder pressure decreased</td>
<td>16</td>
</tr>
</tbody>
</table>

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**Figure**

Improvement in incontinence episodes

Improvement in QOL

Reduction in UI Compared to Baseline
Surgery for Failure to Store

- Denervation procedures
- Bladder augmentation
  - Alternatives
    - autoaugmentation
    - ureterocystoplasty
- Urinary Diversion

Mymectomy
Auto-augmentation

- Popularized by Snow and Cartwright (1989)
- Strip the bladder muscle leaving the mucosa intact
- Essentially creates a large, wide-mouthed diverticulum
- Long-term success in patients with neurogenic bladder dysfunction still?

Detrusor Myomectomy
Auto-Augmentation

Augmentation Cystoplasty

Indications:
- Intractable detrusor overactivity causing incontinence
- Ability/motivation to perform CIC
- Desire to convert from reflex voiding to an intermittent catheterization program
- High risk for upper tract deterioration—hydronephrosis and/or high pressure VU reflux
- detrusor sphincter dyssynergia

Scientific evidence—III
Grade of recommendation—C
Strength of panel opinion—Strong
Augmentation Cystoplasty

- Can use small or large bowel
- Transverse bladder incision facilitates placement of the augmentation
- Reflux: consider reimplantation for high grade reflux, +/- grade 3, grades 4 or 5
- Small but real risk of carcinoma in the augmented bowel segment

Ileal Augmentation Cystoplasty

- Utilize ileocecal segment
- Continent cutaneous stoma
- No ureteral reimplantation if no reflux
- Preserves fertility potential
- No transfer needed to do self cath
- No need for urethral catheterization although it’s still available

Cutaneous Ileocystostomy

- Tetraplegic male who cannot maintain condom catheter because of penile retraction
- Women without dexterity to self-cath
- An ileal conduit “bladder chimney” provides low-resistance to outflow
- Avoids complications of foreign body
- Risks less than cystectomy /ileointestinal anastomoses

Cutaneous Ileocystostomy

- A short isolated ileal segment
- Boari flap anastomosis of bowel segment and bladder dome - avoid a waist
- Distal ileum forms incontinent urostomy
- Consider pubovaginal sling in women

Ileo-Vescicostomy

- Short isolated ileal segment
- Wide anastomosis of bowel segment & bladder dome - avoid waist
- Distal ileum forms incontinent urostomy
- Must have competent outlet
  Consider pubovaginal sling in women

Continent Augmentation Cystoplasty
**Continent Catheterizable Augmentation**

*Indiana Augment*

---

**Surgery for Failure to Store**

- Denervation procedures
- Bladder augmentation
- Urinary Diversion

---

**Continent Urinary Diversion - Indications**

- Patients who cannot access their native urethra due to congenital abnormalities, spasticity, obesity, contracture, or tetraplegia, or who require closure of an incompetent bladder neck.
- Females with tetraplegia with urethral erosion from indwelling catheter.
- Males with SCI with unsalvageable bladders secondary to urethral fistula & sacral pressure ulcers.
- Individuals with bladder cancer requiring cystectomy.

*Scientific evidence—III*

*Grade of recommendation—C*

*Strength of panel opinion—Strong*

---

**Continent Urinary Diversion**

- Indiana Pouch with RLQ / umbilical stoma
- Lower urinary tract is essentially unsalvageable
- Good hand function
- Reasonable life expectancy
- Motivated to undergo the procedure

---

**Ileal Conduit Urinary Diversion**

- Generally, method of last resort
- Requires life-long monitoring of renal function
- Be wary of use in children or young adults
- Pyocystis
- Squamous cell carcinoma of the native bladder

---

**Outlet Incompetence female**

- Urethral Closure
  - Transvaginal
  - Retropubic
- Pubovaginal Sling
- Artificial urinary Sphincter
Outlet Incompetence
male

- Urethral Closure
  - Perineal Approach
  - Retropubic Approach
- Male Sling
- Artificial Urinary Sphincter

Artificial Urinary Sphincter

- Higher risk for erosion or infection in the neurogenic population
  - Does not mean should not be option
- Need motivated, compliant patient
- Carefully assess hand function
- Catheterization is possible, however, it does increase the risk of complications

Artificial Urinary Sphincter

Failure To Empty

Should think of treatment of neurogenic lower urinary tract dysfunction in components:

1. Detrusor function: Is detrusor contraction of significant magnitude to achieve emptying?
2. Sphincter function: Is sphincter creating excessive outlet resistance?

Valsalva & Crede Maneuvers

- Unphysiologic
- Outflow resisted by same mechanisms that assure continence
- No bladder neck opening - outflow resistance may increase
- Risks damage to pelvic floor
- May increase risk to upper tracts esp. w/ poor compliance/ established reflux

Avoid Crede/Valsalva

- Detrusor sphincter dyssynergia
- Bladder outlet obstruction
- Vesicoureteral reflux
- Hydronephrosis

Scientific evidence–III
Grade of recommendation–C
Strength of panel opinion–Strong
Urecholine

- Never proven to generate detrusor contraction in patients with acontractile detrusor
- May increase basal tone of bladder wall
- Largely ineffective in treatment of acontractile detrusor
- May increase storage pressure and susceptibility to upper tract damage

Failure To Empty

- Tube drainage
- Intermittent Catheterization
- Sphincterotomy
- Ileal Conduit
- Ileal-Vescostomy
- Neuro-Prosthesis (Sacral Stimulation)

Tube Drainage (urethral & suprapubic)

- Consider clean intermittent catheterization (CIC) for individuals who have sufficient hand skills or a willing caregiver to perform the catheterization
  Scientific evidence: III; Grade of recommendation: C
- Alternative to CIC (e.g., SP tube) indicated in:
  - Abnormal urethral anatomy - stricture, false passages, and bladder neck obstruction.
  - Bladder capacity less than 200 ml.
  - Poor cognition, little motivation, inability/unwillingness to adhere to the CIC time schedule or the fluid intake regimen
  - adverse reaction toward having to pass the catheter into the genital area multiple times a day.

Intermittent Catheterization

- Need to assure low-pressure storage
- Urodynamics essential to check compliance and leak point pressure
- Hydronephrosis and reflux may resolve
- Urinary tract becomes colonized
- Treat only clinical UTI (fever, hematuria, epididymitis)
- Complications of strictures, false passages

When to avoid CIC?

- Inability to catheterize themselves
- An unwilling (to perform CIC) caregiver
- Abnormal urethral anatomy (urethral stricture, false passages, and BNO)
- Bladder capacity <200 ml
- Poor cognition, little motivation & inability or unwillingness to adhere to catheterization time schedule

Scientific evidence—III
Grade of recommendation—C

Complications of CIC

- Urinary tract infections
- Bladder overdistention
- Urinary incontinence
- Urethral trauma with hematuria
- Urethral false passages
- Urethral stricture
- Autonomic dysreflexia (lesions at T6 and above)
- Bladder stones
Indwelling Catheter - Indications

- Poor hand skills
- High fluid intake
- Cognitive impairment or active substance abuse
- Elevated detrusor pressures managed with anticholinergic medications
- Lack of success with other, less invasive bladder management methods
- For temporary management of vesicoureteral reflux
- Limited assistance from a caregiver

Scientific evidence–III
Grade of recommendation–C
Strength of panel opinion–Strong

Indwelling Catheterization Risks

- Chronic infection, stone formation
- Tissue erosion (traumatic hypospadias, bladder neck/urethral destruction)
- Bladder wall fibrosis, urothelial neoplasia
- Vesicoureteral reflux, hydronephrosis
- Neprolithiasis, renal failure

Avoid indwelling catheterization except as last resort

Indications for suprapubic tube

- Urethral abnormalities
  - stricture, false passages, bladder neck obstruction, or urethral fistula
- Urethral discomfort
- Recurrent urethral catheter obstruction
- Difficulty with urethral catheter insertion
- Perineal skin breakdown due to urine leakage secondary to urethral incompetence
- Psychological considerations - body image
- Personal preference; desire to improve sexual genital function
- Prostatitis, urethritis, or epididymoorchitis

Scientific evidence–III
Grade of recommendation–C
Strength of panel opinion–Strong

External Sphincterotomy

- Establishes low-pressure drainage without indwelling foreign body
- Ensure pt can use external collection device
- Historical risks
  - Hemorrhage 5-23%
  - Recurrent obstruction 12-26%
  - Erectile dysfunction 2.8-64%
- Chemical sphincterotomy
  - Botox denervation

Contraindications for Chemical Sphincterotomy (botulinum toxin)

- Neuromuscular disease
- Known allergy to or previous adverse effect from botulinum toxin
- Current aminoglycoside therapy
- Insufficient hand skills or caregiver assistance
- Patient unable to maintain a condom catheter
- Female patient
External Sphincterotomy

- **Contact Nd:YAG laser**: risks much lower
- **Complications**: rare
  - 23 hr admission (for bleeding, AD)
- **Bladder neck dysfunction/internal sphincter dyssynergia** may persist
- **Follow up**:
  - upper tract imaging
  - UDS

Sphincter Stent Prosthesis

- **Lengths**: 2, 2.5, 3 cm
- **22 French cystoscopic insertion tool**
- **Use 0° telescope**
- **Proximal margin at verumontanum**
- **Distally into bulbous urethra (5 mm)**
- **Overlapping stents may be needed**

Sphincter Stent Prosthesis

- **Acceptable alternative to sphincterotomy**
- **Results equivalent**
- **May have less morbidity**
- **Sphincter ablation potentially reversible**
  - Learning curve favorable (2-5 patients)
    - beware chronically dilated prostatic urethra
- **Serial evaluation mandatory**
  - pelvic radiograph
  - Cystoscopy
  - UDS
  - U/S

Urolume Sphincter Stent
Epithelialized Urolume

Explanted Urolume

Neurostimulation
Sacral nerve root stimulation

**Issues**
- Uninhibited reflex voiding controlled - esp. women
  - hyperreflexia abolished by rhizotomy
  - capacity, compliance increased
- Continent urine if bladder neck intact
- Residual urine (< 60 ml) acceptable
- Decreased incidence of UTI
- Improves VU Reflux & hydronephrosis
- Voiding pressure may be elevated by sphincter stimulation

Neurostimulation
Sacral nerve root stimulation

**Requires intact parasympathetic efferents**

- **When to perform?**
  - Complete SCI: after 1 year
  - Incomplete SCI: after 2 years
- **Technique:**
  - Intradural
  - extradural techniques
  - rhizotomy
- **Surgery challenging**
  - requires:
    - L2-S4 laminectomy
    - intraop stimulation
    - meticulous dissection
- **Dyssynergic sphincteric contraction problematic**
  - Anodal block may be effective

Cauda Equina Syndrome

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Occurrence</th>
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<tbody>
<tr>
<td>Blockage in the flow of urine</td>
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<tr>
<td>Causes</td>
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<tr>
<td>Nerve damage</td>
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<td>Medication</td>
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<td>Physical therapy</td>
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</tbody>
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UTI in Neurogenic Bladder

- For those on intermittent catheterization
  - $10^2$ colony forming units (cfu)
- For those using clean-void specimens
  - catheter-free males who use external condom collecting devices: $10^4$ cfu
- From indwelling catheters
  - any detectable concentration

Gribble, 1994
What is on the Horizon?

- Lumbar to Sacral Nerve Rerouting
- Spinal cord Regeneration
- Stem Cell Transplantation

Take Home Points

- Voiding dysfunction associated with a wide range of neurologic conditions
  - Impairs patient daily activities considerably
- Alterations in afferent and efferent neuronal pathways impact bladder function
- Management considerations include maintaining low bladder pressures, preventing infection, and preserving upper tract function
- Current management includes behavioral interventions, anticholinergic therapy, and surgery

Take Home Points

- Antimuscarinic agents are first-line therapy & oxybutynin is the only antimuscarinic agent approved specifically for neurogenic detrusor overactivity
- Onabotulinumtoxin A intradetrusor injection was approved by the US FDA in 2012 for neurogenic detrusor overactivity (MS and SCI)
- Clean intermittent catheterization is a safe treatment for urinary retention in SCI and MS
- Sacral nerve stimulation is approved for idiopathic OAB but not for neurogenic bladder dysfunction
- Bladder augmentation / urinary diversion is reserved for those failing conservative therapy
- Long-term follow-up is important as changes in detrusor compliance and urodynamic patterns may occur over time
Notes
Record your notes from the workshop here