Neurogenic Bladder
Diagnosis and Management

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Advanced Urology Course
UMMC-MUA Office
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# Physiology of Micturition

<table>
<thead>
<tr>
<th>Anatomy</th>
<th>Function</th>
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</table>
| Brain frontal lobe (micturition control c.) | Tonic inhibition to detrusor  
Can delay voiding by stimulating pons |
| Pontine micturition center (PMC)            | Stimulated to relax sphincter to void                                   |
| Sacral spinal cord                         | Local voiding reflex via sacral reflex center  
Cycle of detrusor filling and emptying  
Injuries: detrusor sphincter dyssynergia, urinary retention (areflexia)  
Can be out-ruled by higher centers |
| Peripheral nerves: sympathetic             | Bladder accommodates and int urethral sphincter is closed to delay void  
It inhibits parasympathetic signals       |
| Peripheral nerves: parasympathetic         | Bladder contracts and int urethral sphincter relaxes to void             |
| Somatic nerve: pudendal nerve              | Somatic nerves control: ext urethral sphincter and pelvic diaphragm: contraction if stim |
Normal physiology

Figure 1: Innervation of the lower urinary tract.
Epidemiology (1)

• Neurogenic bladder/neurogenic LUT dysfunction (NLUTD) effects depend on location and extent of neurological disease

• **Overall prevalence – no data**

• Among important causes:
  – Brain tumour: 24%
  – Dementia and geriatric patients
    • Alzheimer’s disease, occurrence of incontinence 23%-48%
  – Mental retardation: 12%-65%
  – Cerebral palsy: 30-40%
  – Spinal cord lesions: central cord lesion (incomplete Spinal cord Injury) 42% regressing to 12%
  – Basal ganglia pathology
    • 60% Parkinson patients had symptoms
• Other important causes of neurogenic LUTD:
  
  – Demyelination (Multiple Sclerosis): 50%-90%
  – Cerebrovascular accident: 20%-50%, decreasing prevalence with post-insult period
  – Disc disease: 28-87%
  – Spinal stenosis/spine surgery: 50%/38-60%
  – Peripheral neuropathy: ‘diabetic cystopathy’ 43-87% IDDM and 25% type 2 DM
  – HIV: 12% at advanced stage of disease
  – Iatrogenic: 50% APR colorectal surgery, 8-57% of radical hysterectomy & pelvic irradiation, ?data post radical prostatectomy
## Aetiology of NLUTD

**Table 1** Neurological disorders causing lower urinary tract dysfunction

<table>
<thead>
<tr>
<th>Suprapontine causes</th>
<th>Stroke</th>
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<tbody>
<tr>
<td></td>
<td>Trauma</td>
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<tr>
<td></td>
<td>Degeneration: Parkinson’s disease, multiple system atrophy, Alzheimer’s disease, dementia with Lewy bodies</td>
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<tr>
<td></td>
<td>Hydrocephalus, normal pressure hydrocephalus</td>
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<tr>
<td></td>
<td>Cerebral palsy</td>
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<tr>
<td></td>
<td>Neoplasm</td>
</tr>
<tr>
<td>Suprasacral (intrapontine) causes</td>
<td>Demyelination: multiple sclerosis, transverse myelitis</td>
</tr>
<tr>
<td></td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Vascular: Arteriovenous malformations, spinal cord infarction</td>
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<tr>
<td></td>
<td>Neoplasm: metastasis, primary</td>
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<tr>
<td></td>
<td>Hereditary: Hereditary spastic paraparesis</td>
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<tr>
<td></td>
<td>Infections: tropical spastic paraparesis (HTLV-I)</td>
</tr>
<tr>
<td></td>
<td>Cervical spondylosis</td>
</tr>
<tr>
<td>Infrasacral (spinal root and peripheral) causes</td>
<td>Spina dysraphism</td>
</tr>
<tr>
<td></td>
<td>Arachnoiditis</td>
</tr>
<tr>
<td></td>
<td>Intervertebral disc prolapse</td>
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<tr>
<td></td>
<td>Diabetes mellitus</td>
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<tr>
<td></td>
<td>Hereditary: hereditary motor sensory neuropathy</td>
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<td>Iatrogenic: pelvic or retroperitoneal surgery</td>
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### Pathophysiology

<table>
<thead>
<tr>
<th>Lesion location</th>
<th>Symptom complex</th>
<th>Terminology</th>
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| Above pontine micturition center (PMC)               | - Reduced awareness of bladder fullness  
  - low bladder capacity  
  - incontinence  
  - no high bladder pressure                         | Uninhibited bladder                |
| Between PMC and sacral spinal cord                   | - Detrusor sphincter dyssynergia  
  - reduced bladder capacity  
  - detrusor overactivity  
  - incontinence                                         | Upper motor neuron bladder         |
| Sacral cord lesions that damage detrusor nucleus but sparing pudendal nucleus | - Detrusor areflexia  
  - hypertonic ext urin sphincter  
  - large bladder urinary retention                        | Mixed type A bladder                |
| Sacral cord lesions that spare detrusor nucleus but involves pudendal nucleus | - Flaccid ext urin sphincter  
  - Detrusor spasticity  
  - low bladder capacity                                    | Mixed type B bladder                |
| From sacral cord or sacral nerve root injuries       | - Detrusor areflexia  
  - Intact int urin sphincter  
  - incontinence +/- UTI                                       | Lower motor neuron bladder         |
Pathophysiology

Figure 1: Anatomy and physiology of micturition with potential injury sites to urologic system (m: muscarinic receptor, α: alpha-adrenergic receptor, β: beta-adrenergic receptor).
Classification

- Variety, based on
  - Urodynamics, neurological criteria, bladder and urethral function
• History
  – Assess storage and voiding micturition phase
  – Past and present symptoms and disorders
    • Developmental, ObGyn, Diabetes, Hereditary, Neurological disease
  – Prior GU conditions/surgeries
    • Any insidious onset of non-traumatic neurologic bladder sym
    • Accidents and operations
  – Urinary symptom history
    • Storage and voiding functions of LUT
  – Present Functional Hx: Bowel, Sexual
  – Social Hx : smoking, Drug Hx
  – Neurological disorders
  – Red flags: pain, infection, haematuria and fever
Diagnosis (2)

• History
  – Voiding diary
    • Semi-objective
    • Number, volume, incontinence, and urge episodes
    • 24-hr diary (esp in women)
    • Over 3 consecutive days (increased reliability)
    • Diary content:
      – Voiding pattern
      – Fluid intake
      – Voiding issues
Diagnosis (3)

• History
  – Quality of life assessment
    • Visual analogue score (VAS) for symptom bother
    • Validated *Qualiveen* questionnaire (*spinal cord injury and multiple sclerosis*)
    • Generic tools: SF36
    • Specific tools, eg. for incontinence: I-QoL
Diagnosis (4)

• Clinical examination
  – Any physical and mental handicaps?
  – High neurological lesions: HYPOTENSION when changing posture
    • CAUTION: Autonomic dysreflexia – sudden and exaggerated autonomic response to stimuli in spinal cord injuries above T5-T6. HYPERTENSION can be life threatening
  – Test: sensations and reflexes of urogenital area
  – Test: sphincteric and pelvic floor function
Diagnosis: Clinical Examination (1)

completely as possible: (a) dermatomes of spinal cord levels L2-S4; (b) urogenital and other reflexes in the lower spinal cord.
### Table 3.2: Neurological items to be specified

<table>
<thead>
<tr>
<th>Sensations S2-S5 (both sides)</th>
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<tbody>
<tr>
<td>Presence (increased/normal/reduced/absent)</td>
<td></td>
</tr>
<tr>
<td>Type (sharp/blunt)</td>
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<tr>
<td>Afflicted segments</td>
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<table>
<thead>
<tr>
<th>Reflexes (increased/normal/reduced/absent)</th>
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<tr>
<td>Bulbocavernous reflex</td>
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<tr>
<td>Perianal reflex</td>
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<tr>
<td>Knee and ankle reflexes</td>
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<tr>
<td>Plantar responses (Babinski)</td>
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<table>
<thead>
<tr>
<th>Anal sphincter tone</th>
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<tr>
<td>Presence (increased/normal/reduced/absent)</td>
<td></td>
</tr>
<tr>
<td>Voluntary contractions of anal sphincter and pelvic muscles (increased/normal/reduced/absent)</td>
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<tr>
<th>Prostate palpation</th>
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<tr>
<td>Descensus (prolapse) of pelvic organs</td>
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Summary of Clinical Examination

- Neurological
- Mechanical
- Cognition
- Hand-strength and coordination
- Joint contracture
- Mobility
- Sexuality
Diagnosis

• Urodynamics
  – Objective but invasive assessment
  – Preparation
    • Autonomic dysreflexia: check BP regularly
    • Assess maximum anaesthetic bladder capacity
    • Rectal ampulla empty
    • Stop drugs that may influence LUT function (48 hrs)
  – Caveats
    • Beware of artefacts
    • Quality of recording and interpretation
    • Same session: repeat urodynamics
    • Report according to Int Continence Soc standard
Diagnosis

• Components of Urodynamics
  – Free uroflowmetry and PVR volume
    • Initial impression’
  – Filling cystometry
    – Detrusor leak point pressure (DLPP)
  – Pressure-Flow Study
  – Electromyography
    – Urethral pressure measurement
  – Ambulatory urodynamics
  – Provocative tests during urodynamics
  – Video-urodynamics (GOLD STANDARD)
    • Filling cystometry + Pressure-Flow study
**Table 3.3: Typical findings in neuro-urological disorders**

<table>
<thead>
<tr>
<th>Filling phase</th>
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<tbody>
<tr>
<td>Hyposensitivity or hypersensitivity</td>
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<td>Vegetative sensations</td>
</tr>
<tr>
<td>Low compliance</td>
</tr>
<tr>
<td>High-capacity bladder</td>
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<tr>
<td>Detrusor overactivity, spontaneous or provoked</td>
</tr>
<tr>
<td>Sphincter underactivity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voiding phase</th>
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<tbody>
<tr>
<td>Detrusor underactivity or acontractility</td>
</tr>
<tr>
<td>Detrusor sphincter dyssynergia</td>
</tr>
<tr>
<td>Non-relaxing urethra</td>
</tr>
<tr>
<td>Non-relaxing bladder neck</td>
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</tbody>
</table>
Diagnosis

• Uro-neurophysiological tests (elective)
  – Electromyography (EMG) of pelvic floor muscles, urethral sphincter and/or anal sphincters
  – Nerve conduction studies (pudendal n.)
  – Reflex latency measurements (bulbocavernous and anal reflex arcs)
  – Evoked responses (clitoris/glans penis)
  – Sensory testing (bladder, urethra)
Diagnosis: Investigations

• Urinalysis
• Urine culture & sensitivity
• Serum urea/Creatinine
• Creatinine Clearance
• Incontinence quantification
• Urinary tract imaging
Management

• Treatment aims
  – Protect upper urinary tract
  – Improvement of urinary incontinence
  – Restoration of (or parts of) of LUT function
  – Improvement of QoL
Treatment

• Modalities of treatment
  – Non-invasive, Conservative treatment
    ➢ Assisted bladder emptying
    ➢ Lower urinary tract rehabilitation
    ➢ Drug therapy
  – Minimal invasive treatment
  – Surgical treatment
Non-invasive/Conservative (1)

• **Assisted Bladder Emptying**
  – Third party bladder expression (Crede)
    • Dangerous, not practised anymore
  – Valsalva voiding
    • Generates high pressure, dangerous
  – Triggered reflex voiding
    • Stimulated voiding of sacral/lumbar dermatomes (UMNL)
    • **Beware** of autonomic dysreflexia
  – Behavioural modification
    • Timed voiding (bladder training); lifestyle modification
  – Pelvic floor muscle exercises
    • Improve continence
  – Biofeedback
Non Invasive/Conservative (2)

• External appliances
  – Allows for social continence (collecting urine)
    ➢ Condom catheters for men
    ➢ Incontinence pads
  • Observe for infection risks
Non Invasive/Conservative (3)

• **Lower Urinary Tract Rehabilitation**
  – Aims to re-establish bladder function
  – Regain voluntary control over LUTD
  – Electrical or magnetic stimulation
  – Concept: pudendal nerve stimulation inhibits micturition reflex/detrusor contraction
    – *Little data published*

• Types:
  – Peripheral temporary electrostimulation
  – Intravesical electrostimulation
  – Chronic peripheral pudendal stimulation
  – Repetitive transcranial magnetic stimulation
Non Invasive/Conservative (4)

• Drug therapy – combination therapy more useful than monotherapy

*Detrusor OVERACTIVITY*

• Antimuscarinic
  – First line BUT avoid if stress urinary incontinent
  – Treats neurogenic detrusor overactivity
  – Improves bladder compliance and reduces OA
  – Neurogenic patients higher dose but compliance
  – Oxybutinin chloride, trospium chloride, *tolterodine* tartrate [established, for long-term]
    – Darifenacin, Solifenacine (in MS, in SCI), *Fesoterodine* [newer]
  – SE: dry-mouth (so, give transdermal/intravesical) or tolterodine
Non Invasive/Conservative (5)

• Phosphodiesterase inhibitors (PDE-5I)
  – Promising early results (for DO)
  – Acts on urothelium and afferent nerve

• Adjunctive desmopressin – nocturnal enuresis

**Detrusor UNDERACTIVITY**

• Cholinergics (bethanechol chloride, distigmine bromide)
  – No evidence on efficacy

**Decreasing Bladder Neck Resistance**

• Alpha blocker : \(\downarrow\) bladder outlet resistance, autonomic dysreflexia

**Increasing Bladder Outlet Resistance**

• No efficacious drug
Minimally Invasive (1)

• Catheterisation

  – Gold standard
  – *Intermittent*, clean/aseptic, self- or 3rd party
  – Indicated in:
    • Detrusor underactivity or acontractility
    • DO (*with controlled overactivity*)
  – Frequency: 4-6 times/day. For sterile IC, optimum 5 times/day
  – Catheter size: 12-16 F
  – Bladder volume at catheterisation: < 500ml
  – Caution: trauma, urinary tract infection
  – *Indwelling* catheter poses ↑ risk of infection
    • Silicon catheter better (less encrustation, no latex allergy)
Minimally Invasive (2)

• **Intravesical drug treatment**

  – Reduces DO symptoms
  – Reduces side effects of antimuscarinics
  – Allows more drug to be sequestered in bladder
  – Vallinoids, capsaicin, resiniferatoxin
    • Desensitises C-fibres, reduces DO for a few months
    • Dosage: 1-2 mmol capsaicin in 100ml 30% alcohol, or 10-100 nmol resiniferatoxin in 100ml 10% alcohol in 30min
    • Resiniferatoxin superior to capsaicin
    • But inferior to botulinum toxin A injections for detrusor
Minimally Invasive (3)

- **Intravesical electrostimulation**
  
  - Enhances bladder filling sensation and void urge
  - Restores volitional control of detrusor
  - Regime: daily stimulation 90 min with 10 mA pulses of 2 ms duration, at 20Hz frequency ≥ 1 wk
  - Requisites: detrusor muscle intact, afferent pathway from detrusor to brain intact (hence for peripheral nerve lesions)
  - Efficacy: equivocal
Minimally Invasive (4)

• *Botulinum toxin injections in the bladder*

  – Long lasting (reversible) chemical denervation (lasting 9 mths)
  – Mapped injections over detrusor
  – Repeated injections without loss of efficacy
    • Histology: no ultrastructural changes post injection
  – S/E: generalised muscle weakness
Minimally Invasive (5)

- **Bladder neck and urethral procedures**
  - Aim: protect upper urinary tract
  - Chemical denervation of sphincter
    - Botulinum toxin sphincter injection
      - Most effective in reducing neurogenic detrusor overactivity
      - Needs repeated injections, efficacious, few adverse effects
    - Balloon dilatation
      - No longer recommended
    - Sphincterotomy
      - Standard treatment: detrusor sphincter dyssynergia
      - Staged incision to maintain reasonable continence
      - Laser advantageous; efficacious, no serious adverse effects
    - Bladder neck incision
      - For secondary changes at bladder neck (fibrosis)
      - Not useful for hypertrophied detrusor
    - Urethral Stent
      - This is comparable to sphincterotomy but costly and re-interventions may be needed
  - Increasing bladder outlet resistance
    - Relatively early loss of continence
Surgical Treatment (1)

- Surgery enhancing detrusor storage
  - Bladder augmentation
  - Detrusor myectomy
- Surgery controlling detrusor emptying
  - Denervation and sacral neuromodulation
  - Urinary diversion
- Bladder sphincter procedure to enhance emptying
  - Sphincterotomy and Bladder Neck Incision
  - Urethral stents
  - Balloon dilatation
  - Botulinum toxin injection to sphincter
- Bladder sphincter procedure to restrict emptying
  - Artificial urethral sphincter
  - Sling
Surgical Treatment (2)

- **Urethral and Bladder Neck Procedures – to RESTRICT bladder emptying**
  - Sphincteric incontinence suitable only when detrusor activity can be controlled without reflux
  - Post-procedure may result in intermittent catheterisation
  - Types:
    - *Urethral sling: female with ability to self-catheterise*
      - In neurogenic DO with low valsalva leak points (*Spinal Cord Injury*)
      - Infection and erosion rates higher in neurogenic bladders
      - A 66-83% success rate for bulbourethral sling. Long-term outcomes??
    - **Artificial urethral sphincter**
      - GOLD STANDARD for sphincteric incontinence
      - A 75-95% social continence rate at 3-year follow-up
      - Option for catheter free voiding if patient desires so
      - If bladder has low compliance, augmentation cystoplasty is added on
      - Contraindications: urethral diverticula/strictures, bladder stones, VUR, urethra/bladder tumors
      - 35% reintervention rate; device infection (2-3%) and cuff erosion may occur
    - **Functional sphincter augmentation** (gracilis muscle to bladder neck & proximal urethra) – electrostimulation
    - **Bladder neck and urethra reconstruction**: for children with bladder extrophy
Surgical Treatment (3)

- **Urethral and Bladder Neck Procedures – to ENHANCE bladder emptying**
  - Botulinum toxin sphincter injection – detrusor sphincter dyssynergia
  - Balloon dilatation – no reports since 1994
  - Sphincterotomy – staged incision, laser, repeated, no severe side effects
  - Bladder neck incision – only for secondary bladder neck changes (fibrosis)
  - Stents – comparable to sphincterotomy, shorter surgery and hospital stay, but cost
Surgical Treatment (4)

• **Detrusor myectomy (auto-augmentation)**
  – Dissection of 20% detrusor muscle leaving mucosa intact, around the umbilicus
  – Reduces DO & intravesical pressure, improves low detrusor compliance
  – Low morbidity and less invasive

• **Denervation, deafferentation, neurostimulation, neuromodulation**
  – Sacral rhizotomy (sacral deafferentation)
    • Reduces DO; as an adjuvant to sacral anterior root stimulation
  – Sacral nerve stimulation or neuromodulation
    • Stimulates afferent nerve, reduces DO
  – Sacral anterior root stimulation (for complete lesions only)
    • Stimulation amplitude is above pain threshold
    • Both detrusor and urethral sphincter are stimulated
Surgical Treatment (5)

• **Bladder covering striated muscle**
  – Stimulated or volitional contraction of striated muscle covering the bladder: *this is still experimental*
  – Lattisimus dorsi, rectus abdominis

• **Bladder augmentation or substitution**
  – Generally, reduces bladder compliance, capacity and reduces pressure effect of DO
  – Only chosen if all other less-invasive measures fail
  – Bladder augmentation (eg. clam cystoplasty), also increases bladder capacity. Uses ileum or ileocaecal segment.
    • Success rate 90%. Complication rate 40%
  – Bladder substitution indicated for severely thicken and fibrotic bladder wall
Surgical Treatment (6)

• **Urinary tract diversion**
  – Considered when other measures fail
  – Types:
    • ** Continent diversion**
      – First choice
      – Considerations: long-term catheterisation patient, limited dexterity
      – Complications: leakage or stenosis (mainly umbically placed)
      – Outcome: Short-term continence rate 80%
    • **Incontinent diversion**
      – For failed catheterisation
      – For bed-ridden/wheelchair bound/intractable incontinent
      – Ileal segment
      – Outcome: Poor long-term results
    • **Undiversion**
      – Converting an incontinent to a continent diversion
      – Patient compliance
Specific Issues to Address

• **Urinary Tract Infection**
  – Asymptomatic bacteriuria and long-term antibiotics not recommended
  – Recurrent UTI: optimise neuro therapy and remove foreign bodies
  – UTI prophylaxis: individualised

• **Vesicoureteric Reflux**
  – Subtrigonal injection with bulking agent (65% success)

• **Sexual (Dys)function and Fertility**
  – Erectile Dysfunction: PDE-5I is first line. Intercavernous injections are second line. Mechanical device and prostheses are for selected patients
  – Men: Sperm retrieval in spinal cord injury and counsel regarding autonomic dysreflexia (for lesion above T6)

• **Quality of Life**
Follow-Up

- Unstable disease, variable symptoms
- Intervals of follow-up should be < 1-2 years
- Risk stratification guides follow-up frequency
- Components:
  - Physical examination - yearly
  - Urinalysis - yearly
  - Assessment for upper urinary tracts - 6 mthly
  - Urodynamics: at baseline and regular intervals
References

• Dorsher PT and McIntosh PM. Neurogenic Bladder. *Advances in Urology* 2012. doi.10.1155/2012/816274 [accessed on 12 Apr 2014]


Thank you