

## Advanced Analysis of Bladder Diary

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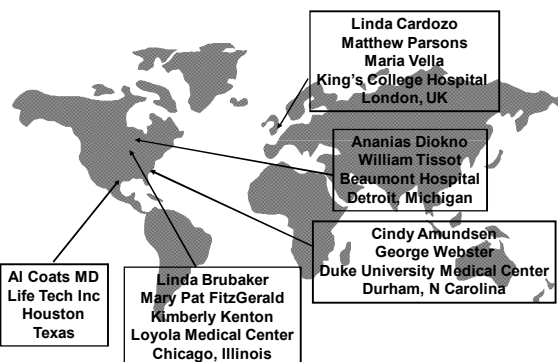
Notes, diary, and other resources

Disclosures – None

## Course Objectives:

1. Determine global and nocturnal polyuria
2. List possible reasons for polyuria
3. Fully assess a measured volume bladder diary.
4. Determine when patients need further medical intervention based on bladder diary results

## Bladder Diary Research Team (BDRT) 2003 to 2006



## This lecture will focus on

- Clinical use of the bladder diary
  - Documentation of patient's status before, during and after treatment
  - To develop treatment plan
  - Educate and training the patient
- In the male and female adults in an outpatient setting

## Psychometrics (Parsons 2010)

- FVC have been shown to be a valid and reliable tool for assessment of micturition patterns
- Test-retest reliability – high to moderate
- Vavg (average or mean voided volume) has the best intra-individual reliability and may be the best measure for outcomes
- Not reliable for
  - Quantity of urine loss
  - Diagnosis discrimination between urge UI (UUI) and stress UI (SUI)

## Types of Records

Haylen 2010 – Appendix one IUGA and ICS definitions

- Frequency volume chart (FVC or FV chart)
  - Volumes voided
  - Time of each micturition
  - Day and night, for at least 24 hours
- Bladder diary
  - Volumes voided
  - Time of each micturition
  - Incontinence episodes and degree of UI (urinary incontinence)
  - Fluid intake
  - Degree of urgency

### Information from Bladder Diary

- Subjective
  - Intensity of the desire to void
  - Leakage occurrence, type and amount
  - Pad usage and type
- Objective
  - Fluid type and amount
  - Micturition pattern
- Appendix 2 – Logistics of Bladder Diary completion – page 22
- Appendix 3: Bladder Diary Instruction – page 23

### Sensations of the Bladder

- Wyndaele 2008 Great summary article
- Physiologic
  - Sensation of micturition
  - Sensation of bladder filling
- Pathologic
  - Urgency
  - Pain

### Sensations of Micturition

- Usually free of sensation
- Some people can feel: passing urine, opening sphincter
- “If voiding is postponed for a long time then the beginning of the void is usually associated with urethral discomfort and a vague suprapubic pain lasting several minutes.”

### Sensations of Bladder Filling

- Empty bladder
  - Immediately after void
  - No sensation
- First sensation of filling
  - Slight pressure
  - Not constant , lasts for a few seconds
  - Vague, lower pelvic region
  - 40% of cystometric capacity

### Sensations of Bladder Filling

- First desire to void
  - “consistent sensation which persuades a person to seek a place to void”
  - Lower abdomen
  - Can be easily delayed
  - Gradually build sensation
  - 59% of cystometric capacity

### Sensations of Bladder Filling

- Strong desire to void
  - With a full bladder
  - “constant almost uncomfortable sensation in perineal region or urethra”
  - Can be deferred only a short time
  - If not emptied will progress to pain due to over distention.

### Bladder sensory symptoms (Haylen 2010)

- Normal - no desire to void is felt when bladder volume is small. As volume increases, the desire to void begins gradually, is felt intermittently and is weak.
- Increased bladder sensation – complaint that desire to void occurs earlier and is more persistent. Differs from urgency in that it is possible to postpone.
- Urgency – complaint of a sudden compelling desire to void which is difficult to differ
- Reduced bladder sensation
- Absent bladder sensation

### A healthy bladder – a consensus statement

- “A healthy bladder ... stores urine without discomfort at low pressures with intermittent signals of filling.”
- “When necessary, an individual should be able to defer voiding without leakage.”

### Desire to Void

- 15 healthy females (De Wachter 2011)
  - Considering all voids
    - 65% occurred without desire to void
    - 9.5% made with strong desire to void related to postponing void
  - Higher sensation of fullness = higher voided volumes
  - FVC with record of sensation of bladder fullness are useful in evaluating bladder sensations

### Starkman 2008

- Great summary article
- OAB cannot be diagnosed without urgency, therefore urgency is a key symptom and must be documented
- “Precise causation of urgency remains elusive despite intensive investigation”

### Two Types of Urgency

- An intensification of normal desire to void – 69%
- Appears without warning (on / off switch) / a different sensation – 29%
- Different sensation or a different pathology and will it respond differently to different treatments?

### Urodynamics

- Theory - urgency is secondary to involuntary detrusor contraction
- In reality urodynamics shows
  - High pressure detrusor contractions with very little sensation
  - Complaint of debilitating urgency with very little rise in detrusor pressure

### Terminology Suggestion

- “Urge” is easy to confuse with “urgency”
- ICS suggest not using the word “urge”
- Instead use “desire or need to void”

### Convenience Void (CV)

- (Honjo 2010)
- “JIC” = just in case
- Void without desire or sensation of bladder fullness.
- Bladder is emptied for social reasons such as exercises, leaving the house, going to bed.
- 310 females: 15.5% OAB, 84.5% Normal

### Convenience Void (CV)

Age	Occurrence of CV
40s	30%
50s	24%
60s	21%
70s	10%

### Documenting Quantity and Quality of Bladder Sensations

- A single score encapsulating all qualities of urgency may not be possible.
- Starkman 2008 provided 7 different scales and some testing of the scales
- Most are called urgency scales but are really scales of bladder sensation

### Recording should include measure of

- Frequency
- Intensity
- With respect to surrounding circumstances
- Ability to defer
- Duration of warning time


### Bladder Sensation Score

	Description
Grade 0	No bladder sensation
Grade 1	Sensation of bladder filling without desire to void – void can be easily delayed for more than 60 minutes
Grade 2	First desire to void - void can be easily delayed for more than 30 minutes
Grade 3	Strong desire to void - void cannot be delayed for more than 15 minutes
Grade 4	Urgent desire to void - void cannot be delayed for more than 5 minutes
Grade 5	UUI

### Studies which include Bladder Sensation

- 3 levels of urgency situations listed from most to least
  - Waking, rising, latch-key
  - Running water, cold weather
  - Fatigue, worry
- Patients with OAB – < 50% of voids associated with urgency

### Appendix 2: Bladder Diary Instruction pg 23



Specific time	Volume of void in ml or √	Desire to void 0 to 4	Leak volume 1 to 3	Felt leak with activity	Felt leak with strong urge	Wetness discovered	Drink type/ amount
5 AM							
6 AM 6:30	350	2					10 oz coffee
7 AM			1	√			16 oz water

### Documentation of Leakage pg 4

- Bladder diary is not reliable for (Parsons 2010)
  - Quantity of urine loss
  - Diagnosis discrimination between UUI and SUI
- Number of pads used and size of pads – this may also not be reliable
  - Anxiety about possible large leak may result in using pad larger than really needed
  - Anxiety and misinformation about leak may lead to using pads longer than needed
  - Patient may change pad just for freshness (such as first AM and last PM)
  - Patient may wear panty liners always – vaginal discharge

### Leakage Frequency

- Leakage frequency – low frequency leakage
  - 25% of patients recorded fewer than 0.3 UI per day on a 3 day diary (Kenton 2006)
  - 34.5% of patients failed to record UI on 3 day diary (BDRT)

### Size of Leaks

- No research on this scale
  - Leak volume - It is nearly impossible to measure the amount of urine leakage (wetness in your pad or underpants). Please try to label the approximate size of each wetness. Please change your pad each time it is wet so you can tell the size of the next wetness.
  - 1 = damp – just a few drops
  - 2 = wet – 15 to 50% of the pad is wet
  - 3 = soaked – more than 50% of the pad is wet

### Activities which Precipitate Leakage

- Description of leak – it is important to note the circumstances surrounding the leak. Please check mark one of these boxes for every wetness / leak recorded.
  - Felt leak with activity
  - Felt leak with strong urge
  - Wetness discovered – went to the bathroom and found wetness but do not know when it occurred.

### Standardization Document

- *Postural urinary Incontinence* – complaint of UI with change of posture. It is unclear whether this is related is SUI or UUI
- *Continuous urinary Incontinence*
- *Insensible urinary Incontinence* – complaint of UI where patient was unaware of how it occurred
- *Coital urinary Incontinence* – complaint of UI during in intercourse, can be further subdivided into UI with penetration or orgasm

### “Wetness discovered”

- Reasons for wetness discovered
  - Decrease sensation
  - Decreased awareness
  - Wetness is not urine
- Insensible urinary incontinence – complaint of UI where patient was unaware of how it occurred

### Fluids that may cause wetness in the perineal area

- Urine
- Sweating
- Vaginal or penile discharge

### Pyridium test / Colored urine test

- Patient takes Pyridium (or over the counter Azo Standard) BID for 3 days and brings used pads into clinic for assessment
- High sensitive – if leakage is present it will be detected
- Low specificity - due to high false positive, Pyridium left on the skin after voiding and wiping





### Pyridium test / Colored urine test

- “minimal, non-clinically significant loss of urine in normal women”
- Nearly 100% of self-reported continent women stained after exercise
- Mean staining area 2.66 mm (0 to 11 mm range)
- Despite difficulties with test authors felt it was helpful in detecting extra urethra UI

### Pad Tests

- 24 hour pad test in normal
  - 1.3g
  - 2.6g
  - Average of 3.1g range 0-9g
- Despite large range of reported normal this text suggests using greater than 1.3g as a positive test.

### Vaginal Discharge

- Exact amount of normal vaginal discharge is unclear
- Amount has been estimated by weighting tampons
  - Average 1.55g to 1.89g per day
  - Secretion greatest on day 14 – ovulation – 1.98g
  - Least on day 7 and 26 – 1.37g

### Appendix 2: Bladder Diary Instruction pg 23

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### In the Handout

- Page 24 – Appendix 4 – bladder diary analysis
- Page 25 – Appendix 5 – Bladder diary patient example one

## Subjective Results pg 24

- Leakage type per \_\_1\_\_ days
- SUI \_\_2\_\_
  - UUI \_\_3\_\_
  - Discovered \_\_0\_\_
  - Number of pads \_\_\_\_\_
  - Type of pad \_\_\_\_\_
- Leak volume per \_\_1\_\_ days
- 1 \_\_4\_\_
  - 2 \_\_1\_\_
  - 3 \_\_0\_\_
- Desire to void per \_\_1\_\_ days
- 0 \_\_2\_\_
  - 1 \_\_2\_\_
  - 2 \_\_5\_\_
  - 3 \_\_1\_\_
  - 4 \_\_0\_\_

## Fluid Need Depend on

- Health / illness
  - Increased fluid need
    - Fever
    - Vomiting
    - Diarrhea
    - UTI / stone
    - Pregnancy and breastfeeding
  - Decreased fluid needs
    - CHF
    - Kidney, liver, adrenal disease
- Exercise
  - Amount of need depends on:–
    - Length of exercise
    - Intensity of exercise
    - How much you sweat
  - Consider sports drinks to replace sodium
  - It is possible to over hydrate– hyponatremia
- Environment
  - Higher fluid intake needed
    - Hot, humid weather due to sweating and fluid loss through skin
    - Indoor heated air due to fluid loss through skin
    - Altitude above 8,200 ft due to increased urine production and increased respiration rate

## Average healthy adult living in a temperate climate

- Replacement method
  - Urine loss = fluid intake
  - Food accounts for about 20% of fluid intake (2 c)
  - Over the span of 3 or 4 days – in and out should match with in 20%
- 8x8 rule
  - Take in 8 eight oz glasses per day = 1900 ml
  - No scientific data to support this
- Dietary recommendations      30 ml = 1 oz

## Dietary Recommendations

- The Institute of Medicine and American Dietetic Assoc - ADA
  - Men 3000 ml (13 c)
  - Women 2200 ml (9 c)
- US food science board recommends ½ oz per pound per 24 hrs (Lukacz 2011)
  - 120 pounds = 7.5 c
  - 160 pounds = 10 c
  - 200 pounds = 12.5 c

## Dietary Recommendations

- Pregnancy – 2300 ml (9.5 c)
- Breast feeding – 3100 ml (13 c)
- Exercise more than 1 hr – need to increase fluid intake 400 to 600 ml (1.5 c to 2.5 c)
- Most clinicians – 1500 ml to 2000 ml (6.5-8 c)

## Thirst

- Thirst is not a good measure of need
  - You may be dehydrated and not thirsty
  - You can be fully hydrated and still thirsty
- Not a good idea to let thirst alone guide fluid intake
- Drink enough so you rarely feel thirsty
- Urine output should be colorless or slightly yellow

### Timing of Fluids

- Should be evenly spaced throughout the day
- Strong relationship between evening fluid intake, nocturia, and nocturnal voided volume (Griffiths 1993)
- Decreasing fluid intake after 7 PM may decrease nocturnal UI (Tomlinson 1999)
- Intake arrives in bladder about 45 to 60 minutes after ingesting

### Evidence for fluid amount recommendations

- Fluid intake over 2400 ml (80 oz) or under 1500 ml (50 oz) can contribute to UI (Tomlinson 1999)
- Fluid intake over 3700 ml - associated with voiding > 10 x/ day and 2 x/ night, higher UI rates as compared to 2400 ml. (Lukacz 2011)
- Decreasing fluid intake does decrease frequency, urgency, and UI in patients with OAB (Swithinbank 2005)



Over 10 to 14 cups is too much  
Might be based on patient's physiology

### Primary Polydipsia

- Excessive fluid intake, no specific levels are given
- In normal patients the kidneys can usually process large volumes of fluid without difficulty if spread over a long time

### Primary Polydipsia

- Excessive water intake in combination with
  - Abnormal renal function
  - Uncontrolled diabetes
  - Psychosis
  - and syndrome of inappropriate antidiuretic hormone (SIADH)
- Can result in hyponatremia
- Most commonly occurring in patients with schizophrenia or other psychiatric illnesses – 4 to 6 liters per day
- Other case reports

### Hyponatremia

- An electrolyte disturbance due to sodium loss or fluid excess
  - Disorientation
  - Coma
  - Seizures
  - Focal neurological defects,
  - Cerebral edema (HA),
  - Death

### Type of Fluid Intake / irritants

- Caffeine – less than 100g (w PFMT) decreases UI
- Alcohol
- Nicotine
- Carbonated beverages
- High acid and high oxalate containing foods
- Artificial sweeteners
- Consider calculating % of non-irritants
  - 500 ml irritant intake - 2000 ml total fluid intake / 2000 x 100 = 75% of fluid intake is not irritants

### In the Handout

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### Fluid intake of patient one pg 25

- 53 oz water
- 10 oz juice
- 6 oz milk
- 69 oz (8.6 cups, 2070 ml) total fluid intake
- Seems to be adequate intake
- No irritants

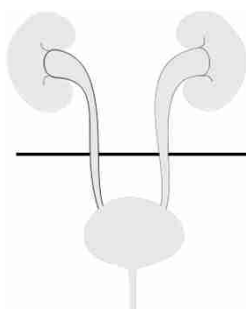
Drink type/ amount
7 oz water
6 oz milk
8 oz water
7 oz water
2 oz juice
7 oz water
8 oz water
8 oz water
8 oz juice
8 oz water
8 oz juice
8 oz water

### Appendix 4 Bladder Diary Analysis pg 24

Patient example one - 60 yo male

	Patient's value	Norms	Interpretation
Total fluid intake	2070 ml (8.6 c)	8 to 13 c male	WNL
Irritant intake	0	-----	WNL

### Localizing urinary dysfunction (BDRT)



- **Upper Tract (Fluid Intake and Urine Production)**
  - Global Polyuria
  - Nocturnal Polyuria
- **Lower Tract**
  - Low bladder capacity
  - UI episodes
  - Urinary retention

### 24 hour urine output – V<sub>24</sub> or V<sub>24</sub>

- Loss of body fluid
- Insensible fluid loss
  - Cannot be easily measured
  - Sweat, breathing, BM, secretions
  - 500 to 1000 ml per day
  - Feces – 100 ml fluid per day
  - Vaginal secretions – 50 ml fluid per day
- Urine

### No real agreement

- No real agreement on what is normal V24
- Many clinicians use ave 1500 ml to 2000 ml
- Recent research to establish norms V24 varied between
  - 600 ml to 2500 ml (Fallis 2005)
  - 725 ml to 4500 ml males (Tissot 2008)
  - 734 ml to 3150 ml females (Amundsen 2007)
  - BDRT scales include 1000 to 3500 ml
  - Means calculated by scatter plots from BDRT data 1250-1900 ml

### No real agreement

- Most agree that under 600 ml or 1000 ml is too low
- There is not much agreement on what is too high (see below)
- Most clinicians say over 3000 ml is too high

### No real agreement

- Urine production rate varies – no norms established
  - 1 ml/min to 20 ml/min (Fallis 2005)
  - Average 0.7 ml/min to 2.1 ml/min – **24 hr**
  - Average 6.1 ml/min (Heesakkers 2003)
- Average 42 to 126 ml per hr

### Urine volume is related to

- Fluid intake
- Rate of renal circulation
- Amount of water lost through other routes
  - Hyperventilation
  - Fever
  - Vomiting
  - Burns or wounds
  - UI
- Blood pressure
- Status of glomeruli – related to antidiuretic hormone and circadian fluctuation
- Medications such as diuretics

### Global Polyuria

- Excessive V24 urine production - often no value is given
- Most common parameters cited – over 2500 ml to 3000 ml per day
- Psychiatric patient with polydipsia syndrome produce V24 of 4934 to 9884 ml

### Global Polyuria

- Standardization document – over 40 ml/ kg of body weight; V24 > 2.8 liters of urine in a 70 Kg (154 lb) female (Haylen 2010)

Patient's weight	V24
132 lbs	2460 ml
154 lbs	2829 ml
176 lbs	3240 ml
198 lbs	5940 ml ???

### Causes of Global Polyuria

- Diabetes mellitus (type 1 and 2)
- Diabetes insipidus (pituitary and renal)
- Polydipsia (psychogenic, dipsogenic, iatrogenic)
- Secondary nephrogenic due to lithium or electrolyte disturbance such as hyperkalemia, hypokalemia
- Secondary to medications such as diuretics

### In the Handout

- Page 24 – Appendix 4 – bladder diary analysis
- Page 25 – Appendix 5 – Bladder diary patient example one
- Page 26 – Appendix 6 – Bladder diary abbreviations, formulas, and norms
- Page 4 in supplementary handout – bladder diary interpretation

### “Bladder diary day” pg 9

- Starts – time of getting out of bed to start the day
- Ends – last void of the night – the one before you get up out of bed to start the day

Specific time	Volume of void in ml or √
5 AM :15	220
6 AM :20	275 BM
8 AM :40	300
10 AM :30	250
11 AM :15	150 BM
12 PM :15	300
3 PM	275
5 PM	175
7 PM :20	250
11 PM :15	100
1 AM :30	350
2 AM	
3 AM	
4 AM	

### V24 - Total 24 hour urine volume

Add all volumes voided in 24 hrs **starting with** the second void of the day

$$275 + 300 + 250 + 150 + 300 + \dots$$

Specific time	Volume of void in ml or √
5 AM :15	220
6 AM :20	275 BM
7 AM :08	
8 AM :40	300
9 AM	
10 AM :30	250
11 AM :15	150 BM
12 PM :15	300

$$\dots 275 + 175 + 250 + 100 + 350 +$$

and **including** the first void of the following day

Patient recorded 5:30 AM wake up with 200 ml void

$$V24 = 2625 \text{ ml per 24 hrs}$$

3 PM	275
4 PM	
5 PM	175
6 PM	
7 PM :30	250
8 PM	
9 PM	
10 PM	
11 PM :15	100
12 AM	
1 AM :30	350

### Intake vs Output

- V24 = 2625 ml per 24 hrs
- Total fluid intake = 2070 ml per 24 hrs
- $2070 - 2625 / 2625 \times 100 = 21.1\%$  difference
- Over the course of 3 days (or so) difference should be no more than 20% unless
  - Patient was inaccurate in recording
  - Significant UI causes V24 to be artificially low
  - May not be able to use bladder diary analysis if UI is large

### V24 - Total 24 hour production / urine volume

- Average 1700 ml per 24 hrs ←pg 9
- Range 1250 ml to 2500 ml pg 26 ↓

Age →	20	30	40	50	60	70	80	Mean Range
V24 male	1300	1500	1750	1800	1750	1550	1300	1300-1800
V24 female	1250	1500	1750	1900	1850	1750	1500	1250-1900

### F24 - Total 24 hour frequency

Count number of voids in 24 hrs starting with the first morning void

F 24 = 11

Specific time	Volume of void in ml or v
5 AM :15	220
6 AM :20	275 BM
8 AM :40	300
10 AM :30	250
11 AM :15	150 BM
12 PM :15	300
3 PM	275
5 PM	175
7 PM :20	250
11 PM :15	100
1 AM :30	350
2 AM	
3 AM	
4 AM	

### F24 - Total 24 hour frequency

- Voiding frequency is related to ( Gulur 2011)
  - Rate of urine output
    - Higher V24 (more urine produced)
    - Higher F24 (more trips to the bathroom) BDRT
  - Reservoir capacity of the bladder
    - Older patients (smaller bladder capacity)
    - Higher F24 (more trips to the bathroom) BDRT
  - Sensitive lower urinary tract sensation
  - Psychological response

### F24 - Total 24 hour frequency

- “epidemiological studies suggest that the normal micturition rate is approximately 8 micturitions per day and 1 or fewer episodes at night” ( Lukacz 2011)
- Traditionally 7 voids per day is thought to be the upper limit of normal F24 ( Haylen 2010)

### F24 - Total 24 hour frequency

- F24 should be adjusted for age, sex, and 24 hour urine volume (BDRT)
- Female  $F24 = 4.25 + 0.00012V24 + 0.015age$
- Male  $F24 = 2.9 + 0.001V24 + 0.04age$

### F24 - Total 24 hour frequency

- Average 7 voids per 24 hrs ←pg 10
- Range 5.3 to 8.5 voids per 24 hrs pg 26 ↓

V24 →	1000	1500	2000	2500	3000	Range
	4c	6c	8c	10.5c	12.5c	
F24 male	6	6.5	7	7.5	8	6-8
F24 female	6	6.8	7.5	8	8.5	6-8.5

### Vavg – average voided volume

- Also called functional bladder capacity
- V24/F24
- V24 = 2625
- F24 = 11
- $2625 / 11 = 238.63$  ml per void

### Vavg – average voided volume

- Circadian rhythms – smaller voided volumes = early in afternoon as compared to early AM, late evening, and night time. ( Orlke 2010)
- Vavg includes convenience voids

	5,709 voids	Mean voided volumes
Grade 0	7.1%	141ml
Grade 1	14%	185ml
Broad CV	21%	170ml

### Vavg – average voided volume

- Vavg should be adjusted for age, sex, and 24 hour urine volume (BDRT)
- Female Vavg =  $105.8 + 0.09V24 - 0.35$  age
- Male Vavg =  $150.8 - 1.5$  age +  $0.106V24$

### Vavg – average voided volume

- Vavg - Volume per void (BDRT)
  - Increases with increasing V24
    - Higher V24 (more urine production)
    - Larger Vavg (larger bladder capacity)
  - Decreases with age
    - Older patient
    - Smaller Vavg (smaller bladder capacity)

### Vavg – average voided volume - 238.63

- Research shows a variety of Vavg (Gray 2011)
  - 330 ml
  - 382 ml
  - 400 ml
- “normal functional bladder capacity in adults ranges from 300 to 400 ml” (Lukacz 2011)

### Vavg – average voided volume

- Average 250 ml per void ←pg 10
- Range 180 ml to 385 ml per void pg 26 ↓

V24 →	1000 4c	1500 6c	2000 8c	2500 10.5c	3000 12.5c	Range
Vavg male	185	225	285	325	385	185-385
Vavg female	180	225	275	300	350	180-350

### Unmeasured voids

- Ideally the patient would measure all voids in a continuous 3 day period – especially if nocturia is a concern.
- Practically this might not be possible
- If the patient is in a location where it is not possible to measure they will place a check in the box
- Do not guess

Specific time	Volume of void in ml or v
5 AM :15	220
6 AM :20	275 BM
8 AM :40	300
10 AM :30	✓
11 AM :15	BM ✓
12 PM :15	✓
3 PM	275
5 PM	175
7 PM :20	250
11 PM :45	100
1 AM :30	350
2 AM	
3 AM	
4 AM	

### Unmeasured voids

- Add all measured volumes and dividing by the number measured
- $$(220 + 275 + 300 + 275 + 175 + 250 + 100 + 350) / 8 = 243.12 \quad (238.63)$$
- This number can then be inserted into the diary at each check mark for other calculations

Specific time	Volume of void in ml or v
5 AM :15	220
6 AM :20	275 BM
8 AM :40	300
10 AM :30	✓
11 AM :15	BM ✓
12 PM :15	✓
3 PM	275
5 PM	175
7 PM :20	250
11 PM :45	100
1 AM :30	350
2 AM	
3 AM	
4 AM	

### Vmax – maximum voided volume

- Also called diary bladder capacity
- List single largest volume voided
- 350 ml
- No data on what is too large

Specific time	Volume of void in ml or v
5 AM :15	220
6 AM :20	275 BM
8 AM :40	300
10 AM :30	250
11 AM :15	150 BM
12 PM :15	300
3 PM	275
5 PM	175
7 PM :20	250
11 PM :45	100
1 AM :30	350
2 AM	
3 AM	
4 AM	

### Vmax – maximum voided volume - 350

- Vmax increases with increased V24 (BDRT)
  - Higher V24 (more urine production)
  - Higher Vmax (larger bladder capacity)
- Average 500 ml ←pg 10
- Range 400 ml to 750 ml pg 26

V24 →	1000	1500	2000	2500	3000	Range
Vmax male	350	450	550	650	750	350-750
Vmax female	400	480	580	650	725	400-725

### Urodynamics

- Cystometric capacity – intra-vesicle volume at the end of a filling cystometrogram. (Gray 2011)
- Can be higher or lower than functional bladder capacity.
- Generally 300 to 600 ml
- Cystometric bladder capacity is not a substitute for functional bladder capacity
- Vmax (maximum voided volume) – significant positive correlation to cystometric bladder capacity. (BDRT)

### Vmin – minimum voided volume

- Single lowest volume voided
- It is much more variable and less reliable than Vavg and Vmax
- Recommend not using Vmin in clinical or research data collection

### Day Voiding Intervals

- Minimum day voiding interval - Single smallest daytime voiding interval
  - 1 hour (11:15 to 12:15)
  - Like Vmin may not be reliable due to CV / BM
- Maximum day voiding interval - Single largest daytime voiding interval
  - 4 hours (7:30 PM to 11:15 PM)
  - Related to V24, age, Vmax, CV, circadian rhythms

### Average day voiding interval

1 + 2.5 + 2 + 1 + 1 ...

	Specific time	Volume of void in ml or
1 hr	5 AM :15	220
	6 AM :20	275 BM
2.5 hr	7 AM	
	8 AM :40	300
2 hrs	9 AM	
	10 AM :30	250
1 hr	11 AM :15	150 BM
1 hr	12 PM	300

### Average day voiding interval

... 3 + 2 + 2.5 + 4 = 19

3 hrs	12 PM :15	300
	1 PM	
2 hrs	2 PM	
	3 PM	275
2.5 hrs	4 PM	
	5 PM	175
4 hrs	6 PM	
	7 PM :30	250
	8 PM	
	9 PM	
	10 PM	
	11 PM	100

### Day Voiding Intervals

- Average day voiding interval
  - Calculated per day
  - List each day voiding interval
  - Total these and divide by (day time frequency – 1)
    - $19 / (10-1) = 2.1$  average hrs between voids
  - Used as a starting point for bladder training

### Day Voiding Intervals

- Voiding interval - approximately every 3 to 4 hours based on volume of liquid consumed (Lukacz 2011)
- In older patients voiding interval is smaller – every 2 to 3 hrs, due to smaller bladder capacity

### Other Considerations

- Urinary retention / elevated post void residual (PVR)
  - Suspect retention if voiding occurs at one hour intervals with high volumes
  - For example 3:00 PM 150 ml, 4:00 PM 350 ml
  - It is not probable that the patient created 350 ml of urine in one hour
  - It is more probable that he did not empty fully at 3:00
- Relationship of leaks to voids
  - Patient may need to void more frequently if the UI occurs after a long period of no voids

### Other Considerations

- Relationship of desire to void to size of void
  - Often there is not a relationship with small voids occurring on high desire and large voids occurring on low desire
- Relationship of irritant intake to UI or urgency
  - Look for urgent void or UI within 1 to 2 hours of intake of irritating fluids

### Patients with DO have (Parsons 2007)

- Higher F24
- Lower Vavg
- More urge related leaks
- Lower volume per leak
- Same number of leaks

### Patients with Urodynamic SUI

- Almost 60% c/o urgency and 40% c/o UUI
- SUI group could be divided into 2 groups
  - Normal bladder capacity – expected clinical picture of SUI
  - Low bladder capacity – looks like OAB except UI occurs with activity.

### Type of UI

- Conclusion – separation between SUI and UUI may not be completely possible or reliable with the FVC chart alone
- Clinical implications – treat impairments identified

### Day Bladder Pattern pg 24

	Patient's value	Interpretation
V24	2625 ml	High volume
F24	11	High frequency
Vavg = V24/F24	238.63 ml	Low ave voided vol
Vmax	350 ml	Low max voided vol
Max day voiding interval	4 hrs	WNL
Total of day voiding intervals	19	
Ave day voiding interval per day = Total of day voiding intervals / day time frequency - 1	2.1 hrs	Low voiding interval

### Vn - nocturnal urine volume pg 12

- Add up all voided volumes included in after the patient retires for the night to before the patient leaves the bed for the day - includes only voids preceded and followed by sleep AND the first void on getting out of bed for the day
- This patient recorded 5:30 AM 200 ml

### Vn - nocturnal urine volume

350 + 200 =

550 ml night time urine volume

Specific time	Volume of void in ml or v
5 AM :15	220
6 AM :20	275 BM
8 AM :30	300
10 AM :30	250
11 AM :15	150 BM
12 PM :15	300
3 PM	275
5 PM	175
7 PM :30	250
11 PM :45	100
1 AM :30	350
2 AM	
3 AM	
4 AM	

### Vn - nocturnal urine volume

- Voided volumes at night are on average 1/3 larger than Vavg (Laureanno 2010)
- Varies greatly (470 ml to 1020 ml) and affected by many factors
- Not reliable in evaluating nocturnal polyuria

### BDRT Male Norms pg 26

Vn 550 ml

90<sup>th</sup> - 95<sup>th</sup> % by age

	Average	5 <sup>th</sup> to 95 <sup>th</sup> %	Age	Vn
<b>Vn</b>	<b>446</b>	<b>78-845</b>	20	645-479
NPi	26.6%	14.5%-42.9%	30	779-613
Pn	0.99	0.39-1.81	40	872-706
Pn/P24	84.9%	43.0%-139.0%	50	922-757
Fn	0.4	0.0-1.5	60	931-765
			70	897-731
			80	822-656

### Fn - Frequency of night time voids

- Count number of voids from after the patient retires for the night to before the patient leaves the bed for the day - includes only voids preceded and followed by sleep
- Fn = One

Specific time	Volume of void in ml or v
5 AM :15	220
6 AM :20	275 BM
8 AM :30	300
10 AM :30	250
11 AM :15	150 BM
12 PM :15	300
3 PM	275
5 PM	175
7 PM :30	250
11 PM :45	100
1 AM :30	350
2 AM	
3 AM	
4 AM	

### Fn - Frequency of night time voids

- Nocturia - is the complaint of interruption of sleep 1 or more times because of the need to urinate. Each void is preceded and followed by sleep ( Haylen 2010)
- Great variety of prevalence reported in the literature 28.4% to over 80% (Fiske 2004)

### Fn - Frequency of night time voids

- Clinically significant nocturia - Based on the degree of bother - 2 or more episodes.
  - Mild - two nocturia
  - Moderate - three nocturia
  - Severe - four or more nocturia
- AUA 2007 = nocturia is urinating 2 or more times per night. ( Levkowitz 2011)

## BDRT Male Norms pg 26

Fn 1

	Average	5 <sup>th</sup> to 95 <sup>th</sup> %
Vn	446	78-845
NPi	26.6%	14.5%-42.9%
Pn	0.99	0.39-1.81
Pn/P24	84.9%	43.0%-139.0%
<b>Fn</b>	<b>0.4</b>	<b>0.0-1.5</b>

90<sup>th</sup> – 95<sup>th</sup> % by age

Age	Fn
20	1.4-1.2
30	1.6-1.3
40	1.7-1.4
50	1.8-1.5
60	1.9-1.7
70	2.1-1.8
80	2.2-1.9

## Nocturia

- Meta-analysis of 43 articles, using 2 or more voids per night as the definition of nocturia (Weiss 2011)
  - Men 20-40 = 2-17%
  - Women 20-40 = 4-18%
  - Men over 70 = 29-59%
  - Women over 70 = 28-62%
  - Higher in African Americans

## Age Related Changes

- 18 - 49 yo = more women have nocturia
- 50 – 59 yo = equal women and men
- 60+ yo = more men have nocturia
- Conclusions
  - With aging - day production ↓ and night production ↑
  - Fn increases with age

## Main Causes of Nocturia

- Global polyuria
- Nocturnal polyuria
- Decreased bladder capacity
- Primary sleep disorders
- Other potential factors

## Nocturnal Polyuria

- Obstructive sleep apnea (often associated with obesity)
- Excessive evening fluid intake
- Peripheral edema / third spacing of fluid into the legs caused by (Laureanno 2010)
  - CHF
  - Low blood volume
  - Venous stasis
  - High intake of salt

## Nocturnal Polyuria

- Idiopathic
- Circadian defect in secretion of AVP – arginine vasopression
- Autonomic disease (Gulur 2011)
- Hepatic failure / chronic kidney disease

### Decreased Bladder Capacity

- Reduced functional bladder capacity
  - Extrinsic compression from tumors
  - Bladder pain syndrome / IC
- Bladder outlet obstruction
  - BPH
  - Elevated PVR – uterine fibroids, POP, urethral stricture

### Decreased Bladder Capacity

- Detrusor overactivity
  - Nocturnal DO
  - OAB – 80% of pts with OAB report nocturia (antimuscarinics may not help)
  - Neurogenic bladder
- Other
  - CA of bladder prostate or urethra
  - Bladder or ureteric calculi
  - Urogenital aging – estrogen deficiency
  - Learned voiding dysfunction

### Primary Sleep Disorders

- Insomnia
- Sleep apnea
- Periodic leg movements
- Narcolepsy
- Arousal disorders – sleepwalking, nightmares

### Other Potential Factors

- Medical disorders – cardiac failure, COPD, endocrine disorders
- Neurological conditions – Parkinson’s disease, dementia, epilepsy
- Psychiatric conditions – depression, anxiety
- Chronic pain disorders
- Alcohol or drug use
- Medications – corticosteroids, diuretics, beta-adrenergic antagonists

### Predictors of Nocturia

Men	Women
Most common predictors <ul style="list-style-type: none"> <li>• Urgency</li> <li>• BPH</li> <li>• Sleep disruption - snoring</li> </ul>	Most common predictors <ul style="list-style-type: none"> <li>• Urgency</li> <li>• Obesity</li> <li>• Sleep disruption - snoring</li> </ul>
Secondary associations <ul style="list-style-type: none"> <li>• Hx of prostate CA</li> <li>• Antidepressant use</li> </ul>	Secondary associations <ul style="list-style-type: none"> <li>• CAD</li> <li>• Diabetes</li> </ul>

### Types of Nocturia

	Night frequency	Night urine production
Low bladder capacity	High	Normal
Nocturnal polyuria	High	High

### NPi - Nocturnal Polyuria index

- $V_n/V_{24} \times 100$ 
  - $550/2625 \times 100 = 20.95\%$
- Nocturnal polyuria - is present when an increased proportion of the 24-hour output occurs at night. ( Haylen 2010, Van Kerrebroeck 2002)
  - NPi > 20% young adults
  - NPi > 33% for those over 65 yo

### NPi - Nocturnal Polyuria index pg 26

90<sup>th</sup> – 95<sup>th</sup> % by age

- This measure does not consider amount of time sleeping

Npi 20.9%

	Average	5 <sup>th</sup> to 95 <sup>th</sup> %
Vn	446	78-845
<b>NPi</b>	<b>26.6%</b>	<b>14.5%-42.9%</b>
Pn	0.99	0.39-1.81
Pn/P24	84.9%	43.0%-139.0%
Fn	0.4	0.0-1.5

Age	Npi=Vn/V24
20	37.6-34.1%
30	39.3-35.8%
40	41.0-37.5%
50	42.7-39.2%
60	44.4-40.9%
70	46.1-42.6%
80	47.8-44.3%

### Pn/P24 –

#### Night / 24 hr production rate ratio

- Age adjusted relative night urine production is the best measure of nocturnal polyuria (BDRT)
- Number of minutes sleeping
- Pn - Night urine production rate
- P24 -24 hour urine production rate

### Night / 24 hr production rate ratio

- Number of minutes sleeping - Count total number of minutes from getting into bed for the night to getting out of bed for the day
  - 11:15 PM to 5:30 AM = 6 hrs = 360 minutes
- $P_n = V_n / \# \text{ minutes sleeping}$ 
  - $550 / 360 = 1.52$
- $P_{24} = V_{24} / 1440$ 
  - $2625 / 1440 = 1.82$

### Night / 24 hr production rate ratio pg 26

90<sup>th</sup> – 95<sup>th</sup> % by age

- $P_n/P_{24} \times 100$
- $1.52/1.82 \times 100 = 83.5\%$

	Average	5 <sup>th</sup> to 95 <sup>th</sup> %
Vn	446	78-845
NPi	26.6%	14.5%-42.9%
Pn	0.99	0.39-1.81
<b>Pn/P24</b>	<b>84.9%</b>	<b>43.0%-139.0%</b>
Fn	0.4	0.0-1.5

Age	Pn/P24
20	115.5-104.8%
30	122.0-111.3%
40	128.5-117.8%
50	135.0-124.3%
60	141.5-130.8%
70	148.0-137.3%
80	154.5-143.8%

### NCBi –

#### Nocturnal Bladder Capacity index

- $F_n - (V_n / V_{max} - 1) = NBCi$
- Measure of small nocturnal bladder capacity
- NBCi does not need to be adjusted for age or V24
- NBCi > 1.3 is significant, > 2 is highly significant
- **Fn > 3 = usually small bladder capacity.**
- **Fn < 1 = usually not small bladder capacity**
- Should calculate NBCi if Fn is between 1 and 3
- Diagnostic significance is undecided .

### Night Bladder Pattern pg 24

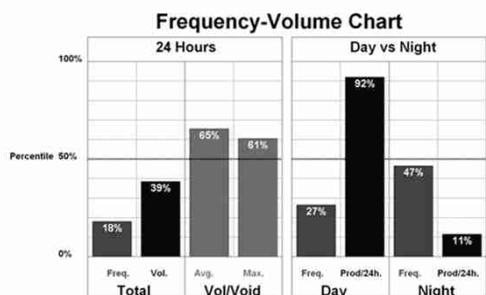
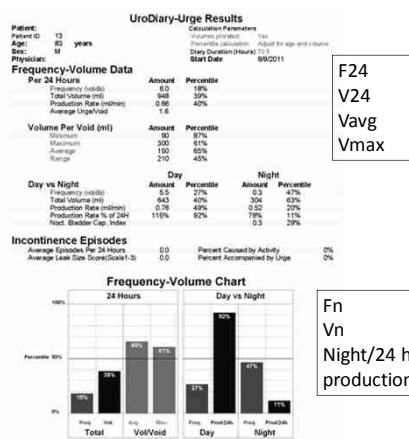
	Patient's value	Interpretation
Vn	550 ml	WNL
Fn	1	WNL
$NPI = Vn/V24 \times 100 = \%$	20.95%	WNL
$Pn/ P24 \times 100 = \%$	83.5%	WNL

### Possible Impairments pg 24

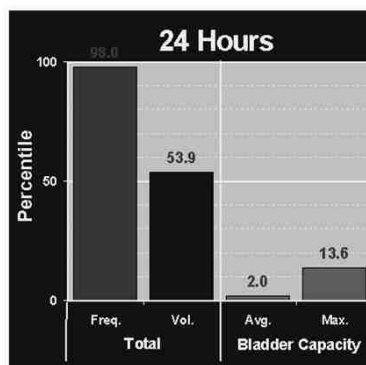
- Global polyuria – present, not present
- Daytime frequency – increased, decreased, normal
- Diary bladder capacity – low or normal
- Day voiding interval – low or normal
- Bladder sensation – normal, increased, decreased, absent
- Leakage types - MUI
- Nighttime frequency – increased, decreased, normal
- NPI – nocturnal polyuria, normal
- Pn/P24 ratio – nocturnal polyuria, normal
- Night time bladder capacity – low, normal

### Conclusion of BDRT Research

- Large overlap between normal and abnormal
- It may be more useful to report measurements as a % of reference population rather than normal or abnormal
- Urodiary Software by LifeTech

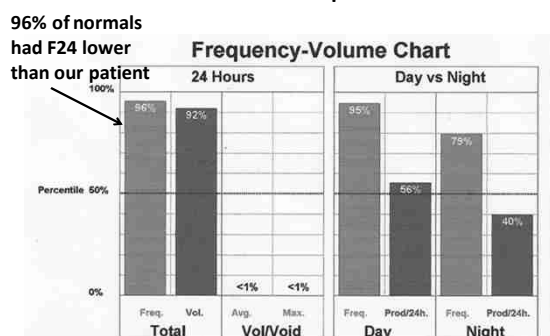


### Detrusor Overactivity



P263669

### Patient Example One



### Practice

- Patient example # 2 is an 83 yo male
- Information for the start of day 3 is on the bottom of the day 2 chart.
- Patient got out of bed for the next day at 8 AM with a 120 ml void
- Work on your own or in groups to complete Bladder Diary Analysis form

### Patient example #2

- V24
  - 150+60+150+120+90+90+120+150+120+180+150+180+240+180+180=2160
  - 120+150+90+90+180+150+150+150+150+150+150+210+120=2010
  - $2160+2010/2=2085$
- V24 = 2085
- Male 80 yo V24 mean = 1300
- High 24 hr urine output for his age

### Patient example #2

- F24
  - Day 1=15
  - Day 2=15
  - $15+15/2=15$
- F24 = 15
- Male 80 yo - F24 mean 7.7
- Male with V24 of 2000 – F24 mean 7
- Very high 24 hr voiding frequency

### Patient example #2

- Vavg
  - $2085/15=139$
- Vavg = 139
- Male 80 yo mean Vavg – 280
- Male with V24 of 2000 mean Vavg – 285
- Very low average voided volume

### Patient example #2

- Vmax = 240 ml 6AM night of day one
- Male 80 yo mean Vmax
- Male with V24 of 2000 mean Vmax – 550
- Very low maximum voided volume

## Patient example #2

- Max day voiding interval = 4 hrs 5-9 PM
- 80 yo – WNL
- Total of day voiding intervals
  - $3+1+2+1+0.5+0.5+1+4+2 = 15/10-1=1.6$
  - $1+0.5+1.5+2+2+0.5+0.5+0.5+0.5+4=13/11-1=1.3$
  - $1.6=1.3/2=1.45$
- Average voiding interval = 1.45 hrs
- 80 yo average voiding interval 2-3 hrs
- Low average voiding interval

## Patient example #2

- Vn
  - $180+150+180+240+180+180=1110$
  - $150+150+210+120 = 630$
  - $1110+630/2=870$
- Vn = 870
- Male mean Vn – 446
- Male 80 yo 95<sup>th</sup> % - 822
- Very high night time urine production

## Patient example #2

- Fn
  - Day 1 = 5
  - Day 2 = 3
  - $5+3/2=4$
- Fn = 4
- Male mean Fn – 0.4
- Male 80 yo 95<sup>th</sup> % - 2.2
- Very high night time voiding frequency

## Patient example #2

- NPi
  - $870/2085 \times 100 = 41.7\%$
- NPi = 41.7%
- Male mean NPi – 26.6%
- Male 80 yo 90<sup>th</sup> % NPi – 44.3%
- High NPi – close to 90% for his age – possibly nocturnal polyuria

## Patient example #2

- # of minutes sleeping
  - 11PM to 8AM = 9 hrs x 60 = 540 minutes
- Pn
  - $870/540=1.61$
- Male mean Pn – 0.99 – high night time urine production
- P24
  - $2085/1440= 1.44$

## Patient example #2

- Pn/P24
  - $1.61/1.44 \times 100 = 111.8\%$
- Pn/P24 = 111.8%
- Male mean Pn/P24 – 84.9%
- Male 80 yo 90<sup>th</sup> % Pn/P24 – 143.8%
- Above average Pn/P24 – possible nocturnal polyuria

### Patient example #2

- NBCi > 3 = usually small bladder capacity
- NBCi
  - $4 - [(870/240) - 1] =$
  - $4 - (3.62 - 1) =$
  - $4 - 2.62 = 1.38$
- NBCi = 1.38
- NBCi normal – less than 1.3
- Low night time bladder capacity

### Patient example #2

- Total fluid intake
  - $6 + 8 + 4 + 8 + 8 + 8 + 8 + 8 + 4 = 62$
  - $4 + 8 + 4 + 8 + 8 + 8 + 8 + 8 + 8 = 64$
  - $62 + 64 / 2 = 63$  oz
  - $63 / 8 = 7.83$  cups
  - $63 \times 30 = 1890$  ml
- Male suggested fluid intake – 8 to 13 cups
- Fluid intake WNL, no irritants
- I and O ratio -  $2085 - 1890 / 1890 \times 100 = 10.3\%$

### Patient example #2

- Leakage type per   2   days
  - SUI   2
  - UUI   7
  - Discovered   0
  - Number of pads
  - Type of pad
- Leak volume per   2   days
  - 1   9
  - 2   0
  - 3   0
- Urge predominate UI

### Patient example #2

- Desire to void per   2   days
  - 0   1
  - 1   3
  - 2   6
  - 3   14
  - 4   6
- Increased bladder sensation

### Patient example #2 – Possible impairments

- Global polyuria – no but might consider decreasing fluid intake slightly
- Daytime frequency – increased
- Diary bladder capacity – low
- Day voiding interval – low
- Bladder sensation – increased
- Leakage types - UUI
- Nighttime frequency – increased
- NP<sub>i</sub> – possible nocturnal polyuria
- P<sub>n</sub>/P<sub>24</sub> ratio – possible nocturnal polyuria
- Night time bladder capacity – low

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