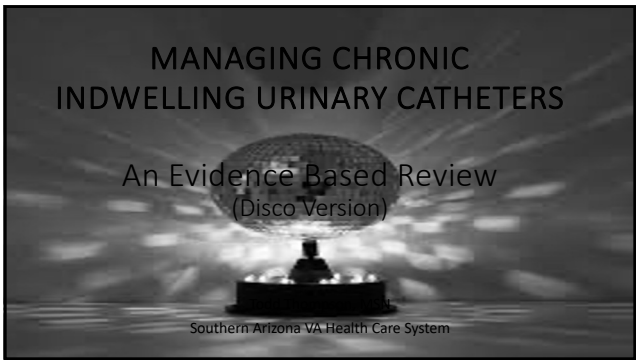


1

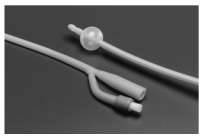
Objectives

- Identify catheter clogging as a common problem associated with chronic urinary catheterization
- List the disruptions to the normal urologic system when a chronic catheter is introduced
- Understand the pathophysiology of different types of bacterial colonization and how this affects catheter clogging
- Recognize underlying medical conditions that can contribute to clogging
- Review evidence-based interventions used to prevent and treat chronic clogging
- Describe an evidence-based paradigm or approach to the management of chronic catheter clogging

2

Scope of Catheter Use

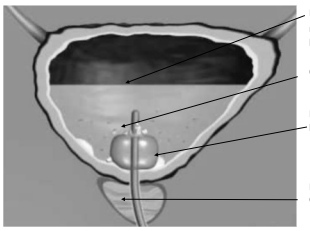
- An estimated 3% of people living in the community and 12% of those living in residential care use long-term urethral catheterization for the management of urine drainage. (Simpson, 2017)
- Adverse Outcomes
  - Sediment 87%
  - Leakage (bypassing) 67%
  - Bladder spasms 59%
  - CAUTI – 57%
  - Catheter pain 49%
  - Kinks/twists 42%
  - Blockage- 34%
  - Accidental dislodgment 28% (Wilde et al, 2016)
- 90+ % of patients with long-term catheters are colonized with bacteria. (Evans & Godfrey, 2000)



Earl Young, the drummer for the Tramps, is credited to have invented the disco beat.

3

How does catheterization affect the body?



Interrupts natural filling/flushing cycle that helps remove bacteria from bladder (causing CAUTI, bladder stone formation)

Creates a environment for biofilm to grow

Foreign object irritates bladder lining (causing bladder irritation/cystitis, mechanical injury)

Prevents prostate seminal vesicles from properly draining (causing prostatitis)

Did you know that the disco ball has been around as early as the Civil War, but it wasn't patented until 1917 by Louis Bernard Woeste, who called it the "Myrid Reflector"

4

Standard Catheter Care

- Maintain closed system
- Maintain dependent drainage
- Proper emptying technique
- Daily catheter care/perineal care
- Empty bag when less than 50% full
- "Clean" technique

5

Evaluation of a Chronic Clogger

1. Chart review to determine the indication for catheter, changing (and clogging) interval, and other interventions used (flushing, etc).

2. Interview patient and/or caregivers to determine how they have been caring for catheter. Physical exam of patient and catheter site.

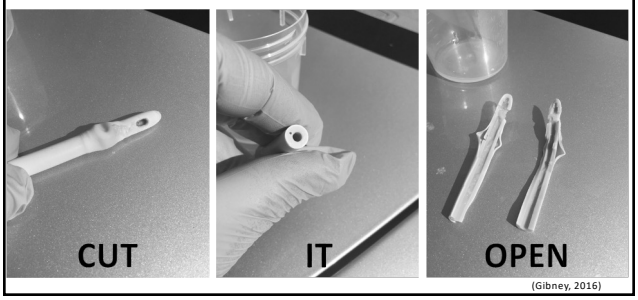
3. U/A with C&S can be used to determine the exact organisms responsible, urine pH, as well as contributing factors such as the presence of glucose and protein. (not to treat with ABX)

4. Examine catheter for encrustation on the inside and the outside. (dissection)

Rick Dees the host of Billboard Top 40 wrote the hit Disco Duck which sold over 6 million copies, and the man who was the voice of the duck was only paid $50.00 for his performance.

6

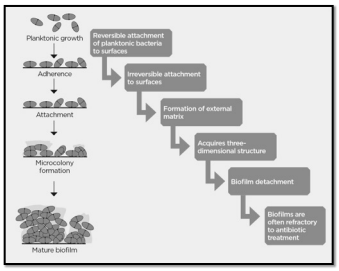
THE GOLD STANDARD



(Gibney, 2016)

7

Pathogenesis of Biofilm



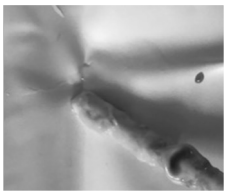
Bacteria can attach to almost any surface. Once attached they begin multiplying and encase the colonies with a slimy matrix that absorbs nutrients and facilitates diffusion the entire colony. As the colony grows aggregated cells can become detached and become "floaters" or entire parts of the biofilm can become detached. (Stickler, 2008).

Discothèques as a venue were mostly a French invention, imported to the United States with the opening of Le Club in Manhattan.

8

EXAMPLES OF BLOCKING BY BIOFILM

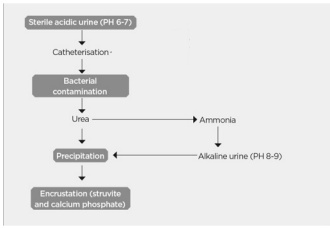
59 year old male with ALS, chronic indwelling catheter and multiple UTIs requiring hospitalizations



74 year old male with suprapubic catheter, clogging about every 3 weeks with biofilm and leaking around catheter.

9

CATHETER ENCRUSTATION BY UREASE PRODUCING BACTERIA



Urease-producing bacteria, particularly *Proteus mirabilis*, results in the conversion of urea in the urine into ammonia. The consequential increase in the alkalinity of the urine causes phosphates to nucleate out of solution, forming crystals.

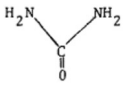
(Feneley, Hopley, & Wells, 2015)

10

Breakdown of Urea

$$(NH_2)_2CO + 2\,H_2O \xrightarrow{\text{Urease}} CO_2 + H_2O + 2\,NH_3$$

Urea — Carbon dioxide — Water — Ammonia



(Stickler, 2014)

11

Relative Urease Activity by Bacteria

Proteus mirabilis is not considered part of "disco" family, but rather classified as a Motile Gram-Negative "Polka" Enterobacteriaceae

Organism	Urease[a] activity
Proteus mirabilis	2.34 (0.21)
Proteus vulgaris	2.13 (0.19)
Providencia rettgeri	1.85 (0.22)
Morganella morganii	1.34 (0.09)
Staphylococcus aureus	0.28 (0.05)
Providencia stuartii	0.10 (0.02)
Pseudomonas aeruginosa	0.06 (0.01)
Klebsiella pneumonia	0.07 (0.02)
Escherichia coli	0.06 (0.02)
Serratia marcescens	<0.01
Klebsiella oxytoca	<0.01
Enterobacter cloacae	<0.01

2.34

39 times more activity

0.06

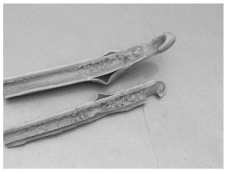
Enzyme activity calculated as uMOL urea hydrolysed min/mg protein

(Stickler, 2014)

12

EXAMPLES OF ENCRUSTATION BY UREASE PRODUCING BACTERIA

90 year old male with a 16F hydrogel suprapubic catheter. Caregiver flushing with 20-30cc of 0.25% acidic acid twice a day. Clogging every 10-14 days.



87 year old make with suprapubic catheter with a 22F hydrogel catheter. Caregiver flushing with 0.25% acidic acid 20cc twice a day. Clogging every 7-10 days.

13

What if you do not find occlusion?

OTHER CAUSES

Displaced catheter
Bladder spasms
Constipation
Kinked tubing
Bag over 75% full
Dependent Drainage

(Schaeffer, Richie, & Chen, 2017)

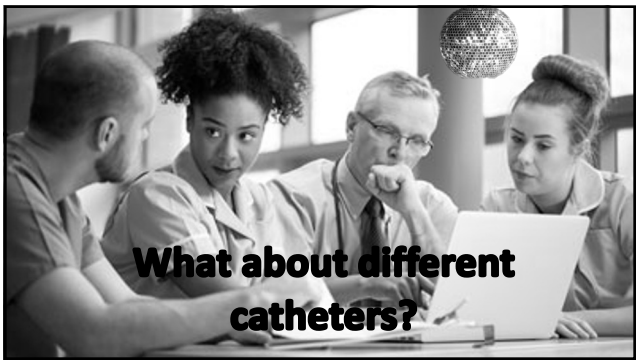
14

COMMONLY USED INTERVENTIONS

- Changing type/size of catheter
- Flushing catheters
- Fluid management
- Acidification of the urine
- Chelating agents
- Cranberry
- Antibiotics

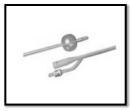
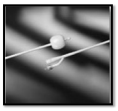
There is no evidence to support that any of the Village People had complications due to long-term urinary catheterization.

15



16

UNDERSTANDING DIFFERENT TYPES OF CATHETERS

Latex	Latex Hydrogel "LUBRICIOUS"	Silicone	Antimicrobial/silver
			
Latex catheters are the softest catheter. Often used in surgical settings. **UP TO 7 DAYS**	Hydrogel Coated Catheters are made of an inner core of latex encapsulated in a hydrophilic polymer. **UP TO 12 WKS**	Silicone catheters are less likely to cause irritation, and have a wider lumen. **UP TO 12 WKS**	Antibacterial (silver ion) catheters have a silver coating and eludes silver ions. **UP TO 12 WKS**

(Bard product manual, 2017) (Walliman, 2017)

17

Hydrogel vs. Silicone

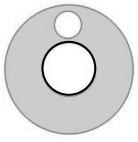
Each time you increase a catheter size (16F to 18F) you increase the inner diameter by about 20%

Hydrogel

Advantages
+ most comfortable
+ cost effective

Disadvantages
-may cause irritation to patients sensitive to latex

-Small internal Lumen



Silicone

Advantages
+ more resistant to bacterial colonization
+ larger internal lumen (45% larger)

Disadvantages
-rigid, less comfortable

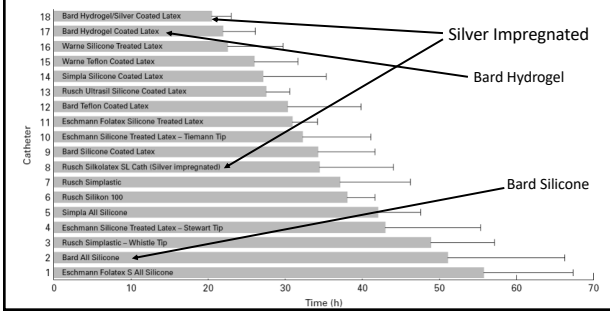
-balloon slowly deflates (gas permeable)

Antibiotic/Silver coated catheters (hydrogel or silicone) may have a smaller internal lumen and antibiotic effect.

(Bard product manual, 2017)

18

Laboratory study of the time taken for 18 different types of catheters to block in the bladder model infected with *Proteus Mirabilis* (Morris, Stickler, & Winters, 1997)



19

So what's the deal with silver impregnated/antibacterial catheters?

Silver impregnated catheters do kill bacteria that attempt to adhere to the surface

Dead Cells now coat the catheter creating a perfect environment for more bacteria to adhere.

New cells now rapidly coat the dead cell layer and develop a biofilm.

(Morris, Stickler, & Winters, 1997)

20

Recommendation on changing catheter size/type

PRO's

- Bigger catheter clogs slower
- Silicone catheter has larger internal lumen and smoother surface
- Silicone may be less irritating.

CON's

- May cause bladder spasms
- May be less comfortable

(Trial and error technique)

Antimicrobial catheters are just not there yet – but maybe some day.

21

22

Consider using a catheter valve.

Preserves the natural antibacterial mechanisms of the bladder and maintains detrusor muscle function. (Virki & Hendry, 2015)

Prevents encrustation and blocking with NO increased risk of UTI (Woodward 2013).

Preferred by most patients over legs bags, but require more effort. (Eijkel & Griffiths, 2006).

Requires functioning detrusor muscle and good manual dexterity.

23

24

SO WHAT ABOUT FLUSHING?

Antiseptic solutions aimed at preventing or reducing bacterial growth
- -Chlorhexidine
- -Povidine/Betadine
- -Neomycin/polymyxin

Acidic solutions aimed at preventing or reducing encrustation
- -Acetic Acid (vinegar)
- -Mandelic Acid
- -Suby G
- -Renacidin

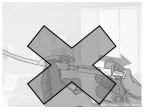
Neutral solutions used to flush debris and small clots.
- -Normal Saline

Flushing is often used in acute hospital situations (remove blood clots, etc.)

25

SO WHAT ABOUT FLUSHING?

- Catheter maintenance solutions can damage urothelium through chemical irritation further causing catheter blockage and is considered ineffective (Gibney, 2016).
- Antimicrobial irrigation of the bladder does not appear to prevent or delay urinary tract infection AND develops more resistant organisms. (Schaeffer, Richie, & Chen, 2017)



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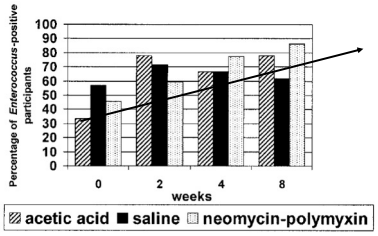
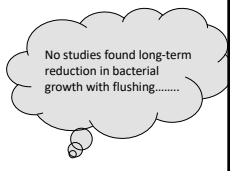


Figure 2. Occurrence of *Enterococcus* spp in each bladder irrigation group over time. There was a significant increase in the total numbers of persons harboring these organisms over time ($P = 0.005$) and within the neomycin-polymyxin group ($P = 0.02$).



After flushing bacterial counts only go down for 1-2 hours and then quickly return to normal or increase.

(Waites K. , Canupp, Roper, Camp, & Chen, 2006)

27

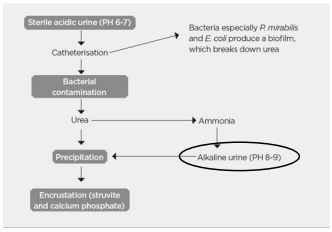
Recommendation on Flushing

- Flushing does not appear to improve clogging, and may make it worse.
- Flushing irritates the lining of the bladder – breaking down natural defenses
- Normal Saline could be used as a short term method of unblocking catheter, but will increase the long-term risk of infection

28

29

Acidification



Natural urine pH is 6-7, which retards bacterial growth.

Precipitation only happens above pH>8

30

What so the studies show?

MORE ACID = MORE AMMONIA CONVERSION.

The addition of more hydrogen ions to urine containing urease simply causes more urea to be converted into ammonia, and alkaline conditions are quickly restored. (Gould, 2014)

BIOFILM RESISTANT TO ACIDIC ENVIORMENTS

No significant difference was noted in bacterial or biofilm growth for the *E-coli* strains at pH 5.0 from pH 8.0. (Gould, 2014)

VIT-C DEGRADES INTO OXALATE

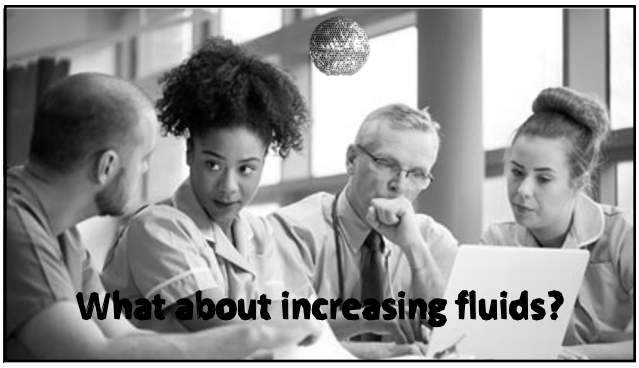
Urinary ascorbate, if present at a high concentration in association with Proteus mirabilis infection, appears to be locally degraded to oxalate. potentially leading to calcium oxalate deposition. (Hokama, et al., 2000)

31

Recommendation on acidifying urine

- **Do not use if urease producing bacteria.**
- **Monitor urine pH – discontinue if unable to maintain 5-6 range.**

32



33

Increased Fluids

A rapid river dose not clog.

vs

34

What so the studies show?

- Increasing fluid intake, spread throughout the day, will increase the urine flow rate and lower the urine solute concentration, both of which protect against encrustation. (Broomfield, Morgan, Khan, & Stickler, 2009)
- Increased urine flow rate will make it more difficult for biofilm to develop. (Stickler, 2008)

It is estimated that at any given time there is a Bee Gees composition being played somewhere around the world.

35

Recommendation on increasing fluids

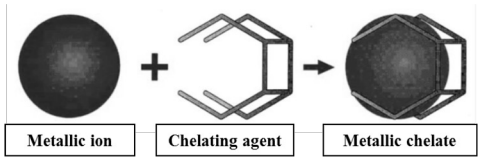
- Requires consistent fluid intake to maintain urine appropriate flow.
- Can be difficult to maintain over time.
- Don't over-do it (hyponatremia)
- May be contraindicated

36

37

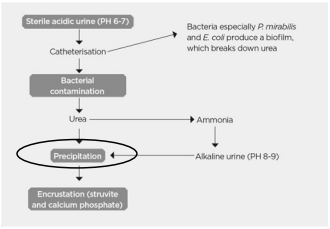
WHAT THE HECK IS A CHELATING AGENT?

- Chelating agent retards spontaneous nucleation of divalent metal ions such as Ca2+ and Mg2+.



38

Citrate is a common chelating agent found in the diet.



- Grapefruit juice (64.7 mmol/L)
- Lemon juice (47.66 mmol/L)
- Orange juice (47.36 mmol/L)
- Pineapple juice (41.57 mmol/L),
- Reconstituted lemonade (38.65 mmol/L)
- Lemonade flavored crystal light (38.39 mmol/L)
- Not from concentrate lemonade (38.24 mmol/L)
- Cranberry juice (19.87 mmol/L)
- Lemon-flavored gatorade (19.82 mmol/L)
- Homemade lemonade (17.42 mmol/L),
- Mountain dew (8.84 mmol/L)
- Diet 7up (7.98 mmol/L)

- Potassium citrate (60 mEq/day)

(Broomfield, Morgan, Khan, & Stickler, 2009).

39

Recommendation on Chelating Agent

Many sources of citrate also contain calcium (orange juice) that may negate the effects of the citrate.

Urinary calcium level was decreased only in lemon juice and potassium citrate groups after treatment

In order for citrate administration to be effective it must be consistently administered

Citrate level can be monitored by urine tests.

40

41

Why cranberries?

- Cranberries has been a traditional cure for UTI's.
- Cranberry contains proanthocyanidins that prevent of bacterial adhesion to uroepithelial cells. (Ledda, et al., 2016)

The Cranberries are an Irish rock band that have never played disco, and are not a cure for UTI's

42

What so the studies show?

- Most cranberry studies do not use a standardized amount and show inconsistent results. (Jepson, Williams, & Craig, 2012)
- A systematic review by Cochrane shows there was some evidence that cranberry administration may decrease the number of symptomatic UTIs over a 12 month period. (Jepson, Williams, & Craig, 2012)
- In order to cranberry to be effective it requires consistent high dose cranberry extract, and results may not be dramatic. (Jepson, Williams, & Craig, 2012)

43

Recommendation on Cranberry usage

- Definitely not harmful, and may be helpful.
- Only recommend consistent administration of a high quality cranberry extract.
- Best used as a preventative strategy

44

45

WHAT ABOUT ANTIBIOTICS?

- Use of antibiotics are controversial – current trend is away from over-use of antibiotics.
- CAUTI guidelines do not recommend antibiotic use unless symptomatic.
- Work with microbiology to avoid the dreaded "contaminated sample" C&S result.
- Antibiotics have no effect on biofilm. (Feneley, Hopley, & Wells, 2015)
- Severe encrustation however, should be considered a "symptom" of a UTI, and can lead to fever/shock/sepsis and is associated with increased mortality. (Gibney, 2016)

Disco Duck became a number-one hit on the Billboard Hot 100 for one week in October 1976

46

Recommendation on antibiotic usage

- Judicious/short term use of antibiotics may help "jump-start" other interventions such as stopping flushing or maintaining closed system. (Gibney, 2016)
- ALWAYS get a C&S and use appropriate antibiotic.
- ALWAYS change the catheter at the initiation of antibiotics to remove/reduce biofilm. (Gibney, 2016)
- Thoughtful, individualized decisions on antibiotic use are sometimes needed.

47

48

Urinary Antibacterial Agent

- Methenamine (Mandelate or Hippurate) + Vit C – Decomposes into formaldehyde and ammonia, and the formaldehyde is bactericidal.

Enzyme Inhibitor

- Acetohydroxamic Acid – Irreversible urease enzyme inhibitor that prevents excessive build-up of ammonia in the urine. (strong side effects limit use)

49

Recommendations

- Consider when other treatments fail.
- Urology consult to assist in management.

50

51

UNDERLYING CONDITIONS

- Interstitial Cystitis: Damage to the glycosaminoglycan layer of the bladder.
- Kidney/Bladder Stones: Damage the urinary tract and create a reservoir for biofilm.
- Trauma to Urinary Tract: urethral strictures, bladder neck contractures, false passages.
- Chronic Prostatitis: Catheter prevents prostate seminal vesicles from properly draining leading to chronic infection or inflammation. (prostate stones).
- Fistula: Abnormal opening into the urinary system.

52

Recommendations

- Look for and treat any underlying conditions that may be a consequence of having a chronic indwelling catheter.
- Urology consultation

53

54

Remove the Catheter!

- Patients may have had the catheter placed for inappropriate reasons, or the patients' condition may have changed and they may no longer require the catheter.
- Many urinary conditions can be better managed using alternative techniques such as clean intermittent catheterizations, external catheters, and incontinence management supplies.

As a minority female, Donna Summer is more likely to have an inappropriately placed urinary catheter, despite being the "queen of disco"

55

Catheter Care at Home

- When changing a long-term indwelling catheter, it has been recommended to leave the catheter out for at least 1 hour, but no longer than 2 hours to allow the urethral glands to drain (Tenke et al., 2008).
- Catheters should be changed only when clinically necessary, or per the manufacturer's current recommendations, which is usually every 12 weeks for silicone or hydrogel catheters. (National Clinical Guideline Center, 2012).
- There is no evidence that reusing cleaned urinary drainage bags or changing drainage bags will increase the long-term risk of infection in chronic indwelling catheters (Paterson, Hanson, Ostaszkiewicz, Pieters, & Townsend, 2011)

56

57

Good Things to do

"Is this catheter necessary?"

- **Improve catheter care**
- **Improve catheter function**
- **Consistently increase fluids**
- **Add natural chelating agents (citrate) if Urease producing bacteria.**
- **Treat any underlying conditions**

58

Bad things to do

- **Do not flush**
- **Do not attempt to acidify urine**
- **Do not break closed system/maintain proper catheter care in the home.**

59

May be helpful

- **Consider recommending a consistent administration of a high quality cranberry extract**
- **Judicious/short term use of antibiotics may help "jump-start" other interventions or improve quality of life.**
- **Urology Consult – When appropriate**
- **Consider Methenamine or Acetohydroxamic Acid if other interventions fail.**

60

Results

Changing Frequency Every 6 weeks

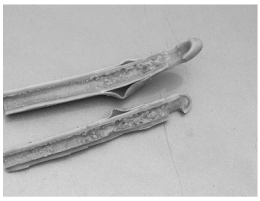
90 Year old male with a 16F hydrogel suprapubic catheter. Caregiver flushing with 20-30cc of 0.25% acidic acid twice a day. Clogging every 10-14 days.

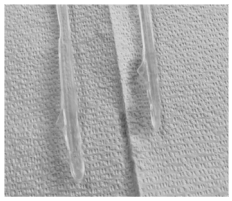
Stop Flushing
Change to silicone
Add oral lemon juice (citrate)

61

Results

Changing Frequency Every 5 Weeks





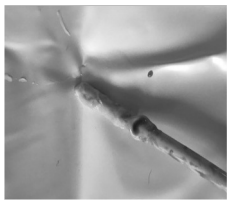
87 Year old make with suprapubic catheter with a 22F hydrogel catheter. Had yellow/brown "pus" coming from urethra and stoma. Caregiver flushing with 0.25% acidic acid 20cc twice a day. Catheter clogging every 7-10 days

change to silicone catheter
Increase fluids throughout the day.
Add oral lemon juice (citrate)
Stop flushing

62

Results

Changing Frequency Every 6 weeks



74 Year Old with suprapubic catheter. Clogging about every 3 weeks with biofilm and leaking around catheter.

Leaking around the catheter caused irritation that resolved by decreasing catheter size. Improved catheter care, improved diabetes management, and increased fluids solved clogging.

63

Results

59 Year-old male with ALS, Chronic indwelling catheter and multiple UTIs requiring hospitalization.

No More Catheter Changes

Switched to external catheter.

UTI rate dropped to zero

64

Any Questions

65

Purple Bag Syndrome

Bacteria + Tryptophan=Purple

Tryptophan in the diet is metabolized by bacteria in the gastrointestinal tract to produce indole. Indole is absorbed into the blood by the intestine and passes to the liver. There, indole is converted to indoxyl sulfate. Indoxyl sulfate is excreted in the urine.

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