Urinary Retention (space adaptation) Cliff

Branch Baseline

Urinary retention is the inability to voluntarily pass urine or completely empty the bladder. It may be without pain or accompanied by painful, palpable or percussable bladder. The retention volume should be significantly greater than the expected normal bladder capacity **(Abrams P, 2002).** .Space adaptation indicates it occurs within the first 5 days of flight.

Incidence Data Included in the Model

The model imports the following incidence information from the IMM database: incidence data category, space adaption status, incidence data, incidence and occurrence distribution data and incidence data characteristics. Data category defines the type of data available for incidence calculations (i.e. raw data vs. fixed data). Space adaptation identifies medical events that onset occurs in the first 5 days of flight and does not reoccur. Incidence values vary by data category and define the number of medical events per person-year or medical events per person-at-risk for each medical condition. Incidence values can be modified by crew characteristics such as gender. Modifying characteristics are noted below and incidence values are listed individually for each characteristic. Distributions are assigned to medical events incidence values and occurrences in the model. For each crew member in a given trial, the incidence and number of occurrences of each medical condition are randomly selected from these probability distributions. Detailed descriptions of the distributions are included in the IMM Technical Description Document.

Incidence	
Data Category:	In-flight
Space Adaptation:	Yes
Incidence Type:	Proportion

Distribution Data	
Incidence:	Beta
Occurrence:	Bernoulli

Female Data Characteristics	
Occurrence Hour Range:	24 to 48
Peak Occurrence Hours:	24
Events:	6
Persons At Risk:	115
Space Flight Incidence Rate (Events / Persons at Risk):	6 / 115 = 0.0521739130434783

Male Data Characteristics	
Occurrence Hour Range:	24 to 48
Peak Occurrence Hours:	24
Events:	5
Persons At Risk:	692
Space Flight Incidence Rate (Events / Persons at Risk):	5 / 692 = 0.00722543352601156

Incidence Comments

Source of incidence data is a compilation of the available in flight medical events (Walton, 2010).

Integrated the real world system incidence data. Added 1 female STS and 1 male STS event to the previous 5 and 2, respectively. Added 25 Persons at Risk to the female incidence and 119 Persons at risk to the male incidence (Saile, 2017).

Updated the Persons at Risk based on the revised real world system integrated incidence data. The integrated RWS persons at risk from 144 to 143 so the conditions integrated iMED value went from 693 to 692 (Saile L., 2017)

Information Regarding Prevention

Selection criteria: Disqualifying genitourinary conditions include: disease, injury, or other disorders of the kidneys or GU tract that could require emergency medical treatment or interfere with successful mission completion; diseases interfering with micturition and potentially requiring emergency medical treatment such as prostatitis, any disabling disorders of the reproductive system or associated anatomical structures that could potentially require emergency medical care (International Space Station Program, 2009) Screening includes evaluation of voiding symptoms such as polyuria, oliguria, frequency, urgency, dysuria, nocturia, diminished force and caliber of urine stream, spraying of stream, hesitancy, dribbling, straining, sense of residual urine after voiding, and incontinence (Jones, 2008).

Vehicle requirement(s): Conditions affecting urinary health are prelaunch, launch, and entry suit, (Jones, 2008)

Other: Mission schedules, inadequate fluid intake, and redistribution of body fluids may affect urinary output. Some medications used for motion sickness may cause urinary retention or have anti cholinergic side effects. (Jones, 2008) Atropine, Vicodin, Metaxalone (Skelaxin) (International Space Station Integrated Medical Group, 2006)

Urinary catheters are included in the medical kit and urinary catheterization is listed in the ISS medical checklist procedures for urinary retention.

Although the causes of urinary retention can be separated into four broad categories: obstructive, pharmacologic, psychogenic, and neurogenic, space travel may predispose astronauts to two or more etiologies. Spaceflight places the astronaut in a unique environment in which microgravity, demanding schedules, and limited access to voiding may predispose an individual to psychosocial etiologies. This environment, compounded by the use of antiemetic medications for space motion sickness prophylaxis and treatment, may have led to the acute presentation of urinary retention. (Stepaniak, 2007)

As a last resort, the condition could be addressed using ISS resources under guidance from ground specialist (Jones, 2008), (Jones, 2007) (Jones, 2009)

Incidence Level of Evidence (LOE)

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

Citation	LOE Value	LOE Category
Walton, 2010	1	Incidence
Saile L., 2017	1	Incidence

Incidence data not included in the model

The model pulls the incidence information from the IMM database ... the information shown below does not go into the model.

Incidence	
Data Category:	Fixed
Space Adaptation:	Yes
Incidence Type:	Rate

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Female Data Characteristics	
Occurrence Hour Range:	to
Peak Occurrence Hours:	
Fixed Rate:	7E-05

Incidence Comments

Incidence rate in Denmark, with a small sample of 18 women over a 9 month period, was 7/100000. The sex ratio (F: M) was 1:13. (Klarskov, 1987 2683 /id;Choong, 2000)

Incidence data not included in the model

The model pulls the incidence information from the IMM database ... the information shown below does not go into the model.

Incidence	
Data Category:	Fixed
Space Adaptation:	Yes
Incidence Type:	Rate

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics	
Occurrence Hour Range:	to
Peak Occurrence Hours:	
Fixed Rate:	0.022

Incidence Comments

The Triumph project reported that amongst 56,958 males with a mean follow-up of 2.8 years, 344 AUR cases occurred, incidence rate 2.2/1000 man-years, of whom more than 40% were precipitated. (Verhamme, 2005)”

Incidence data not included in the model

The model pulls the incidence information from the IMM database ... the information shown below does not go into the model.

Incidence	
Data Category:	Fixed
Space Adaptation:	Yes
Incidence Type:	Rate

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics	
Occurrence Hour Range:	to
Peak Occurrence Hours:	
Fixed Rate:	0.031

Incidence Comments

In England, between 1988 and 2003 primary acute retention was 3.06/1,000 men yearly, = rate of 0.31 (Cathcart, 2006).

Incidence data not included in the model

The model pulls the incidence information from the IMM database ... the information shown below does not go into the model.

Incidence	
Data Category:	In-flight
Space Adaptation:	Yes
Incidence Type:	Proportion

Distribution Data	
Incidence:	Beta
Occurrence:	Bernoulli

Male Data Characteristics	
Occurrence Hour Range:	24 to 48
Peak Occurrence Hours:	24
Events:	4
Persons At Risk:	574
Space Flight Incidence Rate (Events / Persons at Risk):	4 / 574 = 0.00696864111498258

Incidence Comments

Source of incidence data is a compilation of the available in flight medical events (In-flight Compilation Lockdown revised, 2010).

Information Regarding Prevention

Selection criteria: Disqualifying genitourinary conditions include: disease, injury, or other disorders of the kidneys or GU tract that could require emergency medical treatment or interfere with successful mission completion; diseases interfering with micturition and potentially requiring emergency medical treatment such as prostatitis, any disabling disorders of the reproductive system or associated anatomical structures that could potentially require emergency medical care (International Space Station Program, 2009). Screening includes evaluation of voiding symptoms such as polyuria, oliguria, frequency, urgency, dysuria, nocturia, diminished force and caliber of urine stream, spraying of stream, hesitancy, dribbling, straining, sense of residual urine after voiding, and incontinence (Jones, 2008).

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Although the causes of urinary retention can be separated into four broad categories: obstructive, pharmacologic, psychogenic, and neurogenic, space travel may predispose astronauts to two or more etiologies. Spaceflight places the astronaut in a unique environment in which microgravity, demanding schedules, and limited access to voiding may predispose an individual to psychosocial etiologies. This environment, compounded by the use of antiemetic medications for space motion sickness prophylaxis and treatment, may have led to the acute presentation of urinary retention. (Stepaniak, 2007)

As a last resort, the condition could be addressed using ISS resources under guidance from ground specialist (Jones, 2008), (Jones, 2007) (Jones, 2009)

Alternative Incidence Data

The most common causes of difficulty or inability to insert a urinary catheter in a male are urethral strictures and benign prostatic hypertrophy (BPH). The prevalence of urethral stricture in males was 0.6% (Santtucci, 2007)

A 1998 to 2005 database study in England reported mortality within 90 days of spontaneous acute urinary retention: 2.2 (95% CI 1.8 to 2.6 for ages 45-54; and 2.4 (95% CI 2.2 to 2.7) for ages 55-64 (Armitage, 2007).

To date there has been a lack in literature about incidence of female urinary retention. Fowler describes a typical case of a young woman age less than 30 years, presented with the realization of having not voided for a day or more but with none of the sensation of urinary urgency and an increasing lower abdominal discomfort. A bladder capacity of >1 L with no sensations of urgency is necessary for the diagnosis. An additional feature that appears to be pathognomonic is when a patient reports self catheterization and upon withdrawing experiences difficulty removing the catheter (Fowler, 2003).

A retrospective chart review in England, concluded that of 247 women seen over 4 years, 103 (42%) presented with complete retention and 144 (58%) with a combination of obstructed voiding and intermittent/partial retention. The mean (range) age of the referred women in retention was 35.0 (12–81) years. (Kavia, 2006)

Multiple cases of urinary retention and subsequent urinary tract infections have been observed during short duration space flight, chiefly among females (Fogarty, 2009) female to male ratio is 8 :1 (Inflight Compilation Lockdown, 2008)

Estimates of Acute Urinary Retention in males vary widely and it increases with age. Based on the 2000 Population Survey and Utilites and Unicon Research Corporation of male population (40 years and older), the US physician office visits and hospital outpatient visits for benign prostatic hyperplasia and/or lower urinary tract symptom was 4,418,425 or a rate of 8,201 (95% CI 6,765–9,637) per 100,000 (Wei, 2007).

Treatment and Outcomes

Based on the best evidence available best and worst case percentage ranges are assigned. The medical condition is divided into three clinical phases in all three clinical phases a functional impairment is assigned. The clinical phase I and II's functional impairments remain for the duration for that respective clinical phase. The function impairment in clinical phase III represents final impairment for this medical condition and remains for the rest of the mission. Other mission end states include evacuation and loss of crew life.

The IMM checks medical resource availability once the number of medical events and scenarios has been established. If there is not sufficient essential resources called out in the CliFF, then the medical condition will go down an untreated best or worst case scenario pathway.

The table below summarizes the treated and untreated best and worst case scenarios.

	Clinical Phase I Diagnosis & Initial Treatment[1]		**Clinical Phase II On-going Treatment / Convalescence[2]**		**Clinical Phase III Recovered / Mission End State[3]**		
	FI* (%)	**Duration (hrs)**	**FI* (%)**	**Duration (hrs) (Min - ML - Max)**	**FI* (%)**	**EVAC** (%)**	**LOCL** (%)**
ISS-based Treatment (best case scenario %: 83.33 - 91.67)	100	0.5	0 - 21	0 - 12 - 24	0	0	0
ISS-based Treatment (worst case scenario %: 8.33 - 16.67)	100	0.5 - 0.75	2 - 45	24 - 72 - 120	0	0 - 1	0
Untreated Best Case	0	0	2 - 45	0 - 12 - 24	0	0 - 100	0
Untreated Worst Case	0	0	25 - 66	24 - 72 - 120	0	0 - 100	0

[1]Clinical Phase I: Clinical phase I covers only the initial assessment of the affected crew member to define his or her medical condition, and completion of appropriate initial treatment to stabilize the crew member. While the affected crew member is being assessed, he or she is not able to perform any assigned tasks, thus Functional Impairment during this phase is considered 100%. In the untreated case, there is no diagnosis performed or treatment given, therefore Functional Impairment and Duration will always be "not applicable".

[2]Clinical Phase II: On-going Treatment and Convalescence- During clinical phase II, the affected crew member is receiving any appropriate follow-on treatment for his or her medical condition to allow the crew member to recover as much as he or she is able to recover in the ISS environment. Clinical phase II also encompasses relapses or reoccurrences of the same original medical condition in clinical phase I necessitating additional treatment or recovery time due to unsuccessful primary treatment response. The duration in Clinical Phase II is expressed in minimum, most likely (ML) and maximum hours. This was updated for future capabilities in IMM but is currently not being used by the model.

[3]Clinical Phase III: Recovered/Mission End State- Clinical phase III is reached once the affected crew member has recovered from the medical condition as much as he or she is able to recover in the ISS environment. This may or may not be recovery from the given medical condition to the full extent possible. If this "recovered" state results in an evacuation or loss of the crew member, this will be noted in the mission end state results.

*Functional Impairment (FI) is a measure of the affected crew member's health and performance ability.

**Two mission end state results are addressed in the CliFF: 1) Evacuation (EVAC) - crew and patient are evacuated from the spacecraft due to the medical condition, and 2) Loss of crew (LOCL) - death of affected crew member due to medical condition. EVAC is considered as an end state result if any of the following criteria are met: 1) potential LOCL, 2) potential significant permanent impairment, or 3) potential intractable pain. Probability distributions are assigned for each range of values within the Table of Treatments and Outcomes.

Refer to the Integrated Medical Model Technical Document for more information on how risk is reported by the IMM, Crew Health Index (CHI) and Quality Adjusted Mission Time calculations.

Definition and Probability of Best and Worst Case Scenario: (includes definitions of best and worst case scenarios and identifies the probability of those scenarios.)

Scenario Comments

The **best case scenario is defined** as urinary retention that resolves spontaneously or requires straight catheterization.

The **worst case scenario is defined** as urinary retention that requires repeated straight catheterization or indwelling catheter. Extended retention puts the crew member at risk for urinary tract infection, which is addressed in the Urinary Tract Infection CliFF. Retention may be caused by urethral stricture, thus preventing the insertion of the catheter and this will require evacuation of the crew member.

Percentages of how often best versus worst case scenarios occur based on the Real World Systems data there were no worst cases so to integrate this data into the BC/WC percentage the algorithm developed with the original data set was used for all the medical events in both data sets. Therefore, if the next case is a worst case we would 1/12 or 17% of cases as worst cases. If the next case is best case, we would have 12/12 or 100%. Thus the percentage for worst case is 0-17% (Saile L., 2017)

Best Case Comments

During **Clinical Phase I,** Functional Impairment (FI) is 100% by definition. Following ISS procedures for diagnosis is 30 minutes. During **Clinical Phase II,** We are using Table # 7-2 Upper Urinary Tract disease, page 134 in the Guides to the Evaluation of Permanent Impairment ; Table # 7-4 Bladder disease, page 139 in the Guides to the Evaluation of Permanent Impairment. Combined FI ratings are calculated using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008).

FI is estimated to be 0 to 21%. BC duration of symptoms is expected for one day, with retention resolving spontaneously or responding to straight catheterization. (International Space Station Integrated Medical Group, 2006). In this scenario, retention would have resolved **in Clinical Phase III** and there is 0% or no FI. Based on in flight data, EVAC or LOCL is not estimated to occur in the best case scenario (In-flight Compilation Lockdown revised, 2010).

Worst Case Comments

During **Clinical Phase I,** FI and duration are similar to the best case scenario. During **Clinical Phase II,** We are using Table # 7-2 Upper Urinary Tract disease, page 134 in the Guides to the Evaluation of Permanent Impairment ; Table # 7-4 Bladder disease, page 139 in the Guides to the Evaluation of Permanent Impairment. Combined FI ratings are calculated using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008). FI is estimated to be 2-45%. Duration is estimated to be 1 to 5 days. In the worst case scenario, UTI resolves in **Clinical Phase III** and FI is 0%. There is less than1% of cases where catheterization is not successful due to urethral stricture (Santucci, 2008)therefore EVAC is estimated from 0 to 1% for the worst case scenario. It may require surgical treatment to resolve. LOCL is unlikely to occur.

Untreated Best Case Comments

During **Clinical Phase II,** We are using Table # 7-2 Upper Urinary Tract disease, page 134 in the Guides to the Evaluation of Permanent Impairment ; Table # 7-4 Bladder disease, page 139 in the Guides to the Evaluation of Permanent Impairment. Combined FI ratings are calculated using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008). For detailed description of grading and combination table refer to the CliFF Appendix.. FI is estimated to be 2 to 45%. Duration may be 1-5 days. In the best case scenario, retention may resolve without treatment in **Clinical Phase III** and there is 0% or no FI. If retention does not resolve spontaneously EVAC may be necessary and the risk is estimated to be 0 to 100%. LOCL is not likely to occur.

Untreated Worst Case Comments

During **Clinical Phase II**, We are using Table # 7-2 Upper Urinary Tract disease, page 134 in the Guides to the Evaluation of Permanent Impairment ; Table # 7-4 Bladder disease, page 139 in the Guides to the Evaluation of Permanent Impairment. Combined FI ratings are calculated using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008). For detailed description of grading and combination table refer to the CliFF Appendix. FI is estimated to be 25 to 66%. The duration is estimated to be 1 to 5 days. By definition there is no treatment available in this WC scenario. During **Clinical Phase III** retention may not resolve without treatment. If it resolves, FI is 0%. Untreated urinary retention could become serious enough to result in neurogenic bladder, cystic calculi, hydronephrosis, and bladder diverticuli, therefore, risk of evacuation is estimated to be 0 to 100 %. LOCL is not expected.

Treatment and Options Level of Evidence (LOE)

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

Citation	LOE Value	LOE Category
Lopez, 2010	1	EVAC
American Medical Association, 2008	3	FI
Santucci, 2008	4	EVAC
Saile L., 2017	1	BCWC

Additional Comments

We searched PubMed using the terms: Urinary Retention, acute urinary retention, urinary retention and space medicine. Majority of results found refer to men and benign prostatic hyperplasia (BPH) as the primary cause for retention among males.

The Resource Table (RT)

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
BZK wipes	3	3	60	Yes	No	To cleanse skin prior to catheterization
Cotton swabs	1	1	6	Yes	No	Collect urine for chemstrips.
Lidocaine Jelly 2% 30mL Tube	0.33	0.33	3	Yes	Yes	Lubricant with local anesthetic to assist with the insertion of the catheter and discomfort.
Medical tape	0	1	5	Yes	No	single-coated tapepressure adhesive tape
Sterile gloves (large, medium, and small) (pair)	1	1	6	Yes	No	worn when there is contact with sterile instruments or a patient's sterile part
Syringe (10cc)	1	1	6	Yes	Yes	To inflate catheter balloon
Urinary Collection Bag (leg bag)	0	1	250	Yes	Yes	to drain urine from foley catheter
Urine Catheter Short	1	1	10	Yes	Yes	Relieve retention.
Urine Catheter Straight	1	1	2	Yes	Yes	to drain urine from bladder - short term
Urine chemstrips	1	1	10	Yes	Yes	urine test for ph, leukocytes, protein, glucose, ketones, blood, and nitrites

Resource Comments

The source of resource table data was derived from the ISS Medical Check List (MOD, 2011) .

Added cotton swabs for urinalysis in best case, and one 10 cc syringe to worst case. ISS procedure does not indicate that syringe used for inflating the Foley needs to be re-used for deflation.

Required Resources Level of Evidence (LOE)

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

Citation	LOE Value	LOE Category
NASA Mission Operations Directorate (MOD), 2011	2	Resources

Level Of Evidence

Input Data	LOE Average
Incidence	1
Functional Impairment	3
Best Case / Worst Case	1
EVAC / LOCL	2.5
Resources	2
QUALITY OF EVIDENCE	**1.9**

Description	Range
Excellent	1-2
Good	2.1-3
Fair	3.1-4
Poor	4.1-5

Reference List

Reference
Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, et al. The Standardisation of Terminology of Lower Urinary Tract Function. Report from the Standardisation Sub-Committee of the ICS. International Continence Society; 2002. Report No.: 21.
American Medical Association. Guides to the Evaluation of Permanent Impairment. 6th ed. Chicago: American Medical Association Press; 2008.
Armitage JN, Sibanda N, Cathcart PJ, Emberton M, van der Meulen JH. Mortality in men admitted to hospital with acute urinary retention: database analysis. BMJ 2007 Dec 8;335(7631):1199-202.
Cathcart P, van der Meulen J, Armitage J, Emberton M. Incidence of primary and recurrent acute urinary retention between 1998 and 2003 in England. J Urol 2006 Jul;176(1):200-4.
Choong S, Emberton M. Acute urinary retention. BJU Int 2000 Jan;85(2):186-201.
Fogarty J. Human Adaptation to Space:Space Physiology and Countermeasures. NASA; 2009.
Fowler CJ. Urinary Retention in Women. BJU Int 2003;91(6):463-4.
Inflight Compilation Lockdown. In-flight medical events for Apollo, MIR, ISS, Skylab, and STS. 7-10-2008. Houston, Texas, NASA, Johnson Space Center.
International Space Station Integrated Medical Group. Medical Checklist ISS- All Expeditions. Houston: National Aeronautics and Space Administration; 2008.
International Space Station Program. Medical Standards for ISS Crewmembers - MED Vol A. 3.2 ed. NASA; 2011.
Jones JA, Sargsyan AE, Barr YR, Melton S, Hamilton DR, Dulchavsky SA, et al. Percutaneous bladder catheterization in microgravity. The Canadian Journal of Urology 2007 Apr 20;14(2):3493-8.
Jones JA, Pietrzyk RA, Whitson PA. Renal and Genitourinary Concerns. In: Barratt M, Pool S, editors. Principles of Clinical Medicine for Space Flight.New York: Springer; 2008. p. 273-91.
Jones JA, Sargsyan AE, Barr YR, Melton S, Hamilton DR, Dulchavsky SA, et al. Diagnostic ultrasound at MACH 20: retroperitoneal and pelvic imaging in space. Ultrasound Med Biol 2009 Jul;35(7):1059-67.
Kavia RB, Datta SN, Dasgupta R, Elneil S, Fowler CJ. Urinary retention in women: its causes and management. BJU Int 2006 Feb;97(2):281-7.
Lopez V. In-flight medical events revised_Functional Impairment. 2010. Houston, Texas, NASA, Johnson Space Center.
NASA Mission Operations Directorate (MOD). International Space Station Integrated Medical Group Medical Checklist. Mission Operations Directorate (MOD), Systems Operations Data File (SODF) . 6-24-2011. Houston, TX, National Aeronautics and Space Administration (NASA).
Saile L., Boley L, Kerstman E. Integration RWS ISS STS Observed Incidence V2. 2017.
Saile L., Boley L, Arellano J, Kerstman E. iMED Best and Worst Case Percentage Update. 2017.
Saile L, Boley L, Kerstman E. Integration RWS ISS STS Observed Incidence. 2017.
Santucci R, Joyce GF, Wise M. Male Urethral Stricture Disease. The Journal of Urology 2007;177:1667-74.
Santucci RA, Payne CK, Anger JT, Saigal CS. Office dilation of the female urethra: a quality of care problem in the field of urology. J Urol 2008 Nov;180(5):2068-75.
Stepaniak PC, Ramchandani SR, Jones JA. Acute urinary retention among astronauts. Aviat Space Environ Med 2007 Apr;78(4 Suppl):A5-A8.
Verhamme K, Dieleman J, van Wijk M, Bosch J, Stricker B, Sturkenboom M. Low Incidence of Acute Urinary Retention in the General Male Population: The Triumph Project. European Urology 2005 Apr;47(4):494-8.
Walton M, Kerstman E, IMM. In-flight Compilation v20100414_Incidence_calculation. 2010.
Wei JT, Calhoun EH, Jacobsen SS. Benign Prostatic Hyperplasia. In: Litwin MS, Saigal CS, editors. Urologic Diseases in America.Washington DC: US Department of Health and Human Services, Public Health Service, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases. Washington, DC: US Government Printing Office; 2007. p. 43-70.