

REVIEW ARTICLE

Diagnosis and treatment of urinary tract infections: a multidisciplinary approach for uncomplicated cases

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ABSTRACT

Urinary tract infection affects both children and adults. It is a common health problem in children. In pregnant women, treatment for urinary tract infection deserves special attention due to the perinatal risks. The absence of new antimicrobial molecules and the increase in bacterial resistance, the latter favored by the indiscriminate use of antibiotics, prompt us to standardize norms in the approach and initial treatment of urinary tract infection. The article was written by an independent panel from second- and third-level care public and private institutions. We conducted a review of the literature and the statements made within the framework of an interdisciplinary meeting. When urinary tract infection is suspected in children, diagnosis must be confirmed using bacteriological methods. Diagnosis of uncomplicated urinary tract infection in adults can be made based on the clinical examination. Empirical initial treatment must include wide-spectrum antibiotic options and should be modified according to culture results as well as reported sensitivity.

Key words: uncomplicated urinary tract infections, diagnosis, treatment, prophylaxis.

INTRODUCTION

The aim of this article is to promote, among primary care physicians, the knowledge and application of good clinical practice in the diagnosis, treatment and prevention of uncomplicated urinary tract infections (UTI) in both children and adults.

In pediatric patients, UTI is a common health problem that ranks third in infections after upper respiratory and gastrointestinal infections.¹ In this population there are controversies both in the diagnosis as well as treatment, which range from how to collect the urine for analysis in order to confirm the infection, up to how to determine which patient requires ultrasound and cystourethrogram, to rule out any malformations. Similarly, in adults, UTI is a frequent reason for consultation.¹ In pregnant women, treatment of UTI deserves special attention because of the perinatal risks involved.

The lack of new antimicrobial molecules and increased bacterial resistance favored by the indiscriminate use of antibiotics require regulation of behaviors on the approach and initial treatment of UTIs. These recommendations are aimed at general practitioners, pediatricians and all specialists involved in the care of patients with this type of complaint.

SUBJECTS AND METHODS

This review was developed by physicians working in second- and third-level care public hospitals and private fa-

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Received for publication: 7-24-12

Accepted for publication: 1-8-13

cilities in Mexico. Physicians were selected on the basis of their experience in the field of UTI. A multidisciplinary approach included experts in infectious diseases (pediatric and adult), urology (pediatric and adult) and gynecology.

The methodology for this study consisted of review of articles published in the medical literature on UTI up to January 2011. We excluded those articles published before 1999 unless they were articles that described the pathophysiology of the disease. As part of a systematic review, controlled clinical studies were included (with placebo or active drug) and descriptive studies related to the etiology, epidemiology, diagnosis and treatment of UTI. Also included were *in vitro* studies to determine the profiles of sensitivity/resistance to antimicrobials. We performed the literature search using PubMed and Cochrane Library databases. We reviewed other consensus, guidelines and recommendations published by governmental and nongovernmental agencies from different countries. We excluded abstracts, unpublished studies, studies with small sample sizes and studies with poor internal and external validity. The authors' final meeting was held on February 18 and 19, 2011. The final document was subsequently reviewed by the members for final correction.

EPIDEMIOLOGY

In Mexico, the National Epidemiological Surveillance System reported that in 2010 UTIs occupied third place among the leading causes of morbidity.²

Adults

UTI is the leading cause of medical consultation in women of reproductive age. During pregnancy, it is the most common cause of serious perinatal complications¹⁻⁵ and is the third leading cause of neonatal sepsis.⁶ In 2010 there were 1,204,032 cases reported in adults 25-44 years of age, with an incidence rate of 3000/100,000 inhabitants.² In subjects >60 years of age, the incidence rate was 6000/100,000 inhabitants, with predominance in males.²

Children

In this age group, UTI is a common cause of consultation and hospitalization. The frequency varies depending on age and gender. Symptomatic infection occurs in 1/1000 newborns and children <1 month of age and is more

common in males.⁷ After this age, it is more common in girls, with a prevalence of 1-2%. In general, the risk of UTI during the first decade of life is 1% to 3% for males and females. After the second decade of life, UTI continues with a female predominance with a ratio of 4:1.^{7,8}

Definitions

Definitions of each type of disease that were addressed in the present study are listed in Table 1.

ETIOLOGY

Bacteria that generally cause UTIs are gram negative of intestinal origin. Of these, *Escherichia coli* represents 75-95%, with the remainder being caused by *Klebsiella* sp., *Proteus* sp. and *Enterobacter* sp.⁹ Among the gram positive bacteria, *Staphylococcus saprophyticus* and *Streptococcus agalactiae* are the most frequent.^{9,10} In the neonatal group, the frequency of gram positive bacteria increases, although gram negative species predominate.¹¹⁻¹⁵

PATHOPHYSIOLOGY

Children

The urinary tract is sterile. The retrograde ascent of bacteria is the most common mechanism of infection. In girls, bacteria can more easily access and ascend the urinary tract due to the relative proximity of the urethral opening to the anus and the shorter length of the urethra. Another proposed route as a uropathogenic bacterial reservoir has been the presence of the intact foreskin in infants, in whom the frequency of UTI is ten times that of circumcised males.^{11-13,15}

High pressure in the bladder, incomplete or infrequent emptying of the bladder and lack of pelvic floor relaxation during voiding, and constipation or encopresis are other factors that predispose to UTI.^{12,13} Congenital abnormalities of the urinary tract (obstructive uropathy and reflux) and neurogenic bladder including the group of patients with intermittent bladder catheterization are risk factors particularly important to consider in infancy.¹⁶

Patients with a susceptible urothelium facilitate increased bacterial colonization. The predisposition to colonization in children with recurrent UTI in the ab-

Table 1. Different types of UTI

Asymptomatic bacteriuria	In the normal population defined as the presence of >100,000 CFUs of the same microorganism/mL (10^5 CFU/mL) of urine and absence of symptoms During pregnancy and in children, defined as the presence >100,000 CFU/mL of the same species in two subsequent cultures in the absence of symptoms
Uncomplicated UTIs	Symptoms characteristic of dysuria, difficult urination, pollakiuria/increase in urinary frequency, vesicular tenesmus and occasionally urgency, suprapubic pain, nocturia and hematuria. These symptoms usually correspond with lower urinary tract infection. It occurs in patients with a normal urinary tract (anatomic and physiological) without data of systemic involvement (fever, toxicity, persistent vomiting, dehydration) and no history of renal disease or comorbidities (diabetes, immunocompromise). There are no conditions that predispose to UTI or treatment failure
Complicated UTIs	Involves recurrent infection or involvement of the upper urinary tract with fever, nausea, vomiting, back pain and malaise. Also includes all cases that present persons with anatomic alterations
Acute pyelonephritis	Infection of the renal parenchyma, secondary to lower UTI. The patient presents malaise, frequency, dysuria, hematuria, pain in lower back and flank, fever >39°C lasting >48 h and positive Giordano sign
Reinfection	Two episodes of UTI caused by different microorganisms within <6 months
Recurrent infection	>3 episodes of UTI during a 12-month period or 2 episodes en <6 months
Persistence of bacteria	Microbiological evidence of bacterial growth despite appropriate treatment

UTI, urinary tract infection; CFU, colony-forming units.

sence of anatomic or functional alterations is related to an increased adhesion capacity of bacteria like *E. coli* to the inner foreskin,¹⁷ perineum, opening to the vagina and urethra. Often, these microorganisms have type P fimbriae, a mechanism for bacterial adherence, yielding them more virulent and with affinity to the urethelium.¹⁷ In these patients, some type of immunodeficiency associated with low levels of IgA and IgG may be present.¹¹⁻¹³

Adults

In adults, UTIs predominate in females. UTI is frequently associated with two important life events: 1) during pregnancy, with an increase in perinatal morbidity and mortality, and 2) from the initiation of sexual activity.

Certain characteristics of the female anatomy predispose to infection: first, the vicinity of three natural orifices (vagina, urethra and anus, the latter usually colonized by gram negative microorganisms) and second, the length of the urethra. Other factors include increased residual urine secondary to problems of static pelvis and sexual activity because intercourse promotes colonization of the urinary tract by vulvo-perineal microorganisms.¹⁸

In addition, during pregnancy there are some factors that increase susceptibility to the development of UTI: 1) progesterone induces decreased smooth muscle tone, which decreases ureteral peristalsis and makes bladder

emptying difficult. It can also alter the expression of decay accelerating factor (DAF/CD55), which is a regulator of the complement and serves as a receptor of many pathogens, including *E. coli*;¹⁹ 2) anatomic changes favoring anterior superior elevation of the bladder, compression of ureters (more on the right side) and thus an increase in urinary stasis;⁵ 3) a renal hypertonic state inhibiting leukocyte migration, phagocytosis and complement activity as well as a decreased T cell activity, thereby favoring the infectious processes.⁴

Moreover, UTI is the most common medical complication in pregnant women. Treatment is mandatory, in addition to being the only state in which an asymptomatic bacteriuria⁷ should be treated because of the implications of perinatal morbidity and mortality (preterm birth, which is responsible for 75% of neonatal deaths and 50% of long-term neurological disorders).²⁰

In addition, pregnancy makes women particularly susceptible due to the factors already discussed, complicating the initial infection and converting it into an acute pyelonephritis, whose incidence increases by 7%.²⁰

There is a growing group of patients in which UTI is associated with sexual activity. The spectrum of this phenomenon ranges from the so-called "honeymoon cystitis" to multiple recurrences of infection.²¹ In these cases, application of various hygiene/dietary modifications and the use of single-dose postcoital antimicrobials is justified.^{7,22}

DIAGNOSIS

Children

Suspicion of UTI should be confirmed by urinalysis and urine culture. In newborns and infants it is advisable to take a urine sample through a urethral catheter. In children with bowel control, a urine sample should be obtained from the second half of the stream, either after retracting the foreskin and disinfecting the glans in boys or opening the lips and cleaning the periurethral area in girls. A sample obtained with a collection bag only has value if the result is negative.^{12,13,23}

The urine dipstick test can reveal the presence of leukocyte esterase and nitrites. In the microscopic analysis, a count of five or more leukocytes per field and bacteriuria are suggestive of a UTI.^{12,13,23-25} The urine culture is considered positive if there are >100,000 colony forming units (CFU)/mL in a properly collected sample. Specimens for urine culture should be refrigerated if there is no possibility of sending them to the laboratory within 30 min after collection.^{12,13,24-26} A urine culture with up to 1,000 CFU/mL in certain clinical situations may be considered as an actual UTI; however, it is necessary to consider that when the CFUs are low, the chances of contamination increase. There will be situations in which urine culture results must be taken in the context of the clinical picture and the symptoms.²⁷

Current recommendations are that all newborns and infants (children <2 years of age) with their first documented UTI with fever >38.5°C should undergo an ultrasound of the urinary tract to detect anatomic anomalies and, optionally, a renal scan with dimercaptosuccinic acid (DMSA) to confirm evidence of pyelonephritis and evidence of scarring. Voiding cystourethrogram (CUG) is not routinely recommended after the first febrile UTI and is only indicated if the ultrasound reveals hydronephrosis, scarring, or ureteral dilation or if there is recurrence of febrile UTI. Given that the data of the most recent studies do not support the use of antimicrobial prophylaxis to prevent recurrent febrile UTI in infants without vesicoureteral reflux (VUR) and primary grade I-IV reflux, both the American Academy of Pediatrics and the European Association of Urology recommend doing a CUG only if the ultrasound of the urinary tract reveals an abnormality or if febrile UTI recurs in infants 2-24 months of age.^{7,28} Renal DMSA scan should be repeated at any time after 3 months

following the acute infectious event to look for extension of the scarring.²⁹

Adults

Diagnosis of uncomplicated UTI is made based on the clinical picture. In cases where the symptoms are mild or incipient, it is recommended to perform if possible during the consult, "a bedside" urine dipstick examination to detect nitrite and leukocyte esterase. Expanded general urine test with the microscopic analysis of the sediment does not provide additional evidence for UTI diagnosis. No urine culture or imaging studies are warranted³⁰ in case of an isolated uncomplicated UTI. These should be performed only in patients with fever that persists even 72 h after beginning treatment.⁷ Urine culture is recommended in cases of suspected pyelonephritis, persistent symptoms or those that recur within the first 2-4 weeks after completion of treatment and in the case of atypical symptoms.^{7,31}

The most important differential diagnosis is made with vulvovaginal infections, where it is common for the patient to confuse dysuria with terminal vulvar burning, which produces irritation with the urine on the inflamed vulva. The hyperactive bladder is another differential diagnosis. It is generally an idiopathic disease whose cardinal symptoms are urgency, frequency and urinary incontinence.³²

TREATMENT

Currently, the pattern of susceptibility of the bacteria has changed due to the progressively increasing resistance as a result of indiscriminate use of antibiotics as described for *E. coli* (Figure 1).³³ To be able to consider an antibiotic as empirical therapy in the Mexican population, the recommended threshold must be ≤20%, according to treatment guidelines for this condition proposed by the IDSA (Infectious Diseases Society of America (Figure 1)).⁹

Children

Initial empirical treatment should include broad spectrum antibiotic coverage and its adaptation, based on the culture results. In children, short-term treatment is not recommended. Treatment should continue for 7-10 days.^{7,28} Given the documented high resistance of *E. coli* to certain antibiotics such as ampicillin and trimethoprim, cefibuten is recommended (at doses of 9 mg/kg/day) or cefixime (at a dose of 10 mg/kg/day) for 7 days in patients <2 years

of age with UTI.^{12,13,23,24,34,35} This therapy is also recommended for children >2 years of age or high UTI (kidney infection or pyelonephritis). In cases of documented UTI and without fever, nitrofurantoin (7 mg/kg/day in 3 to 4 doses for 1 week) provides good results. The single dose with fosfomycin (2 to 3 g) is an option where there is controlled patient follow-up (Table 2).^{12,13,23,24}

Adults

In pregnant women the use of nitrofurantoin, fosfomycin and cephalosporins (except first generation) is recommended.^{7,36} Due to the high resistance shown by *E. coli* in our environment (79%), its use as an empiric first option is not recommended.³

In the Mexican population, during pregnancy, it is recommended to provide antimicrobial management of asymptomatic bacteriuria and uncomplicated UTI without laboratory tests (urine culture) on the basis of the high incidence of *E. coli* as the causative organism.¹ It is recommended that laboratory and imaging studies be carried out only in cases of persistent symptoms (mainly fever) or in complicated UTIs.^{7,37} Due to the impact of treatment on the embryo and fetus, as well as the resistance shown to certain antibiotics, the therapeutic options are limited. Trimethoprim should not be used during the first trimester due to its action on folic acid metabolism.³⁸ Quinolones are contraindicated for the possible effects on fetal cartilage.³⁸ Sulfa drugs should not be used in the third trimester due to its binding to albumin and its com-

petition with bilirubin, which increases the risk of fetal hyperbilirubinemia.³⁹

In the remainder of the adult population, choice of empirical antibiotic is based mainly on resistance rates of community isolates. In recent years there has been a significant increase in the resistance of *E. coli* to ampicillin, amoxicillin, trimethoprim-sulfamethoxazole, and quinolones (which include nalidixic acid).³³⁻³⁵ Therefore, management with nitrofurantoin or second- or third-generation cephalosporins is suggested because they are safe and well tolerated. Another option is fosfomycin, especially in cases of suspected or proven infection with *E. coli* producer of extended spectrum β -lactamase (ESBL), although this has been little studied in our environment.⁴⁰

PROPHYLAXIS

The recommended measures are the usual for the prevention of UTI^{4,7} and include adequate hydration (forced hydration is not recommended because the theoretical advantage of a rapid decline in bacterial count is canceled with the disadvantage of diluting the antimicrobial agents (level of evidence IIC),⁵ cleaning of the vulvo-perineal area and bladder emptying before and after intercourse when this has been identified as the triggering factor. Regarding the use of lyophilized extracts (immuno-active fractions) of *E. coli* administered for 3 months on a daily basis in patients with recurrent urinary tract infections, in 2002 a meta-analysis was carried out of five controlled studies with a random-

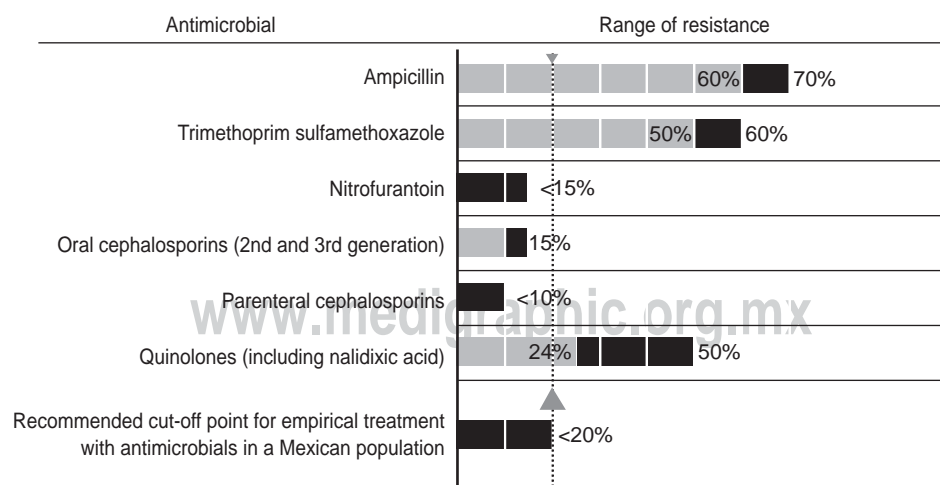


Figure 1. Rates of resistance of *E. coli* in community isolates reported in México.^{3,9,11,33-35}

Table 2. Recommended dosage of antimicrobials for uncomplicated UTIs

Antibiotic*	Children	Adults		Level of evidence**
		Males and females	Pregnant subjects	
TMP-SMX	10 mg/kg/day in 2 doses	160/800 mg/12 h	Contraindicated	IA
Nitrofurantoin	7 mg/kg/day in 3 or 4 doses	100 mg/6-8 h	100 mg/6-8 h	IIA
Fosfomycin tromethamol	2 g single dose orally	3 g single dose orally	3 g single dose orally	IA
Quinolones				
Nalidixic acid	NA	1 g orally/6 h	Under strict medical supervision	IA
Ciprofloxacin	NA	500 mg/12 h		
or 1 g/24 h	Contraindicated			IA
Norfloxacin	NA	400 mg/12 h	Contraindicated	IA
Ofloxacin	NA	400 mg/24 h		
or 200 mg/12h	Contraindicated			IA
Rufloxacin	NA	200 mg/12 h	Contraindicated	IB
Cephalosporins				
Cefuroxime	10 mg/kg/day in 2 or 3 doses	NA	500 mg/12 h	IA
Ceftibuten	9 mg/kg/day in one dose	400 mg/24 h	400 mg/24 h	IA
Cefixime	8 mg/kg/day in one dose	400 mg/24 h	400 mg/24 h	IA

*Treatment can be prolonged 3-5 days. TMP, trimethoprim; SMX, sulfamethoxazole. Adapted from References 3,4,7-9,40. **I. Evidence from ≥ 1 randomized controlled trial. II. Evidence from ≥ 1 well-designed clinical trial without randomization, from cohort analytic studies or case control (preferably to include more than one center), from multiple case series or significant results from uncontrolled experiments. III. Evidence from opinions of respected authorities, based on clinical evidence, descriptive studies or communications from expert committees. Strength of the recommendation: A. Good evidence for recommending its use. B. Moderate evidence for recommending its use. C. Poor evidence for recommending its use. D. Moderate evidence for not recommending its use. E. Good evidence for not recommending its use.

ized, placebo, double-blind study with a similar design. In these studies it was shown that the extracts act as immunostimulants, with an effective prophylactic approximation of the recurrent urinary tract infection (level of evidence IB) ($p < 1\%$; 95% CI 0.64-0.72).⁴¹

The use of nitrofurantoin in doses of 100 mg/day for a period of 1-6 months is another useful preventive measure (level of evidence IA).⁷ In recurrent UTIs, we suggest the use of cranberry juice (at doses of 250-300 mL capsules daily or 300 mg/8 h)⁴² because cranberry juice contains fructose and proanthocyanidins that apparently have an affinity to the fimbriae of *E. coli*, covering them and preventing them from binding to the glycoside receptors of the urothelial cells, thereby decreasing urinary tract colonization by this organism (level of evidence IIC).⁵ Although acidification of the urine through ascorbic acid has shown some encouraging results,⁴³ new research is required with placebo-controlled double-blind studies. Currently, it is impractical, difficult and unnecessary to achieve and maintain acidification of the urine because most antibiotics have appropriate action with the usual pH values of urine (level of evidence IID).⁵

HYGIENE EDUCATION

In adults, conventional personal hygiene of the urogenital area and frequent bladder emptying is recommended, which reduces bacterial adherence to the urothelium. In young girls and women, normal hygiene at voiding is recommended,⁴⁴ proper intake of fluids (especially water), urinating when the urge is felt and complete emptying of the bladder, and wiping the area from front to back when using toilet paper. In women, urinating after intercourse is recommended, wearing loose-fitting cotton underwear and washing the underwear with mild soap, cleaning the urogenital area with soap and water at least once daily, bathing in the shower instead of a tub, and avoiding oil baths, powder, spray, shower or douches. As a general rule, it is advisable to avoid products that contain perfume or other allergens near the genitourinary area.

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REFERENCES

1. Secretaría de Salud. Sistema Nacional de Vigilancia Epidemiológica. Panorama epidemiológico de las infecciones de vías urinarias en México 2003-2008. Epidemiología 2009; Primera parte: 51:1-4; Segunda parte: 52:1-3.
2. SINAVE/DGE/SALUD. Información epidemiológica de morbilidad. Anuario 2009, Versión ejecutiva; 2009. México D.F.: Secretaría de Salud. p. 127. Available at: http://www.dgepi.salud.gob.mx/2010/PDFS/PUBLICACIONES/ANUARIOS/INF_EPID_MORBI_2009_VER_EJEC.pdf
3. Romero-Nava LE, López de Ávalos DR, Quiroz-Garza G. Infección recurrente en las vías urinarias de la mujer. Guías de Práctica Clínica. Ginecol Obstet Mex 2010;78:S437-S459.
4. Guberman C, Greenspon J, Goodwin TM. Renal, urinary tract, gastrointestinal, and dermatologic disorders in pregnancy. In: Decherney AH, Nathan L, Goodwin TM, Laufer N, eds. Current Diagnosis and Treatment: Obstetrics and Gynecology. USA: McGraw Hill, 2007. pp. 374-385.
5. Mandell GL, Bennett JE, Dolin R. Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases. Philadelphia: Churchill Livingstone Elsevier; 2010. pp. 957-984.
6. Arredondo-García JL, Segura-Cervantes E, Calderón-Jaimés E, Mancilla-Ramírez J, Sánchez-Huerta G, Solórzano-Santos F. Consenso mexicano en infecciones de vías urinarias en pediatría. Acta Pediatr Mex 2007;28:289-293.
7. Grabe M, Bishop MC, Bjerklund-Johansen TE, Botto H, Çek M, Lobel B, et al. Guidelines on the management of urinary and male genital tract infections. European Association of Urology 2008. Available at: http://www.uroweb.org/fileadmin/user_upload/Guidelines/The%20Management%20of%20Male%20Urinary%20and%20Genital%20Tract%20Infections.pdf
8. Downs SM. Technical report: urinary tract infections in febrile infants and young children. Pediatrics 1999;103:e54. doi:10.1542/peds.103.4.e54.
9. Gupta K, Hooton TM, Naber KG, Wullt B, Colgan R, Miller LG, et al. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: a 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis 2011;52:e103-e120.
10. Goldstein FW. Antibiotic susceptibility of bacterial strains isolated from patients with community-acquired urinary tract infections in France. Multicentre Study Group. Eur J Clin Microbiol Infect Dis 2000;19:112-117.
11. Arredondo-García JL, Soriano-Becerril D, Solórzano-Santos F, Arbo-Sosa A, Coria-Jiménez VR. Etiología y tratamiento de infecciones de vías urinarias (UTIS) en niños. Rev Enferm Infecc Pediatr 2006;19:100-106.
12. Riccabona M. Urinary tract infection in children. Curr Opin Urol 2003;13:59-62.
13. Rushton HG, Pohl HG. Urinary tract infections in children. In: Belman AB, King LR, Kramer SA, eds. Clinical Pediatric Urology. London: Martin Dunitz; 2002. pp. 261-330.
14. Chon CH, Lai FC, Shortliffe LM. Pediatric urinary tract infections. Pediatr Clin North Am 2001;48:1441-1459.
15. Wiswell TE. The prepuce, urinary tract infections, and the consequences. Pediatrics 2000;105:860-862.
16. Rosser CJ, Bare RL, Meredith JW. Urinary tract infections in the critically ill patient with urinary catheter. Am J Surg 1999;177:287-290.
17. Källenius G, Möllby R, Svenson SB, Helin I, Hultberg H, Cedergren B, et al. Occurrence of P-fimbriated Escherichia coli in urinary tract infections. Lancet 1981;2:1369-1372.
18. Hooton TM, Stapleton AE, Roberts PL, Winter C, Scholes D, Bavendam T, et al. Perineal anatomy and urine-voiding characteristics of young women with and without recurrent urinary tract infections. Clin Infect Dis 1999;29:1600-1601.
19. Hasan R, Pawelczyk E, Urvil P, Venkatarajan MS, Goluszko P, Kur J, et al. Structure-function analysis of decay-accelerating factor: identification of residues important for binding of the Escherichia coli Dr adhesin and complement regulation. Infect Immun 2002;70:4485-4493.
20. McDermott S, Daguise V, Mann H, Szejbka L, Callaghan W. Perinatal risk for mortality and mental retardation associated with maternal urinary tract infections. J Fam Pract 2001;50:433-437.
21. Hooton TM, Scholes D, Hughes JP, Winter C, Roberts PL, Stapleton AE, et al. A prospective study of risk factors for symptomatic urinary tract infection in young women. N Engl J Med 1996;335:468-474.
22. Wong ES, McKeivitt M, Running K, Counts GW, Turck M, Stamm WE. Management of recurrent urinary tract infections with patient-administrated single dose therapy. Ann Intern Med 1985;102:302-307.
23. Hinds AC, Holmes NM. Urinary tract infections in children. In: Baskin LS, Kogan BA, eds. Handbook of Pediatric Urology. Philadelphia: Lippincott Williams & Wilkins; 2005. pp. 58-68.
24. Hinman FJr, Baskin LS. Hinman's Atlas of Pediatric Urologic Surgery. Philadelphia: Saunders Elsevier; 2009. pp. 8, 26.
25. Gearhart JP, Rink RC, Mouriquand PD. Pediatric Urology. Philadelphia: Saunders Elsevier; 2010. pp. 180-195.
26. Zorc J, Kiddoo A, Shaw MD. Diagnosis and management of pediatric urinary tract infections. Clin Microbiol Rev 2005;18:417-422.
27. National Institute for Health and Clinical Excellence (NICE). Urinary tract infection in children. Available at: <http://www.nice.org.uk/nicemedia/live/11819/36032/36032.pdf>
28. Subcommittee on Urinary Tract Infection, Steering Committee on Quality Improvement and Management, Roberts KB. Urinary tract infection: clinical practice guideline for the diagnosis and management of the initial UTI in febrile infants and children 2 to 24 months. Pediatrics 2011;128:595-610. doi: 10.1542/peds.2011-1330.
29. Peters CA, Skoog SJ, Arant BS Jr, Copp HL, Elder JS, Hudson RG, et al. Summary of the AUA Guideline on Management of Primary Vesicoureteral Reflux in Children. J Urol 2010;184:1134-1144.
30. Pfaller M, Rigenberg B, Rames L, Hegeman J, Koontz F. The usefulness of screening tests for pyuria in combination with culture in the diagnosis of urinary tract infection. Diag Microbiol Infect Dis 1987;6:207-215.
31. Bent S, Saint S. The optimal use of diagnostic testing in women with acute uncomplicated cystitis. Am J Med 2002;113(suppl 1A):20S-28S.
32. Gutiérrez EP, Pineda F. Temas Actuales en Ginecología. Vejiga hiperactiva. México: Ed. Intersistemas; 2002. pp. 57-108.
33. Guajardo-Lara CE, González-Martínez PM, Ayala-Gaytán JJ. Resistencia antimicrobiana en la infección urinaria por Escherichia coli adquirida en la comunidad. ¿Cuál antibiótico voy a usar? Salud Publica Mex 2009;51:155-159.
34. Arredondo-García JL, Amábile-Cuevas CF. High resistance prevalence towards ampicillin, co-trimoxazole and cipro-

- floxacin, among uropathogenic *Escherichia coli* isolates in Mexico City. *J Infect Dev Ctries* 2008;2:350-353.
35. Chávez-Valencia V, Gallegos-Nava S, Arce-Salinas CA. Patrones de resistencia antimicrobiana y etiología en infecciones urinarias no complicadas. *Gac Med Mex* 2010;146:269-273.
 36. Villar J, Lydon-Rochelle MT, Gülmezoglu AM, Roganti A. Duration of treatment for asymptomatic bacteriuria during pregnancy. *Cochrane Database Syst Rev* 2000;2:CD 000491.
 37. Dwyer P, O'Reilly M. Recurrent urinary tract infection in the female. *Curr Opin Obstet Gynecol* 2002;14:537-543.
 38. Krcmery S, Hromec J, Demesova D. Treatment of lower urinary tract infection in pregnancy. *Int J Antimicrob Agents* 2001;17:279-282.
 39. Vazquez JC, Abalos E. Treatments for symptomatic urinary tract infections during pregnancy. *Cochrane Database Syst Rev* 2011;1:CD002256. doi: 10.1002/14651858.CD002256.pub2.
 40. Falagas ME, Voulourmanou EK, Togias AG, Karadima M, Kapaskelis AM, Rafailidis PI, et al. Fosfomycin versus other antibiotics for the treatment of cystitis: a meta-analysis of randomized controlled trials. *J Antimicrob Chemother* 2010;65:1862-1877.
 41. Bauer HW, Rahlfs VW, Lauener PA, Blessmann GSS. Prevention of recurrent urinary tract infections with immunoactive *E. coli* fractions: a meta-analysis of five placebo-controlled double-blind studies. *Int J Antimicrob Agents* 2002;19:451-456.
 42. Neri-Ruiz E, Celis-González C, de León-Jaen S, Gutiérrez-Escoto P, Kundhardt-Urquiza E, Ovadia-Rosenfeld L, et al. El jugo de arándano y su papel en las infecciones de vías urinarias. *Ginecol Obstet Méx* 2009;77:512-517.
 43. Ochoa-Brust GJ, Fernández AR, Villanueva-Ruiz GJ, Velasco R, Trujillo-Hernández B, Vásquez C. Daily intake of 100 mg ascorbic acid as urinary tract infection prophylactic agent during pregnancy. *Acta Obstet Gynecol Scand* 2007;86:783-787.
 44. National Institute of Diabetes and Digestive and Kidney Diseases. Awareness and Prevention Series. Infecciones urinarias: lo que usted debe saber. Available at: http://kidney.niddk.nih.gov/spanish/pubs/uti_ez/index.aspx.