Catheter –Associated Urinary Tract Infection, Management, And Preventions

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ABSTRACT: *Catheter-associated urinary tract infections(CA-UTIs) or health care associated UTIs are most common inhospitals, and in long term-care facilities(LTCFs)Up to 25% of patients in the hospitals have a catheter inserted at some time during their stay. Long term catheterization and catheter insertion outside operating room, lack of systemic antimicrobial therapy, female sex, old age, diabetes, elevated serum creatinine,and,instrumentation of urinary tract are the risk factors of CA-bacteriuria. Urinary catheterization provides easier access of uropathogens to bladder. Bacteria attached to catheter form micro colonies that mature into biofilms, these biofilms protect uropathogens from antibiotics. Diagnosis of UTI is based on significant bacteriuria. Frequently isolated uropathogens include Escherichia coli, enterococcus , enterobacteriacae, and Candida albicans. Empiric treatment should be based on Gram stain, culture and antibiotic susceptibility results. Lo E, et al. guidelines for prevention and surveillance of CA-UTIs are useful.*

KEYWORDS: Catheter-associated urinary Tract Infection(CA-UTI),Management, Prevention.

I. INTRODUCTION

Catheter-associated urinary tract infection)CA-UTI) or nosocomial UTIs ,also known as health care associated UTIs.CA-asymptomatic bacteriuria (ASB) as the presence of significant bacteriuria in a patient without symptoms referable to the urinary tract, and CA-UTI as the presence of significant in a patient with symptoms or signs referable to the urinary tract[1].Nosocomial UTIs(comprised mostly of ASB),up to 97 % of which are associated with instrumentation of the urinary tract, are the most common nosocomial infections worldwide[2,3],and account for up to 40% of nosocomial infections in U.S.hospitals each year[4].UTI is also the leading cause of infections in long term-care facilities(LTCFs) and most of these are catheter-associated[5].Urinary catheterization is very prevalent in hospitals and LTCFs and its use appears to be increasing at least in the hospitals [6].Approximately 15% to 25% of patients in general hospitals have a catheter inserted at some time during their stay [4,7].Most of these patients are catheterized for only 2 to 4 days[8].The duration of catheterization is the most important factor for the development of CA-bacteriuria[8]. Other risk factors for CA-bacteriuria include the lack of systemic antimicrobial therapy, femalesex, meatal colonization with uropathogens, microbial colonization of drainage bag, catheter insertion outside operating room, catheter care violations, absence of us of a drip chamber, rapidly fatal underlying illness, older age, diabetes, and elevated serum creatinine at the time of catheterization[7].

Other risk factors include instrumentation of urinary tract. Mostnoncatheterized patients with nosocomial UTI are probably also at increased risk for UTI in the community, due to host behavioral or genetic factors associated with increased risk for UTI[9].There are significant consequences of CA-bacteriuria which is usually associated with an inflammatory response in both short- term and long- term catheterized patients. Bacteremia complicates CA-bacteriuria in up to 4% of cases[10].Most episodes of bacteriuria in short –term catheterized patients are by single organisms, mostly enterococci and gram-negative bacilli, E.coli causes most episodes of CA-

bacteriuria.OtherEnterobacteriaceae,*Klebsiellaspp,Serritia,Citracterspp*,Enterobacter,*Pseudomonasa eruginosa*,coagulase negative staphylococci, and *Candida albicans* are all urinary isolates[10,11].The choice of antibiotics for empiric treatment should be based on available information, including the urine Gram-stain results, previous urine culture results, or antimicrobial sensitivity patterns of urinary pathogens isolated in the patient's hospital or LTCF[11].The paper reviews epidemiology, management and prevention of CA-UTI.

II. UROPATHOGENS

In a study of 7574 uropathogens isolated in patients with nosocomial UTIs in medical-surgical ICUs reported in the U.S.National Nosocomial Surveillance System from 1992 to 1998, *Candidaalbicans* constituted 15.3% and all fungal isolates 31.2% of all urinary isolates compared with 18.5% for E.coli, 14.3% for

enterococcus and10.3% for *P.aeruginosa*.Fungi were more commonly reported in UTIs in catheterized patients than in noncatheterized patients(32 vs21%) [12].In another study of 4458 uropathogens isolated in patients with UTIs from 2006 to 2009, in Malaysia, *Candidaalbicans* constituted 7.3%,*E.coli* 38.2%,for *Klebsiella*pp. 15.0% for *P.aeruginosa* 9.5% and 24.4% for MRSA[13]. Bacteriuria in long –term catheterized patients is usually polymicribial and, in addition to the pathogens seen in short-term catheterized patients. Commonly includes less familiar species such as*P.mirabilis, Providencia*spp and *Morganellamorganii* [11].In these patients, new episodes of infection with organisms that may persist for months [14].A urine culture obtained from a patient whose catheter has abiofilm may not accurately reflect the status of bacteriuria in the bladder, and it is recommended that urine cultures from chronically catheterized patients be obtained from a freshly placed catheter [15,16].

III. PATHOGENESIS

In noncatheterizedpatients, the usual origin of uropathogens is their own fecal microflora which colonizes the periuretheral area and ascends to the bladder, resulting in bacteriuria with or without symptoms. In the mouse model of UTI, inoculation of *E.coli* into bladder is followed by invasion of the superficial bladder cells and the formation of intracellular bacterial colonies that, in response to infection, exfoliate and are removed with the flow of urine[17].To avoid clearance of exfoliation, these intracellular uropathogens can reemerge and establisha persistent, quiescent bacterial reservoir within the bladder mucosa that may serve as a source for recurrent acute infections[17].Although internalization of uropathogenic*E, coli* into bladder and renal epithelial cells been observed in vitro and in vivo, there is only sparse evidence that intracellular bacterial colonies observed in mouse occur in humans[18,19].and only indirect evidence that intracellular bacterial colonies observed in mouse occur in humans[20].It is possible that invasion of uropathogens into uroepthelial cells is the trigger for urinary symptoms since pyuria often accompanies ASB in both catheterized and noncatheterized patients[1].Strains of *E.coli* associated with symptomatic lower or upper tract infection in healthy hosts are more likely to have certain putative virulence determinants such as P fimbriae, composed with colonic strains and those causing ASB .However, many symptomatic UTIs are caused by *E. Coli* with evidence profile similar to that in strains causing ASB, and these putative virulence factors can be found in strains causing ASB, or in colonic flora[21,22].

Symptomatic UTI in healthy women is facilitated by sexual intercourse and alternation of vaginal flora, such as that caused by diaphragm and spermicide use, antimicrobial use or estrogen deficiency, and in healthy men by anal or vaginal intercourse with colonized partner, or lack of circumcision [9,23].Risk factors for ASB in healthy women are similar to those for symptomatic UTI, suggesting a common pathogenic pathway. Inpostmenopausalwomen, anatomical and functional characteristics of the genitourinary tract are more strongly associated with UTI risk than in younger women[9].In addition there is mounting evidence for a genetic predisposition to UTI[9,24].Several host defense mechanisms are thought to have a role in protecting individuals from UTI.These include.in addition to the innate and adaptive immune response, the physical barrier of the urethral mucosa, especially in male, removal of bladderbacteriuria by micturition, intrinsicantibacterial properties of the bladder, an antiadherence glycosaminogly can secreted by bladder epithelium, exfoliation of bladder epithelial cells, and properties of urine itself, including very high or low urine osmolatity,a high urine concentration, a high organic acid concentration and a low pH[21,25].However the importance of these host defense mechanisms in preventing UTI is unknown since few studies have compared host characteristics between patients prone to UTI and those not prone[26].

The most predisposing factor for nosocomial UTI is urinary catheterization which perturbs host defense mechanisms and provides easier access of uropathogens to the bladder. The indwelling catheter introduces an inoculum of bacteria into the bladder at the time of insertion. facilitates ascension of uropathogens from the meatus to the bladder the catheter –mucosa interface, provides a pool of organisms in the drainage bag, if the closed system is not maintained. Which can ascendintraluminally to the bladder, compromises complete voiding and constitutes a frequently manipulated foreign body on which pathogens are deposited via the hands of personnel.Indwelling catheter provide a surface for the attachment of host binding receptors that are recognized by bacterial adhesins, thus enhancing microbial adhesion, as well as disrupting the uroepithelial mucosa to expose new binding sites for bacterial adhesions [19].Bacteria attached to the catheter surface form exopolysaccharides that entrap bacteria, which replicate and form microcolonies that mature into biofilms on the inner and outer surfaces of the catheter[19].These biofilms protect uropathogens from antibiotics and the host immune response and facilitate transfer of antibiotic resistant genes[19].Some uropathogens in biofilms,such as Proteus sp., have the ability to hydrolyze urea to free ammonia and rise the urinary pH ,with precipitation of minerals such ashydroxyapatite or struvite creating encrustatation that can block catheter flow[27,19].The source of uropathogens in catheterized patients includes patients' endogenous flora, health care personnel, or inanimate objects[27].Not unexpectedlyuro pathogen virulence determinants such P fimbriae appear to be of

less importance in pathogenesis of nosocomial UTIs compared with uncomplicated UTIs[22].Approximately two thirds(79% for gram-positive cocci and 54% gram-neagative bacilli) of the uropathogens causing CA-bacteriuria in patients with in dwellimguretheral catheters are extraluminally acquired(ascension along catheter-uretheral mucosa interface) and one third are intraluminally acquired ,although in some trials the proportion of strains originating from the drainage bag is much less, Rectal and periuretheral colonization with the infecting strain often precedes CA-bacteriuria, especially in women[28,29].The relative importance of the intraluminal pathway has much to do the frequency with which closed drainage systems are breached, which has been shown to be associated with UTI. The negative impact of the catheter is demonstrated by the finding that despite the continuous drainage of urine through the catheter,in patients with catheter urine colony count as low as 3 to 4 CFU/ml who are not given antibiotics, the level of bacteriuria or candiduriauniformaly rises to greater than 10^5 CFU/ml,within 24 to 48 hours in those who remain catheterized[30].

IV. DIAGNOSIS OF CA- UTI

The diagnosis of UTI is based on significant bacteriuria.Significant bacteriuria is the level of bacteriuria that suggests bladder bacteriuria rather than contamination, and is based on growth from a urine specimen collected in amanner to minimize contamination and transported to laboratory in a timely fashion to limit bacterial growth. The preferred method of obtaining a urine culture in patients with short- term catheterization is by sampling through the catheter port or, if port is not present, puncturing the catheter tubing with a needle and syringe [11].In long-tern indwelling catheters, the catheter urine may be unreliable, so a urine specimen should be obtained from a freshly placed catheter. Culture should be obtained from the drainage bag [16,17].The level of bacteriuria considered significant in an asymptomatic noncatheterized woman is derived from studies in which colony count in voided urine specimens were compared with paired catheter or suprapubic aspirate specimens. In these studies, a bacterial count of greater than 10^5 CFU/ml in a catheterized specimen was confirmed by a repeat catheterized in more than 95% of cases. On the other hand, greater than or equal to 10^5 CFU/ml in a voided urine specimen was confirmed in second voided specimen in only 80% of cases[31].Microbiologic criteria for diagnosis of ASB in noncatheterized men are not well validated. The finding of a single voided urine specimen with greater than or equal to 10^5 CFU/ml. of an Enter obacteriaceae was reproducible in 98% of asymptomatic ambulatory men when the culture was repeated within 1 week[32].Thus, a single, clean-catch voided specimen with greater than or equal to 10^5 CFU/misidentifies ASB in men[33].Based on a comparison of voided urine specimens(from freshly applied condom catheters) and paired catheter specimens greater than or equal to 10^5 CFU/ml.is also the appropriate quantitative criterion for ASB in a man with a condom catheter [34].In symptomatic noncatheterized men and women, lower colony counts have been shown to be significant. For example, in women with uncomplicated cystitis, bacterial counts in voided urine as low as 10^2 CFU/ml .have been shown to reflect bladder infection [35].In men with urinary symptoms, a quantitative count of greater or equal to 10^3 CFU/ml.in a voided specimen best differentiates sterile from infected bladder urine[36].

V. MANAGEMENT OF CA- UTI

While the catheter is in place systemic antibacterial treatment of asymptomatic catheter-associated bacteriuria is not recommended[37,29,38].Because complications of long- term catheterization are primarily infectious in nature, there is a temptation to treat all patients with catheter-associated bacteriuria; such treatment during catheterization is not helpful in eradicating infection for prolonged periods of time and serves only to select populationsof organisms that are resistant to the antibiotics being used.Therefore ,while the catheter is in place, antibiotic treatment is recommended for symptomatic infection(i.e.bacteremia ,pyelonephritis, epididymitis)[37,29,38].

Short-term catheterization.: Not all patients who have been catheterized for short periods of time require a urine culture after the catheter is removed. Most patients who have bacteriuria immediately after catheter removal are asymptomatic and many patients, especially younger women, will have cleared the bacteria on repeat culture 1-2 weeks later. If symptomatic bacteriuria is present or if the patient is at high risk for symptomatic infection (pregnancy, diabetes, age over 65,or prolonged catheterization over 10 days),a urine culture should beobtained and appropriate antibiotic treatment based on susceptibility data should be instituted. The optimal antibiotic regimen in this setting is unclear. In one study of women, persistent bacteriuria after short –term catheterization(e.g.4-6 days)that was asymptomatic or associated with lower UTI symptoms only was treated as effectively with single doses of TMP-SMX(320-1.,600mg) as with a 10- day course of TMP-SMX(160-800mg twice a day) in women younger than 65 years old. For older women, patients with upper tract symptoms, and males (with possible prosthetic involvement), conventional therapy (i.e.,10-14 days of antibiotic therapy based on antibiotic susceptibility studies) is favored[39].

Long-term catheterization : Urine cultures in patients with chronic indwelling catheters often reveal multiple species of organisms, frequently with counts 10,000 CFU/ml. or more. These results are difficult to interpret and frequently change over short periods of time. Routine cultures are not recommended if catheter is draining properly [40].Antibiotic irrigation of the catheter and bladder is of no advantage. Although bacteria can be suppressed, the beneficial effect is canceled by the contamination that occurs by periodically opening the collecting system. Asymptomatic bacteriuria should not be routinely treated. This condition is very common, because of the presence of a foreign body (i.e.catheter), one cannot sterilize the bladder for prolonged periods of time. Unnecessary or prolonged use of antibiotics will only increase the likelihood of selecting out more resistant organisms [40].Systemic antibiotics should not be used for catheterized patients who are febrile and ill-appearing presumably from a UTI, with signs or symptoms of suggesting a possible UTI-related bacteremia or pyelonephritis. Causes of fever other than a urinary tract source should be evaluated, catheter should be assessed for partial orcomplete obstruction, the patient should be examined periuretheral complication of urethralcatheterization, and urine culture should be aseptically obtained. Because these are hospital acquired infections, relatively resistant bacteria should be anticipated when selecting empiric antibiotic therapy. Definitive antibiotic therapy should be adjusted based on susceptibility studies once they are available[40]..

If bacteremia is suspected or known, broad- spectrum antibiotics are indicated while one is awaiting results of urine and blood cultures. For the hospitalized patients, enter ococcalbacterima would be uncommon and for all practical purposes, be excluded if an unspun urine Gram stain showed no gram-positive cocci. While awaiting cultures, an amino glycoside or a fluroquinolone alone could then be chosen on the basis of local antibiotic susceptibility patterns. These patients usually require a full 10 to 14 day course of antibiotics because of the associated bacteremia. Once culture data are available, initial empiric therapy can be tailored based on susceptibility data[40].

In nonbacteremicUTI. If no bacteremia is suspected or documented,these patients should be treated with less than 10 days of antibiotics, and shorter courses(e.g.,5 to 7 days) are suggested[37].This will usually sterilize the urine without selecting out more resistant bacteria. The optimal duration of therapy for a UTI in a male with chronic catheter is not established. Prolonged therapy may only select out resistant organisms. However, a 3- to 5 day course may allow a prostatic focus to persist. While waiting for further guidelines in this setting, a 7-day course may a reasonable compromise [40].

Condom catheters. To obtain adequate urinary outputs, to maintain dryness of the patient with urinary incontinence, or to prevent soiling of an adjacent wound of the sacrum orperineum, acondom catheter system is an excellent alternative to indwelling urethral catheters in male patient without obstruction. This avoids problems associated with having a catheter within bladder. However bladder bacteriuria may still develop in condom-catheterized patients [41].

VI. PREVENTION
Infection control measures. Intensive infection surveillance and control programs in U.S.hospitals are strongly associated with reduction rates of nosocomial UTI [42].Updated, evidence-based comprehensive guidelines by Lo E, Nicolle, *et al*. have been recently published for prevention and surveillance of CA-UTIs in hospitalized patients [43].Although the cross-infection of bacteriuria in catheterized patients is common and episodes of noscocomialbateriuria occur in clusters, the data is conflicting as to whether as segregation of patients with urinary catheters from noncatheterized patients reduces the risk of CA-bacteriuria [44,45].However, this practice seems reasonable in institutions in which is feasible. In addition, periodic performance feedback of CA-bacteriuria rates to staff members may be effective in reducing CA-bacteriuriarates, presumably by resulting in improved compliance with infection control measure [46].

Avoidance of catheterization. Reducing unnecessary catheterization is the most effective way to prevent CA-ASB and CA-UTI.Studies have repeatedly documented that urinary catheters are often inserted for inappropriate reasons or remain place longer than necessary[47].Several studies have been demonstrated to be effective in reducing inappropriate insertion of catheters and duration of catheterization. Strategies shown to reduce inappropriate insertions of catheters include education and use of a catheter indication sheet in the emergency department, use of a multifaceted intervention restricting urinary catheterization in the operating room and post-anesthesia care unit and expedited catheter removal on the postoperative surgical ward, use of an ultrasound bladder scanner to assess bladder volumes following surgery, and use of an in-and-out catheterization rather than short term indwelling catheterization in postoperative patients with urinary retention [48,49].

Substitutes to indwelling Catheterization and Condom Catheterization. Although comparative studies are sparse, the consensus is that indwelling uretheral catheterization places the patient at the greatest risk for

CA.bacteriuria and othercomplications, and that alternative bladder drainage modalities to be used when appropriated[50].In non-randomized studies, use of condom catheters has been shown to result in lower incidence of CA-bacteriuria compared with indwelling uretheral catheters[51].

Intermittent and SuprapublicCatheterization.Intermittent catheterization is widely viewed to be associated with fewer complications than indwelling catheterization, including CA-bacteriuria,hydronephrosis,bladderand renal calculi,bladder cancer and autonomic dysreflexia[50].Complications with long- term intermittent catheterization,although apparently less common than with indwelling uretheral catheterization include CA-bacteriuria,prostatitis,epididymitis,urethritis,uretheral trauma with bleeding and subsequent uretheral strictures and false passages[50].

Potential advantages of suprapublic catheters in patients who need bladder drainage, compared with indwelling uretheralcatheters,include lower risk of CA-bacteriuria because abdominal skin is less likely to be colonized with uropathogens compared with urethra,reduced risk of uretheral trauma and stricture,less interference with sexual activity and, in those undergoing short-term catheterization,ability to more easily assess the appropriate time for catheter removal[52].

Catheter Insertion.Although the use of aseptic technique for inserting indwelling uretheral catheters is widely recommended,few data exist to support such a recommendation [43].Some studies have shown that catheter insertion outside operating room(where adherence to aseptic technique may be less than optimal) is associated with higher risk of CA-bacteriuria[28].Nevertheless,given the ubiquity of multi-drug resistant pathogens in the health care environment,it seem prudent to use aseptic technique for inserting indwelling uretheral catheters in patients in the hospital[43].

Beneficial Preventions?._Antimicrobial coated Catheters_. In vitro studies have shown anti-adherence or antimicrobial activity associated with silver,minocycline,andrifampin,andnitrofurazone coated catheters [53].A meta-analysis of randomized trials comparing types of indwelling urinary catheters in hospitalized adults undergoing short time catheterization found that use of silver alloy, but not silver oxide catheters, compared with standard catheters, significantly reduced the incidence of CA-ASB in patients catheterized up to two weeks[54].

Prophylaxis with Antimicrobial Agents.Systemic antibiotic drug therapy has been shown repeatedly in prospective and retrospective studies to prevent CA-bacteriuria,although the protective effect appears to be transient and development of antimicrobial resistance has been noted in some studies[8].Unfortunately,as many as 60% to 80% of hospitalized catheterized patients receive antimicrobials for variety of reasons, and not controlling for this important variable in the analyses of many intervention trials may explain why some interventions have not been shown to be effective in CA-bacteriuria[55].

MethenamineSalts. Methenaminemandelate and methenaminehippurate are hydrolyzed to ammonia and formaldehyde, which is responsible for the antibacterial activity of methenamine.Antimicrobial activity in urine is correlated with concentrations of formaldehyde is dependent on the concentration ofmethenamine in the urine and the urine pH[56].Methenamine salts have been shown to prevent uncomplicated cystitis in young women,but not as effective or convenient as currently available regimens for prevention of UTI[56].

Preventive measures, like enhanced meatal care, cranberry products, bladder irrigation with antimicrobials or saline, antimicrobials in the drainage bag, routine catheter change, and prophylactic antimicrobials at catheter removal or replacement are less effective in reducing the risk of CA-bacteriuria[1].

VII. CONCLUSION

Reducing the unnecessary catheterization is the most effective way toprevent CA-ASB and CA-UTI.Urinary catheters are often inserted forinvalid reasons or remain place longer than necessary.

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