







## RESEARCH ARTICLE

## URINARY TRACT INFECTIONS IN POST OPERATIVE PATIENTS: PREVALENCE RATE, BACTERIAL PROFILE, ANTIBIOTIC SENSITIVITY AND SPECIFIC RISK FACTORS

Abdulrahman Y. Al-Haifi<sup>2</sup> , Abdul Salam Mohamed Al Makdad<sup>1</sup> , Mohammed Kassim Salah<sup>1</sup> , Hassan A. Al-Shamahy<sup>3</sup> 

<sup>1</sup>Department of of Medicine, Faculty of Medicine, Thamar University, Dhamar, Yemen.

<sup>2</sup>Department of Microbiology, Faculty of Medicine , Thamar University, Dhamar, Yemen.

<sup>3</sup>Medical Microbiology and Clinical Immunology Department, Faculty of Medicine and Health Sciences, Sana'a University, Republic of Yemen.

### Article Info:



#### Article History:

Received: 5 April 2020

Reviewed: 12 May 2020

Accepted: 27 June 2020

Published: 15 July 2020

#### Cite this article:

Al-Haifi AY, Al Makdad ASM , Salah MK, Al-Shamahy HA. Urinary tract infections in post operative patients: prevalence rate, bacterial profile, antibiotic sensitivity and specific risk factors. Universal Journal of Pharmaceutical Research 2020; 5(3):21-26.

<https://doi.org/10.22270/ujpr.v5i3.411>

#### \*Address for Correspondence:

Dr. Hassan A. Al-Shamahy, Faculty of Medicine and Health Sciences, Sana'a University, P.O. Box 775 Sana'a, Yemen, Tel: +967-1-239551, E-mail: [shmahe@yemen.net.ye](mailto:shmahe@yemen.net.ye)

### Abstract

**Background and objective:** Urinary tract infections (UTIs) are the most common minor complication after operations, mostly due to bladder catheterization that used routinely during operations. This investigation seeks to determine prevalence rate, bacterial features, antibiotic sensitivity and risk factors for urinary tract infection in postoperative patients in tertiary hospitals in Sana'a, Yemen.

**Methods:** This prospective analysis included 390 patients undergoing surgery between 2017 and 2018 at Al-Thawra Hospital. The study includes 258 male and 132 female between the ages 5 to 80 years. Clinical and demographic data and factors affecting UTIs were collected in the standard questionnaire. The samples were cultured, examined for significant possible bacterial pathogens, isolated and identified by standard laboratory techniques, and microbial sensitivity testing was carried out by disc diffusion method. The operative characteristics associated with postoperative UTI were also analysis.

**Results:** Postoperative UTI (POUTI) occurred in 144/390 (37%), and the predominant post-operative uropathogen was *Escherichia coli* (34%), followed by *Pseudomonas aeruginosa* 1(27%) and *Staphylococcus coagulase* negative (16.7%). In Gram-negative bacteria, high resistance to ampicillin (95%), nalidixic acid (63%), ceftriaxone (68%) and cotrimoxazole (55%) was recorded, while high sensitivity to amikacin (98%) and ciprofloxacin. (84%), cefotaxime (87%), gentamicin (87%) and imipenem (98%). In Gram-positive bacteria, high resistance to penicillin (90%), erythromycin (85%), and amoxicillin (78%) was recorded, while high sensitivity to aztreonam (94%), augmentin (83%), ciprofloxacin (93%), cefotaxime (86%), gentamicin (85%), Rifampicin (100%) and vancomycin (97%).

**Conclusions:** POUTI remains an important problem in our hospitals and what complicates the situation is that all the causative microorganisms are MDR with few treatment options; and several risk factors were independently associated with POUTI.

**Keywords:** antibiotics, Catheter associated Urinary tract infections, drug resistance, post operative UTI, POUTI, Sana'a City, Yemen.

### INTRODUCTION

Urinary tract infection is the fourth most important cause of healthcare-related infection<sup>1</sup> with around 70 - 80% attributable to improper use of indwelling urinary catheters<sup>2</sup>. Catheter UTI (CAUTI) is connected with escalated morbidity and mortality and extended the length of hospital stay<sup>2</sup>. Indwelling bladder catheterization is a recognized risk factor for

developing UTIs<sup>3</sup>. There is no commonly recognized guideline concerning catheterization in the perioperative setting, to date, with surgeon preferred mainly bladder management<sup>4,5</sup>. Practice catheterization has been used in various surgical centers with the purpose of avoiding postoperative urinary retention, something that patients undergo during operation are recognized to be at increased risk, and that itself is associated with UTIs<sup>6,7</sup>. UTIs account for between 13-

15% of all health care-related diseases worldwide, leading to long hospital stays, increased health care expenditures, and an increased mortality rate<sup>2,8</sup>. Postoperative UTIs are estimated at 30.26%<sup>9</sup>. POUTIs are described as the most common minor systemic complications after operations, which exceeding pneumonia, deep venous thrombosis, and renal insufficiency<sup>8</sup>. Also, POUTIs have been linked to considerable unfavorable events such as implant failure, periprosthetic infection, and subsequent revision procedures, consequential in extended and costly hospital stays<sup>10-14</sup>. This investigation seeks to determine prevalence rate, bacterial profile, antibiotic sensitivity and specific risk factors for UTI in post operative patients in tertiary hospitals in Sana'a, Yemen.

## SUBJECTS AND METHODS

The study design was an active prospective follow-up study. All patients undergoing surgery between 2017 and 2018 at Al-Thawra Hospital, who agree to participate in the study, were targeted. During the study time period, 390 patients who underwent surgery with indwelling urinary catheters were included in the study. They are 258 male and 132 female, between the ages of 5 and 80 years old. Clinical and demographic data, factors affecting urinary tract infection and operational characteristics data as a type of surgery (elective surgery, emergency surgery, etc.), types of catheters, duration of catheter, etc. for each post-operative patient were collected. After that, a urine sample was obtained (midstream) after the catheter was removed; or, in patients with a clinical indication of continuous catheterization, a sample was obtained after the obtaining of a new catheter. After that the samples were cultured in blood agar and MacConkey agar aerobically; cultures were then examined for significant possible bacterial pathogens of UTIs. Possible bacterial pathogens were isolated and identified by standard laboratory techniques, and microbial sensitivity testing was carried out by disc diffusion method as described by Clinical and Laboratory Standards Institute (CLSI)<sup>15</sup>.

The antibiotics employed in this study were: Aztreonam, Amoxicillin, Amikacin, Augmentin, Ampicillin, Ciprofloxacin, Clarithromycin, Cotrimo-

xazole, Ceftriaxone, Cefixime, Ceftazidime, Cefotaxime, Cefepime, Gentamicin, Imipenem, Nalidixic acid, Nitrofurantoin, Norfloxacin, Penicillin, Erythromycin, Rifampicin and Vancomycin (Oxide, USA). Inhibition zone was measured after 24 h of incubation at 37°C. The experiments of each antibiotic were performed in triplicate. The results were interpreted according to Clinical and Laboratory Standards Institute (CLSI) methodology<sup>15</sup>.

### Data analysis

The data were statistically analyzed by a software version for statistical significance (Epi Info version 6, CDC, Atlanta, USA). First rates were calculated, then from two-by-two tables, the independence odds ratios\* were calculated and *P*-value was determined using the uncorrected chi square test. Fisher's exact test was used for the small expected cell sizes with a two-tailed probability value.

## RESULTS

This prospective analysis included 390 patients undergoing operation between 2017 and 2018 in Al-Thawra Hospital, with indwelling urinary catheters were analyzed for UTI and antibiogram susceptibility, 258 male and 132 female, aged 5 to 80 years (Table 1). Postoperative UTI occurs in 144/390 (37%) of patients following operations (Table 2). The predominant postoperative uropathogen was *E. coli* (34%), followed by *P. aeruginosa* (27%) and in Gram-negative bacteria, a high resistance to ampicillin (95%), nalidixic acid (63%), ceftriaxone (68%), and cotrimoxazole (55%) was recorded, while a moderate sensitivity to amoxicillin/clavulanate (65%), ciprofloxacin (84%), cefixime (76%) etc, and high sensitivity to amikacin (98%), ciprofloxacin (84%), cefotaxime (87%), gentamicin (87%) and imipenem (98%) (Table 5). In Gram-positive bacteria, high resistance to penicillin (90%), erythromycin (85%), and amoxicillin (78%) was recorded, while moderate resistance to cotrimoxazole (45%), ceftazidime (38%) and cefepime (24%). High sensitivity to aztreonam (94%), augmentin (83%), ciprofloxacin (93%), cefotaxime (86%), gentamicin (85%) and rifampicin (100%) and vancomycin (97%) was recorded (Table 6).

**Table 1: The age and gender distribution of catheterized patients Characters.**

Age groups	Male (n= 258)		female (n= 132)		Total n = 390	
	No.	%	No.	%	No.	%
< 15 years	46	17.8	26	19.7	72	18.5
15 – 24 years	30	11.6	20	15.2	50	13
25 – 34 years	76	29.4	32	24.2	108	27.8
35 – 44 years	38	14.7	12	9.1	50	12.9
≥ 45 years	68	26.4	42	31.8	110	28.2
Total	258	66.2	132	33.8	390	100
Mean age	34.3 years		32 years		34.1 years	
S D	20 years		18.5 years		19.3 years	
Min	5 years		1 years		1 years	
Max	80 years		70 years		80 years	
Median	30 years		29 years		30 years	
Mode	60 years		40 years		60 years	

The following characteristics are independently associated with postoperative UTI: female sex (OR 2.1, 95% CI 1.3–3.2), Rubber PTFE catheter (OR 4.7, 95% CI 1.99–11.4), longer duration of catheterization >10 days (OR 4.4, 95% CI 2.3–8.3), overweight (OR 1.7, 95% CI 1.1–2.9), and emergency surgery (OR 1.9, 95% CI 1.2–3.0) (Table 3).

## DISCUSSION

CAUTI is the most common hospital infection and accounts for about 30-40% of all hospital acquired infections and is a major source of hospital sepsis and related deaths in acute care hospitals<sup>16</sup>. Current study examined bacterial POUTI rate in postoperative patients at Al-Thawra University Hospital along with testing for common risk factors and common pathogens associated with bacterial post operative UTI. In the current study, the bacterial POUTI rate was found to be 37% (144/390). These infections are mainly bacterial

infections, and previous studies have shown that about 26% of patients who have an indwelling urinary catheter in place for 2-10 days will develop bacteriuria. Obtained results are to some extent higher than published rates perhaps because all of the patients enrolled in this study had undergone operations and stayed longer in hospitals and had a number of risk factors that increase the opportunity of the development of bacterial CAUTI<sup>17,18</sup>. Substantial research has been done on nosocomial UTIs in general<sup>16</sup> (Ref); nevertheless, research on UTIs is strictly limited in postoperative patients<sup>19-22</sup>. In this study, a number of potential risk factors for the development of bacterial CAUTI were evaluated. Obtained results revealed that 48.5% of patients suffering from bacterial CAUTI were female sex is independently associated with postoperative UTI (OR 2.1, 95% CI 1.3–3.2); this is consistent with what has been published in other studies<sup>23,24</sup>.

**Table 2: The prevalence and association of postoperative UTI among different sex and age groups.**

Factors	Positive for POUTI N=144		OR	CI	X <sup>2</sup>	p
	No.	%				
Male n=258	80	31	0.47	0.3-0.7	11.4	<0.001
Female n=132	64	48.5	2.1	1.3-3.2	11.4	<0.001
< 15 years n=72	20	27.8	0.6	0.3-1.0	3.2	0.07
15 – 24 years n=50	16	32	0.77	0.4-1.4	0.59	0.43
25 – 34 years n=108	39	36.1	0.9	0.6-1.5	0.04	0.83
35 – 44 years n=50	18	36	0.9	0.5-1.7	0.02	0.88
≥ 45 years n=110	52	47.3	1.4	0.95-2.2	3.0	0.08
Total n=390	144	37				

OR=odds ratio, CI=confidence interval 95%, X<sup>2</sup>=Chi square, p=p value

**Table 3: The relationship between positive urine culture and types of catheters and its duration, etc among post operative patients.**

*Independent risk factors	Positive for POUTI N=144		OR	CI	X <sup>2</sup>	p
	No	%				
<b>Type of catheter</b>						
Silicon catheter N=48	6	12.5	0.2	0.08-0.5	14	<0.001
Rubber PTFE catheter N=342	138	40.4	4.7	1.99-11.4	14	<0.001
<b>Duration of catheterization</b>						
1-3days N=182	30	16.5	0.16	0.1-0.2	61	<0.001
4-6days N=90	41	46.7	1.6	1.0-2.5	3.7	0.05
7-9days N=68	38	55.9	2.5	1.5-4.3	12.7	<0.001
>10 days N=50	34	68	4.4	2.3-8.3	23.7	<0.001
<b>BMI</b>						
Underweight n=77	35	45.5	1.5	0.9-2.5	2.9	0.08
Normal n=231	70	30.3	0.49	0.3-0.7	10.6	0.001
Overweight n= 82	39	47.6	1.7	1.1-2.9	5.0	0.02
Diabetes mellitus n=39	19	48.7	1.7	0.8-3.3	2.5	0.1
Hypertension n=36	14	38.9	1.1	0.5-2.2	0.06	0.79
<b>Type of Surgery</b>						
*Elective surgery n=273	87	32	0.49	0.3-0.7	9.0	0.001
*Emergency surgery n=117	56	48	1.9	1.2-3.0	8.5	0.003
Amputation n=32	15	47	1.5	0.7-3.2	1.4	0.22
Excision n=65	29	44.6	1.5	0.8-2.5	1.9	0.1
*Others n=293	100	34.1	0.62	0.3-0.9	3.9	0.04

OR=odds ratio, CI=confidence interval 95%, X<sup>2</sup>=Chi square, p=p value

\*independence is generally defined in a statistical sense: a variable is called an independent risk factor if it has a significant contribution to an outcome in a statistical model that includes established risk factors.

\*Elective surgery is done to correct a non-life-threatening condition, and is carried out at the person's request.

\* Emergency surgery is surgery which must be done promptly to save life, limb, or functional capacity.

**Table 4: The frequency of bacterial causative agents of CAUTI in post operative patients.**

Bacteria	Number	Percentage %
<i>Escherichia coli</i>	49	34
<i>Klebsiella pneumoniae</i>	7	4.9
<i>Pseudomonas aeruginosa</i>	39	27
<i>Proteus mirabilis</i>	6	4.2
Coagulase negative <i>Staphylococci</i>	24	16.7
<i>Enterobacter</i> spp.	5	3.5
<i>Staphylococcus aureus</i>	11	7.6
<i>Enterococcus faecalis</i>	3	2.1
Total	144	37

The mean age of bacterial CAUTI patients in this study was  $34.1 \pm 19.3$  years and it was noted that only 26.4% of these patients were over 45 years of age; this result differs from many studies that reported CAUTI is most common in patients over the age of 45 years<sup>16</sup>. The most important risk factor for the development of bacterial CAUTI is the duration of the catheterization<sup>18</sup>. In the current study, the longer catheter period > 10 days was independently associated with postoperative urinary tract infection (OR 4.4, 95% CI 2.3-8.3) (Table 3), this result is similar to the one previously reported and in which one of the important risk factors for the development of bacterial CAUTI is the duration of the catheterization as has been verified in several studies<sup>23,26</sup>. This association can be explained by increasing the duration, most probably increases the chance of bacteria ascending to the bladder either around the catheter or throughout its lumen. Also, increased period of catheterization has been an important factor linked with acquiring CAUTI in this study (>6 days) as has been shown in many other studies<sup>23,26</sup>. Also, the two mainly significant factors that lead to the occurrence of CAUTIs and have been the main focus of quality improvement areas are unnecessary urinary catheter placement and inappropriate delay in removing a catheter when it is no longer needed<sup>27,28</sup>. Regrettably, 38% of attendance physicians are unconscious that their patients have a urinary catheter in place<sup>29</sup>. In addition, in 20% to 50% of cases, there is no obvious sign in favor of catheter placement<sup>1,29</sup>.

Diabetes mellitus was not significant independently associated with postoperative UTI, (OR 1.7, 95% CI 0.8–3.3,  $p=0.1$ ) (Table 3). These results are contrary to Saint *et al.*, and Lobdell *et al.*, studies where one of the risk factors for developing CAUTI is diabetes mellitus<sup>30,31</sup>. Emergency surgery was independently associated with postoperative UTI (OR 1.9, 95% CI 1.2–3.0) (Table 3). With respect to postsurgical patients in further surgical specialties, investigation reveals that the appreciable incidence of postoperative UTIs is not exclusive to type of surgeries<sup>11</sup>. One study exploring the incidence of postoperative UTIs subsequent major surgeries in a variety of specialties discovered that the prevalence are certainly similar across multiple surgical services: 30-day postoperative UTI rate for coronary artery bypass, vascular, colorectal, and TJA surgeries were 3.3, 3.4, 4.0, and 3.4%, respectively<sup>11</sup>.

**Table 5: Antibiotic pattern of Gram negative bacteria (101) isolated from post-operative patients, Sana'a, Yemen.**

Antimicrobial agents	Sensitive %	Resistance %
Amikacin	98	2
Amoxicillin/clavulanic acid Augmentin	65	35
Ampicillin	5	95
Ciprofloxacin	84	16
Clarithromycin	47	53
Cotrimoxazole	45	55
Ceftriaxone	32	68
Cefixime	76	24
Ceftazidime	73	27
Cefotaxime	87	13
Cefepime	74	26
Gentamicin	87	13
Imipenem	98	2
Nalidixic acid	37	63
Nitrofurantoin	71	29
Norfloxacin	93	7

**Table 6: Antibiotic resistance pattern of Gram positive bacteria (43) isolated from post-operative patients, Sana'a, Yemen.**

Antimicrobial agents	Sensitive %	Resistant %
Amoxicillin	22	78
Aztreonam	94	6
Augmentin	83	17
Gentamycin	85	15
Ciprofloxacin	93	7
Cefixime	75	25
Ceftazidime	72	28
Cefotaxime	86	14
Cefepime	76	24
Co-trimoxazole	55	45
Penicillin	10	90
Erythromycin	15	85
Norfloxacin	60	40
Rifampicin	100	0
Vancomycin	97	3

In the current study, the predominant post-operative uropathogen was *E. coli* (34%), followed by *P. aeruginosa* (27%) and *Staphylococcus* coagulase negative (16.7%) while other bacterial cause were less frequent (Table 4). Current results are differ from other nosocomial investigation studies published in Europe and North America that support *E. coli*, *Klebsiella* spp., and *Enterococci* spp. as the prevalent bacterial pathogens cause CAUTI<sup>32,33</sup>. Also the current study

results are different from findings by Rebmann and Greene study; and Gaynes and Edwards reviews in which *Klebsiella* spp. were the most commonly identified bacteria (8/16, 50%), followed by *Enterococci* (7/16, 44%). Although *E. coli* is known to be the most predominant etiology for UTI<sup>24,34</sup>, it was isolated from 34% of positive bacterial culture patients enrolled in this study. This finding might suggest dissimilarity in bacterial population consistent with different locality and suggests a role of the environment in determining the bacterial population in each hospital<sup>35</sup>. All bacterial post-operative uropathogens were found to be resistant to most of the tested antimicrobials (Table 5 and Table 6). These results are consistent with previous studies that demonstrated that organisms recovered from hospitalized patients are often resistant to multiple antibiotics<sup>36-38</sup>. The high rate of MDR among nosocomial pathogens reflects the extensive use of antimicrobials in the hospital in addition to the huge ability of the organism to acquire resistance genes<sup>39,40</sup>. Amikacin and imipenem were the most active drugs against Gram negative bacteria (98% sensitivity). Rifampicin and vancomycin were the most active drugs against Gram positive bacteria (100% and 99% sensitivity, respectively). The current findings are similar to that reported by Daef *et al.*, study and Daef *et al.*, in which Gram negative bacteria *Klebsiella* spp. were highly sensitive to amikacin and imipenem (100% sensitive in 2008, 94.4% in 2010, 87.5% in 2013)<sup>41,42</sup>. On the other hand, other antibiotics were found to have high and moderate resistance to all bacterial post-operative uropathogens, and this constant increase in antibiotic resistance over time is frightening and creates a risk for patients with it being the only antimicrobial option to isolate MDR.

## CONCLUSIONS AND RECOMMENDATIONS

Present study has identified multiple properties independently associated with postoperative UTIs, which may be helpful for clinicians in classifying patients at risk. While this information alone may have the potential to improve the quality of patient care, at this time, the clinical utility of these risk factors is unproven. Further research such as a prospective study stratifying patients into risk groups to guide postoperative management or perioperative catheterization may be employed to establish practical utility. CAUTI remains a huge problem in our hospitals and what makes it worse is that all causative microorganisms are MDR with few treatment options. According to obtained results, amikacin, and imipenem can be used for empirical treatment. The Comprehensive Unit-based Safety national program, must be applied in our hospitals that aim to reduce catheter-associated urinary tract infections (CAUTI) by focusing on proper technical skills, behavioral changes, education, and feedback. Implementation of the CUSP recommendations to reducing catheter use and CAUTIs in post-operative patients. The program will be likely successful because it included both socio-adaptive and

technical changes and allowed the individual hospitals to customize interventions based on their own needs.

## ACKNOWLEDGEMENTS

The authors would like to acknowledge Sana'a University, Sana'a, Yemen which supported this work.

## AUTHOR'S CONTRIBUTION

**Al-Haifi AY:** writing original draft, methodology, investigation. **Al Makdad ASM:** Laboratory work, data collection. **Salah MK:** clinical work. **Al-Shamahy HA:** writing, supervision. All authors read and approved the final manuscript.

## DATA AVAILABILITY

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## CONFLICT OF INTEREST

None to declare.

## REFERENCES

- Magill SS, Edwards JR, Bamberg W, *et al.* Multistate point prevalence survey of health care-associated infections. *N Engl J Med* 2014; 370:1198–208. <https://doi.org/10.1056/NEJMoa1306801>
- Nicolle LE. Catheter associated urinary tract infections. *Antimicrob Resist Infect Control* 2014; 3:23. <https://doi.org/10.1186/2047-2994-3-23>
- Platt R, Polk BF, Murdock B, Rosner B. Risk factors for nosocomial urinary tract infection. *American J Epidemiol* 1986; 124(6):977–985. <https://doi.org/10.1093/oxfordjournals.aje.a114487>
- Nyman MH, Gustafsson M, Langius-Eklöf A, *et al.* Intermittent versus indwelling urinary catheterization in hip surgery patients: a randomised controlled trial with cost-effectiveness analysis. *Int J Nurs Stud* 2013; 50(12):1589–1598. <https://doi.org/10.1016/j.ijnurstu.2013.05.007>
- Huang Z, Ma J, Shen B, Pei F. General anesthesia: to catheterize or not? A prospective randomized controlled study of patients undergoing total knee arthroplasty. *J Arthro* 2015; 30(3):502–506. <https://doi.org/10.1016/j.arth.2014.09.028>
- Darrah DM, Griebing TL, Silverstein JH. Postoperative urinary retention. *Anesthes Clinics* 2009; 27(3):465–484. <https://doi.org/10.1016/j.anclin.2009.07.010>
- Hansen BS, Søreide E, Warland AM, Nilsen OB. Risk factors of post-operative urinary retention in hospitalized patients. *Acta Anaesthesiol Scan* 2011;55(5):545–548. <https://doi.org/10.1111/j.1399-6576.2011.02416.x>
- Thakker A, Briggs N, Maeda A, *et al.* Reducing the rate of post-surgical urinary tract infections in orthopedic patients. *BMJ Open Quality* 2018; 7:e000177. <https://doi.org/10.1136/bmjopen-2017-000177>
- Alvarez AP, Demzik AL, Alvi HM, *et al.* Risk factors for postoperative urinary tract infections in patients undergoing total joint arthroplasty. *Adv Orthop* 2016; 2016: 7268985. <https://doi.org/10.1155/2016/7268985>
- Berbari EF, Hanssen AD, Duffy MC, *et al.* Risk factors for prosthetic joint infection: case-control study. *Clin Infect Dis* 1998;27(5):1247–1254.

- <https://doi.org/10.1086/514991>
11. Peersman G, Laskin R, Davis J, Peterson M. Infection in total knee replacement: a retrospective review of 6489 total knee replacements. *Clin Orth Relat Res* 2001; (392):15-23. *PMID: 11716377*
  12. Phillips JE, Crane TP, Noy M, Elliott TSJ, Grimer RJ. The incidence of deep prosthetic infections in a specialist orthopaedic hospital: a 15-year prospective survey. *The J Bone Joint Surg—British* 2006; 88(7):943–948. <https://doi.org/10.1302/0301-620x.88b7.17150>
  13. Poss R, Thornhill TS, Ewald FC, Thomas WH, Batte NJ, Sledge CB. Factors influencing the incidence and outcome of infection following total joint arthroplasty. *Clin Orth Relat Res* 1984; 182:117–126. *PMID: 6692605*
  14. Pulido L, Ghanem E, Joshi A, Purtill JJ, Parvizi J. Periprosthetic joint infection: the incidence, timing, and predisposing factors. *Clin Orth Relat Res* 2008; 466(7):1710-1715. <https://doi.org/10.1007/s11999-008-0209-4>
  15. Clinical and Laboratory Standards Institute [CLSI]. Performance Standards for Antimicrobial Disc Susceptibility Tests. (11<sup>th</sup> edn.), Approved standard M02-A11– Publication of Clinical and Laboratory Standards Institute [CLSI], 2012; USA, 32.
  16. Burke JP, Yeo TW. Nosocomial urinary tract infections. In: Mayhall CG editor. *Hospital epidemiology infection control*. 3<sup>rd</sup> ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2004:267-286.
  17. Erikson H, Iverson B, Aavitsland P. Prevalence of nosocomial infections in hospitals in Norway 2002 and 2003. *J Hosp Infect* 2005; 60:40–45.
  18. Bagshaw SM, Laupland KB. Epidemiology of intensive care unit-acquired urinary tract infections. *Curr Opin Infect Dis* 2006; 19:67–71. <https://doi.org/10.1097/01.qco.0000200292.37909.e0>
  19. Platt R., Polk B. F., Murdock B., Rosner B. Risk factors for nosocomial urinary tract infection. *American J Epidemiol* 1986; 124(6):977–985. <https://doi.org/10.1093/oxfordjournals.aje.a114487>
  20. Darrah DM, Griebeling TL, Silverstein JH. Postoperative urinary retention. *Anesthesiol Clin* 2009; 27(3):465–484. <https://doi.org/10.1016/j.anclin.2009.07.010>
  21. Hansen BS, Søreide E, Warland AM, Nilsen OB. Risk factors of post-operative urinary retention in hospitalised patients. *Acta Anaesth Scand* 2011;55(5):545–548. <https://doi.org/10.1111/j.1399-6576.2011.02416.x>
  22. Wald HL, Ma A, Bratzler DW, Kramer AM. Indwelling urinary catheter use in the postoperative period: analysis of the national surgical infection prevention project data. *Archives of Surgery* 2008; 143(6):551–557. <https://doi.org/10.1001/archsurg.143.6.551>
  23. Rebmann T, Greene LR. Preventing catheter-associated urinary tract infections: an executive summary of the association for professionals in infection control and epidemiology, inc, elimination guide. *Am J Infect Control* 2010; 38:644–646. <https://doi.org/10.1016/j.ajic.2010.08.003>
  24. Talaat M, Hafez S, Saied T, Elfeky R, El-Shoubary W, Pimentel G. Surveillance of catheter-associated urinary tract infection in 4 intensive care units at Alexandria University Hospitals in Egypt. *Am J Infect Control* 2010; 38:222–228. <https://doi.org/10.1016/j.ajic.2009.06.011>
  25. Parlak E, Erol S, Kizilkaya M, Altoparlak U, Parlak M. Nosocomial urinary tract infections in the intensive care unit patients. *Mikrobiyol Bul* 2007; 41:39–49. *PMID: 17427551*
  26. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *Am J Med* 2002; 113:S5–S13. [https://doi.org/10.1016/s0002-9343\(02\)01054-9](https://doi.org/10.1016/s0002-9343(02)01054-9)
  27. Tambyah PA, Oon J. Catheter-associated urinary tract infection. *Curr Opin Infect Dis* 2012; 25(4):365-370. <https://doi.org/10.1097/QCO.0b013e32835565cc>
  28. Fakhri MG, Watson SR, Greene T, et al. Reducing inappropriate urinary catheter use. *Arch Intern Med* 2012; 172(3):255-260. <https://doi.org/10.1001/archinternmed.2011.627>
  29. Saint S, Wiese J, Amory JK, Bernstein ML, et al. Are physicians aware of which of their patients have an indwelling urinary catheters? *Am J Med* 2000; 109(6):476-480. [https://doi.org/10.1016/s0002-9343\(00\)00531-3](https://doi.org/10.1016/s0002-9343(00)00531-3)
  30. Lobdell KW, Stamou S, Sanchez JA. Hospital-acquired infections. *Surg Clin N Am*. 2012; 92(1):65-77. <https://doi.org/10.1016/j.suc.2011.11.003>
  31. Gray M. Reducing catheter-associated urinary tract infection in the critical care unit. *AACN Adv Crit Care*. 2010; 21(3):247-257.
  32. Laupland KB, Zygun DA, Davies HD, Church DL, Louie TG, Doig CJ. Incidence and risk factors for acquiring nosocomial urinary tract infection in the critically ill. *J Crit Care* 2002; 17:50–57. <https://doi.org/10.1053/jcrc.2002.33029>
  33. Gaynes R, Edwards JR. Overview of nosocomial infections caused by gram-negative bacilli. *Clin Infect Dis* 2005; 41:848–854. <https://doi.org/10.1086/432803>
  34. Al-Hasan MN, Eckel-Passow JE, Baddour LM. Bacteremia complicating Gram-negative urinary tract infections: a population-based study. *J Infect* 2010; 60:278–285. <https://doi.org/10.1016/j.jinf.2010.01.007>
  35. Rashid T, Ebringer A. Ankylosing spondylitis is linked to Klebsiella –the evidence. *Clin Rheumatol* 2007; 26:858–864. <https://doi.org/10.1007/s10067-006-0488-7>
  36. Sader HS, Jones RN, Dowzicky MJ, Fritsche TR. Antimicrobial activity of tigecycline tested against nosocomial bacterial pathogens from patients hospitalized in the intensive care unit. *Diagn Microbiol Infect Dis* 2005; 52:203–208. <https://doi.org/10.1016/j.diagmicrobio.2005.05.002>
  37. Zhanel GG, DeCorby M, Laing N, et al. Canadian Antimicrobial Resistance pathogens in intensive care units in Canada: results of the Canadian National Intensive Care Unit (CAN-ICU) study, 2005–2006. *Antimicrob Agents Chemother* 2008; 52:1430–1437. <https://doi.org/10.1128/AAC.01538-07>
  38. Aly SA, Tawfeek RA, Mohamed IS. Bacterial catheter-associated UTI in ICU of Assiut Univ Hospital. *Al-Azhar Assiut Med J* 2016; 14:52-8.
  39. Hsueh PR, Chen WH, Luh KT. Relationships between antimicrobial use and antimicrobial resistance in Gram-negative bacteria causing nosocomial infections from 1991–2003 at a university in Taiwan. *Int J Antimicrob Agents* 2005; 26:463–472. <https://doi.org/10.1016/j.ijantimicag.2005.08.016>
  40. Beceiro A, Tomás M, Bou G. Antimicrobial resistance and virulence: a successful or deleterious association in the bacterial world? *Clin Microbiol Rev* 2013; 26:185–230. <https://doi.org/10.1128/CMR.00059-12>
  41. Daef EA, Aly SA, El-Din S, El Sherbiny, El Gendy SM. Phenotypic and genotypic detection of extended spectrum beta lactamase *Klebsiella pneumoniae* isolated from intensive care units in Assiut University Hospital. *Egypt J Med Microbiol* 2009; 18:29–40.
  42. Daef E, Elsherbiny N. Clinical and Microbiological Profile of Nosocomial Infections in Adult Intensive Care Units at Assiut University Hospitals, Egypt. *J Am Sci* 2012; 8:12–17.