Catheter-related urinary nosocomial infections in intensive care units: An epidemiologic study in North of Iran

Abstract

Background: Urinary tract infection (UTI) is one of the most common infections in developing countries. The aim of this study was to investigate the incidence of nosocomial catheter- associated UTI and its related factors in hospitalized patients in intensive care units of hospitals affiliated to Mazandaran University of Medical Sciences, in 2014.

Methods: This cross-sectional study was conducted on patients who were admitted in hospitals and urinary catheterization was performed for them. Beds of intensive care units were followed-up for the occurrence of catheter-associated UTI for 14 months. Data were analyzed using SPSS Version 16.

Results: Our results showed that of the 1409 patients (11648 catheter - days), the incidence of catheter-related UTI was 18.2% (among 256 individuals) equals to 21.987 per 1,000 catheter - days. E. coli was the most important cause of UTI. The results show that the history of the underlying disease, duration of catheterization and perineal washing were significantly associated with the incidence of UTIs.

Conclusion: The findings of this study show a high incidence of UTIs caused by catheters in ICU. The incidence of this infection increased hospital length of stay and hospital cost. It seems that the necessary use of urinary catheters and its reduced duration use can be effective in decreasing this incidence.

Keywords: Epidemiology, Nosocomial infections, Urinary catheter

Citation: Rezai MS, Bagheri-Nesami M, Nikkhah A. Catheter-related urinary nosocomial infections in intensive care units: An epidemiologic study in North of Iran. Caspian J Intern Med 2017; 8(2): 76-82.

Nosocomial infections are defined as infections that occur within 48 to 72 hours after admission and a week after discharge; they do not include previously contacted or incubated infections at the admission time (1). Urinary tract infection (UTI) is the most common infection in developing countries (2). UTI is caused by blood and pathogens that enter the space surrounding the urethra through the perineum, the digestive system, or urinary catheter (3). UTI comprises more than 40% of nosocomial infections in the United States every year, and most of these infections are associated with urinary catheterization (4). In a study conducted in Iran, 30.9% of ICU patients with nosocomial infections had UTI (5). In a study conducted in Tehran, UTI affected 18.7% of patients (6). The most common bacteria causing UTI are Escherichia coli and Pseudomonas aeruginosa (7). The increasing incidence of UTI in ICUs is affected by the high rate of urinary catheterization, frequent contact with health care workers, and increased resistant pathogens (8). Increasing bacterial resistance to a variety of antibiotics leads to increased mortality and morbidity and prolonged hospital stay following the acquisition of nosocomial infections. Excessive use of antibiotics wastes financial resources, which account for 20% to 50% of the total hospital medication costs. More than half of the hospitalized patients are treated with antibiotics; yet more than 50% of all antibiotics administered are used for inappropriate durations (9).
In recent years, certain measures have been taken to control nosocomial infections, including establishing nosocomial infection committees, frequent culture from different parts of the hospital, training medical employees, use of modern infectious waste disposal methods, and rinsing hands before surgical procedures (10). Nevertheless, nosocomial infections continue to cause numerous problems in the process of treatment, including prolonged hospital stay, increased medicine use and increased laboratory costs. The diversity of infectious agents, medical interventions, excessive use of a wide range of antibiotics, and the importance of prevention, diagnosis, and treatment are among the main reasons for studying the rate of nosocomial infections (11).

To the best of our knowledge, no epidemiological study in this area has been conducted in Mazandaran, hence, the present study was conducted to investigate the incidence and factors related to nosocomial infections caused by urinary catheterization among the ICU patients of hospitals affiliated to Mazandaran University of Medical Sciences, the results can be compared to international statistics and problems in service-provider systems be identified to pave the way for logical solutions.

Methods

This descriptive-analytical study was conducted in the ICUs of hospitals in Mazandaran after obtaining permission from Mazandaran University of Medical Sciences. The study setting consisted of intensive care units (CCU, BICU, NICU, PICU, and ICU) containing a total of 256 beds. The study population included hospitalized patients who had undergone urinary catheterization. ICU beds were monitored daily for catheter-induced urinary infections for 14 months. Demographic and medical details of patients and clinical and laboratory symptoms of urinary infections and associated factors were recorded on nosocomial urinary tract infection checklists. These forms contained specific clinical and laboratory protocols for nosocomial infection diagnosis. The final diagnosis was necessarily based on these guidelines. The questionnaire has been used in various studies (12-15). Symptoms associated with UTI such as fever (increased body temperature equal to or greater than 38 °C), suprapubic tenderness or urinary urgency with positive urinary culture (CFU/mL ≥ 10^5) (16), antibiogram reports and culture and types of antibiotics were recorded. Culture and antibiogram were performed according to microbiology (17, 18) and CLSI standards (19). Study exclusion criteria were fever and UTI symptoms 48 hours before admission (20). Sterile urinary samples were taken from midstream urine (16). Data were reviewed on a weekly basis by a project assistant and followed-up and revised (if necessary) using the patient’s data as recorded. Statistical analysis was performed in SPSS Version 16 using descriptive statistics such as mean, frequency and percentage, and inferential statistics such as chi-square and t-tests.

Results

Of these 1409 cases (11648 catheter-day), 256 (18.2%) had catheter-induced UTI equivalent to 21.978 cases per 1000 catheter-day. The mean age of infected and non-infected patients was 64.503±18.66 years and 61.265±19.471 years, respectively. T-test showed a significant difference between age and time of catheterization UTI (P=0.015, 0.001, respectively) (table 1).

| Variable                          | Urinary tract infection | Odds ratio | Confidence interval | P-value |
|-----------------------------------|------------------------|------------|---------------------|---------|
| Age                               | yes (64.503±18.66)     | no (61.26±19.47) | 0.619-5.857 | 0.015   |
| Time of catheterization           | 11.67 ± 17.65          | 7.69 ± 7.29 | 1.739-6.218 | 0.001   |
| Gender                            |                         |            |                     |         |
| Male                              | 116 (14.7%)            | 675 (47.9%) | 1.739-6.218 | 0.001   |
| Female                            | 140 (22.7%)            | 478 (33.9%) | 0.587-1.842 | 0.001   |
| Perineal care                     | Yes (29% (18.3%))      | No (11% (0.9%)) | 3.450     | 1.837-6.477 | 0.001   |
| History of underlying disease     | Yes (131(10.5%))       | No (106(80.5%)) | 11.386 | 1.043-1.842 | 0.004   |
| Antibiotic therapy before catheterization | Yes (126(9.7%)) | No (115(8.9%)) | 0.908     | 0.686-1.201 | 0.004   |
The results showed a significant relationship between UTI and history of underlying diseases, duration of catheterization, and perineum rinsing method. No significant relationship was found between UTI and the use of antibiotics before catheterization (table 1). According to the results, E. coli was the main agent for urinary infection (69 patients, 34.9%), followed by Klebsiella (29 patients, 15.3%), Pseudomonas aeruginosa (18 patients, 9.5%), and miscellaneous (82 patients, 40.3%).

Samples of E. coli isolated from patients were highly resistant to third generation cephalosporin and aminoglycosides. The pattern of antibiotic resistance and susceptibility of a number of UTI-causing bacteria is shown in table 2.

Table 2. Antibiotic resistance patterns of bacterial strains isolated from urine in intensive care units in northern Iran

| Susceptibility | Antibiotic       | E. coli | Klebsiella pneumonia | Pseudomonas aeruginosa |
|---------------|------------------|---------|----------------------|------------------------|
|               | R    | S    | R    | S    | R    | S    | R    | S    |
| Amikacin      | 2    | 8    | 4    | 2    | 4    | 2    |
| Imipenems     | 18   | 9    | 5    | 9    | 7    | 5    |
| Gentamicin    | 15   | 21   | 7    | 10   | 8    | 3    |
| Ceftriazoxin  | 17   | 15   | 4    | 5    | 4    | 2    |
| Ceftriaxon    | 26   | 9    | 31   | 6    | 6    | 2    |
| Ciprofloxacin | 19   | 9    | -    | 10   | 9    | 4    |
| Cefexim       | 5    | 7    | 29   | 1    | 4    | 2    |
| Co-trimoxazole| 25   | 10   | 7    | 4    | 7    | 3    |
| Amp/Sul       | 11   | 1    | 8    | 19   | 6    | -    |
| Amoxicillin   | 2    | 1    | 1    | 3    | -    | 1    |

Discussion

According to our findings, the catheterization rate was 18.2%. This ratio was 15.1% and 17% in other studies conducted in Iran (21, 22). In investigations conducted in other countries, this was 8.9 (23), 8.3 (24), and 9.6 (25) cases per 1000 catheter-day. As a consequence, compared to other studies, catheter-acquired UTI in Iran is twice as frequent as in other countries indicative of its high rate. The quality of healthcare personnel actions is highly important in the mitigation of nosocomial infections. A study conducted in Iran showed that nurses lack adequate knowledge of nosocomial infection control (26). The high incidence rate of catheter-induced UTI in Iran demands training programs focused on performance feedback. In the present study, women tend to have more UTIs than men. Similarly, studies by Kolawole (27) and Laupland (25) also showed a high incidence rate of UTI in women. The short urethra and its short distance to the rectum in women could explain this difference (28). The results obtained showed a direct relationship between age and UTI. The findings a study by Rafiei showed an increase prevalence rate of UTI with aging (29). In the current investigation, prolonged duration of catheter use led to increased rate of UTI. Other research also confirmed these results (30). Bacteria may gain entry into the urinary tract via catheter insertion site. Catheterization causes the biofilm development between catheter and urethral mucus, thus, preparing the environment for bacterial attack and proliferation (31). The risk of infection increases by 3% to 10% on a daily catheter-use (27). It is essential to thoroughly observe the aseptic technique during catheterization, consider alternatives to catheterization, and reduce the duration of catheter use (32).

In this study, a significant correlation was found between UTI and the presence of an underlying disease. Furthermore, in this paper, diabetes was the most common underlying disease in patients. A study by Shah showed that diabetic patients experienced increased rate of infection and infection-related mortality (33). In another study showed that diabetic patients were found to enhance the risk for UTI, of which glucosuria and impaired immune system were induced (34). Nonetheless, reduced sensitivity and changes in bladder distention due to impaired autonomic nervous system in diabetic patients could also cause urinary stasis and increased risk of UTI in these patients (35). In the existing study, daily rinsing of the perineum led to a reduced UTI.
Tsuchida et al.’s study showed a relationship between daily rinsing of the perineum and UTI. They also proposed fecal incontinence as a major risk factor in UTI incidence in patients with urinary catheterization (36). Regular rinsing of the urinary tract and perineal washing is essential, especially in patients with fecal incontinence to reduce UTI.

In the ongoing study, the administration of antibiotics before catheterization had no effect on reducing UTI. In contrast, Crouzet et al. reported different results. In their study, the administration of antibiotics for treatment of infections in places other than urinary system before and during catheterization reduced catheter-induced UTI; yet the author did not consider this to support antibiotic therapy (32), since the non-essential administration of antibiotics can lead to emergence and development of antimicrobial resistance (37). Administering antibiotics is recommended after culture and microbial susceptibility results (38). In this study, majority of patients did not have the history of anomalies and infection of the urinary tract, so these cases were not reported.

In this study, E.coli was the most common microbial agent. This was also observed in other studies (39, 40). In contrast, in a study by Tunaja et al., Klebsiella was the most common microbial agent for UTI, followed by E.coli, Enterobacter, and Pseudomonas aeruginosa (41). In our study, E.coli showed a high resistance to third-generation cephalosporin and gentamicin. In line with this study, another study reported the highest susceptibility of E.coli of the study samples to amikacin and ciprofloxacin (42, 43). This bacterium showed the highest resistance to ceftriaxone. In another study conducted in Mazandaran, the most antibiotic resistance was related to the cephalosporin group (44). In a study on children, E.coli showed high resistance (100%) to a number of cephalosporins (45). These results confirm that E.coli is becoming increasingly resistant to cephalosporin.

Klebsiella showed a high resistance to ceftriaxone and cefixime in this study. Klebsiella had the highest susceptibility to ampicillin-sulbactam, ciprofloxacin, gentamicin, and imipenem. A study by Paterson et al. on Klebsiella showed better outcomes in patients treated with carbapenem (46). Kang et al.’s study on Klebsiella also showed favorable results in patients treated with carbapenem (47). Due to the high prevalence of resistance to carbapenem, rational use of this antibiotic is recommended (48). In our study, Pseudomonas aeruginosa showed high resistance to aminoglycosides and third-generation cephalosporin. In a study conducted in 228 hospitals in Europe, the highest resistance to antibiotics included gentamicin, ciprofloxacin, and tobramycin (49). Findings of a study in Iran showed the highest resistance to Pseudomonas aeruginosa was caused by ceftriaxone and ciprofloxacin (44), which was similar to the present study results. In this study, its highest susceptibility was to imipenem. A study by Karlowskey et al. showed that nearly 80% of the Pseudomonas aeruginosa samples isolated from ICU patients were susceptible to imipenem (50).

In conclusion, the high incidence of catheter-induced UTI in ICUs in this study, which is twice as much as in other countries, appears too high. This infection leads to prolonged hospitalization and aggregate hospital costs. It shows that the use of urinary catheter when needed and the reduced duration of catheter may decrease UTI. According to a study, infections caused by antibiotic-resistant pathogens generally cause higher mortality rates (51). Accordingly and because of the difference in resistance of the most common urinary infections such as E.coli to certain cephalosporins and their susceptibility to aminoglycosides based on this province-wide study; further studies are recommended to design clinical guidelines for catheter-induced UTIs.

Acknowledgments

Hereby, the authors would like to express their gratitude to all the nurses at the Infection Control of the selected hospitals affiliated to Mazandaran University of Medical Sciences.

Funding: This grant project was funded by the National Elites Foundation a research project approved by Mazandaran University of Medical Sciences (grant no 878).

Conflict of Interests: There was no conflict of interest.

References
1. Masoomi Asl H, Zehrai M, Mejidpor A, et al. National Guideline of nosocomial infections surveillance. 1st ed. Tehran, Iran: Department of Health and Medical Education. Center for Disease Management 2006; pp: 7-30. [in Persian]
2. Tessema B, Kassu A, Mulu A, Yismaw G. Predominant isolates of urinary tract pathogens and their antimicrobial
susceptibility patterns in Gondar University Teaching Hospital, northwest Ethiopia. Ethiop Med J 2007; 45: 61-7.

3. Grabe M, Bjerklund-Johansen T, Botto H, et al. Guidelines on urological infections. European Association of Urology. 2015. pp7-8.

4. Mandell GL, Bennett JE, Dolin R. Principles and practice of infectious diseases. 7th ed. USA: Elsevier Press 2010; pp: 3669-717.

5. Akbari M, Nejad Rahim R, Azimpour A, Bernouei I, Ghaheemlanu H. A survey of nosocomial infections in intensive care units in an Imam Reza hospital to provide appropriate preventive guides based on international standards. J Urmia Univ Med Sci 2013; 23: 591-6. [in Persian]

6. Amini M, Sanjary L, Vasei M, Alavi S. Frequency Evaluation of the nosocomial infections and related factors in Mostafa Khomeini hospital "ICU" Based on "NNI " system. J Army Univ Med Sci 2009; 7: 9-14. [in Persian]

7. Brunner LS, Smeltzer SC. Brunner &Suddarth’s textbook of medical-surgical nursing. 12th ed. Philadelphia: Wolters Kluwer/ Lippincott Williams & Wilkins 2010; p: 1360.

8. National nosocomial infections surveillance (NNIS) system report, data summary from January 1992-April 2000, issued June 2000. Am J Infect Control 2000; 28: 429-48.

9. Khosravi B, Razavi A. Nosocomial infection. Ebnesina- J Med 2010; 13 (1 and 2):43-51. Available at: URL: http://ebnesina.ajaums.ac.ir/article-1-39-fa.html

10. Sohrabi MB, Khosravi A, Zolfaghari P, Sarrafha J. Evaluation of Nosocomial Infections in Imam Hossein(as) Hospital of Shahrood, 2005. J Birjand Univ Med Sci 2009; 16: 33-9. [in Persian]

11. Schulman J, Wirtschaffer DD, Kurtin P. Neonatal intensive care unit collaboration to decrease hospital-acquired bloodstream infections: from comparative performance reports to improvement networks. Pediatr Clin North Am 2009; 56: 865-92.

12. Rosenthal VD, Rodríguez-Calderón ME, Rodríguez-Ferrer M, et al. Findings of the International Nosocomial Infection Control Consortium (INICC), part II: impact of a multidimensional strategy to reduce ventilator-associated pneumonia in neonatal intensive care units in 10 developing countries. Infect Control Hosp Epidemiol 2012; 33: 704-10.

13. Rosenthal VD, Guzman S, Orellano PW. Nosocomial infections in medical-surgical intensive care units in Argentina: attributable mortality and length of stay. Am J Infect Control 2003; 31: 291-5.

14. Rosenthal VD, Maki DG, Jamulitrat S, et al. International nosocomial infection control consortium (INICC) report, data summary for 2003-2008. Am J Infect Control 2009; 38: 95-104.

15. Edwards JR, Peterson KD, Mu Y, Banerjee S, Allen-Bridson K, Morrell G, et al. National Healthcare Safety Network (NHSN) report: data summary for 2006 through 2008, issued December 2009. Am J Infect Control 2009; 37: 783-805.

16. Mehta A, Rosenthal VD, Mehta Y, et al. Device-associated nosocomial infection rates in intensive care units of seven Indian cities. Findings of the International Nosocomial Infection Control Consortium (INICC). J Hosp Infect 2007; 67: 168-74.

17. Collee J, Miles R, Watt B. Tests for identification of bacteria. In: Collee JG, Fraser AG, Marmion BP, eds. Practical medical microbiology. 14th ed. Edinburgh: Churchill Livingstone 1996; pp: 131-50.

18. Koneman E, Allen S, Janda W, Schreckenberger R, Winn W. Introduction to microbiology. Part II; Guidelines for collection, transport, processing, analysis, and reporting of cultures from specific specimen sources. In: Koneman EW, Alien SD, Janda WM, Schreckenberger RC, Winn W, editors. Color atlasand textbook of diagnostic microbiology. 5th ed. Philadelphia: Lippincott 1997; pp: 121-70.

19. CLSI. Performance Standards for Antimicrobial Susceptibility Testing: Twenty-Third Informational Supplement. CLSI document M100-S23. Wayne, PA: Clinical and Laboratory Standards Institute 2013.

20. Melaku S, Kibret M, Abera B, Gebre-Sellassie S. Antibiogram of nosocomial urinary tract infections in FelegeHiwot referral hospital, Ethiopia. Afr Health Sci 2012; 12: 134-9.

21. Bijari B, Abbasi A, Hemati M, Karabi K. Nosocomial infections and related factors in southern khorasan hospitals. Iran J Med Microbiol 2014; 8: 69-73.

22. Mobaie AR, Amirhasani SH, Nekoe A, Nekoei B. Study of nosocomial urinary tract infections in the ICUs of Hamadan Besat and Ekbatan Hospitals during the
1387-89 Period. J Zanjan Univ Med Sci 2012; 20: 94-102. [in Persian]

23. Rosenthal VD, Guzman S, Safdar N. Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina. Am J Infect Control 2005; 33: 392-7.

24. Leblebicioglu H, Rosenthal VD, Arikar OA, et al. Device-associated hospital-acquired infection rates in Turkish intensive care units. Findings of the International Nosocomial Infection Control Consortium (INICC). J Hosp Infect 2007; 65: 251-7.

25. Laupland KB, Bagshaw SM, Gregson DB, et al. Intensive care unit-acquired urinary tract infections in a regional critical care system. Crit Care 2005; 9: R60-5.

26. Ghadmaighi F, Zighaimat F, Ebadi A, Houshmand A. Knowledge, attitude and self-efficacy of nursing staffs in hospital infections control. Iran J Mil Med 2011; 13: 167-72.

27. Kolawole A, Kolawole O, Kandaki-Olukeni Y, et al. Prevalence of urinary tract infections (UTI) among patients attending Dulhatu Araf Specialist Hospital, Lafia, Nasarawa state, Nigeria. Int J Med Med Sci 2010; 1: 163-7.

28. Smeltzer SC, Bare B, Hinkle J, Cheever KH. Brunner and Suddarth's textbook of medical-surgical nursing. 12th ed. North American: Lippincott 2010; pp: 1360-80.

29. Rafiei MH, Aghaii H. Frequency of Urinary Tract Infection in ICU Patients with Urinary Catheter. J Isfahan Med Sch 2011; 28: 1759-64. Available at: http://jims.mui.ac.ir/index.php/ jims/article/view/879 [in Persian]

30. Dadmanesh M, Dormanesh B, Ghasemzadeh S, Ghorban KH, Zahirian S. Evaluation of nosocomial urinary tract infection in the intensive care unit patients at Tehran 501 hospital during 2007. Ann Mil Health Sci Res 2008; 5: 1407-10. [in Persian]

31. Tenke P, Kovacs B, Johansen TEB, et al. European and Asian guidelines on management and prevention of catheter-associated urinary tract infections. Int J Antimicrob Agents 2008; 31: 68-78.

32. Crouzet J, Bertrand X, Venier AG, et al. Control of the duration of urinary catheterization: impact on catheter-associated urinary tract infection. J Hosp Infect 2007; 67: 253-7.

33. Shah BR, Hux JE. Quantifying the risk of infectious diseases for people with diabetes. Diabetes Care 2003; 26: 510-3.

34. Chen SL, Jackson SL, Boyko EJ. Diabetes mellitus and urinary tract infection: epidemiology, pathogenesis and proposed studies in animal models. J Urol 2009; 182: 51-6.

35. Peleg AY, Weeraratna T, McCarthy JS, Davis TME. Common infections in diabetes: pathogenesis, management and relationship to glycaemic control. Diabetes Metab Res Rev 2007; 23: 3-13.

36. Tsuchida T, Makimoto K, Ohsako S, et al. Relationship between catheter care and catheter-associated urinary tract infection at Japanese general hospitals: a prospective observational study. Int J Nurs Stud 2008; 45: 352-61.

37. Muller A, Lopez-Lozano JM, Bertrand X, Talon D. Relationship between ceftriaxone use and resistance to third-generation cephalosporins among clinical strains of Enterobacter cloacae. J Antimicrob Chemother 2004; 54: 173-7.

38. Fahimzad A, Eydian Z, Karimi A, et al. Surveillance of Antibiotic consumption point prevalence survey 2014: antimicrobial prescribing in pediatrics wards of 16 Iranian Hospitals. Arch Iran Med 2016; 19: 204-9.

39. Saffar MJ, Enayti AA, Abdolla IA, Razai MS, Saffar H. Antibacterial susceptibility of uropathogens in 3 hospitals, Sari, Islamic Republic of Iran, 2002-2003. East Mediterr Health J 2008; 14: 556-63.

40. Cherati JY, Shojae J, Chaharkameh A, et al. Incidence of nosocomial infection in selected cities according NISS software in Mazandaran Province. J Mazandaran Univ Med Sci 2015; 25: 64-71. [in Persian]

41. Taneja N, Rao P, Arora J, Dogra A. Occurrence of ESBL & Amp-C [beta]-lactamases & susceptibility to newer antimicrobial agents in complicated UTI. Indian J Med Res 2008; 127: 85-8.

42. Esfami G, Salehifar E, Behbudi M, Rezaie MS. Rational Use of Amikacin in Buali-Sina Hospital in Sari, 2011. J Mazandaran Univ Med Sci 2013; 23: 2-9. [in Persian].

43. Rezaie MS, Bagheri-nesami M, Hajalibeig A, Ahangarkani F. Multidrug and Cross-resistance Pattern of ESBL-producing Enterobacteriaceae Agents of Nosocomial Infections in Intensive Care Units. J Mazandaran Univ Med Sci. 2017; 26: 39-49. [in Persian]

44. Rezaie MS, Salehifar E, Rafiei A, et al. Characterization of Multidrug Resistant Extended-Spectrum Beta-Lactamase-Producing Escherichia coli among Uropathogens of Pediatrics in North of Iran. BioMed Res
45. Behzadnia S, Davoudi A, Rezai MS, Ahangarkani F. Nosocomial infections in pediatric population and antibiotic resistance of the causative organisms in north of Iran. Iran Red Crescent Med J 2014; 16: e14562.

46. Paterson DL, Ko WC, Von Gottberg A, et al. Antibiotic therapy for Klebsiella pneumoniae bacteremia: implications of production of extended-spectrum β-lactamases. Clin Infect Dis 2004; 39: 31-7.

47. Kang CI, Kim SH, Kim DM, et al. Risk factors for and clinical outcomes of bloodstream infections caused by extended-spectrum β-lactamase-producing Klebsiella pneumoniae. Infect Control Hosp Epidemiol 2004; 25: 860-67.

48. Eslami G, Rezaie MS, Salehifar E, et al. Epidemiology of Extended Spectrum Beta Lactamases Producing E. coli Genes in Strains Isolated from Children with Urinary Tract Infection in North of Iran. J Mazandaran Univ Med Sci 2016; 25: 270-9. [in Persian]

49. Bouza E, San Juan R, Munoz P, et al. A European perspective on nosocomial urinary tract infections I. Report on the microbiology workload, etiology and antimicrobial susceptibility (ESGNI−003 study). Clin Microbiol Infect 2001; 7: 523-31.

50. Karlowsky JA, Draghi DC, Jones ME, Thornsberry C, Friedland IR, Sahm DF. Surveillance for antimicrobial susceptibility among clinical isolates of Pseudomonas aeruginosa and Acinetobacter baumannii from hospitalized patients in the United States, 1998 to 2001. Antimicrob Agents Chemother 2003; 47: 1681-8.

51. Rezai MS, Ghaffari V, Abbaskhanian A, Puramiri R. Comparison of once versus twice daily dose of amikacin in neonatal early sepsis. Health Med 2012; 6: 3946-51.