DNA Procedure of Dispute Paternity Case in Forensic Medicine and Medicolegal Department Airlangga University

Desy Martha Panjaitan,[1] Ahmad Yudianto, [2] Indah Nuraini [3]

[1]*Resident of ForensicMedicine and Medicolegal Specialist Program Airlangga University*
2 The Department of Forensic Medicine and Medicolegal Specialist Program Airlangga University
[3] *Human Genetic Laboratory Institute of Tropical Disease Airlangga University*
[*]*Corresponding author. Email: desymartha40@gmail.com*

ABSTRACT
Disputed Paternity cases are still prevalent in the society and they arise when a father claimed not to be the biological father of a child. It is important to resolve these cases because every child has the human right to be informed about their origin and legal status. Therefore, paternity or DNA test, which is a sophisticated development in science and technology is used to determine the biological father of a child. This study aims to determine the procedures of DNA test used for disputed paternity cases that was performed in Forensic Medicine and Medicolegal Department of Airlangga University. The materials used in this study include reviewing books, journals, and other relevant literature. The DNA test was able to find a gene match between the child and the biological father. In conclusion, the DNA procedures, in these cases were carried out in seven stages after taking samples from children, biological mother, and suspected fathers.

Keywords: paternity, disputed, DNA, procedure

BACKGROUND

The advancement and development of applied forensic DNA Typing provides vivid demonstrations of its potential, not only to convict the guilty but also to free the innocent [1]. In today's world development, the application of forensic medicine such as DNA test is not only related to handling cases of the deceased but also plays an important role in cases of living victims. The use of this method for solving forensic cases is increasing [2]. In recent years, DNA evidence has become the standard forensic testing, and is an invaluable tool for criminal justice[9]. DNA testing has become the only formal and right method for paternity testing now[10]. One of the most fundamental challenges is individualization, which is the determination of a person's identity (such as the perpetrator of a crime) with a high degree of specificity [3].

In general, forensic DNA test is used for personal identification, tracing genetic relationships, and finding the source of biological contents. Personal identification is carried out to determine unknown victims in cases of murder, accident, mass disaster, etc. On the other hand, Parent-child relationship tracking is adopted in cases of father's or mother's doubt, baby swap cases, etc. Also, tracing the source of biological materials is used to track evidence of criminal acts (trace evidence), cases of mutilation, sexual crimes, etc [2]. Therefore, in the rapidly evolving field of forensic medicine, DNA test is not only used in criminal investigation but also plays important role in other applications such as parentage and kinship test where results from potential relatives are being compared.[1] This also includes the many benefits of forensic DNA test, including the paternity test carried out in cases of doubt, which is still prevalent in Indonesian society. Meanwhile, in the United States, DNA test is performed on more than 200,000 cases annually. This number does not include the tests conducted at non-accredited centers. Furthermore, a DNA test in cases of doubt took place in the Forensic Medicine and Medicolegal Department of Airlangga University in 2019-2021.

Disputed paternity cases arises when there is a denial from a husband or a man about a child delivered by a wife or woman he had a sexual relationship with. One way to clarify cases of doubt about paternity is to provide evidence through an examination by a competent doctor in the field of forensic medicine and medicolegal [8]. There are two types of paternity tests, these include the conventional method with phenotypic analysis (blood group system) and the molecular forensic (DNA test). However, the more accurate and specific is DNA test and it has legal force [4].

A DNA test is used to determine the biological father of a child. This is done by comparing the DNA pattern of the child with the alleged father to examine evidence of inheritance that confirms the existence of a biological relationship. The paternity and maternity test uses nuclear and mitochondrial DNA, respectively, and their procedure involves several stages[2].

Furthermore, every part of the human body is a useful specimen because all nucleated cell has an identical DNA sequence, where a child receives the amount of genetic material from his mother and biological father (a trait of Mendel) [5]. This typically involves the mother, the child, and one or more alleged father. The determination of parentage is made based on the alleles shared between the child and the alleged father, when a certain number of the genetic element are present[1].

This DNA test is very important because it involves human right. The rights of children to live, maintain life, and improve standard of living are recognized and protected by law. (Law 39 on Human Rights Article 59). Therefore, the paternity DNA test is a legal effort not only regarding the determination of paternity but also determining the legal status of the child in the future.

Unfortunately, many disputed paternity cases are not resolved through proper procedures due to the lack of understanding of the community and legal practitioners. This is due to the relatively expensive examination fees and the assumption that cases like this are disgraceful and must be hidden[2]. For this reason, a study was carried out to determine the DNA test procedure in cases of paternal dispute in the department of Forensic Medicine and Medicolegal Airlangga University.

2. MATERIALS AND METHODS

Styles The materials and method contain information about data sources from books, journals, research, thesis, and the internets. Furthermore reviewer looked for potential sources, collected data and carry out an analysis.

3. DISCUSSION

This Deoxyribonucleic acid (DNA) was analyzed in stains of body fluids and other biological tissues obtained from evidence. The results of DNA test on evidence samples are compared with known individuals. This makes it possible to analyze the relationship between the victim and the suspect with either the given evidence or the crime scene[1]. Furthermore, the Serology/DNA Section conducts nuclear DNA testing on samples according to the type of evidence. The type of test used is in the form of Y-STR (Short Tandem Repeats) analysis, which is male-specific DNA analysis. [6]

Short Tandem Repeats (STR) are highly polymorphic sections of DNA that have many types of reproducible alleles. It is the core-DNA used as the locus of choice in analysis. Each child has two alleles, one from the mother (maternal DNA), and the other from the father (paternal DNA), which are found in each locus.[2]

Furthermore, core-DNA (nuclear DNA) examination is the most discriminatory type and is usually performed on evidence containing blood, semen, saliva, body tissues, and hair that has tissue at the root tips. The power of this test lies in its ability to identify or include individuals as sources of DNA obtained from items of evidence, as well as to exclude them as possible sources of biological material.[3]

The DNA test procedure in disputed paternity cases begins when the client visits the forensic doctor for consultation. At this stage, it is important to ask for follow-up actions after the results are known, and whether there are planned legal steps. This consultation can be done at the discretion of the client or at the request of the investigator or court. Then the next visit, all parties to be examined are present accompanied by witnesses. After the doctor explains the examination procedure, everyone whose samples will be taken must sign an informed consent. For clients that are children, the informed consent is signed by their parents. However, for safety reasons, it is recommended that the informed consent also be signed by witnesses from both parties. Subsequently, samples of 1-3cc of venous blood are taken in a close and label tube containing EDTA from children, biological mother, and suspected fathers. Also, blood samples can be taken using an FTA card. In a case where the sampling of children is not possible, then 2-4 sterile cotton swabs are taken through a buccal swab[5]. Afterward, the collected samples are taken to the Institute of Tropical Disease Airlangga University laboratory. All these sampling procedures are important, therefore, it was documented[2].

Based on DVI Interpol guideline, known reference samples of subjects and victims are required for comparison with evidence. The data collection should include direct samples from the examined missing person and reference samples from closely related biological family members (familial samples). Good sources for direct samples are buccal swab, blood, bone marrow, teeth, etc[7].

The first stage of samples was DNA extraction-isolation, in which all methods involved disruption and lysis of basic materials followed by removal of proteins and all debris such that the DNA is finally obtained. Stage II is to measure the level and purity of the isolated DNA while stage III is the Polymerase Chain Reaction (PCR) which is an amplification of the target DNA sequence in vitro using the polymerase enzyme. Furthermore, stage IV is the separation of DNA fragments with polyacrylamide gel electrophoresis process. Stage V is staining, in this case, the silver colour was used, separate lines will be seen as brown DNA bands with a yellow background on the gel. Finally, stage VI is result analysis, and in one paternity test, marker ladder tapes appear that function as measurements (basepair), positive (usually using K562) or negative controls (aquadest), sample bands from mothers, children, and suspected fathers. [5] When a DNA fragment of the suspected father is found to be the same as the children then the man is declared to be the biological father. Furthermore, a suspected father is true to be the biological

father when the paternal band of the child is the same as one of the male's DNA at each locus examined. Conversely, when at two or more DNA loci examined there is a discrepancy (exclusion) of their paternal DNA, then he is declared not to be biological father[2].

Paternity Index is the ratio of two conditional probabilities where the numerator assumes paternity and the denominator assumes that a random man of similar ethnic background was the father. Also, the probability of paternity is how likely a man is to be the biological father of a child (%) [2]. If the DNA patterns of parents and children match, then the parents can determined with certainty greater than 99.999%[8].

CONCLUSION

The procedure for DNA test in the disputed cases of paternity consists of six stages, namely extraction, measurement of level and purity of isolated DNA, Polymerase Chain Reaction (PCR), the separation of DNA fragments, staining, and the analysis of the results of the examination. Furthermore, the analysis carried out in the Institute of Tropical Disease Airlangga University was able to find a gene match between the child and his biological father.

ACKNOWLEDGMENTS

The authors are grateful to the Chief of Forensic Medicine and Medicolegal Airlangga University for permitting us to publish this study. The authors are also grateful to the staff of the Institute of Tropical Disease Airlangga University. The author claim to have no financial interest in the commercial products in this study.

REFERENCES

[1] John M. Buttler. Forensic DNA Typing 2th ed. USA: Elsevier;2005.

[2] Abdul Munim Idries. Penerapan Ilmu Kedokteran Forensik dalam Proses Penyidikan. Edisi Revisi.Jakarta: Sagung Seto;2011 [10] B. Meyer, Applying "Design by Contract", Computer 25(10) (1992) 40–51. DOI: https://doi.org/10.1109/2.161279

[3] David E.Newton. DNA Evidence And Forensic Science. New York: Facts On File;2008.

[4] John Buckleton. Forensic DNA Evidence Interpretation. USA : CRC Press; 2005.

[5] Ahmad Yudianto, Agung Sosiawan. Panduan Laboratorium DNA Forensik. Surabaya: Revka Petra Media; 2015.

[6] Forensic Science Division Montana Department Of Justice. Serology/DNA Evidence Collection Manual. Montana: Montana State Crime Lab; 2016.

[7] Interpol. Disaster Victim Identification Guide. 2014 [Cited July 30]. Available from : http://www.interpol.int/INTERPOL-expertise/Forensics/DVI-Pages/DVI-guide

[8] Baynes, J W. dan Marek, H D. Medical Biochemistery, Second Edition. Elsevier, Inc. USA. 2007..

[9] Frumkin, D.; Wasserstorn, A.; Davidson, A., Grafit, A. Authentication of Forensic DNA Samples. Forensic Science International. 2009.

[10] Cherng, S.; Ma, H.; Zhu, H.; Guan, F. Paternity Testing. Journal of American Science. 2006..

Risk Factors for of Urinary Tract Infection in Catheter Installation in Hospitals

Kusbaryanto[1] and Listiowati[2]

[1]*Faculty of Medicine and Health, Departement of Medical, Universitas Muhammadiyah Yogyakarta, Indonesia*
[2]*Faculty of Medicine and Health, Departement of Medical, Universitas Muhammadiyah Yogyakarta, Indonesia*
** Correspondence : koesbary@yahoo.co.id*

ABSTRACT
CAUTI has been shown to increase the mortality rate, length of stay (LOS), susceptible patients to CAUTI are due to risk factors, namely women, the elderly, and diabetics. This study aimed to analyze the risk factors for the Incidence of urinary tract infections in patients with catheters in Hospitals. The research design used was an observational analytic study with a cross sectional design approach. The sample in this study were patients diagnosed with UTI in the inpatient room for 4 months from November 2019 to February 2020, obtained as many as 11 respondents with inclusion criteria being patients diagnosed with clinical urinary tract infection and having a catheter installed for at least 3 days. Sample selection is done by Consecutive Sampling. Data were taken from medical records at the hospital. Ethical permission for this research was granted from the research ethics section of Aisyiyah University Yogyakarta. There are three results of the analysis, namely: 1) gender has an effect on UTI (p = 0.023), the female gender is 7 times more at risk than the male gender (OR = 7.041), 2. age affects UTI (p = 0.004), age more than 70 years old is 11 times more likely to have UTI compared to those less than 70 years old (OR = 11,445), 3. Age factor is more influential on UTI than gender. The risk factors for the incidence of urinary tract infections in patients with catheters in the hospital are: 1. Gender, female sex is 7 times more at risk than male sex, 2. Age, over 70 years old is 11 times more at risk of UTI compared to those aged less than 70 years.

Keywords: *Risk factors, incidence, CAUTI, hospital*

INTRODUCTION

Approximately 1.7 million infections that occur in hospitals in the United States have resulted in 99,000 deaths, of which types of infection are UTIs. The incidence of urinary tract infections is 32% of all hospital infections and results in a total cost in the United States of $390-450 million[1].

Urinary tract infection (UTI) is an infectious disease that most individuals often experience. UTI infections are classified as upper UTI (pyelonephritis) and lower UTI (cystitis, prostatitis). The classification depends on the location. The clinical manifestations of UTI vary from asymptomatic bacteriuria to septic shock. A good understanding of UTI and the proper use of antibiotics is important to prevent complications and misuse of antibiotics.[2]

The type of tube that is inserted into the bladder through the urethra is called an indwelling catheter. Indwelling urinary catheters play an important role in this aspect of medical practice. However, several problems arise in the installation of a persistent urinary catheter, namely CAUTI. CAUTI ranges from asymptomatic bacteremic urinary tract infections to symptomatic urinary tract infections. Approximately 30-40% of all hospital-acquired infections are CAUTI, 80% of which are catheter-related. Among the complications of the genitourinary tract are pyelonephritis and cystitis. Approximately 3% of all patients with catheters will develop bacteremia. Complications of CAUTI lead to a lengthy hospital stay and increased costs, morbidity and mortality. Morbidity and mortality due to CAUTI, according to the Center for Disease Control, increased 2.8 times and length of stay increased by 1-3 days.[3]

There are hundreds of thousands of CAUTI in the United States, among the symptoms of CAUTI is bacteriuria, but not all cases of bacteriuria cause complaints in patients. The environment around the catheter insertion is very conducive to bacterial colonization so that catheter-related bacteriuria is unavoidable.[4]

About one-third of all healthcare-associated infections in the United States are caused by CAUTI and lead to increased patient care costs. Safety concerns and increased patient discomfort are also widely associated with CAUTI. Prevention of Catheter-related Urinary Tract Infections has important cost implications for hospitals.[5]

In 2011, there were an estimated 93,000 CAUTI cases in US acute care hospitals. More serious complications of CAUTI can arise such as sepsis and endocarditis, and it is estimated that more than 13,000 deaths each year are related to health care-associated UTIs.[6]

The increase in the mean number of days hospitalized for complications of a UTI was approximately 0.4 days for asymptomatic UTIs, and about 2.0 days for symptomatic UTIs. without symptoms, length of hospitalization, an increase in the average number of days of hospitalization due to complications of symptomatic UTI. Other complications associated with the use of

indwelling urinary catheters include urethritis, urethral stricture, hematuria, bladder perforation, catheter obstruction, and urosepsis. Complications due to CAUTI are largely preventable.[7]

Factors that increase the risk of hospital-acquired infections, in particular catheter-associated urinary tract infections (CAUTI), are well documented and in many of them in surgical patients. Among the risk factors are older age, female gender, diabetes mellitus, and longer urinary catheter insertion time[8].

Preventing health care-associated infections (HAIs) has become a major concern to improve inpatient safety. Catheter-associated urinary tract infections (CAUTI) are one of the most common HAIs in the United States. CAUTI is included as a preventable disease so that costs due to cauti events during hospitalization are no longer reimbursed by the hospital[9]. This study aims to analyze the risk factors for the incidence of urinary tract infections in patients with catheters in the hospital.

1. METHOD

The research design used was an observational analytic study with a cross sectional design approach. The sample in this study were patients with catheter insertion in the Hospital Internal Medicine Room as many as 11 respondents. The sample in this study were patients diagnosed with UTI in an inpatient room for 4 months from November 2019 to February 2020 with inclusion criteria being patients diagnosed with a urinary tract infection clinically and having a catheter inserted for at least 3 days. Sample selection is done by Consecutive Sampling. Data were taken from medical records at the hospital. Ethical permission for this research was granted from the research ethics section of Aisyiyah University Yogyakarta.

RESULT

Table 1. The Incidence of UTI by Gender and Age

Variable	Incidence of UTI				p
	UTI		No UTI		
	F	%	F	%	
Gender					
Woman	9	17,6	42	82,4	0,058
Man	2	4,5	42	95,5	
Age					
> 70 year	9	23,1	30	76,9	0,007
< 70 year	2	3,6	54	96,4	

The results of the analysis showed that the gender and age variables had a p value of < 0.25 so that both variables were included in the multivariate test.

Table 2. Odds Ratio (OR) from the results of the multivariate test

Variable	Incidence of UTI				P	OR	CI 95%	
	UTI		No UTI					
	F	%	F	%			Lower	Upper
Gender								
Woman	9	17,6	42	82,4	0,023	7,041	1,315	37,689
Man	2	4,5	42	95,5				
Age								
> 70 year	9	23,1	30	76,9	0,004	11,445	2,176	60,199
< 70 year	2	3,6	54	96,4				

DISCUSSION

There are significant differences both anatomically and physiologically in the male and female urogenital tracts. From the results of statistical tests it was proven that there was a difference, it was found that the female sex was 7 times more at risk for UTI than men with OR = 7.041, 95% CI 95% CI 1.315 - 37.689.

Age factors also often affect the risk factors for disease, even including the type of permanent risk factor. From the results of statistical tests, it was found that those aged over 70 years were 11 times more at risk of UTI than those aged less than 70 years with OR = 11.445 and 95% CI 2.176 - 60.199.

The urethra in women is shorter and closer to the rectum, this makes the urinary tract more susceptible to bacterial infection, so UTIs are more common in women. Among other risk factors for UTI are a history of previous UTI, sexual activity especially with a new partner, prostate enlargement and poor hygiene.[10]

Of all the incidence of UTI, about 70-80% are Cauti. Furthermore, CAUTI is associated with increased morbidity and mortality. Health insurance no longer reimburses costs for additional treatment resulting from hospital-acquired CAUTI.[11]

For decades, research has shown that the incidence of CAUTI has been decreasing steadily. However, research on the incidence, risk factors, and efforts to optimize CAUTI prevention strategies is important to prevent the risk. Potential risk factors of interest include patient gender, age, comorbidities, use of parenteral nutrition, urinary catheterization, suprapubic catheterization, and having undergone urological procedures.[12]

Increased resistance of microorganisms that cause CA-UTI is associated with increased mortality, morbidity, health care costs, and needs. It aims to introduce broad-spectrum antibiotics. Identification of risk factors for antimicrobial resistance may contribute to the improvement of CA-UTI treatment. The risk factors associated with an increased incidence of CAUTI are E. coli and Klebsiella spp. These bacteria can potentially produce CA ESBLs, including old age, female gender, diabetes mellitus, recurrent UTIs, invasive urological procedures, and previous use of antibiotics, such as aminopenicillins cephalosporins, and fluoroquinolones.[13]

Approximately 75% of UTIs are caused by the use of a urinary catheter. CAUTI is almost always preceded by bacteriuria. Among the symptoms of bacteriuria are urgency, dysuria and fever. Sepsis, septic shock, and multiorgan failure can result from microbes from the urinary tract. With prolonged use of the catheter, neurogenic bladder dysfunction will occur. This condition can progress to damage to the brain, spinal cord, or other nerve damage. Forms of disease that arise include stroke, spinal cord injury, multiple sclerosis.[14]

As many as 20.6% of CAUTI patients were caused by colorectal surgery. The incidence of Cauti may be related to patient characteristics, laboratory values, and surgical procedures. Among the risk factors for CAUTI are the patient's age, gender, steroid use, diabetes, hypertension, and history of cerebrovascular disease.[15]

We found that gender had no association with CAUTI. Men and women have the same chance of suffering from infection, but the number of men who suffer from infection is more than women. This study contradicts the theory that women are more at risk of developing infections because women have short urethras. The increase in urinary tract infections due to catheter insertion in men causes differences in hormones and microorganisms in the urine. An equal chance of developing a catheter-related urinary tract infection is due to personal hygiene. Poor personal hygiene in men and women, especially in the genital area is at risk for infectious diseases. For the effect of Age, in this study it was found that, those aged over 60 years had a greater risk of suffering from catheter-related urinary tract infections. This is in accordance with the theory of immunosenescence (immune dysfunction due to age), like other diseases as well, that age is a permanent risk factor[16].

The prevalence of long-term catheter use varies between countries and healthcare settings. In Italy it was found that 35.9% of men and 27.4% of women in elderly home care patients used either indwelling catheters, in other countries the figure was lower, namely in Finland (2.9%) and in women in the Czech Republic (0.6%). including urinary tract infections. Complications arising from the use of long-term catheters besides UTI are the appearance of mineral deposits and leaks around the catheter[17].

Among the most effective approaches to reducing CAUTI is limiting the use of indwelling urethral catheters to a list of appropriate indications, as most inpatients have catheters inserted at some point during hospitalization, with many of these insertions not considered medically necessary[5].

A study of cauti, when the catheter was removed immediately after surgery or within 24 hours was safer than removing the catheter after 48 to 72 hours. The catheter should be left in place for as short a time as possible to prevent UTI. This is one of the recommended strategies to minimize the incidence of CA-UTI[18].

Inserting a catheter is a risk factor for CAUTI, so proper insertion can reduce infection and prevent CAUTI. Other risk factors for CAUTI are female gender, older age, and not maintaining a closure system19.

In addition to the above factors, cerebral infarction is thought to increase the incidence of CAUTI. Cerebral infarction is a common neurological disorder associated with urinary tract infections due to bladder dysfunction. 6,10-12 A prospective study reports that urinary tract infections complicate cerebral infarction and are associated with poor outcomes. Cerebral infarcts are susceptible to CAUTI, evidence of antimicrobial efficacy in preventing CAUTI in these patients is lacking20.

CONCLUSION

The risks of urinary tract infections during catheter insertion in hospitals are 1. Gender, female sex is seven times greater risk than male sex, 2. Age, over 70 years old, has 11 times greater risk of experiencing urinary tract infection. UTI compared to those less than 70 years of age.

ACKNOWLEDGEMENT

Thank you, Universitas Muhammadiyah Yogyakarta, for supporting this research conducted by the dean of Architecture for Medicine and Health.

CONFLICT OF INTEREST

There is no conflict of interest for this manuscript.

REFERENCES

1. Weber DJ, Bennett EES, Gould CV, Brown VM, Huslage K, and Rutala WA. Incidence of Catheter-Associated and Non-Catheter-Associated Urinary Tract Infections in a Healthcare System. *Infect. Control Hosp. Epidemiol.*, vol. 32, no. 8, pp. 822–823, 2011, doi: 10.1086/661107.
2. Kang CI, Kim J, Park DW, Kim BN, Ha US, Lee SJ, Yeo JK, Min SK, Lee H, Wie SH. "Clinical Practice Guidelines for the Antibiotic Treatment of Community-Acquired Urinary Tract Infections," *Infect Chemother*, vol. 50, no. 1, pp. 67–100, 2018.
3. Leelakrishna P and Rao BK. A study of risk factors for catheter associated urinary tract infection. International

Journal of Advances in Medicine, 2018 Apr;5(2):334-339.

4. Siddiq,DM and Darouiche, RO. New strategies to prevent catheter-associated urinary tract infections. *Nature Reviews Urology* volume 9, pages305–314 (2012).
5. Greene MT, Fakih MG, Fowler KE, Meddings J, Ratz, D, Safdar N, Olmsted RN, Saint, S. Regional Variation in Urinary Catheter Use and Catheter-Associated Urinary Tract Infection: Results from a National Collaborative. *Infection Control and Hospital Epidemiology* , Vol. 35, No. S3, Preventing Healthcare-Associated Infections: Results and Lessons Learned from AHRQ's HAI Program (October 2014), pp. S99-S10.
6. Kriegel ASL, Salmasian H, Vawdrey DK, Youngerman BE, Green RA, Furuya EY, Calfee DP. Identifying the risk factors for catheter-associated urinary tract infections: a large cross-sectional study of six hospitals. *BMJ Open*. 2019 Feb 21;9(2):e022137.
7. Schiessler MM, Darwin LM, Phipps AR, Hegemann LR, Heybrock BS, Andrew J Macfadyen AJ. Don't Have a Doubt, Get the Catheter Out: A Nurse-Driven CAUTI Prevention Protocol. *Pediatr Qual Saf* 2019 May 24;4(4):e183.
8. Gillen JR, Isbell JM, Alex D. Michaels, . Lau CL, Sawyer RG.Risk Factors for Urinary Tract Infections in Cardiac Surgical Patients. *Surg Infect (Larchmt)*. 2015 Oct 1; 16(5): 504–508.
9. Saint S, Greene MT, Kowalski CP, Watson SR, Timothy P, Hofer TP, Krein, SL. Preventing Catheter-Associated Urinary Tract Infection in the United States A National Comparative Study. *JAMA Intern Med.* 2013;173(10):874-879.
10. CDC. *No What is a urinary tract infection (UTI)*?. *CDC*, 2020. [Online]. Available: https://www.cdc.gov/antibiotic-use/community/for-patients/common-illnesses/uti.html.
11. Conover MS, Mireles ALF, Hibbing ME, Dodson K, and J. Hultgren SJ. Establishment and Characterization of UTI and CAUTI in a Mouse. *Model.J Vis Exp.* 2015; (100): 52892.
12. Strassle PD, Bennett EES, Klompas M, Lund JL, Stewart PW, Marx AH, DiBiase LM, Weber DJ. Incidence and risk factors of non–device-associated urinary tract infections in an acute-care hospital .Infect Control. *Hosp Epidemiol*. 2019 November ; 40(11): 1242–1247
13. Koksal E, Tulek N, Sonmezer MC, Temocin F, Bulut C, Hatipoglu C, Erdinc FS, and Ertem G. Investigation of risk factors for community-acquired urinary tract infections caused by extended-spectrum beta-lactamase Escherichia coli and Klebsiella species. *Investig Clin Urol.* 2019 Jan; 60(1): 46–53.
14. Magnusson, B *et al.*, "Long-term use of noble metal alloy coated urinary catheters reduces recurrent CAUTI and decreases proinflammatory markers," *Ther. Adv. Urol.*, vol. 11, p. 175628721985491, 2019, doi: 10.1177/1756287219854915.
15. Muacevic A, Adler, JR, Farsi AH.Risk Factors and Outcomes of Postoperative Catheter-Associated Urinary Tract Infection in Colorectal Surgery Patients: A Retrospective Cohort Study. *Cureus*. 2021 May; 13(5): e15111.
16. Hariati H, Suza DE, and Tarigan S. Risk Factors Analysis for Catheter-Associated Urinary Tract Infection in Medan. *Indonesia.Open Access Maced J Med Sci.* 2019 Oct 15; 7(19): 3189–3194.
17. Cooper FPM, Alexander CE, Sinha S, and Omar MI. Policies for replacing long-term indwelling urinary catheters in adults. *Cochrane Database Syst Rev*. 2016 Jul; 2016(7): CD011115.
18. Kranz J, Stefanie Schmidt S, Wagenlehner F, Schneidewind L.Catheter-Associated Urinary Tract Infections in Adult Patients Preventive Strategies and Treatment Options. *Dtsch Arztebl Int.* 2020 Feb; 117(6): 83–88.
19. Lo, E;Nicolle, LE; Coffin, SE; Gould, C; Maragakis, LL; Meddings, J; Pegues, DA; Pettis, AM; 8 Saint, S; Yokoe, DS. Strategies to Prevent Catheter-Associated Urinary Tract Infections in Acute Care Hospitals: 2014 Update. *Infection Control and Hospital Epidemiology* , Vol. 35, No. 5 (May 2014), pp. 464- 479.
20. Muramatsu K, Fujino Y, Kubo T, Otani M, Fushimi K, and Matsuda S. Efficacy of Antimicrobial Catheters for Prevention of Catheter-Associated Urinary Tract Infection in Acute Cerebral Infarction. *J Epidemiol.* 2018; 28(1): 54–58.