

CHEPTER II

REVIEW OF THE LITERATURE

CONCEPTS AND THEORIES

The urinary system includes of kidneys, ureters, urinary bladder and urethra. Normally, there is no microorganism in the urinary tract, from kidneys to the distal urethra. At the urethral opening there may be some bacteria but the bacterial culture usually shows gram positive bacteria, e.g. Diptheroids lactobacilli, Staphylococcus epidermitis, etc. where by most of the urinary tract infections caused by gram-negative bacteria(Warren JW, et al., 1982. Henry M, 1992) and few were caused by fungi or virus.

URINARY TRACT INFECTION

There are differences of causes, pathology and signs & symptoms of the urinary tract infection. There may be bacteriuria or the infection of the kidney or even septicemia. The infection of each organ of the urinary system has specific pathological nature, epidemiology and diagnostic methods. Normally, the urine itself is sterile. If the bacteria were found in urine, this may due to the infection of the urinary tract system or the contamination during getting the urine sample. Therefore, the diagnosis of the urinary tract infection must be differentiated between the real urinary tract infection and the contaminated urine sample.

The significant bacteria which are used to determine the urinary tract infection refer to the result of bacteria culture that the number of bacterial colony are 10^2 - 10^4 CFU/ml especially for women who also have dysuria (Johnson, 1991).

The infection control committee recommended to use the higher number of bacterial colony for diagnosing urinary tract infection in females, by using the number of bacterial colony of $\geq 10^4$ CFU/ml of Enterobacteriaceae, Enterococci, and Staphylococcus saprophyticus.

For men, the number of bacterial colony of 10^4 CFU/ml is used for diagnosing urinary tract infection.

For those who have indwelling urinary catheters, the number of bacterial colony / fungi of $\geq 10^4$ CFU/ml is used to diagnose the infection of urinary tract. (Kunin, C.M. 1994)

According to Johnson C.C. 1991 who has recommended the significant bacteria of the bacterial culture for diagnosing urinary tract infection as follows: for women who have dysuria, the bacterial colony of $\geq 10^2$ CFU/ml can be used to diagnose where by criterion of $\geq 10^5$ CFU/ml was used, the sensitivity of diagnosis will be decreased.

For men, who have dysuria, urethritis all the time, frequent urination, and the number of bacterial colony of $\geq 10^3$ CFU/ml, can be diagnosed as urinary tract infection.

For asymptomatic bacteria, if the repeated urine culture was confirmed with the bacterial colony of $\geq 10^5$ CFU/ml, with the same type of bacteria.

For the patients with indwelling urinary catheters, who have the signs of infection, e.g., high fever, if the bacterial colony of $\geq 10^2$ CFU/ml was found it means that there were significant bacteria. It will be also found that the number of bacteria will increase very rapidly from 10^2 to 10^5 CFU/ml within few days.

Some researchers have classified the urinary tract infection accordingly with its pathology as follows: for a healthy male/female, who has normal urinary tract and normal urination but has urinary tract infection which may be caused by spermicides, this type is called uncomplicated urinary tract infection which may include cystitis, bacteriuria. After treatment the kidney will function normally.

The second type, complicated urinary tract infection, can occur with both male and female who had abnormal function or structure of urinary system, for example, bladder stones. Besides, it was also found that those who had this type of infection usually had underlying diseases, for example, diabetes, and cord injury which caused neurogenic bladder. Among this group of the infection, most of the patients have lower function of kidney. For the patients with indwelling urinary catheters, this type of infection is the infection with complications. There are different types of urinary tract infection, sometime this term was replaced by the term "bacteriuria", which has a close meaning. According to Garibaldi, who indicated that if bacteriuria was found it meant that the patient has urinary tract infection which showed that there were colonized

microbes and if the microbes invade into the urinary tract tissues the patient can get the urinary tract infection. In the patients with indwelling urinary catheters they may not have clearly signs of infection. For this study, for the appropriateness of the study and the feasibility of the laboratory examination, the criteria used to diagnose the urine examination of the urine samples from the urinary catheters were higher than the criteria used in the studies of other countries.

NOSOCOMIAL URINARY TRACT INFECTION

Identification is by urine culture. Most patients remain asymptomatic, but 20-30 percent develop the symptoms of urinary tract infection, of which a proportion, about 1 in 100, develops bacteraemia. The types of organisms that cause nosocomial urinary tract infections.

Indwelling urinary catheters account for 80 percent of nosocomial urinary tract infections, which is scarcely surprising as 50 percent of patients catheterized for longer than 7-10 days develop bacteriuria. Most of the other urinary tract infections are accounted for by instrumentation of the urinary tract. The main source of organisms is the periurethral flora. Bacteria gain access to the bladder, usually by spreading up the outside of the lumen of the catheter. Occasionally, the infecting organisms are acquired from an exogenous source, as part of an epidemic nosocomial infection. Most symptomatic or bacteraemic urinary tract infections occur within 24 hours of the organisms gaining access to the bladder.

Clinically, symptomatic cases present with dysuria, frequency, lower abdominal discomfort, loin pain, fever, and sometimes features of septic shock. Treatment of a symptomatic patients broadspectrum antimicrobials administered empirically after obtaining appropriate cultures. Treatment should later be adjusted according to the results of bacteriological studies. There is no need to treat asymptomatic patients.

Prevention of nosocomial urinary tract infections has received much attention. Prophylactic antimicrobial treatment does not have a significant role, but it is important to avoid urinary catheterization or reduce the period of catheterization. Catheters should be inserted aseptically, and close sterile drainage systems, uninterrupted gravity drainage, or intermittent or suprapubic catheterization used. (Ledingham &Warrell, 2000 :P 1491.)

Urinary tract infection is the most common site of nosocomial infections with a rate of approximately 40% of all nosocomial infection (Center for Disease Control, 1797). This average figure is from studies in U.S.A. which represents the approximate infection rates of U.S. hospitals. Similarly, many studies in Thailand have shown that nosocomial urinary tract infections varied from 30-40%, the highest rate among other sites of the infections (Pinyowiwat, et al., 1988;Danchaivijitr and Waitayapiches, 1988; Danchaivijitr and chokloikeaw, 1988; Sithikesorn, 1988; Limsuwan and Danchaivijitr, 1988). The only study of nosocomial infection in Chiangmai University hospital conducted in 1987 showed that the urinary tract infection was the most common site, about one fourth of all nosocomial infections.

From the above information, it is clear that the proportion of urinary tract infection has been unduly high. For many patients, this infection and its associated adverse effects could have been avoided.

Catheter associated urinary tract infections are generally assumed to be benign. However, occasionally infection persists and leads to other complications such as prostatitis, cystitis, pyelonephritis or gram-negative bacteria in high risk patients (Kunin, 1979). The mortality rate of patients who have catheter-associated urinary tract infection is three times that of the patients who do not (Platt, Polk, Murdock, and Rosner, 1982).

The organisms causing urinary tract infection which commonly are bacteria usually invade urinary tract by two routes: blood stream and urethra or so called ascending route. The urethra or the ascending route is the most common (Ayliffe, et al., 1982; Infection Control Committee, Ramathibodi Hospital, 1988). The organisms are usually of faecal origin which are found on the perineum or in the anterior urethra. Infection occurs by retrograde spread of large numbers of patient's own organisms. Moreover, cross-infection from other patients is likely to occur by hands of health care personnels. Infections are more common in female owing to shorter urethra (Ayliffe, et al., 1982). However, about 66-90% of urinary tract infection usually occurs after instrumentation (Martin and Brookrajian, 1962; Infection control committee, Ramathibodi Hospital, 1988). Report rates of infections have varied from 1-5% after a single brief catheterization (Truck, Goff, and Peerdorf, 1962). Infection rates resulting from indwelling urinary catheters were reported at 20%, 27.2%, and 50% after

indwelling catheter for 24 hours, 72 hours and 7 days respectively (Nimmannit, et al., 1979). Rate of hospitalized patients undertaken instrumentation of urinary tract have varied between 7-25% (Infection Control Committee, Ramathibodi Hospital, 1988). Therefore, many patients are potentially at risk of acquiring nosocomial urinary tract infections.

The risk of acquiring a urinary tract infection, apart from host susceptibility, depends on the method of catheterization, catheter indwelling duration and quality of catheter care by health personnel.

DIAGNOSIS OF NOSOCOMIAL URINARY TRACT INFECTION

The United States Center for Disease Control developed the diagnostic standard of nosocomial urinary tract infection, by dividing the infection into 3 types as follows:

1. Symptomatic Urinary Tract Infection
2. Asymptomatic Urinary Tract Infection
3. Other Urinary Tract Infection, which includes the infection of kidneys, ureters and bladder.

DIAGNOSIS CRITERIA OF NOSOCOMIAL URINARY TRACT INFECTION

1. Symptomatic urinary tract infection must meet one of the following criteria:
 - 1.1 One of the following : fever ($>38^{\circ}$ C), urgency, frequency, dysuria, or suprapubic tenderness and a urine culture of $\geq 10^5$ colonies/ml urine with no more than two species of organism.

- 1.2 Two of the following : fever($>38^{\circ}$ C), urgency, frequency, dysuria, or suprapubic tenderness and any of the following :
 - a. Dipstick test positive for leukocyte esterase and/ or nitrite.
 - b. Pyuria (white blood cells $\geq 10/ml^3$ or WBC ≥ 3 HPF of unspun urine)
 - c. Organisms seen on Gramstain of unspun urine.
 - d. Two urine cultures with repeated isolation of the same uropathogen with $\geq 10^2$ colonies/ml urine in nonvoided specimens
For urine specimens to be of value in determining whether a nosocomial infection exists. They must be obtained aseptically using an appropriate technique such as clean catch collection, bladder catheterization, or suprapubic aspiration. Gram-negative bacteria or *Staphylococcus saprophyticus*.
 - e. Urine culture with $\leq 10^5$ colonies/ml urine of single uropathogen in patient being treated with appropriate antimicrobial therapy.
 - f. Physician's diagnosis.
 - g. Physician institutes appropriate antimicrobial therapy.

2. Asymptomatic bacteria must meet either of the following criteria:
 - 2.1 An indwelling urinary catheter is present within 7 days before urine is cultured and patient has no fever, urgency, frequency, dysuria, or suprapubic tenderness and has urine culture of $\geq 10^5$ colonies/ml urine with no more than two species of organism.

- 2.2 No indwelling urinary catheter is present within 7 days before the first of two urine cultures with $\geq 10^5$ colonies/ml urine of the same organism and patient has no fever, urgency, frequency, dysuria, or suprapubic tenderness.
3. Other infections of the urinary tract (kidney, ureter, bladder, urethra, or tissues surrounding the retroperitoneal or perinephric spaces) must meet one of the following criteria:
 - 3.1 Organism isolated from culture of fluid (other than urine) or tissue from affected site.
 - 3.2 An abscess or other evidence of infection seen on direct examination, during surgery, or by histopathologic examination.
 - 3.3 Two of the following: fever ($>38^\circ\text{C}$), localized pain, or tenderness at involved site and any of the following:
 - a. Purulent drainage from affected site.
 - b. Organism isolated from blood culture.
 - c. Radiographic evidence of infection.
 - d. Physician's diagnosis.
 - e. Physician institutes appropriate antimicrobial therapy.
4. Patient ≤ 12 months of age has one of the following: fever ($>38^\circ\text{C}$), hypothermia ($< 37^\circ\text{C}$), apnea, bradycardia, lethargy, or omitting and any of the following:
 - a. Purulent drainage from affected site.

- b. Organism isolated from blood culture.
- c. Raiographic evidence of infection.
- d. Physician's diagnosis.
- e. Physician institutes appropriate antimicrobial therapy.

DURATION OF CATHETERIZATION

It can be categorized into 2 types:

1. Short term catheterization. The duration of catheterization is less than 30 days.
2. Long term catheterization. The duration of catheterization is longer than 30 days, which used with the patient who can't hold urination or who had obstruction of the urinary tract system.

Some researchers categorized the duration of catheterization accordingly with the patients' symptoms as follows:

1. Short period. It was used with post-operation patients whereby catheterization was 1-7 days.
2. Intermediate period. It was used with the patients of the Internal Medicine department whereby catheterization was about 7-30 days.
3. Long term period. It was used with the patient with the abnormal of urinary tract system whereby catheterization was longer than 30 days.

THE ENTRY OF MICROBES IN THE CATHETERIZED PATIENT

1. The Urethral Opening.

Usually at the urethral opening there are some bacteria, when the catheter has inserted in the urethra the bacteria may get into the urethra and usually caused urinary tract infection about 20 percent of all urinary tract infection(Beilski 19..).

2. The Area Between the Urethra's Wall and the Catheter.

Because the entrance to a woman's urethra is nearer to anus and perineum where the normal flora is usually found. These microbes are easier to grow when keeping the catheter for a long period of time. When the catheter has been moved oftenly it will make the microbes near the catheter and from an endogenous source more into the urinary tract and caused urinary tract infection about 70 percent (Garibaldi, 1987:338).

3. The Drainage System.

In the patients with indwelling urinary catheters and using the close drainage system, microbes can enter into the drainage system if aseptic technique has not been used. The entry parts may be as follows:

- 3.1 If the nurses did not wash their hand before and after pouring the urine of each patient out from the urine bag, the microbes can enter into the urinary tract through the opening part of the urine bag and the infection can be transmitted from one patient to another patient through the contaminated hands of the nurses or the nurses did not lean the connected part of the opening area of the urine bag and the

microbes can get into the urine bag and grow inside the bag. These microbes then, can move through the catheters and cause infection. The other cause of infection may be from the unclean urine containers or using the same urine containers with many patients whereby the microbes can be contaminated and enter into the urine bag through the opening of the urine bag.

- 3.2 The connected area between the opening of the catheters and the urine bags can also be the source of infection if the urine bag is full or the urine bag is placed higher than the level bladder or place the urine bag on the floor whereby the urine can flow backward to the bladder.
- 3.3 The connection between the catheter and the tube of the urine bag can be another source of infection if this connection was taken off which taking the urine sample or by accident, the microbes from an exogenous source can enter the connection. The entries of microbes were presented in Figure 1 (APPENDIX D)

THE CAUSES OF NOSOCOMIAL URINARY TRACT INFECTION

Nosocomial urinary tract infection is caused by the following factors:

1. Urinary Catheterization and Indwelling Urinary Catheters. Urinary Catheterization can be the cause of infection if the catheter is contaminated or the reproductive organs are not clean enough, especially the urethral opening. When the catheter is inserted the microbes can be pushed by the catheter to enter into the bladder and cause the infection. (Beilski, 1980: 703-707) indicated that one urinary catheterization is susceptible to 1-2

percent of the urinary tract infection and the infection rate will be increased with the indwelling urinary catheters. Indwelling urinary catheters will damage body's defense mechanism because there will have some urine left at the end of the catheter which makes the bladder unable to destroy the microbes. Another reason is the indwelling urinary catheter will make the sphincter open all the time and make the urine flow backward to the bladder when the pressure in the bladder is lower after urination.(Stamm, 1992: 598) also indicated that indwelling urinary catheters account for 80 percent of urinary tract infection.

2. Diagnosis or Treatment by Inserting Instruments into the Urethra. The instruments used include endoscope, pandoscope and cystoscope which are special instruments used most in diagnosis urinary system diseases. Transurethral resection is a treatment of the enlarge of the prostate gland or cancer of the bladder, by inserting resectoscope through urethra and cut the cyst / tumor into smallpieces, then irrigated by saline water. After operation, the indwelling urinary catheter was inserted and have the balloon at the end of the catheter pressed at the blood vessel to stop bleeding. If a lot of bleeding occurs the continous bladder irrigation with saline water in order to prevent blood clot is needed. The diagnosis and treatment mentioned may cause injury of the membrane of the urinary tract and the urinary tract can not release the secretion to cover the urinary tract.This situation makes it easy for the microbes to enter the body and if some patients may have bleeding the blood will be the good media for the growth of the microbes and makes the infection getting worst. The research

revealed that inserting the instruments into the urethra accounted for 20 percent of urinary tract infection (Stamm, 1992:588).

3. Surgery of the Urinary Tract System. The susceptibility of getting urinary tract infection depends on the types of surgery and the underlying diseases, for example, stones, tumors, or congenital abnormal urinary tract. During the operation, if the tissues were damaged a lot, for example, too much contraction of the surgical wound, over use of electrodesiccation at the bleeding part, or holding a large portion of the bleeding blood vessels, inserting the drainage tube at the wrong position, or have an instruction in the drainage tube which may cause the retention of urine, blood, serum after the operation and will be the good media for the growth of the microbes and will lead to an infection.

EPIDEMIOLOGY OF NOSOCOMIAL URINARY TRACT INFECTION

The nature of the nosocomial urinary infection can be classified accordingly with the epidemiological principles as the following 3 factors:-

1. Host
2. Agent
3. Environment

If these 3 factors exist the infection will be occurred through the mode of transmission.

1. **Host. Some important factors include:**

1.1 Sex. Most of urinary tract infection was found most in females than in males (Somwang Danchaiwichitr, 1996; Kunin, 1987). This finding may be due to the short urethra, about 4-5 cm., of females and it located very near to the anus where there are many microbes. Therefore, it is easier for microbes to be contaminated and enter into the urethra to the bladder. For males, the urethra is about 15-20cm. Whereby an opportunity for contaminated microbes to the bladder is very small (Surakiet Archanuparp, 1995; Burke & Riley, 1996). Besides, in males there is Tamm-Horsfall protein, an enzyme released by the prostate gland, that can inhibit the growth of microbes, thus, the urinary tract infection was found less in males than in females (Suchai Suntarapa, 1992; Stamm, 1992). It was also found that indwelling urinary catheters account for 70-80 percent of urinary tract infection among females whereas the urinary tract infection was found 20-30 percent among male patients with indwelling urinary catheters (Garibal, 1993).

1.2 Age. Among the elderly it was found that higher cases of nosocomial urinary tract infection were found because of the body degeneration and the lower immunity. In normal situation, the urinary tract infection was found about 10-20 percent compared with 30 percent during hospitalization. Among the persons age 55 years and older, the infection rate for males and females is similar, the rate of females is 10-15 percent while the rate for males is 4-15 percent. This may be due to the enlarged prostate gland in males which caused the retention

of urine in the bladder where microbes grow very fast in urine. At the same time less Tamm-Horsfall protein enzyme was released and makes the infection easier (Measley & Levison, 1991).

Besides, the elderly is susceptible to infection because of the low body immunity, having chronic diseases, for example, disease of the nervous system, cardiovascular disease, diabetes, etc. which caused the abnormal function of the urinary tract system. Generally, there was about 44 percent of urinary tract infection found among the elderly compared with 28.0 percentage found in the younger group. It was also found that the older patients with indwelling urinary catheters who had urinary tract infection are 5 percent susceptible for septicemia (Emori et al., 1991).

1.3 Underlying of diseases.

1.3.1 Diabetes. There is about 20 percent of the diabetic patients to get urinary tract infection whereby female diabetics are three time more likely to have urinary tract infection than normal ones (Nicolle, 1993). This was due to the abnormality of the automatic nervous system which usually controls the function of the bladder in releasing urine. Therefore, there are the retention of urine in the bladder. Sugary urine is the appropriate media for the growth of bacteria and fungi and also damages the body's natural defense mechanism including the degeneration of capillaries which resulting in tissue inflammation and tissue necrosis (Measley & Levison), 1991).

1.3.2 Obstruction of the Urinary System. The obstruction may be due to congenital abnormality or acquired causes, for example, stones, enlarged prostate gland, etc. The obstruction occurred will disturb the urine flow and the retention of urine makes the rapid growth of bacteria (Kunin, 1987).

1.3.3 The Diseases that Destroy the Body's Immune System. The diseases include cancer, blood diseases, abnormality of body's immune system, including the patients who are on immunity-block medication or radiotherapy, which lowers the body's immune system and easier to get infection.

2. **gent**

Microorganism that cause nosocomial urinary tract infection can be classified into 2 groups as follows:

2.1 Endogenous organism. These organism are normal flora that are found at skin, digestive system, perinial area, vagina, openings of urethra and anus. Among the patients with indwelling urinary catheters, Enterobacteriaceae are the most important organism especially E.coli which caused about 50 percent of urinary tract infection (Turck & Stamm, 1981; Sobel, 1991).

2.2 exogenous organism. Most of the nosocomial urinary tract infection caused by the organism that resisted to the antibiotics used which contaminated the medical instruments inserted in the body's organs, for example, the catheters, the instruments used for inspecting the inside of the urinary system, contaminated flushing solution, etc. The

exogenous organism were passed in the urinary tract through medical personnel or medical instruments.

3. Environments

The environments that cause the nosocomial urinary tract infection are the non-living environments, for example, medical case instruments, nursing care, antibiotics used, and also living environments which include patients' relatives, other patients, medical personnel, etc. The living environments may be the source of infection through the following activities:

3.1 urinary catheterization technique. During performing urinary catheterization the organism may enter the urinary system by 3 means: the unclean catheter due to improper sterilization, contamination occurred while holding the catheter, pushing the organism at the end of the contaminated catheter into the bladder, or in case of indwelling urinary catheter the organism at the area between the catheter and the urethral epithelium get in the bladder.

Besides, the urinary catheterization without indications, improper technique used, improper size of the catheter, including the lack of knowledge and experience of the nurse who performs the catheterization may make the urethra irritated or injured which caused the increased infection (Hustinx et al.,1991). According to Garibaldi et al.,1974. who studied 405 patients with indwelling urinary catheters and have urinary tract infection, 255 females and 150 males. The association between the staff who performed urinary catheterization and the bacteriuria of the female patients who had

indwelling urinary catheters was tested and it was found that the highest number of bacteria was found in the patients that received the services from technical nurses 34.3 percent, followed by professional nurses 21.0 percent and physicians 10.0 percent.

3.2 Another source of infection from the environment is the use of unsterilized instruments for performing urinary catheterization including unclean disinfectant solution and other solutions. These contaminated instruments are the carriers of organism into the urinary system. The data from the studies showed that there was a correlation between the nosocomial urinary tract infection and the medical instruments used was 75 percent. (Degrot & Kunin, 1975), as related to the size and the type of materials used for making the catheters.

The urinary catheters which were made of latex coated by silicon are the most popular type of catheter because the smooth surface of the silicon which makes the insertion easily. But the silicon coated will be melted within 2-3 hours (Ruutu et al. 1985). If there are bacteria in urine it will take the silicon to be melted within 2-3 days. Therefore the catheter must be replaced before the urinary tract infection occurs (Garibaldi, 1993). For the patients who need to have indwelling urinary catheters longer than 7 days the catheters that were made of silicon should be used (Wiroj Chodchoi, 1986). The study carried out by Edwards et al., 1983 regarding the insertion of urinary catheters and the urethral epithelium of rats showed that the catheters made of red rubber destroyed almost of the urethral epithelium and caused severe inflammation with secretion and bleeding. It was found that latex catheters caused middle level of damage and some urethral epithelium were shed, with some bleeding. For plastic catheter, it

was found that some inflammation occurred and some urethral epithelium were shed, with no secretion from the inflammation. For silicon catheter, the change has been occurred.

3.3 The situation of the patient wards and of the patients. The unhealthful physical environments cause the dirty and contaminated environment. Because, the crowded wards and the nonuse of guarantee principles may promote the spreading of organism from one patient to another. The conditions of the patients within one room, for example, having infected wounds, abscess, communicable diseases, being catheterized or other inserted instruments, etc., these conditions are the sources of infection that can be transmitted to other patients. The data from the studies revealed the high rate of urinary tract infection 35-40 percent was found in the following wards: surgical, internal-medicine, neurological surgery, and orthopedics surgery. But the lower rate of urinary tract infection was found in the obstetric and gynecology section. The source of organism was found most in the high wetting areas like wash-basins, faucets, disinfectant solution, and cabinets that keep medical instruments, including unorganized the physical surroundings. The most important factor is the crowded patients, room, the bed of the catheterized patient is closer to the bed of infected patient. These conditions are the causes of the transmission of organism from one patient to another ones through the nursing personnel's hand, especially the personnel did not clean their hands

and ignored aseptic techniques (Bunternng Thanadpojanarmaty et al., 1986; Garibaldi et al., 1974).

- 3.4 Nursing personnel. The nursing personnel who are disease carriers or who have signs of infections disease including who ignored washing their hands, these personnel's hands are the significant media of spreading the organism directly or indirectly. From the 5-year epidemiological report, investigated by the United States Center for Disease Control, it was found that there were 7 times of epidemics of urinary tract infection which occurred with the patients with indwelling urinary catheters. The organism that caused the epidemics were Gram negative bacteria that resisted many types of antibiotics. The investigation showed clearly that these organism were from nursing personnel's hands (Schaberg, Weinatein & Stamm, 1976).

MODE OF TRANSMISSION

Most of the nosocomial urinary tract infection in the patients with indwelling urinary catheters are caused by direct and indirect transmission of the nursing personnel, as follows:

1. Direct Contact. The organism were transmitted from nursing personnel's hand, who did not clean their hands and cleaned their hands improperly, to another patients. Thus, if the nursing personnel clean their hands properly before and after providing nursing will help decrease the nosocomial infection about 50 percent (Craven & Hernle, 1992).

2. Indirect Transmission. This related to the use of contaminated instruments for urinary catheterization, or the contaminated saline water and disinfection solutions used for providing nursing care of the patients with indwelling urinary catheters. These instruments, if were not disinfected or sterilized properly or used without separating for each individual patient, they will be the good transmitters of organism to the urinary system and will result in infection. The urinary catheter is the most important transmitter of the organism that cause urinary tract infection (somwang Danchaiwijitr, 1990; Kunin, 1987, and Stamm,1992).

INDICATIONS OF URINARY CATHETERIZATION

Urinary catheterization is usually used with the patients who could not urinated or the severe patients that kidney function and blood circulation needed to be evaluated. In Thailand it was found that one fourth of urinary catheterizations were operated without indications (Somwang Danchaiwijitr and Supat wanichayakorn, 1996). Each urinary catheterization operated can directly bring organism into the bladder. Therefore, urinary catheterization should be done only for the patient with indications and the indwelling urinary catheter should not be done just for the convenience of the care givers. The indications for urinary catheterization are as follows (Falkiner, 1993; Potter & Perry, 1990; Taylor, Illis, and Emon,1993).

1. Indications for temporary urinary catheterization

- 1.1 Urinary catheterization is needed for those patients who could not urinate by themselves because of the injury of the urethra, post-surgery patients and postpartum patients who could not urinate within

8-12 hours, and other types of patients who could not urinate by themselves, which may be caused by the effects of the depressive drugs and anesthetic, with the aim to drain the urine left in the bladder and release the uncomfortable condition caused by the increased pressure in the bladder.

- 1.2 The urinary catheterization will be recommended when aseptic technique for getting urine samples was needed.
- 1.3 In case of cord injury, urinary catheterization is needed for measuring the quantity of the urine left in the bladder after the patient had urinated.

2. Indication for Indwelling Urinary Catheters:-

- 2.1 The obstruction of the urethra which may be caused by the narrowed urethra, severe enlargement of prostate gland, tumor of the prostate gland or the urethra, etc.
- 2.2 In the post surgery patients of urethra or nearby areas of urethra, whereby wetting is inhibited.
- 2.3 To release the contraction of the bladder during surgical operation or in case of long period of surgery.
- 2.4 To prevent the obstruction of urethra from blood clot after the surgery of urethra or tumor of the urethra.
- 2.5 To measure the correct quantity of the urine of the severe patients.
- 2.6 To prevent wetting that may promote the occurrence of bed sore in the patients who could not hold urination, who had unstant urination, or the coma patients. Among these patients if avoidance of urinary

tract infection from urinary catheterization is needed, pampers can be used instead of urinary catheterization but the patient must be closely cared.

2.7 To irrigate bladder, temporary or continuously.

CHARACTERISTICS AND CHOOSING OF THE URINARY CATHETER

The urinary catheter is the instrument used to insert through the urethra into the bladder. It is a tube, with one or more than one holes at the opening part that goes into the bladder, to have urine flow easily from the bladder (Christenson & Kookrow, 1991). Usually, the catheter was made of soft plastic, rubber, or metal but plastic or rubber catheter was used for urinary catheterization because the softer catheter will cause less irritation to the urethral epithelium. The urinary catheters have been developed and improved gradually in order to make them appropriate for urinary catheterization and to lower the complications caused by the catheters. Many types of materials have been tested. There are 2 characteristics of the catheters that were mostly used, as follows (Prapit Janprugsu, 1997):

1. Non-indwelling urinary catheter. This type of catheter has a single lumen, was made of metal, glass, and rubber, etc. The end of the catheter that inserted into the bladder is a circular shape, one-lumen tube. This type is used for temporary catheterization but if continuous catheterization is needed, the plaster type can be used for holding the tube. Therefore, this catheter was used rarely and sterilization must be done for repeated use.
2. Indwelling urinary catheter. This type is the Foley catheter. Within the tube there is an extra passage for pulling water into the small balloon-water bag near

the opening part that goes into the bladder. There are two types of the catheter, double-lumen catheter and triple-lumen catheter. The first lumen is for removing the urine, the second lumen is for instilling 5-10 ml. of saline water which makes the balloon to hold the catheter inside the bladder, and the third lumen is for instilling saline water to irrigate the bladder. This type of catheter must be disposed after using once because it will be more dirty than the temporary urinary catheter (Wanee Phoethinakorn, 1997).

There are different sizes of the catheters. The choosing of the correct size of the catheter is very important. The correct size of the catheter that fits to the urethra must be chosen. The smaller or bigger size should not be avoided. The smaller size may cause less irritation of the urethral epithelium compared to the bigger size but the flow of the urine is slowly and may cause the leak of urine near the catheter (Kasinee Henpitugs, 1993; Jantarapugsa, 1997). This may transmit the organism near the catheter into the bladder easily (Kaye & Hessen, 1994). For the bigger catheter, it will irritate or injure the urethral epithelium coupled with the difficulty of the secretion flow released by the urethra near the catheter which makes the rapid growth and spreading of organism to the nearby tissues and leading to infection complications (Anupan Tantiwongs, 1986). Therefore, the selection of the appropriate size of the catheter must be made seriously in performing urinary catheterization. Presently, the numbers of the catheter have been assigned for different sizes based on the standard diameters of the catheters. The popular standard that was used worldwide is French (Fr), whereby 1 Fr is equal to 1/3 mm. (Sawanee Subannaratna, 1993). The sizes that are used popularly, are as follows (Poonsuph Soparatana, 1997):

Male child	6-8	Fr.
Female child	8	Fr.
Male adult	14-16	Fr.
Female adult	14-16	Fr.
Elderly	22-24	Fr.



URINARY CATHETERIZATION TECHNIQUE

Urinary catheterization is the insertion of the catheter through the urethra into the bladder to withdraw urine. Therefore, urinary catheterization is considered as a risky procedure for transmission of organism directly into the body whereby aseptic technique must be used strictly (Willis, 1995). If indwelling urinary catheter is needed, the susceptibility to urinary tract infection is more increased (stickler, 1990; Warren, 1995). Thus urinary catheterization for each patient must be done accordingly with the indication only and the responsible personnel must be knowledgeable and skillful in using appropriate aseptic technique in every step of urinary catheterization starting from preparation of instruments, preparation of the patient and catheterization technique.

The United States Center for Disease Control recommended that handwashing must be done before performing and after contaminating with patient's blood urine or secretion (Bryant & Lewicki, 1992). Since handwashing is the most effective technique that can be easily done, with low cost, and can lower the contamination from the direct exposure (Cole, 1996). The appropriate technique of handwashing can lower the amount of organism (Ayliffe, Collius & Taylor, 1990; Larson & Preston, 1995), and

can lower the nosocomial infection about 50 percent (Craven & Hirnle, 1996). The results of the study showed that handwashing before and after providing nursing care could lower the nosocomial infection from 33 percent to 12 percent (Coney et al., 1989). Generally, there are 3 types of handwashing technique: normal or social handwashing; hygienic handwashing, the technique used before and after providing aseptic nursing technique with the patient with contagious disease or contaminated objects; and surgical handwashing. For performing urinary catheterization and providing nursing care for the patients with indwelling urinary catheters, hygienic handwashing must be used, by using chlorhexidine gluconate 4% or iodophor 7.5% (Akoeh Unhalekhaga, 1998). The details are as follows (Somwang Danchaiwijitr, 1992; Gould, 1994):

1. Before doing handwashing, taking off the accessories, for example, a ring, a watch;
2. wetting the hands up to the elbows with faucet water;
3. Washing hand with disinfection solution for at least 30 minutes, in accordance with the washing steps presented in Figur 2, Appendix B.
4. Washing hands with clean water, dry with clean cloth (one piece of clean cloth for 1 time of handwashing).

In case of emergency, if the hands are not wet and are not contaminated, 70% alcohol and 1% glycerine can be used instead by pouring about 3-5 ml. of the solutions into the palms, rubbing hands thoroughly, let the hand dry without using neither water nor cloth (Sayomporn Sirinawin and Bunjong Wannaying, 1994). But this technique is used in case of emergency only.

RELATED LITERATURE

Platt et al.(1986) studied the risk factors of urinary tract infection among the patients with indwelling urinary catheters by using multivariate analysis. The following risk factors were found: period of catheterization, nonintravenous- antiseptics prescribed, poor drainage system, female, contaminated urine bag, indications of indwelling urinary catheter, diabetes, and poor catheter care during catheterization e.g. misplacing of the connection between urine bag and the catheter,etc. These factors caused urinary tract infection among the patients with indwelling urinary catheters.

Husynx et al.(1991) reported the surgery of 2 hospital in Netherland that 61 percent of the patients received antibiotics during having indwelling urinary catheters. It was also found that the patients with catheterization within the period of 3-4 days, if appropriate antibiotics were prescribed within 48 hours before taking off the catheters could be able to lower the bacteria 5 times. But this conclusion is still controversial. Among the patients with indwelling urinary catheters of less than 3 days or longer than 14 days, only positive effect could be get from antibiotics (Bryan & Reynolds, 1991).

According to Garibaldi et al. (1980) and Daifuku (1984), it was found that having bacteria at the urethral meatus was higher risk for urinary tract infection whereby the female patients whom bacteria were found at the urethral meatus were 4 times likely to have urinary tract infection. But for male patient, the risk of having urinary tract infection was decreased to 2 times compared to those whom no bacteria were found at the urethral meatus.

Patt et al. (1983) found that the close of various connections between the catheters and urine bag, and close the connection at the drainage port will lower the infection rate from 15 percent to 10 percent which was congruent with the study carried out by Schaeffer (1986) and Warren (1987). The risk of urinary tract infection is going up. If the open drainage system was used, it was found that the urinary tract infection will be 100 percent within 3-4 days. But if the closed drainage system was used the infection rate will be decreased to 5 percent/day and bacteria will be lasted to more days, about the 8th day of catheterization. However, warren (1991) mentioned that the bacteriurea will be lasted for 30 days if the closed drainage system was used.

Somwang Danchiwijitr et al. (1992) studied the result of the use of indications for prescribing urinary catheterization by the physicians for 16,958 percents in the Internal Medicine and Surgery Departments of 13 hospitals from every region of Thailand, during april-may, 1989. It was found that having the physicians read the information of indications before prescribing urinary catheterization did not lower the urinary catheterization prescription rate. There were 96.5 percent of the physicians cooperate with reading the indications for urinary catheterization. There were 3 times that the physicians did not prescribed urinary after they read the indications. The researcher discussed about the unnecessary urinary catheterization that because of the inadequate member of the nurses compared with the large number of the patients and sometimes the unconscious patients urinated oftenly, therefore, the physicians prescribed urinary catheterization in order to prevent uncomfortable condition of the unconscious patients whereby the researcher thought that it was not appropriate for the physician to do that.

Since it is unable to lower the rate of indwelling urinary catheters, other methods have been studied to replace it, for example, using condom to retain urine, and suprapubic catheterization. Hirsh et al. (1979) studied the use of condom in male patients instead of indwelling urinary catheters. It was found that the use of condom to retain urine caused bacteriuria and urinary tract infection. It also caused infected wound at the reproductive area, including the obstruction of urine flow because the condom was soft and was easy to be folded, which was one of the disadvantages of condom catheterization. Regarding the comparison of the urine drainage between the use of suprapubic catheterization and condom catheterization there was no adequate data to justify the difference of urinary tract infection occurred when compared with indwelling urinary catheterization.

The United States Center for Disease Control (1991) recommended that the new urinary catheter should be replaced the old one if there is an obstruction of the catheter, including changing the urine bag. There is no evidence that the urinary tract infection will be lowered if the change of urinary catheter or the urine bag was done in a certain date. However, it was found that the change of the urine bag only increased the urinary infection rate.

The Center of Disease Control also recommended for hospitals, nurses, and the members of the nosocomial infection prevention and control committee in controlling and preventing urinary tract infection as follows:

1. The recommendations that must be followed strictly which can lower the urinary tract infection at a high level:

- 1.1 Education program should be organized for the hospital staff regarding aseptic technique in inserting urinary catheters and patient care.
 - 1.2 Use indwelling urinary catheter only when it is necessary.
 - 1.3 Handwashing before and after measuring the urine of each patient should be emphasized.
 - 1.4 Maintenance care of the closed drainage system.
 - 1.5 If urinary catheterization is needed, intermittent catheterization is recommended.
 - 1.6 When taking the urine sample, use the appropriate technique, not open the connection of the urinary catheter and the urine bag.
2. The recommendations that should be followed which can lower the urinary tract infection at the moderate level:
 - 2.1 Organizing a refreshment course for the hospital staff regarding caring patients with indwelling urinary catheters.
 - 2.2 Choosing the appropriate size of the catheters.
 - 2.3 Changing of the urinary catheter and the urine bag should not be done at definite schedule set.
3. The recommendations that should be followed which can lower the urinary tract infection at the low level:
 - 3.1 using other technique to drain urine.

3.2 Separating the patients with urinary tract infection from the patients without infection.

3.3 Avoiding constant sample urine taking for urine cultures.

RESEARCH CONCEPTUAL FRAMEWORK

From the review of related literature, the epidemiological study of nosocomial infection revealed the following related factors:

Host. There are specific characteristics of the host that affect high sensitivity to the infection, e.g. gender, age, and underlying diseases.

Agent. Most of the organism that cause the infection are Gram-negative bacteria from both endogenous and exogenous sources. The bacteria can be found in the environment both living and non-living environments, e.g. nursing personnel, disinfection solutions, instruments, etc.

Environment or Mode of Transmission. The important transmission mechanisms of organism from one source to the patients are: contact, urinary catheterization, and indwelling urinary catheters whereby an instrument has been inserted into the urinary tract system. The personnel who performed urinary catheterization is the living environment if did not the aseptic technique by using unsterilized instruments and did not wash their hands by using hygienic handwashing, the organism can get into the patients' body from the nursing personnel's hand while

inserting the urinary catheter and providing nursing care for the patients with indwelling urinary catheters.

Therefore, if the nursing personnel provided appropriate care for the patients with indwelling urinary catheters, it will help prevent and control nosocomial urinary tract infection.

CONCEPTUAL FRAMEWORK

