**Infection Control**

**Executive Summary**

Catheter-Associated Urinary Tract Infections (CAUTI) is one of the most common causes of infections in hospitals in Hong Kong. Foley Catheter is commonly used invasive device and is widely associated with urinary tract infections. Escherichia coli are common bacteria that are easily transmitted through the invasive devices used to assist patients with serious complications. STEC produces two bacteriophage-encoded Shiga toxins, Stx2 and Stx 1. The two bacteriophages are of AB5 –Type toxins. Binding occurs between the B-pentema of holotoxin and the host’s globotriaosylceramide (Gb3) present in the microvascular endothelial cell surface such as intestines, brain and kidney. Shiga toxin-producing E. coli was first reported as a human pathogen when the first outbreak occurred nearly 30 years ago in Wong Sin Tai District. STEC O 157:H7 was then labeled as rear until 1993 when undercooked hamburgers resulted into a multistate outbreak. I would recommend the government to totally implement the policy guidelines put in place by the World Health Organization to minimize the cases of STEC infections which are associated with invasive devices.

**Introduction**

Healthcare associated infections are on the rise and troubling the healthcare Industry. Hospitals have become breeding grounds for the organism associated infections. Patient safety networks and organizations which are more concerned with the quality of service delivery, are looking for appropriate ways to improve infection control and reduce the number of patients who get infected. Some of the bacteria that are widely liked to Healthcare-associated infections are Clostridium difficile, Staphylococcus aureus, norovirus and Escherichi coli. Catheter-Associated Urinary Tract Infections (CAUTI) is one of the most common causes of infections in hospitals in Hong Kong. Foley Catheter exposes the patients to a greater risk of getting urinary tract infection (UTI). The infection which is mainly in the form of bacteria such as the Shiga Toxin-Producing E. coli, can gain access to the urinary system through the urethra. It can then spread to the kidney causing serious failure of the organ and damage to the body. This paper aims to discuss Catheter-Associated Urinary Tract Infections in details including the risks to the patients.

**Shiga Toxin-Producing E. coli (STEC)**

STEC produces toxins referred to as Shiga-toxins because they are similar to the toxins that come from Shigella dysentriae. STEC can thrive in temperatures that range between 70C and 500C. The temperature at which the bacteria have it optimum operations is at 370C. Some STEC can grow in acidic environment of up to a pH 4.4. The bacteria are versatile and can survive in foodstuff with a very low water activity of up to (aW) of 0.95. High temperatures that go up to 700 C and above are likely to denature the organism. The most common serotype of STEC is STEC O157:H7 in relation to public health through other serotypes have also tested positive in cases of outbreak.

STEC produces two bacteriophage-encoded Shiga toxins, Stx2 and Stx 1. The two bacteriophages are of AB5 –Type toxins. Binding occurs between the B-pentema of holotoxin and the host’s globotriaosylceramide (Gb3) present in the microvascular endothelial cell surface such as intestines, brain and kidney. GB3 is highly expressed in the renal glomerular endothelial cells of humans allowing the binding of the Shiga toxins which is followed by endocytosis of the toxin. The toxin then finds its way to the endoplasmic reticulum and the Golgi apparatus. Cleavage happens where N-terminal A1 domain subunit is separated from the C-terminal A2 domain by the help of a protease. The reduction of the disulfide bonds results into the release of the A1 subunits which then enters the cytosol through chaperone-mediated transfer. The 1A subunit is an N-glycosidase that acts upon the 28S RNA of the 60S ribosomal subunit resulting to apoptosis of endothelial cells and the inhibition of the process by which the proteins are synthesized. This process majorly affects the kidney. The damage of the endothelial cells contributes to the renal glomerular lesions. The cells enlarge in size and detach from the fibrin thrombi form, the basement and then capillary lumen is also narrowed. The glomeruli experience cut off of the blood supply when the capillary lumen becomes narrow and this is likely to result to interference with the kidney functions.

The Stx2, on the other hand, can cause the damage of the kidney indirectly via uncontrolled complement activation or directly. A purified Stx2 activates an alternative path of the complement system and binds to the fluid phase complement regulator, factor H. When the complement cascade is activated and the regulator factor H is immobilized, there results induced renal injury. There is a huge number of variant Shiga toxins that are associated with the STEC. For instance, Stx1 consist of three variants (stx1a, Stx1c, Stx1d) and Stx2 has (stx2a, stx2b, stx2c, stx2d, stx2f, stx2e, stx2g) thus labeled a more potent toxin than the Stx1. There is a report showing that Stx2a is more virulent than the Stx1 since the Lethal Dose 50 (LD50) in mice >1000 ng in Stx1 and only 6.5 ng in Stx2a.

Shiga toxin-producing E. coli was first reported as a human pathogen when the first outbreak occurred nearly 30 years ago in Wong Sin Tai District. STEC O 157:H7 was then labeled as rear until 1993 when undercooked hamburgers resulted into a multistate outbreak. The statics by the Center for Disease Control and Prevention showed 350 cases of the outbreak in 49 states with about 8598 patients. The rate of hospitalization was at 17.4%. 75 % of the infections came from fresh produce and ground beef. The rest came from person to person infection, animal contact and waterborne sources. Majority of the infections took place between the period of May and September. Very young and the elderly population are the most likely target of the theses infections. In Hong Kong, the STEC bacteria are associated with the most cases of acute kidney failure in healthy children with an infection rate of 1/100,000.

**Invasive Devices Associated with CAUTI**

Invasive devices are commonly used in the hospital in handling infectious complications such as the ones caused by STEC. Immediately the patient is taken to the hospital, they are evaluated for venous access needs. The patients who have serious conditions and those with urinary retention may require a urinary catheter. A Foley catheter which is a thin flexible tube is a commonly used CAUTI to drain urine out of the patient’s body. The tube is normally attached to the bladder of the patient. The patient is at a huge risk of getting infected by bacteria such as STEC which is a common urinary tract infection (UTI). The bacteria can gain access through the urethra and ladder spread to other parts such as the kidney causing serious complications such damage of the entire organ. The medical providers can always prevent CAUTI. The nurse attending to the patient should ensure high level of hygiene around the patient whole using the devices. The devices should never be put on the floor or other surfaces that they can get exposed to infections.

**Local Practice in the Hong Kong on CAUTI**

Cases of Catheter urinary associated infection (CAUTI) which are related to Shiga Toxin-Producing E. coli (STEC O157:H7) is estimated to 3,200 infections and 96,000 cases of diarrhea, reported in hospitals in Hong Kong each year. Human infections have been reported to occur three to four days after the bacteria have been ingested. The patients were reported to exhibit vomiting, diarrhea, low-grade fever that continues for 5 to 7 days and stomach cramps. Cases urinary associated infections, that may cause permanent or transient kidney damage has also been reported though in rare occasions. A case was reported on October 24, 2011, by Wong Tai Sin District Department of Health where a cluster of STEC O 157:H7 infections. Following this development, the Center for Disease Control and Prevention (CDC) rolled out a multistate investigation and the outcome was that there were cases within Districts in the Hong Kong. The local and State Public Health Officials in Wong Tai Sin District identified Laboratory confirmed cases of STEC O157. An overall 58 cases of STEC infection were reported in 10 states. The median age of cases was 28 years. The female population was at 61% and 39% were male. 34 of the cases which contribute to 68% were hospitalized and there were 3 documented cases of who developed hemolytic uremic syndrome (HUS). In all the cases, there were no deaths reported.

The report found out that most of the human cases reported in Hong Kong were linked to CAUTI with STEC O157 being the bacteria responsible. There is a rise in cases of infections coming from Foley Catheters in the entire Hong Kong. These findings emphasize the importance of public health to educate people on the risks of using invasive devices that are not carefully taken care off. This has also been done by putting in place policies that will help minimize the exposure of the public to feature infections. In this study, Foley Catheter contributed to a huge number of cases of illness of up to 64.9%. In Hong Kong, STEC O 157 has been isolated as the major bacteria resulting into CAUTI. The outbreaks associated with CAUTI are not expected to reduce in the Hong Kong unless the changes in handling invasive devices as proposed by the CDC are implemented. The rising cases of contamination associated with CAUTI in Wong Tai Sin District have raised important preventive questions.

The nurses are in Hong Kong are carrying out their practice according to the recommendations put forward by Scientific Committee on Infection Control (SCIC) on CAUTI. The recommendations provide the nurses with best practice of urinary catheters. The necessary are provide with education that will help them to carry out their practice with competence. The nurses are required to limit the use of catheters to patients who have serious conditions only and the use of the devices have more benefits than risks. The nurses educate the patients on the importance of maintaining the hygiene of the catheters. The nurses are advised to use alternative options in cases where the need of catheters is not that much important. The alternative options include the use of catheterization, use of condom catheters, use of disposable nappies and intermittent urethral catheterization. The nurses are adopting the use of automatic urinary catheters that will stop when they are no longer needed.  The nurses change their gloves when they change patient to avoid the transfer of the CAUTI.

**Chain of infection of CAUTI**

**Figure 1: Six Links Chain of Transmission**

The links between each stage shows something that can help spread the disease. This can be an invasive device or a person. Infection is passed to the next person when the chains remain linked together. This chain shows how STEC infections can move from one patient to the other and eventually to the whole facility. The bacteria grow in or on a person (the reservoir), they can then be spread to the next person through bodily fluids such as stool (The portal of exit). The organisms then spread to the invasive devices such as the Foley Catheters through contamination when they are handled by the infected persons. The nurses or other medical providers can be the mode of transmission if the hygiene around the facility is not well maintained. The bacteria enter the body of a new person as shown in the chain and continue to spread the infection. Invasive urinary catheters serve important purpose as medical devices, but when handled in appropriately can introduce infections to the patients resulting to CAUTIs and other healthcare-associated infections. There are however several ways through which the chain of infection can be broken. It can be achieved through educating the healthcare providers together with the patients on hand hygiene by using sanitized gloves. They should ensure that the patients are allocated clean rooms and the surfaces where the devices are placed should be disinfected. The Catheters should be well taken care off so that they are not infected. The patients should maintain high levels of personal hygiene; have their wounds covered, taking precautions during isolations and proper waste disposal.

The staff at the hospital has role to play in preventing the patients from the portal of exit of the infections. They should the approved rules for handling the indwelling urinary catheters. The Center for Disease Control and Prevention (CDC) acceptable criteria for indwelling catheters are:

* Perioperative for selected surgical procedures of the genitourinary tract or long procedures.
* In residence with prolonged immobilization
* Assist in the healing of sacral wounds
* Bladder outlet obstruction

 

**Figure 2: Entry Pathways of Microbes**

An indwelling urinary catheter (Foley catheter) can increase the risk of a patient getting infected. The Foley catheter is a tube that is connected through the urethra into the bladder and leads to the closed drainage system. They can therefore act as an entry of microbes. They become a way in for the E. coli and associated bacteria when they are in contact with the skin such as the perineum which can contain some of the most harmful E. coli. The STEC then gets attached to the catheter and finds its way into the bladder. Many CAUTI have been found to derive from the host’s own bacteria which is located just next to the rectum.  The outside part of the catheter is known to be most common route through which the infection finds its way into the bladder. With time, when the catheter is not well taken care off, the inside of the catheter becomes a route of infection and even the drainage bag.

**Comparison of Statics**

In 2009, Center of Disease Control and Prevention came up guidelines that required that all the stools submitted to the clinical laboratories for the diagnosis of acute community diarrhea be tested for Shiga toxin. The guideline was put in place after STEC was associated with most cases of CAUTI. The routine consisted of the use of selective differential agar technique to detect Shiga Toxin-Producing E. coli (STEC). The reports of this publication found out about 96, 534 STEC O157 infections occur annually in the Hong Kong. The infections are linked to 3,600 hospitalization cases and 30 deaths each year. According to the report by Center of Disease Control and Prevention Annual Summary, there were 0.72 per 100,000 population national isolation rate of STEC O157:H7 related CAUTI in 2009 alone. Overall cases of STEC are detected in 0% to 4% of stools submitted to testing in the clinical laboratories. These figures are approximated because the signs and symptoms associated with CAUTI vary from one individual to the other before it riches a stage deemed as life threating. Thus the main of the Center of Disease Control and Prevention current recommendation was to ensure that cases of outbreaks are diagnosed at an early stage. This allows the patients to receive the appropriate care and the additional cases of CAUTI can also be identified and documented. According to CDC, the beginning of 2008, most clinical microbiology laboratories put in place protocols to minimize CAUTI complications.

Another study was conducted in the Hong Kong between 1983 and 2012 to determine the cases of CAUTI that result from STEC O157:H7 and the necessary mitigation measures to improve the conditions in England and Wales. The study was divided according to different demographics such as age, sex and geography. According to age, 13,015 which is 91.8% of the cases were based on age. Children aged 15 years and below were 45.1% while those between 1 and 4 years were 22.8%. Patients with a younger age were more vulnerable to severe cases of STEC infections just as it was in the Hong Kong. Patients with 60 years and above reported an infection rate of 0.98 cases per 100,000 persons annually. Children of ages 1 to 4 years experienced severe cases with a rate of 7.21 cases per 100, 000 persons annually. Those between 20 and 59 years experienced a rate of 7.16, p<0.001 and patients with 60 years and older had a rate of 7.36, p<0.001.

According to sex, there were 13, 947 patients which is 98.3% of the population. Female was 7,717 which is 55.3% of the cases and male patients constituted 44.7% with an infection rate of 1.19, p<0.001; 1.76 cases per 100,000 persons annually. The cases of infections in women were more severe at 1.48 per 100,000 persons annually. Sex disparity was highest in patients in the age bracket of 20 and 59 years with a rate of RR 1.60 for female and p<0.001 for male. Similar to Hong Kong, the proportion of the Stx2 strain reduced as the age increased. The outbreak of CAUTI from STEC was more prone in some regions in England such as the regions of Lancashire and Cumbria which had an infection rate of 3.70 cases per 100,000 persons per year. Yorkshire and Humber recorded rate of 2.75 cases per 100,000 persons annually while Cornwell, Somerset and Devon recorded the lowest cases at 2.71 cases per 100,000 persons annually. These statics are in accordance with the ones experienced in Hong Kong with some regions such as Wong Tai Sin District recorded the highest cases of outbreak of CAUTI.

**How Effective is Local Practice**

Due to the persistent cases of CAUTI infection, the local government in the Hong Kong has put a lot of effort to try to combat the increasing cases associated with the bacteria, STEC. This involves establishing a control measure at all the stages of the chain of spread of infection by the bacteria. It is confirmed that good hygiene can reduce the CAUTI cases but does not totally eliminate the presence of CAUTI. The guidelines require that all the surfaces which are touched frequently in the hospital are disinfected. This helps to reduce the chances of spread of CAUTI to the patient and the staff in the hospital. Disinfecting the surfaces kills the bacteria and viruses that are not visible with the baked eye. This ensures that when the next person touches the surfaces and will not carry the microorganisms on their hands to the next place or infect themselves in the process. The commonly touched surfaces in the hospital are door handles, telephone, tray table, bedside table, bed rails and call buttons among many other surfaces.

The hospital stuff are also provided with training module to help them handle the equipment that are used in the hospital to minimize the risks of CAUTI. At the end of the training module the staff is expected to identify the chain of infection and use appropriate strategies to break the chain. They should be able to explain the role a clean environment plays in preventing CAUTI complications. They should understand the importance of maintain and taking care of catheters in terms of the cleanliness of the environment. This will help the hospital residence from acquiring catheter-associated urinary tract infections (CAUTI). The staff should also be able to use important steps when using environmental disinfected to clean the surfaces that are commonly infected with CAUTI. Proper indwelling catheter care by the staff is very important in breaking the chain in which CAUTI takes place. Foley Catheter for instance requires high level of care and maintenance especially if they are not maintained appropriately. The staff assists the patients with good personal hygiene, proper waste disposal and dresses the open wounds to help prevent the spread of the CAUTI through person to person contact.

**Conclusion**

A Foley catheter which is a thin flexible tube is a commonly used CAUTI to drain urine out of the patient’s body. The patient is at a huge risk of getting infected by bacteria such as STEC which is a common urinary tract infection (UTI). Shiga toxin-producing E.coli have several biological adaptabilities that will enable them to survive in the environment and in the body of the host organism for long. STEC can survive up to very high temperatures of 500C and low water content surfaces. It can also live in acidic environment with pH as low as 4.4. The ability to survive in surfaces with low water content enables it to stick on the surfaces of walls before it is spread. These biological properties of STEC make it very difficult to eliminate. Researchers have made an observation that paying attention to high levels of hygiene will lower the rate of spread of infection but can’t totally eliminate STEC. Cases of outbreak of the CAUTI by STEC have been reported in the Hong Kong as well as England. In both countries, the modes of contamination are almost similar to the vulnerable population being the young children and adults of 60 years and above. The local government in Hong Kong has come up with several mitigation procedures to minimize CAUTUI some of which are working but a slow rate. I would recommend the government to totally implement the policies guidelines put in place by the World Health Organization to minimize the incidences of CAUTI.

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