

# An Updated Review on Modified Catheter Related Blood Stream Infections (CRBSIS)

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## **Abstract:**

The CRBSI (the acronym for which is known as the catheter-related bloodstream infection) is known to be the presence of the organism bacteremia that seems to be originating from the source called intravenous catheter. The occurrence of CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is known to occur very commonly and frequently. The CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is also said to be very lethal and is said to be a very frequently occurring complication in the central venous catheterization. Also, other facts about the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is that it is said to be the most commonly occurring cause of the nosocomial bacteremia. The intravascular catheters are said to be play an integral part when it comes to the modern practices undertaken in the healthcare sector. The current review provides an overview of the epidemiology, risk factors, pathogenesis, diagnosis and management of CRBSI.

**Tob Regul Sci. <sup>TM</sup> 2023;9(1): 1161-1176**

**DOI: Doi.Org/10.18001/TRS.9.1.79**

## **Introduction**

The intravascular catheters in the healthcare spectrum is said to be inserted in the patients who are critically- ill so that the fluids, products related to blood, solutions containing medicinal and nutritional substances and vice versa could be administered. However, it is said that the CVCs (the acronym for which is known as the central venous catheters) in comparison to the any other types or kinds of medical devices is said to pose a great risk and threat when it comes to infections that are

procured through device [1,2]. It is said that the infections caused by CVCs (the acronym for which is known as the central venous catheters) are said to cause a large number of morbidity as well as mortality rate. It is also said that the CVCs (the acronym for which is known as the central venous catheters) is said to be the one and only main source for the occurrence of septicemia and bacteremia in the patients that are hospitalized. It is said that the majority or most of the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection) are said to be associated with the CVCs (the acronym for which is known as the central venous catheters) [3,4]. It is said that the when the CRBSIs (the acronym for which is known as the catheter-related bloodstream infection) comes in association with the CVCs (the acronym for which is known as the central venous catheters) then in such case, the risk is said to increase by about 64 times as opposed to the situation where the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection) comes in association with the PVC (the acronym for which is known as the peripheral venous catheters) [5].

### **Epidemiology**

Many researches have been conducted till date with regard to studying and detecting the epidemiology of the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection). The data collected and recorded all show varying results and outcomes. According to the data collected from the North American from the NNIS (the acronym for which is known as the nosocomial infection surveillance system) between the year 18986 to the year 1990, the incidence related to the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection) accounted to about 2.1 % for the respiratory ICUs (the acronym for which is known as the intensive care units) in the hospital, while that for the medical surgical oriented ICUs (the acronym for which is known as the intensive care units) accounted to about 5.1 %, while that for the trauma ICUs (the acronym for which is known as the intensive care units) accounts to about 5.8 % and that of the burn units accounted to about 30.2 % and vice versa [6,7]. As per the data recorded in the year 2005, it was stated that the incidence of occurrence of the CRBSIs (the acronym for which is known as the catheter-related bloodstream infection) related infections accounted to about 2.79 % per 1000 days of catheter out of which it stated that the CVCs (the acronym for which is known as the central venous catheters) is said to be responsible for nearly about 2.09 % of the overall cases [8,9]. As per a report that was published in the year 2010, the infection rate of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) was said to be around 0.48 % per1000 of the device days. As per a report that was published in the year 2011, the incidence occurring due to the infection related to the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) was said to have accounted to about 8.75 % per 100 of the days of the catheter [10,11].

The incidence recorded with regard to the infection prevailing because of the cases related to CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is said to be different for all the regions around the world [12,13]. Not only that the incidence recorded with regard to the

infection prevailing because of the cases related to CRBSI (the acronym for which is known as the catheter-related bloodstream infection) is said to be different for all of the hospitals as well (be it from within the same country, state, or other country). According to the study conducted via meta-analytical showed that the infections relating to the BSIs (the acronym for which is known as the blood stream infections) is said to be ranked third in the world with regard to the infections procured in the hospital settings itself [14]. The infections procured in the hospital relating to the BSIs (the acronym for which is known as the blood stream infections) is said to have recorded the rate of mortality at about 12 to 25 %. It has been stated that in the United States alone, every year nearly about 250, 000 of the individuals gets infected with the BSIs (the acronym for which is known as the blood stream infections) out of which nearly about 60 % of the CRBSIs (the acronym for which is known as the catheter-related bloodstream infection) seems to have been caused by the micro-organisms present in the skin of the patients. It has been stated that most of the occurrence of the CRBSIs (the acronym for which is known as the catheter-related bloodstream infection) mostly seems to be originating in the emergency rooms and in the ICUs (the acronym for which is known as intensive care units) where nearly about 5.3 % of the infections occurring in the bloodstreams occurs per 1000 days of the CVCI (the acronym for which is known as the central venous catheter insertion) [15,16]. The devices that are most frequently utilised to provide the fluids into the bloodstream are the intravenous catheter. Albeit, the infection related incidence occurring with the usage of the intravenous catheter is very low, however, in case if the infection ends up getting serious then in such situation complication might occur and hence results in the mortality of the patient [17].

As per a report which was published in the United Kingdom, it states that the when it comes to the occurrence of infections in the hospital, the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) accounts to only about 10 to 20%. With the help of the clinical interventions, the rates of the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) might in turn be modified during the insertion and the utilisation of the CVCs (the acronym for which is known as the central venous catheters) [18]. The type of incidence occurring via the infection of the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) varies depending upon the kind of catheter used or depending upon the frequency of manipulation of the catheter and vice versa [19]. Since, most of the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) are somewhat associated or linked with the CVCs (the acronym for which is known as the central venous catheters), the rate of risk for the occurrence of the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) usually ends up increasing by nearly about 64 times when it comes in association with the CVCs (the acronym for which is known as the central venous catheters) as opposed to the situation when it comes in contact or is associated with the PVC (the acronym for which is known as the peripheral venous catheters) [20].

The CVCs (the acronym for which is known as the central venous catheters) occurs in two ways and they are as follows- the short-term CVCs (the acronym for which is known as the central venous catheters) and the long-term CVCs (the acronym for which is known as the central venous catheters) [21,22]. The short- term CVCs (the acronym for which is known as the central venous catheters) are said to be mostly colonized by the organisms that are cutaneous along the outer surface of the catheter [23]. While, the long- term CVCs (the acronym for which is known as the central venous catheters) are said to be caused by the endo- luminal spread [24]. Preventive measures for both the short- term CVCs (the acronym for which is known as the central venous catheters) and the long- term CVCs (the acronym for which is known as the central venous catheters) are as follows- When it comes to the short- term CVCs (the acronym for which is known as the central venous catheters), the most effective preventive system that can be used in order to provide protection against the occurrence of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is to decrease the contamination of the extra- luminal. In contrary to that, when it comes to the long- term CVCs (the acronym for which is known as the central venous catheters), the most effective preventive system that can be used in order to provide protection against the occurrence of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is to used technologies which helps in minimizing the colonization of the endo-luminal [25,26]. Amongst the patients also, the risk of occurrence of the bacteremia is said to be the highest in the patients going through hemodialysis and are utilising the CVC (the acronym for which is known as the central venous catheters) for getting vascular access [27].

### **Risk factors**

The formation and the occurrence of the risk factors regarding the infection of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) vary from country to country and it also vary from hospital to hospital (be it within the same region or from another geographical region) [28,29]. However, most of the potential factors of risks with regard to the infections relating to the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) consists of the following factors such as- the presence of any other underlying sickness or disease, the technique utilised for the insertion of the catheter, the place or the site where both the insertion as well as the duration of the catheter is done and vice versa. It is also stated that the administering of the nutrition related to the parenteral through the help of the intravascular catheters ends up increasing the risk of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) [30]. Now, if we are to talk about the risk factors that occurs locally which could end up increasing the chances for the formation or developing the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) infection are as follows poor maintenance of personal hygiene, occlusive dressing that are transparent, presence of moisture in the site of the exit, the colonization of the nasal *S. aureus* and vice versa [31,32]. Some of the other types

of risk factors that are present with regard to the dialysis are as follows- contamination of the equipment used for dialysis, inadequate treatment of the water, re- use of the dialyzer, older generation, by inserting a higher dose of the intravenous iron, by increasing the dose of the recombinant human erythropoietin, occurrence of lower level of hemoglobin, presence of lower level of albumin and vice versa [33,34].

### **Pathogenesis**

Till date many varied proposals have been put forward with regard to the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) so as to find its pathogenesis [35,36]. It has been proven and stated that the catheter is involved in different pathways for its pathogenesis (to be specific four different pathways for pathogenic). The four different pathways for pathogenic are as follows:

- The first one is through the migration of the skin organisms in the site of the insertion onto the tract of the cutaneous catheter which further pass along to the surface of the catheter which further results in the tip of the catheter tip being colonized. It is said that this route or this pathway of contamination is said to be the most commonly pathway or route for infection of the short- term form of CRBSI (the acronym for which is known as the catheter- related bloodstream infection) [37].
- The second type of the route or the pathway of contamination of the catheter is through the process of contamination by direct contact with the catheter or by direct contact with the hub of the catheter. The process of contact mostly takes place by hands or via fluids and devices that are already contaminated [13].
- The third type of the route or the pathway for the contamination of the catheter is known to be the less commonly route or pathway for the contamination of the catheter. Here, the catheter going through a hematogenous seeding caused from other site of infection.
- The fourth type of the route or the pathway for the contamination of the catheter is also a route where the infection of the catheter very rarely occurs. Here, in this type of the pathway or route, the infusion of the contamination might lead to the occurrence or the formation of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) [38].

There are many varied existing determinants through which the pathogenicity of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is recorded or identified and they are as follows- the first one important determinant of the pathogenicity of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is the type of materials via which the materials are made, the second type of important determinant of the pathogenicity of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is through the existence of different factors within the host which consists of the adhesion of the protein such as the fibronectin and the fibrin (which forms a sheath in and around the catheter) and the last type of important determinant of the pathogenicity of the CRBSI (the acronym for which is known as the

catheter- related bloodstream infection) is through the interference of factors that are virulent in nature such as the EPS (the acronym for which is known as the extracellular polymeric substance) which are generally produced by the adherence of the organisms [39].

It is stated that some of the materials of the catheter is known to have or experience some irregularities with regard to their surface which ends up enhancing the adherence of the microbes in some of the species such as the *S. epidermidis* and vice versa [40,41]. And so, the catheters that are encoded with such irregularity filled materials seems to show more vulnerability to the colonization of the microbes and also with regard to the infection that follows subsequently. The formation of the fibrin sheath by the microbes *S. epidermidis*, it leads to the association of the silastic catheters towards a much higher risk of infection related to catheter. However, on the other hand it is stated that the formation of the biofilm by the microbes *C. albicans* seems to occur mostly on the surface of the catheter of the silicone elastomer. The modification of the surface of the properties of the bio material is known to have influence or trigger the formation of the biofilm by the microbes *C. albicans*. It is said that some of the materials of catheter are said to be more on the thrombogenic side as opposed to others which might also be one of the main characteristics that end up predisposing the colonization of the infection of the catheter [42].

When it comes to the pathogenicity, it is stated that the possession of the properties of adherence of the micro- organisms and the relationship that it shares with the factors of the host is also said to play an important role in the kick- start of the pathogenicity of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection). An example of the above stated statement is- micro- organisms such as *S. aureus* is said to be capable of adhering to the proteins of the host that are commonly available on the catheters which ends up further expressing the factors of clumping that ends up binding to the adhesins of the protein [43-45]. It is states that the capacity of the adherence is said to be further enhanced by undergoing production with the help of the microbial organisms (for example like the *S. aureus*, the *Pseudomonas aeruginosa* and vice versa). The biofilm produced by the microbial organisms is said to be very much enriched with the presence of cations that are divalently metallic (for example, like the magnesium or the calcium and vice versa). The presence of such biofilm ends up potentiating the pathogenicity of the varied microbes by further enabling them to withstand the defense mechanism of the host or by making the host less accepting to the agents of anti-microbes [46].

### **Microbiology concept**

The micro- organisms such as the bacterial organisms and the microbial organisms ends up creating vulnerability for the contamination of the patients with the CRBSI (the acronym for which is known as the catheter- related bloodstream infection). If we were to describe the main leading cause of the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) in the order of descending frequency then here are the micro- organisms that caused the contamination or the

infection of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection)- *Staphylococci*, aerobic Gram-negative yeast and the bacilli, the enterococci and vice versa [47]. It is stated that when the Gram-negative bacilli undergoes assessment in the formation of a group, it is said that the frequency of the stated micro- organisms follows that of the staphylococci. It is stated that some of the materials of the catheter is known to have or experience some irregularities with regard to their surface which ends up enhancing the adherence of the microbes in some of the species such as the *S. epidermidis* and vice versa. And so, the catheters that are encoded with such irregularity filled materials seems to show more vulnerability to the colonization of the microbes and also with regard to the infection that follows subsequently [48]. The formation of the fibrin sheath by the microbes *S. epidermidis*, it leads to the association of the silastic catheters towards a much higher risk of infection related to catheter. However, on the other hand it is stated that the formation of the biofilm by the microbes *C. albicans* seems to occur mostly on the surface of the catheter of the silicone elastomer. The modification of the surface of the properties of the bio material is known to have influence or trigger the formation of the biofilm by the microbes *C. albicans*. It is said that some of the materials of catheter are said to be more on the thrombogenic side as opposed to others which might also be one of the main characteristics that end up predisposing the colonization of the infection of the catheter [49].

It has been stated that certain or some of the pathogens are said to be associated with some specific host, specific form of treatment done and also is said to be associated with some specific characteristics of the catheters. The infections of the *S. aureus* are said to be disproportionately linked when it comes to the infections of the hemodialysis form of catheters. The Gram- negative bacilli on the other hand is said to have been associated with the infections occurring in the patients suffering from or being diagnosed of cancer and it further stated that such pathogens tend to recover at a much quicker pace of being infusate with the contaminations. Micro-organisms such as the Gram- negative yeast and Gram- negative bacilli are said to be somewhat affiliated with the catheters that are put in the femoral part of the veins [50].

## Management

### General management:

For the general management of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) form of infection, the following types of anti- microbials are being recommended in order to carry out empiric treatment of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) that are under suspicion:

- The anti- biotics that are active against fighting the contamination of organisms such as the Gram- negative bacilli. However, the recommendation of the stated anti- biotic is done on the basis of the patterns shown by the susceptibility or on the basis of the increased severity of the illness [18].

- The anti- biotics that are active against fighting the contamination of organisms such as the Pseudomonas aeruginosa. However, the recommendation of the stated anti- biotic is done on the basis of the patterns shown by the susceptibility in context of neutropenia or increased of severity of the illness.
- The anti- microbials that are active against fighting the contamination of organisms such as the Candida that are in the setting of the catheterization of the femoral or are in the setting of the parenteral form of nutrition and vice versa [51].

**Short term management:**

For the patients on whom the cultures with regard to the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is confirmed, therapy that is centric around empiric antibiotic is recommended so as to properly address the profile that is under vulnerability of the pathogen identified [52]. Also, it is further advised to ask for some guidance of some experts in the field to review the pathogen identified. For the patients suffering with short- terms CV (the acronym for which is known as central venous) or arterial form of CRBSI (the acronym for which is known as the catheter- related bloodstream infection), the catheter that is infected or the catheter that is placed near the guide wire so as to exchange the catheter that is infected should be expeditiously removed [53]. In case if the patients are suffering from pathogens that are susceptible then in such case, medicines such as linezolid or fluoroquinolones and vice versa are orally administered for the treatment of the staphylococci that are resistant to methicillin. When the infection of the blood stream is not complicated that arises when the factors are not present, or the one that gets treated within a span of 72 hours of being infected, the following treatments are recommended.

- In case if the micro- organism is coagulase- negative staphylococci then in such case around five to seven days are recommended for the treatment.
- In case if the micro- organism is Gram- negative bacilli and enterococci then in such case around seven to fourteen days are recommended for the treatment

**Long term management:**

For the patients that are suffering with long- term form of CRBSI (the acronym for which is known as the catheter- related bloodstream infection) that are in association with the septic thrombosis or in association with the metastatic infection or in association with the subcutaneous catheter, the catheter should by any means be removed as soon as possible. The removal of the catheter is recommended for the infections and contamination via pathogens such as S. aureus, the Bacillus species, candida and vice versa. When the confirmation of the cultures of long- term CVC (the acronym for which is known as the central venous catheter) that are associated with bloodstream form of infection, the therapy regarding the empiric form of anti- biotic should be arranged in such a way that the susceptibility profile is addressed in a optimal manner. For the patients suffering diagnosed with long- term form of CRBSI (the acronym for which is known as the catheter- related bloodstream infection) infection, the duration for the anti- biotic centric treatment purely depends on the condition of the patient, the type



of pathogen that has contaminated it, or the characteristic of the disease. It is also advised that further seeking guidelines and suggestion from an expert in the field is highly recommended. For organisms such as *S aureus*, nearly around 4 to 6 weeks of therapy is recommended however, the duration for the stated pathogenic organism is also purely depended on the condition of the patient, the type of pathogen that has contaminated it, or the characteristic of the disease. In case if the patients are suffering from pathogens that are susceptible then in such case, medicines such as linezolid or fluoroquinolones and vice versa are orally administered for the treatment of the staphylococci that are resistant to methicillin

**Interventions to prevent further complications:**

The infection of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is said to mostly occur in the presence of pathogenic micro- organisms, and so in order to cancel the severity of the infection some form of intervention at the basic level can be attended to. It is said that many varied and multiple guidelines are present so as to prevent the occurrence or the formation of the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection). However, it is said that in order to implement all the varied and multiple available guidelines to prevent the occurrence or the formation of the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection) when it comes to practices related to clinical activities, the methods and the techniques implemented should be put- forward in such a way that they end up coordinating well with one another [54]. As stated earlier, the rate of morbidity and mortality is very high when it comes to the occurrence or the formation of the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection). However, with the help of multi- faceted centric reimbursement system or practice along with the inclusion of good and robust medical support and care from the healthcare workers (such as the doctors, the nurses and vice versa), the rate of morbidity and the rate of mortality occurring due to the occurrence or the formation of the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection). Many of the studies have proved that the cases pertaining to the occurrence or the formation of the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection) have witnessed a considerable amount of improvements when the healthcare workers (such as the doctors, the nurses, the medical officers and vice versa) are said to have a well- rounded knowledge about the diagnostic nature of the disease then in such case, the treatment of the patients suffering or patients who have procured the stated infection called the CRBSIs (the acronym for which is known as the catheter- related bloodstream infection) are said to attended to on a more robust and feasible level. The literature study was done on the CRBSI (the acronym for which is known as the catheter- related bloodstream infection). As we went further along with our study, we came to know that the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is known to be the presence of the organism bacteremia that seems to be originating from the source called intravenous catheter. The occurrence of CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is known to occur very

commonly and frequently. The CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is also said to be very lethal and is said to be a very frequently occurring complication in the central venous catheterization. There are many varied existing determinants through which the pathogenicity of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is recorded or identified and they are as follows- the first one important determinant of the pathogenicity of the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) is the type of materials via which the materials are made, the second type of important determinant of the pathogenicity of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is through the existence of different factors within the host which consists of the adhesion of the protein such as the fibronectin and the fibrin (which forms a sheath in and around the catheter) and the last type of important determinant of the pathogenicity of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection) is through the interference of factors that are virulent in nature such as the EPS (the acronym for which is known as the extracellular polymeric substance) which are generally produced by the adherence of the organisms [55]. We also came to know that the micro- organisms such as the bacterial organisms and the microbial organisms ends up creating vulnerability for the contamination of the patients with the CRBSI (the acronym for which is known as the catheter- related bloodstream infection). If we were to describe the main leading cause of the CRBSI (the acronym for which is known as the catheter-related bloodstream infection) in the order of descending frequency then here are the micro- organisms that caused the contamination or the infection of the CRBSI (the acronym for which is known as the catheter- related bloodstream infection)- Staphylococci, aerobic Gram- negative yeast and the bacilli, the enterococci and vice versa. Also, we came to learn that the management of the infection relating to CRBSI (the acronym for which is known as the catheter- related bloodstream infection) can be managed via- the general management method, the short- term method and lastly, the long- term method.

## Conclusion

This literature review discusses about Catheter related blood stream infection and how it can be diagnosed, the risk factors and how it can be prevented with the help of bundles. It is obvious for a fact that CRBSI have a lot of complications and issues for those people who are hospitalized with catheters infections. There have been increased use of catheters all over the world especially in Malaysia and in the United States. The continuous use of catheters has increased the number of blood stream infections. While a lot of the institutions have been working on it to successfully decrease the number of CRBSI infection cases to zero, this is still a huge issue because it has to make sure that each and every individual involved in it must cooperate with certain kinds of changes starting from cultural change.

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