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Surveillance of ventriculitis complicating in neurosurgical patients in a tertiary care teaching hospital

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Abstract
Ventriculitis is an imperative complexity following neurosurgery and is frequently connected with the utilization of an outer ventricular deplete (EVD). The rate changes from <5% to 20%, somewhat because of varieties in the definitions utilized for conclusion. Staphylococci are the most vital causes however the detachment of coagulase-negative staphylococci from a cerebrospinal Fluid (CSF) test should be deciphered with alert as it might speak to sullying. Hazard factors for ventriculitis incorporate propelled age, the length of EVD arrangement, the quantity of controls and the nearness of intraventricular discharge. Anticipation systems progressively center around the execution of a consideration package that incorporates aseptic strategy at the season of inclusion and amid any controls, skin planning, prophylactic anti-toxins, and fitting dressings at the site of the EVD. The utilization of EVDs impregnated with antimicrobial operators is expanding in any case, though a few examinations demonstrate that these are compelling, it isn't evident whether they give included advantage when there is consistence with different measures. Antimicrobial treatment is trying the same number of generally utilized operators don't enter into the CSF and causative microscopic organisms are progressively multidrug safe. Frequently a blend of high-portion intravenous and intraventricular specialists is required, particularly for Gram-negative contaminations. Expansive preliminaries around there are trying to direct; along these lines, to more readily educate preventive procedures and to streamline the executives of this vital condition, continuous national observation and pooling of information on treatment methodologies and results are required. We have explicitly investigated catheters gathered from patients who had no clinical disease so as to comprehend the risk comprised to patients by and large because of the nearness of various medication opposition properties in this gathering of biofilm confines from these incidentally embedded therapeutic devices. The absolute quantities of recovered inserts were 227. Out of them, 141 were vascular catheters (fringe venous catheters/focal venous catheter) and 86 were Foley catheters. The inserts stayed in situ for variable timeframes (1 day-14 days).

Keywords: Ventriculitis, neurosurgical, anticipation systems progressively

Introduction
Intraventricular catheters (IVCs) are vital neurosurgical diagnostic and therapeutic tools that provide for continuous intracranial pressure monitoring and external CSF drainage. Although first introduced in 1875, the technique was not widely used until the 1960s, when Lundberg refined the technique and demonstrated its usefulness for bedside analysis [1, 2]. Lundberg's reports paved the way for widespread use of IVCs for critical neurosurgical patient management. IVCs can be used to measure intracranial pressure in patients with many conditions, including traumatic brain injury, intracranial hemorrhage, intracranial mass, or any intracranial process that may result in ventricular obstruction or hydrocephalus. Although IVCs have been useful as monitoring devices and direct portals for removal of CSF or injection of therapeutic agents, their benefits have always been tempered by complications associated with their use. Chief among these complications is infection (eithermeningitis or ventriculitis), which occurs in 0%–45% of patients, depending on technique of insertion and management of the IVC [1, 3-11]. As might be expected with the use of Percutaneous catheters, gram-positive infections traditionally have been predominant; however, gram-negative infections have been reported in association with IVC use and are associated with patient mortality rates of up to 58% [12].

In 1998, we noted an increased rate of IVC-related infections caused by gram-negative organisms at the Johns Hopkins Hospital (Baltimore). Cohort data on neurosurgical patients are prospectively collected and maintained in detailed database for monitoring purposes by the infection control department. We systematically analyzed these data to determine the incidence of IVC-related infections, to assess the risk factors for acquiring infection, and to examine the trend of acquisition of pathogenic gram-negative organisms.

Materials and Methods

Medical devices/ implants used in the study: The samples used in the study were temporary implants- vascular catheters which are blood contacting devices and Foley catheters which are mucous membrane contacting devices removed from patients of neurosurgery ward. The total number of retrieved implants was 227. These included vascular catheters (141) and Foley catheter (86). All the retrieved implants were from patients who had no clinical infection or pyrexia. The skin swabs from the site of entry of vascular catheters were also analysed. For this sterile swab soaked in Fluid D (Himedia M1686 a combination of peptic digest and polysorbate 80) was used.

Patient details: They were post-operative neurosurgical patients who had undergone surgery
for primary neurological condition and were nonambulatory following surgery and had vascular/urinary Foley catheters in place. These patients had an antibiotic cover of Cephalosporin or Chloramphenicol and Amikacin commenced 12 hours prior to the procedure and continued upto 5 days as prophylaxis based on clinical experience. All patients from whom the catheters were retrieved were operated electively. Patients with pre-existing infections including brain abscess were excluded {head and spine injuries are not routinely operated in our Centre (Sree Chitra Tirunal Institute for Medical Sciences and Technology, a tertiary referral centre) and hence such cases were not included in this series}. In cases of active infection the retrieved catheters were subjected to clinical Microbiological profiling for treatment. This forms a group where infection is overt and therefore identified. So these are not included in this study and this data forms part of patient records.

Microbiological culture methods: The tips of various catheters (vascular and Foley) withdrawn from patients were collected into sterile containers containing Fluid D. Bacterial biofilm on the catheters were removed by sonication (Ultrasonic cleaner Cole – Palmer 8891) and vortexing. The bacteria removed by sonication and vortexing were isolated and identified by standard microbiological techniques and their antibiograms patterns were studied by disc diffusion assay.

Scanning electron Microscopic examination of retrieved implants: Retrieved implants from patients were fixed with 2% gluteraldehyde and dehydrated ingraded series of ethanol and gold sputter coated and processed for SEM and viewed using Hitachi Scanningelectron microscope S2400.

Results

Biofilm based infections are associated with antibiotic resistance development in pathogenic bacteria and fungi. Biofilms are an ideal site for plasmid exchange in bacteria and provide the necessary environment for induced antibiotic resistance development, specifically, when we consider that many of the catheterised patients may be receiving antibiotics. Here we have specifically analysed catheters collected from patients who had no clinical infection in order to understand the threat constituted to patients in general due to the presence of multiple-drug resistance properties in this group of biofilm isolates from these temporarily implanted medical devices.

The total numbers of retrieved implants were 227. Out of them, 141 were vascular catheters (peripheral venous catheters/ central venous catheter) and 86 were Foley catheters. The implants remained *in situ* for variable periods of time (1 day-14 days). Table 1shows the microorganisms isolated from these two classes of temporary medical devices and Figure 1 is a representation of the biofilms on these catheters. About 80% of the retrieved Foley catheters showed microbial biofilms. Figure 2 shows that *Enterococcus* species was the major isolate, forming about 28%, followed by *E.coli* and *Staphylococcus* species which were isolated from approximately 16% of catheters. Figure 2 shows that in about 69% of the retrieved Foley catheter, biofilm was formed by a single genus. About 21% of the retrieved Foley catheters had polymicrobial biofilm formed from two or more types of microorganisms. Among the isolates most of the strains were resistant to multiple antibiotics. About 28% of the retrieved vascular catheters show microbial biofilms. Figure 3 details the percentage prevalence of microorganisms isolated from vascular catheters. Biofilm present in about 93% of the retrieved vascular catheters contained single genus and about 7% biofilms contained multiple genus (Figure 4). In single genus biofilms *Staphylococcus* species dominated and accounted for about 65% of single genus biofilms. Majority of *Staphylococcus* strains were resistant to multiple antibiotics including methicillin. When comparing the isolates from skin atinsertion point Figure 3 it was observed that 80% of isolates were of the same genera. Only 20% of isolates from the biofilm on vascular catheters were not part of the skin flora. Figures 4 show the prevalence of antibiotic resistance profile in these isolates. These finding are an indication of this niche which can give rise to multiple drug resistant infection in patients which may be recalcitrant to antibiotic therapy. Figure 5 shows SEM of biofilms and crystal on retrieved Foley catheters. The crystal formation leads to blockage of the catheter preventing easy deflation of the balloon and catheter removal. Figures 6 give an indication of the duration of catheterisation required for biofilm development. In Foley catheters when duration of catheterisation was more than 3 days, 80% of time there was biofilm formation. In vascular catheters 33% of time biofilm was detected when duration exceeded three days.

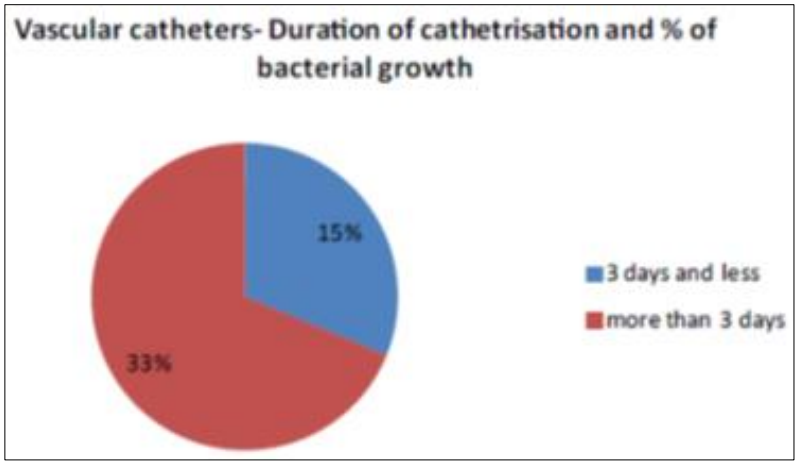

Fig 1: Foley's catheter

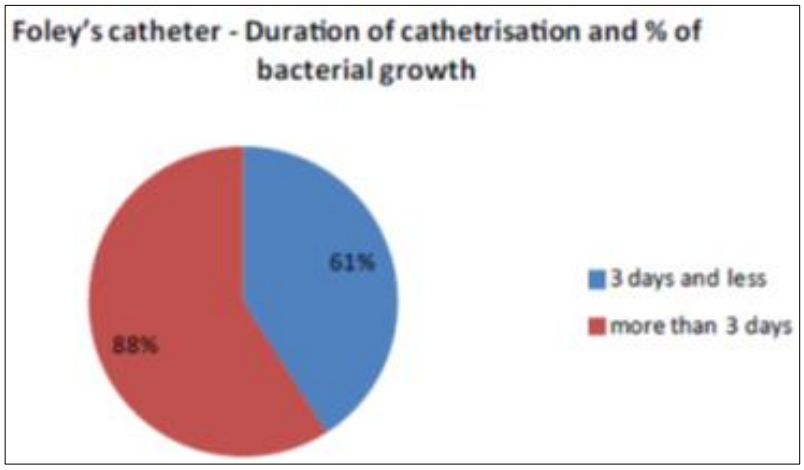

Fig 2: Vascular Catheters

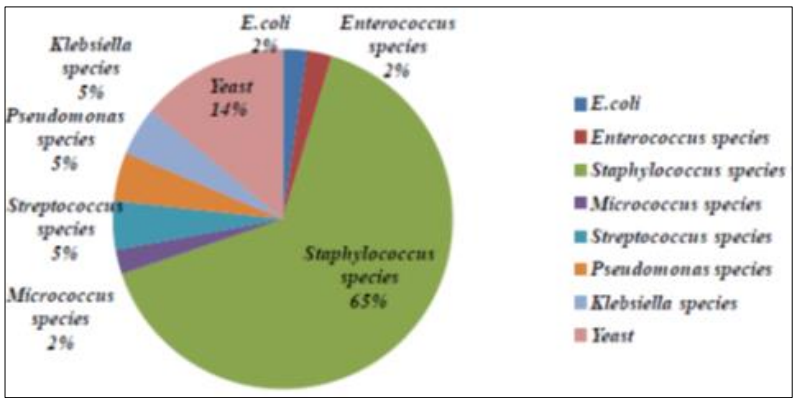

Fig 3: Statistics of isolated organisms

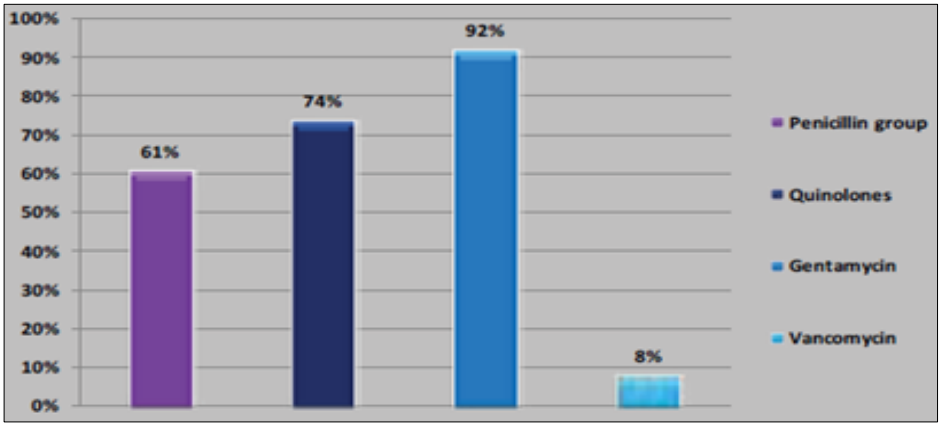

Fig 4: Antibiotic resistance patterns

Fig 5: TEM view of organisms

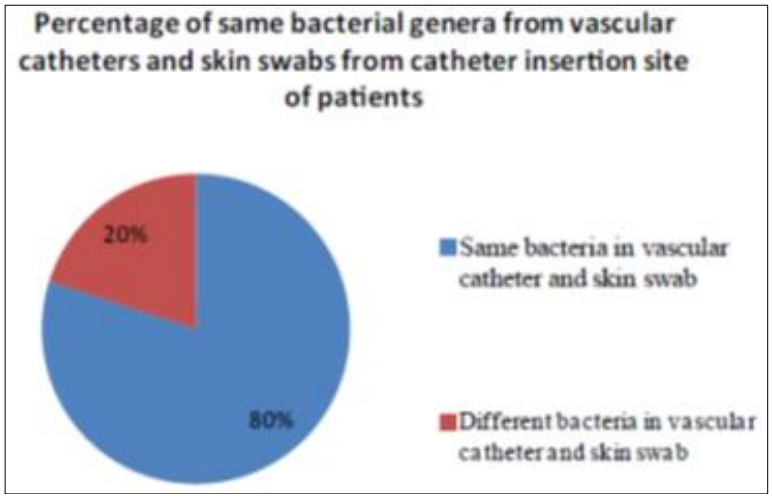

Fig 6: Percentage of same bacterial genera

Discussion

Biofilm is the predominant mode of growth of bacteria and this plays a central role in pathogenesis of catheter associated Urinary tract infection (CAUTI) and vascular catheter associated blood stream infections (BSI). Foley catheters are mucosal surface contacting medical devices and CAUTI accounts for about 40% of all nosocomial infections. 6 In our study of biofilms in Foley catheters it has been found that about 80% of the retrieved Foley catheters showed microbial biofilms. The patients from whom the Foley catheters were retrieved were on antibiotic cover of Cephalosporin/Chloramphenicol and aminoglycosides as prophylactic therapy. *Enterococcus* species was the major isolate and was isolated from about 36% of all catheters. As per previous reports in intensive care units 7 *Enterococcus* was the major causative agent for CAUTI although generally *E. coli* is predominant pathogen for UTI. A similar situation was noticed in our study also with increased isolation of *Enterococcus* from Foley catheter biofilms. This may be due to the presence of prophylactic antibiotic cover in these patients resulting in increased survival rate due to multiple drug resistance. Biofilm formed in about 69% of the retrieved Foley catheters contained single genus. About 31% of the retrieved Foley catheters contained multiple genera. Among the isolates most of the strains were resistant to multiple antibiotics. Vascular catheters are externally communicating devices and biofilms associated with them were an important cause of BSI. In our study it was found that 28% of retrieved vascular catheters had bacterial biofilms. Biofilm found in about 92% of the retrieved vascular catheters were single genus and mixed genera was found only in 8% of the retrieved vascular catheters. Among the different genera *Staphylococcus species* was the major isolate and most of them were methicillin resistant and a proportion of them were Vancomycin resistant. The 80% bacteria isolated from the skin near the point of insertion of vascular catheters and vascular biofilm constituents were of similar genera and included *Staphylococcus* species (Both coagulase positive (38%) and coagulase negative (14%). Many of the isolates were resistant to multiple antibiotics. 82% of the *Staphylococcus* species isolates were methicillin resistant and 14% was vancomycin resistant. The device provided a safe heaven for microbial colonisation and also for such colonies to develop multiple drug resistance for which the antibiotic cover provided sufficient stimulus. Our hospital policy is that when there is any clinical symptoms of the infection either UTI or BSI the catheters and blood or urine samples are sent to clinical microbiology laboratory for microbiological profiling and treatment. Such patients had an overt infection and were treated and therefore are not included here. The samples that were analysed here were from patients who did not have clinical symptoms of infection clearly pointing to the potential for this group to give rise to antibiotic resistant infections at any point of time till the device is in place. As the devices were removed before development of clinical symptoms we believe that the threat of infection to patient was aborted. Catheters and medical devices have become an indispensable part of modern day medical practice and device associated infections are adverse outcome of it. Most developing countries do not have laws mandating health-care

associated infection control programmes and this is true of India also. Here funds and resources are limited and nurse to patient ratio is lower than in developed nations. But the recent document "National Policy on containment of antimicrobial resistance in India" released by Directorate General of Health Services, India is an indication that Government of India is serious about the prevention and spread of anti-microbial resistance. Prevention of HAIs is the responsibility of all those associated with the development of the medical devices and the physicians and surgeons who use it. Surveillance of health-care associated infections – defining magnitude and nature of the problem is the first step towards reducing risk of infection. The second step is to implement targeted basic infection control practices that have been shown to prevent HAIs. Then technology and a dynamic antibiotic usage policy will help in an effective nosocomial infection control programme. Some of the technological advancements in this area specifically to prevent catheter related blood stream infection (CRBSI) are antibiotic lock prophylaxis by flushing and filling the lumen of the catheter with an antibiotic solution and leaving the solution to dwell in the lumen of the catheter. For CAUTI usage of antimicrobial ointments and lubricants, bladder instillation/ irrigation, antimicrobial agents in collection bags, impregnation of catheter with antimicrobial agents such as silver oxide or use of synthetic antibiotics [4]. The most promising development in this area has been catheter with antiseptic Chlorhexidine and silver sulphadiazine (CHSS catheter - ArrowGard) which became available 10 years ago. Since its inception more than 8 million catheters have been sold world-wide and has shown two-fold reduction in the incidence of catheter colonisation and 5 fold reduction in CRBI [4]. Silver has been used extensively to develop infection resistant urinary catheters. Today silver nanoparticles are being used for infection resistant catheters specifically urinary catheters [4, 8]. Other technologies like more potent anti-infective materials, microbe-impervious anti-reflux valves, conformable (collapsible) urethral catheters and vaccines for bacteria in Biofilms are all at various stages of research and development. So strategies have to be devised to control and prevent nosocomial infections associated with the use of implants in clinical practice. The antibiotic policy need to be changed at regular intervals to prevent the development of resistant pathogens that leads to medical device related complications. Also newer microbiological techniques need to be developed to identify biofilm based infection. Current antibiotic sensitivity assays are performed on planktonic forms of pathogens while in biofilms they are resistant to more than 1000 times the pharmacologically effective concentrations.

Conclusion

In conclusion it can be seen that bacteria colonise and develop biofilms on temporary indwelling devices often by 75 hours and hence these devices should be removed as early as possible. As duration of catheterisation increased the biofilms consisted of multiple genera and majority of them were resistant to a number of antibiotics. Vascular catheter biofilms in 80% of cases were of Staphylococcus species a major skin isolate. This study underscores the pressing need for development of antimicrobial vascular and urinary catheters and their deployment when longer durations of catheter access is required.

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