

**A RANDOMISED CONTROL TRIAL ON THE USE
OF TOPICAL METHICILLIN IN REDUCING
VENTRICULOPERITONEAL SHUNT
POSTOPERATIVE INFECTION**

**by
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ABSTRAK

Bahasa Malaysia

Topik :

Analisis prospektif efek penggunaan antibiotic methicillin secara topikal dalam mengurangkan infeksi pascapembedahan ventriculoperitoneal shunt.

Objektif

Matlamat penyelidikan ini adalah untuk menilai penggunaan antibiotic methicillin dalam pembedahan ventriculoperitoneal shunt termasuk merendam alat-alat system shunt dalam bancuhan antibiotic methicillin untuk membasmi infeksi pasca pembedan shunt.

Prosedur Kajian

Kajian ini adalah sebuah kajian prospektif yang bermula dari bulan November 2005 sehingga bulan Mei 2007 semua kes-kes yang di rujuk atau di masukkan ke wad Neurosurgeri di Hospital Sultanah Aminah Johor Bahru yang di diagnosa dengan hidrokefalus, di perhatikan selama 3 bulan setelah pembedahan ventriculoperitoneal shunt. Pasien di pilih secara random dan di bagi kepada 2 kumpulan, kumpulan 1 tanpa penggunaan topikal methicillin dan kumpulan 2 dengan penggunaan topical ,methicillin.

Analisa statistik

Keputusan ujikaji tersebut di analisa menggunakan aplikasi SPSS versi 12.0 [2003]

Sejumlah 90 pasien di lantik untuk mengambil bahagian dalam kajian ini dimana diteliti factor-faktor seks, umur, lama dan waktu pembedahan di lakukan, etiologi dan tahap kecekapan ahli bedah yang boleh mempengaruhi jangkitan kuman pascapembedahan ventriculoperitoneal shunt. Faktor- faktor yang diteliti selama 3 bulan setelah pembedahan ventriculoperitoneal shunt.13 orang telah mendapat jangkitan kuman pasca pembedahan ventriculoperitoneal shunt dalam 3 bulan. Dimana kumpulan 1 tanpa methicillin kadar jangkitan di dapati 20% dan kumpulan 2 dengan methicillin kadar jangkitan 8.9%. secara statistik di dapati tiada perubahan dalam menurunkan kadar jangkitan walaupun dengan penggunaan topical methicillin ($p=0.230$) Didapati kadar jangkitan yang lebih tinggi pada kanak-kanak di bawah 1 tahun yaitu 64.3% dan jangka waktu pembedahan yang melebihi satu jam menyebabkan kadar jangkitan lebih tinggi yaitu 84.5%.

Kesimpulan

Dari penyelidikan ini dapat di buat kesimpulan bahwa penggunaan topical methicillin tidak mengurangkan jangkitan kuman pasca pembedahan ventriculoperitoneal shunt ($p=0.0230$). Walau bagaimanapun di dapati bahwa factor-faktor lain seperti umur dan jangka masa pembedahan memainkan peranan dalam menentukan jangkitan kuman pasca pembedahan.

Role of topical methicillin in ventriculoperitoneal shunt surgery – a randomized control study

Objective:

To evaluate the role of methicillin as a topical installation during shunt insertion in ventriculoperitoneal shunt surgery with the aim of reducing the rate of postoperative infection.

Research procedure

A single blinded randomized control study was carried out on all patients who were admitted or referred to the Neurosurgery Department, Sultanah Aminah Hospital Johor Bahru with the diagnosis of Hydrocephalus; a ventriculoperitoneal shunt was indicated. The period of study was from November 2005 to May 2007. The follow up period for this study was of 3 months after surgery. The period of study was considered adequate to assess the role of our observation. Randomization was carried out in the operation theatre prior to the procedure. The scrub nurse would pick up a sealed envelope and prepare as stated. That is Group 1 with topical methicillin, Group 2 without topical methicillin. One dose of prophylactic antibiotic, IV Cefuroxime 25mg/kg was given at induction. Stringent operative technique was followed preparing patient and draping. Ethical approval was received JTP/KKM 1- 0805. Statistical analysis was done using SPSS version 12 (2003).

Result

A total of 90 patients were recruited in the study, 13 (14.4%) patients developed infection within 3 months, of this Group 1 had a 8.9% risk of infection and Group 2 had a 20% risk, however statistically there was no significant postoperative VPS infection reduction with the use of topical methicillin in ventriculoperitoneal shunt surgery ($p=0.230$). Multivariate analysis showed that duration of surgery had a significant influence on the postoperative VPS infection in the non-Methicillin group.

Conclusion

Topical methicillin has no significance in reduction of postoperative VPS infection.

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1. INTRODUCTION

The development of effective cerebrospinal fluid (CSF) shunts represents a landmark achievement in neurosurgery. Although shunts have improved the morbidity and mortality associated with disordered cerebrospinal fluid mechanics over the past 30 years, they still are associated with many potentially avoidable complications. Of these postoperative infections remains a major complication (Choksey and Malik, 2004, Rotim et al., 1997, Simpkins, 2005). Analysis of determining ways to prevent infection is the subject of great deal of experimental and clinical research. The problem of shunt infections nonetheless remains unsolved, contradictory data abound and data on the incidence of shunt infection vary widely (Lima et al., 2007, Lenfestey et al., 2007, Vinchon and Dhellemmes, 2006, Sarguna and Lakshmi, 2006).

The quoted shunt infection rates ranges from 5-27% in South America (Lima et al., 2007) with most centres reporting an incidence between 5% and 20% (Choksey and Malik, 2004). Most shunt infection occurs within 2 months and 80% within 6 months of surgery. Inoculums are believed to arise from skin organisms at the time of shunt implantation, although this is not always the case (Sarguna and Lakshmi, 2006).

Factors that are most commonly implicated in shunt infections are stated in a table 1.0.

Table 1.0 : Factors implicated in shunt infection

-
1. Poor preoperative skin condition
 2. Age especially less than 6 months
 3. Reinsertion after infection
 4. The presence of wound dehiscence
 5. Proximal versus distal revision (greater risk with proximal)
 6. The aetiology of hydrocephalus
 7. The time of day the operation performed
 8. Number of staff in operation room
 9. Neurosurgeon's experience
 10. Length of operation (shorter the better)
 11. Presence of airborne organism in operating room
-

(Lima et al., 2007, Choksey and Malik, 2004, McGirt et al., 2003)

The most common bacteria involved in early shunt infections are *Staphylococcus epidermidis* (52.8-88.9%) and *Staphylococcus aureus* (12-40%). These bacteria may enter the operating field during surgery, from hair follicles and sebaceous glands opened by the surgical incision; aided by insufficient asepsis and a long lasting surgery contributes to this risk.(Sarguna and Lakshmi, 2006, McAdams et al., 2006, Sacar et al., 2006)

In Malaysia, VPS infection is the most common infection seen in neurosurgery. Even though stringent rules have been applied in the operation theatre, the desire of decreasing the infection rates in our operation theatres still eludes us. As many studies have shown us

infection rates are much higher in neonates and infants (Lima et al., 2007). There are certain neurosurgical centres that only allow consultants and senior registrars to perform this surgery. However even this protocol has not greatly decreased the infection rates (Dallacasa et al., 1995, Rotim et al., 1997, Sacar et al., 2006).

The use of topical antibiotics and antibiotic impregnated shunt systems during VPS surgery has been widely practised (McGirt et al., 2007, Shah et al., 2005).

However, there is no specific study done in our local setting to evaluate the efficacy of this procedure. As VPS surgery is usually done emergency after office hours the surgeon is usually a medical officer or a postgraduate trainee. The main objective of our study was to observe whether the use of topical methicillin in VPS surgery can decrease the postoperative infection rate independent of the surgeon's experience or timing of surgery.

We chose to use topical methicillin as it is cheap and does not need any special preparation and it has been practised in many centres and also quoted in ventriculoperitoneal shunt surgery by Andrew Kaye in his textbook, Operative Neurosurgery.

The diagnosis of postoperative VPS infection is made if there are obvious signs of shunt infection that is fever with no other obvious source, inflammation over shunt tract, pus discharge or when CSF analysis confirms infection. To confirm the CSF analysis shunt tapping is done on admission under sterile technique. Shunt infection due to this technique is said to be less than 1 % (Turgut et al., 2005).

2. LITERATURE REVIEW

2.1 Introduction

First performed in 1908, the ventriculoperitoneal shunt procedure is associated with a mortality rate of 0.1 to 0.13% and an even higher morbidity rate (Rotim et al., 1997). The reported incidence of CSF shunt infection ranges from 3 to 29% with an average of 5-15%.

The morbidity is quite disturbing as those who survive risk intellectual, cognitive and neurological deficits (Schreffler et al., 2002, Choksey and Malik, 2004).

Analysis of the various risk factors and determining ways to prevent shunt infection is the subject of a great deal of experimental and clinical research. The problem of shunt infection nonetheless remains unsolved and there is a lot of contradictory data (McGirt et al., 2003, Simpkins, 2005, Patwardhan and Nanda, 2005, Sun et al., 2002).

2.2 Shunt systems and its characteristic

A ventriculoperitoneal (VP) shunt is used most commonly to treat hydrocephalus. The lateral ventricle is the usual proximal location. The advantage of this shunt is that the need to lengthen the catheter with growth may be obviated by using a long peritoneal catheter. The ventriculoatrial (VA) shunt also called a "vascular shunt." shunts the cerebral ventricles through the jugular vein and superior vena cava into the right cardiac atrium. It is used when the patient has abdominal abnormalities (eg, peritonitis, morbid obesity, or after extensive abdominal surgery). This shunt may require repeated lengthening in a growing child. A lumboperitoneal shunt is indicated in cases of communicating hydrocephalus, CSF fistula, or pseudotumor cerebri. Yadav et al conducted a 10 year prospective study to evaluate the lumboperitoneal shunt procedure done on 409 patients and concluded that lumboperitoneal shunt is an effective shunting procedure in communicating hydrocephalus (Yadav et al., 2004).

The Torkildsen shunt is used rarely. It shunts the ventricle to cisternal space and is effective only in acquired obstructive hydrocephalus. A ventriculopleural shunt is considered as second line. It is only used if other shunt types are contraindicated.

Implantable shunts are composed of a silicone elastomer and are often impregnated with barium. The shunt consists of a proximal catheter, a valve and distal tubing. Evolution of shunts has been guided by the need to reduce the incidence of complication. There is no perfect shunt system (Braxton et al., 2005).

There are currently numerous shunting systems available for use in the treatment of hydrocephalus. Whether shunt systems plays a role in postoperative VPS infection has not been proved except that the preconceived notion that if something is more expensive then it has to be more resilient and reliable. Warf investigated the 1-year outcomes for shunt treatment of hydrocephalic children in Uganda, comparing the results using the inexpensive Chhabra shunt (\$35 US dollars), widely used in East Africa, with those using the Codman-Hakim Micro Precision Valve shunt (\$650). There was no statistically significant difference in any outcome category for patients receiving the Codman or Chhabra shunt. Ventriculoperitoneal shunt insertion for treatment of hydrocephalus can be performed in a developing country with results similar to those reported in developed countries. No difference in outcome was noted between the two shunt types (Warf, 2005).

Since the development of the antisiphon device (ASD) by Portnoy and Schulte in 1971, technology has advanced to the point at which many shunt valves have an integral siphon-control device (SCD). Such devices were intended to prevent over drainage of the CSF compartment. There is, however, continuing controversy over the benefits of siphon-reducing devices. Reported findings range from "no significant benefit from the inclusion of a siphon control device (SCD) in the shunting system" to the conclusion that "any form of ventriculoperitoneal shunt, with or without valves, with slit-end valves or cranial valves seemed to work equally well in the hands of a dedicated paediatric neurological surgeon." It appears that performance of the Delta valve was not significantly different from the H-H and H-S valves, two valves without an antisiphon device. There was no significant difference in the occurrence of symptomatic subdural fluid collections based upon valve type, or in the combined valve breakage/obstruction rates based upon valve type (Davis et al., 2000, Patwardhan and Nanda, 2005, Kay et al., 2000). Study by Kesert et al in a multicenter prospective study showed the 1 year survival rate of Strata valve shunt system when used in

initial shunt insertion procedures or shunt revisions was similar to those demonstrated for other valves (Kestle and Walker, 2005)

Epstein et al noted that even the large number of shunt systems, particularly valves with different pressures and flow characteristics; did not significantly improve the success rates of shunting surgery. There are some unique features of the hardware construction that are important in preventing shunt malfunctions as well as dealing with them when they do occur. From this perspective, a one piece shunt system is advantageous in that it is easier to insert, with a short duration operation and it avoids the possibility of shunt disconnection or disintegration associated with the connector. A connector also prevents the extra tubing from elongating, since it eventually becomes fixed in its position subcutaneously due to ingrowths of scar tissue.

Shunt system should also have a right angle ventricular catheter valve just distal to the right angle. This enables the surgeon to have easy access to the shunt catheter. It avoids having to work underneath a reservoir with a catheter that becomes partially embedded in the brain. The valve system should have an incorporated flushing or tapping chamber to have access to tapping the shunt, as well as possibility/feasibility to pump and test a shunt by manual compression in the neurosurgeon's office. The shunt system should have either a proximal and distal occluder system, so that the proximal and distal portions of the shunt can be tested separately, or a double bubble configuration which also allows separate testing of both proximal and distal limbs of the shunt (McGirt et al., 2007).

Bacterial biofilms have recently been shown to be important in neurosurgical device-related infections. Because the concept of biofilms is novel to most practitioners, it is important to understand that both traditional pharmaceutical therapies and host defense mechanisms that are aimed at treating or overcoming free-swimming bacteria are largely ineffective against the sessile bacteria in a biofilm. Bacterial biofilms are complex surface-attached structures that

are composed of an extruded extracellular matrix in which the individual bacteria are embedded. Superimposed on this physical architecture is a complex system of intercellular signalling, termed quorum sensing. These complex organizational features endow biofilms with numerous microenvironments and a concomitant number of distinct bacterial phenotypes. Each of the bacterial phenotypes within the biofilm displays a unique gene expression pattern tied to nutrient availability and waste transport. Such diversity provides the biofilm as a whole with an enormous survival advantage when compared to the individual component bacterial cells. Thus, it is appropriate to view the biofilm as a multicellular organism, akin to metazoan eukaryotic life. Bacterial biofilms are much hardier than free floating or planktonic bacteria and are primarily responsible for device-related infections. Now that basic research has demonstrated that the vast majority of bacteria exist in biofilms, the paradigm of biofilm-associated chronic infections is spreading to the clinical world. Understanding how these biofilm infections affect patients with neurosurgical devices is a prerequisite to developing strategies for their treatment and prevention. The majority of shunt infections occur within 6 months of shunt placement and chiefly result from perioperative colonization of shunt components by skin flora (Bayston et al., 2004)

Antibiotic-impregnated shunt (AIS) systems have been designed to prevent such colonization. Ritz et al in their study analyzed if AIS can diminish the rate of shunt infection. The pathogenic nature of shunt infection in patients with AIS systems and those without antibiotic impregnated shunts (non-AIS) was compared. A total of 258 patients were studied where in 86 patients AIS systems were implanted. Shunt catheters were commercially impregnated with clindamycin and rifampicin. Infection rates and underlying bacterial pathogens of patients with AIS were compared to patients with implanted non-AIS systems (172 patients). This study concluded there was no significant difference between the two groups. AIS did not significantly reduce shunt infection in hydrocephalus patients in the presented study (Ritz et al., 2007)

2.3 Age

Hydrocephalus remains an endemic condition in the paediatric population (Mottolese et al., 2000). Davis et al in a retrospective study reviewed the records of all patients undergoing a ventriculoperitoneal shunt insertion or revision over a period of 9 years in a paediatric institute. There were a total of 2,325 ventriculoperitoneal shunting procedures performed on 1,193 patients. The overall infection rate was 3.2% (74 infections). Analyzed by age, the infection rates were as follows: <1 month 9/223 (4.0%), 1-6 months 16/449 (3.6%), 6-12 months 13/297 (4.4%), 12-18 months 3/122 (2.5%), 18-24 months 7/116 (6.0%) and 24+ months 26/1,118 (2.3%). There was no statistically significant difference between age groups. Upon selectively examining premature neonates who developed hydrocephalus secondary to intraventricular haemorrhage from the figures given above, one finds that 2/44 (4.5%) of neonates became infected, which was also not significant. The infection rate was the same irrespective of whether the procedure was to insert or revise the shunt, or whether another operative procedure was done under the same anaesthesia. The aetiology of the hydrocephalus was not a factor, nor was the presence of an open neural tube defect. However the presence of fluid accumulation along the shunt tract (peritubal leak) or at another neurological operative site was associated with a significant increase in incidence of infection 15/168 (8.9%) when compared to those with no fluid accumulation (Davis et al., 1999).

McGirt et al in their study showed that patients with shunt infections were more likely to be premature and younger. They have a greater number of prior shunt revisions, and are more likely to have had previous shunt infection; they are also more likely to have had IVH and less likely to have a brain tumour as the aetiology of hydrocephalus. Insertion of a VP shunt in a premature neonate was associated with a nearly 5-fold increase in the risk of shunt infection. Each decreasing year of patient age was associated with a 4% increase in the risk of shunt infection (McGirt et al., 2003). Recent retrospective studies have concluded that the aetiology of hydrocephalus in neonates such as intraventricular haemorrhage or the presence of an open neural tube defect does not make them more susceptible to infection. However the presence of fluid accumulation along the shunt tract or at another neurological operative site

was associated with a significant increase in incidence of infection (Lenfestey et al., 2007, Davis et al., 1999, Simpkins, 2005). The patient's age at the time of initial shunt placement and the time interval since previous surgical revision are important predictors of repeated shunt failures in paediatric age group (Vinchon and Dhellemmes, 2006, Turgut et al., 2005)

2.4 Gender and Race

These two factors don't seem to play a role in postoperative infection as many studies have shown that it does not influence the risk of a ventriculoperitoneal shunt infection

2.5 Surgeon's experience

Neurosurgical trainees particularly had a significantly higher rate of infection than consultants (Borgbjerg et al., 1995). The surgeon was found to be the largest single factor in the incidence of shunt infections. A similar report was presented by George et al, who found that the experience of the surgeon was the single most important factor in the reduction of shunt infection rates. A 25-fold variance in infection rates among surgeons could be related to individual experience and technique (George et al., 1979). Venes and McCarthy and Wenzel also placed particular emphasis on surgical technique in the control of infection. A study done by Cochrane et al in Canada explored the relationship of surgeon experience, measured by operative volume, to the outcomes of ventricular shunt treatment of hydrocephalus in children. Three thousand seven hundred and ninety-four first VPS insertions, performed by 254 surgeons, were reviewed. Surgical experience was represented by the number of shunt operations performed during the study period by each surgeon prior to the date of the operation. The 6-month shunt failure risk for less experienced surgeons was 38%, compared to 31% for more experienced surgeons. The infection rate for initial shunt insertions was 7% for patients treated by more experienced surgeons and 9.4% for those treated by less experienced surgeons. A relationship between surgeon experience and shunt outcome that appears to be based on the operative experience that a surgeon brings to a procedure is in keeping with clinical experience. This observation has implications for public policy, service

planning and surgical mentorship during the earlier years of a surgeon's career (Cochrane and Kestle, 2003)

2.6 Timing and duration of surgery

Study done by Ratanalart et al on ventriculoperitoneal shunt infections over a 5 year period in Songklanagarind Hospital showed that only notable risk factor for shunt infection was an operation lasting more than 59 min (Ratanalart et al., 2005).

2.7 Aetiology

Studies on children are still inconclusive on the role of aetiology of hydrocephalus in increasing the rate of infection. Some studies say that hydrocephalus with spina bifida have a higher incidence for infection but there are many other studies which contradict this (Chadduck and Reding, 1988). A study by Caldarelli et al concluded that open neural tube defect increases infection and the myelomeningocele level did influence the outcome of CSF shunting: a higher percentage of infection was observed among the patients with "high level" myelomeningoceles than in the group with more caudal location of the spinal defect. Similarly, the degree of ventricular dilatation correlated with the incidence of complications (more severe ventricular dilatation was associated with the highest incidence of complications)(Caldarelli et al., 1996).

2.8 Postoperative VPS infection

By Odio's criteria for CSF shunt infection is considered present when a pathogenic organism is cultured from lumbar or ventricular CSF, or blood. In addition, a shunt infection is also considered present if the patient developed pyrexia higher than 38.5°C, shunt malfunction, or abdominal or neurological symptoms; even if cultures are negative (Odio et al., 1984)

The bacteria that most frequently appear in shunt infections are *staphylococci* (*S. epidermidis and aureus*), the percentage varies from 62–90%. Infections due to Gram negative bacteria are infrequent but important, because mortality is very high at 40–90%. The variation in quoted infection rates may partly be caused by different study designs. The incidence of infection is related either to the number of patients or to the number of procedures, inclusive of revisions. Clearly, infection rates per patient will be higher than infection rates per procedure, as in any series many patients will have multiple procedures. In some series there was no difference in infection rate between initial and revision shunt procedures. Odio et al showed an increased risk of CSF shunt infection in shunt revisions (Odio et al., 1984). Meirovitch and Choskey et al in contrast reported a similar rate of shunt infection in primary and shunt revision operations (Choksey and Malik, 2004)

S.aureus shunt infection predicted subsequent *S. aureus* infection, as did increased length of hospital stay before shunt infection. The prevailing clinical opinion is that, in most cases, the infecting agent is introduced at the time of shunt insertion. This hypothesis is the best explanation for the finding that the majority of shunt infections were due to skin flora (Ratilal et al., 2006) A study by McGirt et al showed that the bacterial organisms early after shunt surgery (<14 days) were the same as those late after shunt surgery (>14 days) (McGirt et al., 2003).

Lenfestey et al studied the normal ranges for cell count parameters in neonates with VP shunts and CSF reservoirs, as well as to determine the predictive value of CSF parameters as markers of infection. They evaluated neonates from 150 different neonatal intensive care units who had undergone a lumbar puncture, VP shunt insertion, or CSF reservoir placement for a period of 7 years. Data were collected from 9704 neonates with a mean birthweight of 2573 g and a mean gestational age of 35 weeks. In neonates with negative CSF cultures, significant differences were found between those with and without VP shunts or CSF reservoirs when comparing red blood cell (RBC) count, absolute eosinophil count, protein levels, and glucose levels. No significant difference was found between white blood cell (WBC) counts in neonates with or without VP shunts who had negative CSF cultures. The study concluded that

differences existed between CSF parameters found in neonates with or without VP shunts or CSF reservoirs, only the difference in RBC count is large enough to be clinically significant. It found that the utility of CSF parameters in neonates with VP shunts or CSF reservoirs was limited due to poor diagnostic sensitivity and specificity (Lenfestey et al., 2007). A study done by Mc Clinton et al concluded that in patients suspected of having a VP shunt malfunction, the presence of $>$ or $\approx 5\%$ eosinophils in the ventricular fluid indicates shunt malfunction or shunt infection. The combination of fever and ventricular fluid neutrophils $> 10\%$ is predictive of shunt infection (McClinton et al., 2001).

Polymerase chain reaction (PCR) is a powerful molecular technique that allows rapid and precise amplification of bacterial deoxyribonucleic acid (DNA) and has proven a powerful tool in the detection of a wide variety of clinically important infectious diseases. Banks et al analyzed specimens of CSF derived from ventriculoperitoneal shunts or external ventricular drains by using both conventional cultures and PCR. In their study, 86 CSF samples from adult patients who underwent either shunt tap or routine surveillance cultures of their ventriculostomy. These specimens were chosen from a larger group of 300 specimens that were routinely collected (many serially). They were chosen because clinical suspicion of infection was increased because of either patient signs and symptoms (fever, stiff neck, lethargy, worsening neurological examination) or preliminary laboratory analysis of CSF data (increased white blood cell count, increased protein level, decreased glucose). Preliminary data of the study suggested that PCR is a highly sensitive, rapid, and potentially promising modality for the detection and treatment of CSF shunt ventriculostomy infection (Banks et al., 2005).

A retrospective study by Lan et al assessed the parameters of ventriculoperitoneal shunt infection and malfunction found in 129 children with hydrocephalus who had undergone a ventriculoperitoneal shunt placement at Taipei Veterans General Hospital from January 1997 to June 2001. The clinical characteristics and differences among these patients were reviewed to determine the potential predictors of shunt infection and malfunction. Fever (60%, 6/ 10) and seizure (40%, 4/10) occurred significantly more often in the infection group than in the

malfunction and control groups ($p < 0.05$). A higher blood C-reactive protein level was noted in the infection group than in the malfunction and control groups ($p < 0.05$). Examination of the cerebrospinal fluid of infected patients showed significantly higher white blood cell count and neutrophil count, higher protein concentration, and lower glucose levels compared with the other 2 groups ($p < 0.05$). However, the number of patients with cerebrospinal fluid eosinophilia was significantly higher in the malfunction group ($p < 0.05$). The diagnostic usefulness of laboratory parameters in patients with ventriculoperitoneal shunt infection is as follow: cerebrospinal fluid white blood cell count over 100/mm³, 96% specificity and a positive predictive value of 0.55; and cerebrospinal fluid neutrophils over 10%, 90% sensitivity and a negative predictive value of 0.99. In conclusion, Fever, seizure, high blood C-reactive protein, combined with leukocytosis, neutrophil over 10%, low glucose level, and high protein level in the ventricular fluid are factors that may help in distinguishing shunt infection from shunt malfunction (Lan et al., 2003)

2.9 Prophylactic antibiotics

The use of prophylactic antimicrobials remains controversial. In a recent control study, the infection rate was 6.25% in patients without antibiotic prophylaxis as compared with 2.56% in patients with antibiotic prophylaxis. This difference was not found to be statistically significant. At present, the benefit of perioperative antimicrobial prophylaxis remains unestablished. As CSF shunt infections continue to be common and life threatening for patients with hydrocephalus, we give prophylactic antibiotics to our patients. Many regimes have been used ranging from penicillin group to third generation cephalosporin and may be criticised for lack of Gram negative cover. However, the vast majority of shunt infections are caused by Gram positive cocci. (Acs, 1992; Ajir, 1981; Wang, 1984)

Several reports identified perioperative airborne contamination as the main source of infection, particularly in procedures that included the insertion of a prosthetic device. In one series there was a twofold difference in infection complications between different surgical teams (6–11.7%). Thus, aseptic technique appeared to be a significant factor influencing the