



## The Contemporary Microbiology and Concomitant failure factors of ventriculo-peritoneal shunts

### Neurosurgery

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### ABSTRACT

**Background:** ventriculo-peritoneal (VP) shunt insertion is the primary option in the treatment of Hydrocephalus. Though it is a well-established procedure, numerous factors have contributed to its failure. Ventriculo-peritoneal (VP) catheter occlusion remains a significant source of shunt morbidity in the pediatric population.

**Impetus:** This study carried out to analyze the VP shunt concomitant factors resulting in its failure. We seek to describe the current microbiology of shunt infection and coexisting factors leading to hardware failure.

**Material and Methods:** A retrospective review conducted in all patients presented at our clinic with shunt failure between January 2014 and December 2016. Forty one patients presented with signs and symptoms of hardware failure and infection. The study population was evaluated clinically and radiographically.

**Results:** Overall shunt failure was seen in 41-cases patients, constituting 15.58% of a total of 263 patients with hydrocephalus were treated. There were 24 males (58.53 %) and 17 females (41.46 %) with male to female ratio of 1.4:1. Age of patient ranged between 0 and 40 years with a median age of 11 years ( $\pm$ standard deviation of  $4.2 \pm 2$  years). The most common age group in this study was 1–14 years 36 (87.80%). Single and multiple shunt revisions were required in eight and five patients, respectively.

**Conclusions:** Ventriculo-peritoneal catheter insertion, though it is a well-established procedure, nevertheless there are still various and significant complications attendant with shunt diversion surgeries failure. Shunt infection remains a vexing problem. Staphylococcus aureus continues to be an important cause of shunt infections. The presence of concomitant factors are associated with higher failure rates.

### KEYWORDS:

Ventriculo-peritoneal shunt, infections, Complication; Disconnection; Hydrocephalus; shunt failure.

### Introduction

**Background:** Placement of ventriculo-peritoneal (VP) shunt is staple option in the treatment of Hydrocephalus. Although it is a well-established procedure, numerous factors have contributed to its failure such as obstruction, migration, and shunt infection; which is one of the cardinal and persistent troublesome complications and is a substantial source of prolonged hospital stay and increased the number of operative procedures (1). [1-3] Ventriculo-peritoneal (VP) catheter occlusion remains a significant source of shunt morbidity in the pediatric population.

**Impetus:** This study carried out to analyze the VP shunt concomitant factors resulting in its failure. Awareness of the presence of attendant shunt infection is also important to guide clinical management. We seek to describe the current microbiology of shunt infection and coexisting factors leading to hardware failure.

**Material and Methods:** A retrospective review performed in all patients presented at our clinic with shunt failure between January 2014 and December 2016 in a single center K.H.M.C. We reviewed the medical records of all patients who had VP shunts insertion for treatment of hydrocephalus during this period 263 patients. Forty one patients presented with signs and symptoms of hardware failure and infection. Criteria for CSF shunt infection defined by Odio et al. [4] Shunt infection was considered present when: CSF culture that yielded a pathogenic organism or indicated CSF leukocytosis (leukocyte count, 150 leukocytes/mm<sup>3</sup>) associated with fever (temperature, 38.5 C), shunt malfunction, or neurological symptoms. The study population was evaluated clinically and radiographically.

**Operative details:** Standards of practice during the study period for shunt insertion included; the induction of general anesthesia, in supine position, skin preparation was performed using povidone-iodine scrub solution, and adherent povidone-iodine-impregnated plastic drapes were placed over the incisions and tunneling sites, a small incision is made towards the back of the skull (keen point). The skin is retracted away, after which a small burr hole in the skull is performed. An

opening in the dura mater is then made and a ventricular catheter is passed through the opening into the ventricle, This catheter is then attached to a valve (medium pressure) and the valve (size appropriate to age group) is connected to an abdominal catheter which is then tunneled under the skin from the scalp down toward into the abdominal cavity. A right para-median small incision is then made in the lower abdomen in order to insert the tip of the distal catheter inside of the peritoneal cavity where CSF will be drained and absorbed. The incisions are then closed prior to the termination of the operation [5].

As a protocol of management in suspected shunt infection; a CSF sample is taken from the reservoir, if the CSF analysis indicates infection, we remove the hardware and insert an EVD then we introduce empirical antibiotics (Ceftriaxone –meningeal dose) as a primary management. Appropriate antibiotics are then modified according to the primary culture results. After obtaining consecutive sterile cultures the shunt infection is considered eradicated and a new shunt hardware is re-inserted. In cases of shunt failure a single or multiple shunt revisions were required.

**Results** Overall shunt failure was seen in 41-cases patients, constituting 15.58% of a total of 263 patients with hydrocephalus were treated between January 2014 and December 2016. Case files of these patients were retrospectively studied. There were 24 males (58.53 %) and 17 females (41.46 %) with male to female ratio of 1.4:1. Age of patient ranged between 0 and 40 years with a median age of 11 years ( $\pm$ standard deviation of  $4.2 \pm 2$  years). The most common age group in this study was 1–14 years 36 (87.80%), while adult age group had the least frequency 5 (12.19%) [Table 1].

Single and multiple shunt revisions were required in eight (16.7%) and five (10.4%) patients, respectively

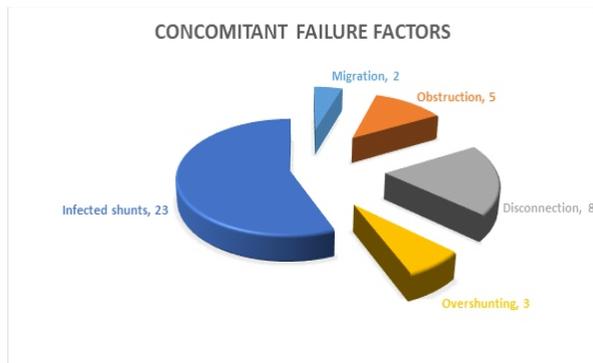
**Analysis of risk factors attendant to failure:** Forty one patients had documented shunts failure in many forms; migration 2-cases, obstruction 8-cases, disconnection 50cases and shunt infection 23-cases [Figure 1]. Patients who had infections were analyzed regarding the major suspected microbiology contributing to their colonization

[Figure2].

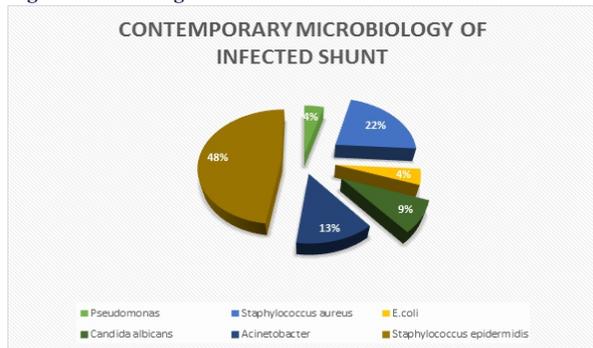
**Table1. Demographic characteristics of patients included**

Variable	Population (n/263)	Failure shunt
		Gender
Male	119	24
Female	144	17
pediatric	230	36
adult	33	5

**Figure 1. Concomitant shunt failure factors identified.**



**Figure 2. Micro-organisms isolated from infected shunts.**



**Discussion:** Ventriculoperitoneal shunt is globally established procedure with numerous success rates based on the primary pathology. However, shunt surgery still encountering many complications such as shunt infection, shunt disconnection, pseudocyst formation, shunt cutaneous exposure, and migration [6,7]. Shunt Infection is one of foremost and enduring problems worldwide [8,9]. Its impact on every health system due to long hospitalization, number of surgeries, antibiotics use and as secondary effect on the cost is well documented. With world wide range between 0.33%-40% [10,11]. O'Brien et al. reported 2.7% rate of infection in 778 cases. [12] While in a study conducted by Lee et al. they reported an infection rate of 10.5%. [13] We reviewed cases for better understand of this issue regarding the associated new generations of microorganisms colonizing the hardware. In our cases with positive cultures which proved infected, results showed 8.74% incidence of shunt infection of the general population. Although high, but it was within the normal ranges reported worldwide.

Regarding the span of microorganisms isolated in this study, Staphylococcus epidermidis isolated in most of the cases 48%, while Staphylococcus aureus in 22% of the cases, which may attribute to manual handling of hardware during shunt implantation, or secondarily due to manipulation of the external ventricular [Figure2]. Worldwide, most of the reports defining Staphylococcus aureus as the most common isolated pathogens in shunt infections [11].

Mechanical complications of a VP shunt, however, are common in both pediatric and adult patients with a reported incidence of 45% to 59% [7,14,15,16,17]. Disconnection and obstruction due to clot formation or catheter obstruction by scar tissue or choroid plexus are two significant mechanical VP shunt dysfunctions and must be adequately assessed even during routine follow-ups [14]. This review

revealed an incidence of 20% of shunt failure due to disconnection where obstruction observed in 12% of cases. Regardless of the cause, leading to shunt hardware failure, management is the same, to re-establish its integrity, by eradication of infection, in cases of mechanical failure revision of shunt in mandatory.

**Study Limitations:** Given the fact that this is a retrospective study and not prospective. The small sample and the short period of the study included.

**Conclusions:** Ventriculo-peritoneal catheter insertion is the mainstay in the treatment options of Hydrocephalus. Although it is a well-established procedure, nevertheless there are still various and significant complications attendant with shunt diversion surgeries failure. They are costly in terms of morbidity, human suffering, intellectual, neurological deficits and health care funds. Shunt infection remains a vexing problem in the Era of antibiotics. S. aureus continues to be an important cause of shunt infections. The presence of concomitant factors are associated with higher failure rates.

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