



Original Research

## Incidence of Ventriculoperitoneal (VP) Shunt Infection In Vancomycin-Drenched VP Shunts

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### ABSTRACT

**Objective:** To determine the occurrence of infection in patients with VP (Ventriculoperitoneal) shunts that were drenched in vancomycin.

**Materials and Methods:** A descriptive case series study was done in The Department of Neurosurgery, Lady Reading Hospital, Peshawar, Pakistan from 10 September 2019 to 31 December 2020 to ascertain the frequency of VP shunt infections in vancomycin-drenched VP shunts. The patients were followed for 06 months.

**Results:** A total of 100 patients were included in this study. There were 44 (44%) men and 56 (56%) women. Age ranged from birth to 18 years. Patients younger than 1 year were 44 (44%), older than 1 to 10 years were 33 (33%) and older than 10 years were 23 (23%). Congenital hydrocephalus was the most common type observed in 49 (49%) patients. Shunt infection occurred in 7 patients (7%) within 6 months after surgery. Staphylococcus aureus was the most common pathogen identified in 05 of 07 (71%) infected patients. P value <0.05 was observed in Vancomycin-soaked VP shunts and shunt infection, which is significant.

**Conclusion:** The rate of shunt infection was significantly reduced when 2 mg/mL topical vancomycin was used intraoperatively (intra- and peri-shunt) in conjunction with a multi-step shunt infection prevention program. This treatment may be less expensive than using an antibiotic-impregnated catheter (AIC).

**Keywords:** Ventriculoperitoneal Shunt, Infection, Vancomycin, Hydrocephalus, Antibiotic-Impregnated Catheter (AIC).

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### INTRODUCTION

In most critical cases, the only way to treat

hydrocephalus is to implant a cerebrospinal fluid shunt into the atrium, peritoneal cavity, or both. Shunt infection is one of the common potential problems that can arise with VP shunt insertion. The usual rate of shunt infection is around 5 to 15%, although high and low rates have also been reported in the literature.<sup>1,2,3</sup> The rate of shunt infection in our department was 18% during the previous year. Staphylococcus species cause 90% of shunt infections and the majority of these infections occur in the early months after surgery.<sup>4</sup> Shunt infections are caused primarily by skin flora colonizing the shunt device during surgery.<sup>5</sup>

Risk factors for shunt infection, mentioned in the literature, are additional manual handling of shunt devices during surgery, increased timing of shunt surgery, CSF leak from the wound site, revision surgery for shunt malfunction, previous shunt infection, premature birth, less age of the patient and presence of gastrostomy tube, etc.<sup>6</sup>

The effects of a shunt infection are severe. An infection typically necessitates the removal of the present shunt and the subsequent re-insertion of a new shunt, necessitating weeks of further hospitalization and incurring significant additional costs. More significantly, though, an infection may have harmful neurological implications on patients.<sup>7</sup>

Numerous efforts have been attempted to reduce the shunt infection rate with different shunt infection prevention protocols in different institutes. Regular intravenous prophylactic antibiotic administration is a cornerstone to prevent the infection.<sup>8</sup> Although there is little to no proof for each intervention, a variety of approaches are reported to help lower the rate of shunt infections.<sup>9</sup> The most successful way to avoid shunt infection is to combine all of these strategies into an institutional plan for shunt infection prevention.<sup>10</sup> The use of catheters with two separate long-release antibiotics via an antibiotic-impregnated catheter (AIC) is the latest innovation. According to several meta-analyses, AIC significantly reduces the rate of shunt

infections.<sup>11,12</sup> There are significant additional costs associated with the use of AIC and other adverse effects that can accelerate the emergence of antibiotic resistance.<sup>13</sup>

Ragel et al. reported that popularizing the shunt infection prophylaxis procedure resulted in a decrease in the shunt infection rate in their department from 12% to 8% when it was introduced in 2004. To further reduce the shunt infection rate, they used intraventricular gentamicin and vancomycin during surgery.<sup>14</sup> This study was conducted to determine the effect of Antibiotics on shunt infection rate. Differences in etiology and time of infection were also evaluated.

A multicentric randomized control trial named the BASICS trial (the British antibiotic and silver-impregnated catheters for ventriculoperitoneal shunts) was registered in the UK in 2012. This study has been completed but the final results have not been published yet. This study has included data from 17 neurosurgical centers comparing standard silicone VP shunts, antibiotic-impregnated (Clindamycin + Rifampicin) VP shunts, and silver-impregnated VP shunts.<sup>15</sup>

A single-centered RCT from South Africa showed no significant statistical difference between the two groups of antibiotics-impregnated VP shunts and non-impregnated VP shunts.<sup>16</sup> Another meta-analysis of 11 observational studies, however, showed a statistically significant difference between the two groups, depicting results in favor of antibiotic-impregnated shunts.<sup>17</sup>

The present study aimed to ascertain the frequency of VP shunt infection in vancomycin-drenched VP shunts because, despite numerous attempts to reduce them, cerebrospinal fluid (CSF) shunt infections still account for 5–15% of cases of shunt surgery morbidity. We modified our current shunt infection prevention policy to include topical vancomycin (intrashunt and perishunt) to decrease the rate of shunt infections of patients at our institution. Vancomycin was specifically chosen because of its high efficacy against the skin flora,

especially *Streptococcus* and *Staphylococcus* species.

## MATERIALS AND METHODS

### Study Design & Setting

This descriptive case series was conducted at the Department of Neurosurgery, Lady Reading Hospital, Peshawar from September 10, 2019, to December 31, 2020. The hospital's ethics and scientific committee gave its clearance before this investigation could be carried out.

### Sampling Technique

We used a non-probability consecutive sampling technique for patient selection. With the help of WHO software, a total sample size of 100 was calculated using a 15% VP shunt infection rate. The confidence level was 95% and the margin of error was 7%.

### Inclusion Criteria

All patients, regardless of gender, diagnosed with hydrocephalus needing a CSF shunt, whether it was their first implantation or a revision, and were under the age of 18 years between September 10, 2019, and December 31, 2020, were included in the study.

### Exclusion Criteria

Patients more than 18 years of age, those with infected CSF or active shunt infection, those with External ventricular Drain (EVD), and those who declined to participate were not included.

### Data Collection Procedure

All patients who met the inclusion criteria and were seen in the emergency room or admitted through O.P.D. were included in the study. All the patients were told of the study's benefits and goals, and their agreement was acquired. Each patient

underwent a thorough clinical examination and history. All of the patients had routine investigations. A senior who was a fellow of CPSP and had experience in his area oversaw all operations on patients. Medium-pressure silicon shunts drenched in a solution of injection Vancomycin 500mg diluted in 250 ml of normal saline i.e., 2 mg/ml were used in all cases.

### Follow up

The patients were followed for 06 months. If a patient had wound infection, sepsis from a ventriculoarterial (VA) shunt, peritonitis from a ventriculoperitoneal (VP) shunt, or meningitis, and if germs were found in the shunt, he/she was considered infected. A shunt infection was also assumed to exist in the absence of a positive culture in the presence of the usual positive clinical symptoms and CSF pleocytosis. Only shunt infections occurring within 6 months of surgery were collected (in line with most literature).

### Data Analysis

Analysis of all the variables was done by count and percentage. For numerical variables like age, mean $\pm$ SD were computed. For categorical variables like gender and VP shunt, frequencies and percentages were determined.

## RESULTS

A total of 100 patients were included in this study.

### Gender Distribution of Patients

The sample had female predominance as there were 44 (44%) males and 56 (56%) females.

### Age Distribution of Patients

The age ranged from birth to 18 years. Patients

younger than 1 year were 44 (44%), older than 1 to 10 years were 33 (33%) and older than 10 years were 23 (23%). Congenital hydrocephalus was the most common type observed in 49 (49%) patients. In Table 01 age age-wise distribution of infection rate has been shown.

**Table 1:** Age-wise distribution of patients.

Age (Years)	Number of Patients	Percentage (%)
Birth – 1 Year	44	44
>1-10 Years	33	33
>10-18 Years	23	23
<b>Total</b>	100	100

## Etiology of Hydrocephalus

While searching for etiology, it was revealed that congenital hydrocephalus was the most noted etiology in 41 patients (41%) of this age group i.e. below 18 years of age. Other etiologies noted were post-infectious 32 patients (32%), patients with tumors in their brain 17 (17%), post-traumatic 03 (3%) and idiopathic 07 (7%). As shown in the table 02 below.

**Table 2:** Etiology of Hydrocephalus.

Etiology	Number of Patients	Percentage (%)
Congenital	41	41
Post-Infectious	32	32
Post-Tumor	17	17
Post-Traumatic	03	03
Idiopathic	07	07
<b>Total</b>	100	100

## Incidence of Infection

Shunt infection occurred in 7 patients (7%) within 6 months of surgery. Staphylococcus aureus was the most common pathogen identified in 05 out of 07 (71%) of infected patients. A p-value <0.05 was observed in vancomycin-drenched VP shunts and shunt infection, which is significant. Table 03 depicts the distribution of the percentage infection rate.

**Table 3:** Distribution of infection rate.

Infection Rate	Number of Patients	Percentage (%)
Yes	07	07
No	93	93
<b>Total</b>	100	100

## DISCUSSION

We have examined how the occurrence of postoperative shunt infections changed when topical vancomycin was included in an existing shunt infection prevention program. The shunt infection rate dropped dramatically from 18.5% pre-addition to 07% post-addition of vancomycin.

The percentages of the cause of hydrocephalus as noted in our study agree with most of the studies which searched for the etiology of hydrocephalus. A study from our province searching for causes of hydrocephalus in different age groups published by Khan MU et al. in 2018 showed the top cause as post-infectious but the study included patients up to 69 years of age.<sup>18</sup>

An almost similar study was done in Neurospine and Cancer Care Institute Karachi, Pakistan by Kalhoro A. et al, from 2017 to 2020. In this study, they used a diluted solution of vancomycin to clean the skin from the scalp to the umbilicus and also to drench the shunt system in the solution. They got significant results to prove that the use of vancomycin this way can decrease shunt-related infections. In their study, the rate of shunt infection was observed as 3.6 % with the use of topical vancomycin.<sup>19</sup>

In contrast to this study, the shunt infection rate was noted as 10.71% by Khan M. et al. in a study conducted from 2017 to 2020 in two different hospitals in our province, KPK, Pakistan. This study was conducted with routine protocols without additional interventions.<sup>20</sup>

In a retrospective cohort study that included all patients undergoing cranial shunt surgeries performed between 2001 and 2013 at All Children's Hospital, Joshua M. Beckman et al,

applied bacitracin powder instead of vancomycin to the surgical wound site before closure. Their results also showed promising effects with a decrease in the shunt infection rate from 13% to 01%, signifying the use of topical antibiotics.<sup>21</sup>

In favor of our study, in another meta-analysis published by Ganesh VL in 2022. et al. The rate of shunt infection in the topical antibiotic group was 2.24% versus 5.24% in the control group. This study demonstrated a significant risk reduction with the use of topical and intraventricular antibiotics during shunt surgery. The meta-analysis reported no side effects of topical or intracerebroventricular antibiotics. This study did not reveal significant differences between the antibiotics used.<sup>22</sup>

Regarding topical antibiotic use, most reviews showed that topical antibiotics gave mixed results in different surgical fields.<sup>23</sup> Although topical antibiotics are used in different ways, there is still no level I evidence from randomized controlled trials. Their use is further complicated by significant variations in clinical practice concerning antibiotics used and route of administration.<sup>24</sup>

## CONCLUSION

The purpose of the present study was to determine the incidence of VP shunt infection in VP shunts treated with vancomycin. The risk of shunt infection in CSF shunts is significantly reduced with the use of 2 mg/mL topical vancomycin intraoperatively along with a multi-step shunt infection prevention approach. As a result, using this treatment may be less expensive than using AICs.

## LIMITATIONS

The small size of the sample and single-center study may limit the generalizability of our findings.

## RECOMMENDATIONS

Further studies involving multi-centers and large sample sizes of diverse populations would provide

better results to be adopted and incorporated in shunt infection prevention protocols.

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### AUTHORS CONTRIBUTIONS

Author's Full Name	Intellectual Contribution to the Paper in Terms of:
Muhammad Nawaz Khan	Idea and topic selection.
Mudassir Shah	Literature review.
Arshad Khan	Methodology and study design.
Muhammad Sajjad	Data compilation and referencing.
Muhammad Salman	Paper writing and editing.