



# Topical instillation of vancomycin lowers the rate of CSF shunt infections in children

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## Abstract

**Introduction** Shunt surgery in pediatric patients still bears a significant risk of infection, in addition to mechanical complications of the shunt system. Antibiotic-impregnated systems and perioperative antibiotics have been extensively studied for their potential to reduce shunt infections. We examined the effectiveness of intrawound application of vancomycin powder during shunt surgery.

**Patients and methods** Patient records of 78 primary shunt implantations at a mean age of 40 months were reviewed. In total, 52 patients (mean age 50 months) had been treated according to standard surgical and perioperative procedures (Std), whereas 26 patients (mean age 20 months) additionally had received topical application of vancomycin powder before wound closure (Vmc). Overall infection rate was 3.8%, in Std patients 5.8%, and in Vmc patients 0%. The rates of CSF fistula and revision surgery were similar in both groups (5.8% vs 8% and 23.1% vs. 30%, respectively).

**Conclusion** To the best of our knowledge, this is the first report on topical vancomycin instillation, indicating its efficacy for the prevention of shunt infection in pediatric patients. Further studies with a higher number of patients are needed to verify this finding.

**Keywords** Hydrocephalus · Shunt infections · Topical vancomycin

## Introduction

Hydrocephalus in childhood that requires treatment with shunt systems exposes the patient to the risks of shunt infection and device-related complications. In literature, shunt infections are quoted with 10 up to 24% [4]. There is an ongoing debate about prevention and reduction of shunt infections in order to avoid neurological or psychological sequelae for the patients and to improve further cognitive development. Especially antibiotic-impregnated shunts have been excessively promoted for that purpose. A meta-analysis showed a reduction of shunt infections in pooled data of pediatric

patients from 8.6 to 5.5% [3]. Despite the widespread use of antibiotic-impregnated catheters, some centers restrict the indications to a proven shunt infection or to secondary shunt implantations.

In spine surgery, prophylactic use of vancomycin significantly reduces the risk of surgical site infections in instrumentation and non-instrumentation cases [1, 2, 5].

## Patients and methods

Our pediatric neurosurgical patients undergo a strict regimen of perioperative and intraoperative handling. For every pediatric neurosurgical patient, the procedure, follow-up, complications, and re-interventions are documented meticulously in a pseudonymized database by the same neurosurgeon (MK), allowing for timely assessment and retrospective analyses.

Patients planned for shunt insertion receive i.v. antibiotics (standard group, Std): Cefuroxim at 30 mg/kg bodyweight at time of surgery and continuing thrice daily for 3 days in primary surgery with low risk, 5 days for high-risk patients, and 7 days for patients with previous shunt infection.

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**Table 1** Overview of shunt implantations, revisions, and infections in the overall cohort, the group with topical vancomycin application (Vmc), and the standard implantation group (Std)

	<i>n</i>	Mean age (months)	CSF fistula	Surgical revision	Shunt infection
Shunts total	78	40	5 (6.4%)	20 (25.3%)	3 (3.8%)
Shunts Vmc	26	20	2 (8.0%)	8 (30.7%)	0 (0.0%)
Shunts Std	52	50	3 (5.8%)	12 (23.1%)	3 (5.8%)

Supplementary application of vancomycin powder was used on selected high-risk patients on an individual basis at the discretion of the surgeon, e.g., premature-born babies after intraventricular hemorrhage, or patients requiring shunt surgery below 2 years of age. Vancomycin powder was applied into the shunt wounds before closure. Parental consent had been obtained prior to shunt implantation (vancomycin group, Vmc).

Shunt infection was diagnosed either by positive CSF culture, or by pathological CSF protein concentrations, lactate to glucose ratio, or CSF cell count combined with shunt malfunction. Obvious swollen or open wounds with putrid secretion were also counted as shunt infection.

Infection rates and revision rates were statistically compared with two-tailed Fisher's exact test.

The data analysis was approved by the local ethics committee (Ethikkommission Universität Leipzig Az 182-16/ek25042016).

## Results

An overview of the patient cohorts and results is shown in Table 1. The group of patients that received topical vancomycin powder before wound closure (Vmc) had a somewhat higher revision rate for non-infectious reasons and a rather similar rate of CSF fistulas after shunt implantation. The differences did not reach statistical significance when assessed by two-tailed Fisher's exact test ( $p = 0.5$ ). Patients in the vancomycin group were younger than the "standard-treated" patients at time of primary shunt surgery (20 vs. 50 months).

None of the Vmc patients experienced a shunt infection necessitating shunt explantation. Even patients with CSF fistulas after shunt implantation did not show signs of shunt infection. In contrast to this, all patients with standard protocol suffering from CSF fistula showed signs of a shunt infection.

## Discussion

Compared to the standard implantation technique, additional topical vancomycin application before wound closure reduced the shunt infection rate from 5.8% to calculated 0% ( $p = 0.55$ ). This is in concordance with reports from other surgical

specialties, e.g., spine surgery, in which vancomycin helps in the prevention of surgical site infections [1, 2, 5].

Using the described standard antibiotic protocol during shunt implantation, the incidence of shunt infections compares favorably to a meta-analysis of studies using antibiotic-impregnated shunts (5.8%) [3]. This demonstrates that detailed surgical technique to avoid CSF fistulas, rigid perioperative protocols, and perioperative antibiotics exert a significant impact on the incidence of shunt infections.

The data of the patients with topical vancomycin instillation seem to be promising. Though not reaching statistical significance, the reduction of the infection rate warrants prospective studies with larger patient cohorts to allow for reliable statistical evaluation, preferably in a randomized monocentric setting. This enables ruling out interfering factors, e.g., different surgical techniques or individual differences in perioperative handling.

## Conclusion

Topical vancomycin application into the surgical wound at time of primary shunt insertion bears the potential to reduce shunt infection rates to the same extent as antibiotic-impregnated catheters. Further large-scale prospective studies are needed to confirm these findings and to estimate the impact of potential side effects.

**Authors' contribution** All authors revised the manuscript carefully. CVM and MK collected the clinical data, performed the follow-up examinations, and drafted the manuscript. SS reviewed radiological examinations and sonographies.

## Compliance with ethical standards

**Conflict of interest** The authors declare no conflict of interest.

**Statement of ethics** The study has been evaluated by the local ethics committee and the data analysis was approved (Ethikkommission Universität Leipzig Az 182-16/ek25042016).

## References

1. Devin CJ, Chotai S, McGirt MJ, Vaccaro AR, Youssef JA, Omdorff DG, Arnold PM, Frempong-Boadu AK, Lieberman IH, Branch C,

- Hedayat HS, Liu A, Wang JC, Isaacs RE, Radcliff KE, Patt JC, Archer KR (2018) Intrawound vancomycin decreases the risk of surgical site infection after posterior spine surgery: a multicenter analysis. *Spine (Phila Pa 1976)* 43(1):65–71
2. Dodson V, Majmundar N, Swantic V, Assina R (2019) The effect of prophylactic vancomycin powder on infections following spinal surgeries: a systematic review. *Neurosurg Focus* 46(1):E11. <https://doi.org/10.3171/2018.10.FOCUS18470>
  3. Klimo P Jr, Thompson CJ, Baird LC, Flannery AM, Pediatric Hydrocephalus Systematic Review and Evidence-Based Guidelines Task Force (2014) Pediatric hydrocephalus: systematic literature review and evidence-based guidelines. Part 7: antibiotic-impregnated shunt systems versus conventional shunts in children: a systematic review and meta-analysis. *J Neurosurg Pediatr* 14(Suppl 1):53–59 Review
  4. Klimo P Jr, Van Poppel M, Thompson CJ, Baird LC, Duhaime AC, Flannery AM, Pediatric Hydrocephalus Systematic Review and Evidence-Based Guidelines Task Force (2014) Pediatric hydrocephalus: systematic literature review and evidence-based guidelines. Part 6: preoperative antibiotics for shunt surgery in children with hydrocephalus: a systematic review and meta-analysis. *J Neurosurg Pediatr* 14(Suppl 1):44–52. <https://doi.org/10.3171/2014.7.PEDS14326> Review. Erratum in: *J Neurosurg Pediatr*. 2015 Aug; 16(2):237-9
  5. Tailaiti A, Shang J, Shan S, Muheremu A (2018) Effect of intrawound vancomycin application in spinal surgery on the incidence of surgical site infection: a meta-analysis. *Ther Clin Risk Manag* 14:2149–2159

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