- Antibiotic-Impregnated Catheters for Ventriculoperitoneal Shunt in Neonates and Infants: A Systematic Review and Meta-Analysis
- Trends in the Treatment of Pediatric Hydrocephalus Since 2014: Understanding the Role of the 2014 Hydrocephalus Guidelines
- Risk Factors for 30-Day Postoperative Infection in Pediatric Ventricular Shunts for Hydrocephalus
- Infection rates during eras of intrathecal antibiotic use followed by antibiotic-impregnated catheter use in prevention of cerebrospinal fluid shunt infection
- Antibiotic-Impregnated Ventriculoperitoneal Shunts Decrease Bacterial Shunt Infection: A Systematic Review and Meta-Analysis
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- Antibiotic impregnated catheters and intrathecal antibiotics for CSF shunt infection prevention in children undergoing low-risk CSF shunt surgery
- Utilization trends in cerebrospinal fluid shunt infection prevention techniques in the United States from 2007 to 2015

Antibiotic impregnated catheters are antimicrobial catheter that have been introduced with the primary objective of reducing the incidence of shunt related infections.

The incidence of shunt infection is still high despite routine administration of perioperative antibiotics. A lower incidence of shunt infection was observed when antibiotic impregnated shunts (AIS) were used to treat hydrocephalus and a rapid cure was reported in cases of ventriculitis when antibiotics were injected into external ventricular drain (EVD).

[[mechanism of action]]

Designed to reduce the colonization of Gram-positive bacteria. Laboratory tests show these antibioticimpregnated catheters provide antimicrobial activity for at least the first 31 days, the time when patients are most susceptible to shunt infections 1(2)(3)(4)

AIC catheters slowly release antibiotics over several weeks to prevent the colonization of shunt systems by gram-positive bacteria, which account for most shunt infections $^{5)}$ $^{6)}$ $^{7)}$ $^{8)}$ $^{9)}$ $^{10)}$.

Costs

The bulk of the literature to date has demonstrated a reduction in shunt-associated infections associated with the use of AICs; however, there has been some reluctance to adopt these systems because of their increased cost compared with conventional catheters ^{11) 12) 13) 14) 15) 16)}.

Al catheters were found to be associated with a significant reduction in infection incidence, resulting

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in tremendous cost savings. Al catheters were associated with a cost savings of 42,125 and 230,390 per 100 de novo shunts placed in adult and pediatric patients, respectively¹⁷.

Antibiotic-impregnated shunts have yet to find widespread use in the developing world, largely due to cost. Given potential differences in the microbial spectrum, their effectiveness in preventing shunt infection for populations in low-income countries may differ and has not been demonstrated ¹⁸⁾

Types

Bactiseal C and NC

Ventriclear

Ares Antibiotic Impregnated Catheter

Duration

A study determined the protective effect of antibacterial processing of cerebrospinal fluid (CSF) shunt catheters against infection with staphylococci, which is an important complication following CSF shunt placement for hydrocephalus. Also examined is the effect of a conditioning film such as that seen on the luminal surface of shunts used in posthemorrhagic hydrocephalus. Conventional preventative measures, including antimicrobial prophylaxis, confer a temporary or unproven benefit. Bayston et al. have therefore developed a process for impregnation of CSF shunts with rifampicin and clindamycin, and this has been shown previously to achieve the target duration of 28 days of protective activity in vitro. The present study demonstrates the limit of the period of protection and the efficacy of the processing against a wide range of staphylococci, particularly in the presence of a plasma protein conditioning film. Five strains of Staphylococcus aureus and 17 coagulase-negative staphylococci, all clinical isolates, were inoculated into the shunts at 2-week intervals until failure of antimicrobial protection occurred. The results showed that the process protected against all strains for between 42 and 56 days and that the conditioning film did not diminish the protection ¹⁹.

CSF culture for diagnosis of ventriculitis

Concern has arisen over the effect of released antimicrobial agents from antibiotic-impregnated external ventricular drainage (EVD) catheters on the reliability of CSF culture for diagnosis of ventriculitis.

Bayston et al. designed a laboratory study to investigate this possibility, and to determine whether there was also a risk of loss of bacterial viability when CSF samples were delayed in transport to the laboratory. METHODS Three types of commercially available antibiotic-impregnated EVD catheters were perfused with a suspension of bacteria (Staphylococcus epidermidis) over 21 days. Samples were analyzed for bacterial viability and for concentrations of antibiotics released from the catheters. The authors also investigated the effect on bacterial viability in samples stored at 18°C and 4°C to simulate delay in CSF samples reaching the laboratory for analysis. RESULTS Bacterial viability was significantly reduced in all 3 catheter types when sampled on Day 1, but this effect was not observed

in later samples. The results were reflected in stored samples, with significant loss of viability in Day 1 samples but with little further loss of viable bacteria in samples obtained after this time point. All samples stored for 18 hours showed significant loss of viable bacteria. CONCLUSIONS While there were differences between the catheters, only samples taken on Day 1 showed a significant reduction in the numbers of viable bacteria after passing through the catheters. This reduction coincided with higher concentrations of antimicrobial agents in the first few hours after perfusion began. Similarly, bacterial viability declined significantly after storage of Day 1 samples, but only slightly in samples obtained thereafter. The results indicate that drugs released from these antimicrobial catheters are unlikely to affect the diagnosis of ventriculitis, as sampling for this purpose is not usually conducted in the first 24 hours of EVD ²⁰.

Metaanalysis

2015

The majority of data derive from studies on the effectiveness of AICs, followed by studies on the effectiveness of silver impregnated catheter SCCs. Statistical heterogeneity was observed in several analyses. Antimicrobial shunt catheters (AICs, SCCs) were associated with lower risk for CSF catheter-associated infections than conventional catheters (CCs) (RR 0.44, 95% CI 0.35-0.56). Fewer infections developed in the patients treated with antimicrobial catheters regardless of randomization, number of participating centers, funding, shunting or ventricular drainage, definition of infections, de novo implantation, and rate of infections in the study. There was no difference regarding gram-positive bacteria, all staphylococci, coagulase-negative streptococci, and Staphylococcus aureus, when analyzed separately. On the contrary, the risk for methicillin-resistant S. aureus (MRSA, RR 2.64, 95% CI 1.26-5.51), nonstaphylococcal (RR 1.75, 95% CI 1.22-2.52), and gram-negative bacterial (RR 2.13, 95% CI 1.33-3.43) infections increased with antimicrobial shunt catheters.

Based on data mainly from nonrandomized studies, AICs and SCCs reduce the risk for infection in patients undergoing CSF shunting. Future studies should evaluate the higher risk for MRSA and gram-negative infections. Additional trials are needed to investigate the comparative effectiveness of the different types of antimicrobial catheters ²¹.

Cui et al. evaluated the efficacy of antibiotic impregnated catheter (AIC) and silver impregnated catheter compared with plain catheters for the prevention of catheter related infections (CRI).

The authors performed an independent search of Medline, Embase, and the Cochrane Library to identify eligible studies published between January 2002 and August 2014.

They searched all relevant literature using an exhaustive search strategy. Randomized controlled trials or observational studies that compared (AIC) catheters with plain catheters for the prevention of CRI were included. The quality of each included study was assessed using a risk of bias assessment tool and the Newcastle-Ottawa Scale. RevMan5.3 software (The Cochrane Collaboration, Oxford, UK) was used to perform this meta-analysis, and publication bias was investigated using funnel plot constructions and Egger test.

A total of 4 randomized and 10 observational studies involving 4,399 patients were included in this metaanalysis. Pooled results comparing AIC catheters with plain EVD catheters in the management of patients with acute high intracranial pressure demonstrated the superiority of antimicrobial EVDs for

the prevention of CRI with a risk induction of 62% (95% confidence interval [CI], 0.25-0.58; P < .00001). Subgroup analyses of pooled data from separate analyses of AIC and SIC showed the efficacy of both measures for CRI prevention, with a risk ratio (RR) of 0.31 (95% CI, 0.18-0.55; P < .0001) and an RR of 0.59 (95% CI, 0.40-0.88; P = .010), respectively. The protective effects of these AIC catheters remained significant in the subgroup of randomized controlled trials with an RR of 0.48 (95% CI, 0.25-0.90; P = .02). A similar result was also seen after a pooled analysis of observational studies with an RR of 0.35 (95% CI, 0.21-0.60; P = .0001). The heterogeneity among studies was moderate (I(2) = 49%) and was primarily attributed to the inclusion of 1 large, positive cohort study. Publication bias was unlikely in the current meta-analysis.

The restults indicate that both AIC and SIC are more effective than plain EVDs for the prevention of CRI. There is no conclusive evidence on the preference of AIC vs SIC because of insufficient data. Further well-designed, multicenter randomized controlled trials are required to confirm the findings of this meta-analysis²²⁾.

Cost analysis

The current value analysis demonstrates that evidence supports the use of AICs as effective and potentially cost-saving treatment ²³⁾.

see Antibiotic impregnated shunt

Case series

Antibiotic impregnated catheter case series.

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