Infected Ventriculoatrial Shunts
A Method of Treatment

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Bacterial colonization of the tubing and valve is an important complication of ventriculovenous shunting procedures for hydrocephalus. The incidence of shunt infection is reported in the range of 15 to 20%, and the resulting syndrome may take the form of acute sepsis or indolent bacteremia most often caused by coagulase negative staphylococci. Although occasional success has been reported in treating these infections without removal of the valve and catheter, use of antibiotics alone almost invariably fails to sterilize the colonized foreign body. The resulting obligatory extraction of a functioning right-sided ventriculoatrial shunt, with replacement at another site several days or weeks later, subjects the patient to increased risk of morbidity from active hydrocephalus, ventriculitis, and multiple surgical procedures.

We have successfully treated six hydrocephalic children by total removal of infected valve and catheters and immediate replacement in the same site with a sterile shunt including a Rickham reservoir. To prevent reinfection the surgical procedure was followed by systemic and intraventricular antibiotic coverage, the latter route in order to percolate the valve directly with high concentrations of drugs. All six patients had had persistent bacteremia without ventriculitis.

Method

Bacteriological Identification. For serial cultures, specimens of venous blood or ventricular fluid drawn by aseptic technique were dispersed in 0.5 ml aliquots into several tubes of triple soy broth and incubated at 37° C aerobically. A pour plate from 0.5 ml of the broth inoculum was also incubated aerobically, and a thioglycolate tube was set up for anaerobic culture. All specimens were examined daily for 14 days, and the broth tubes were subcultured on days 1, 7, and 14.

Staphylococcal species were identified by colonial and microscopic characteristics and by the slide method of coagulase testing using human serum. In this paper the coagulase negative staphylococcus is referred to by the species name Staphylococcus epidermidis according to the seventh edition of Bergey’s Manual.

Antibiotic sensitivity was determined with commercially prepared discs, penicillin in a concentration of 10 mg per ml and methicillin 5 mg per ml.

Surgical Procedure. Each patient originally had a right-sided Holter valve ventriculoatrial shunt placed for the treatment of hydrocephalus. When serial blood cultures gave evidence of shunt colonization, the entire apparatus was removed and immediately replaced with a new one. The right internal jugular vein was used, and placement of the distal tubing in the right atrium was determined by electrocardiography. Postoperative skull and chest films also demonstrated proximal and distal catheter positions. In five of the six patients a Rickham reservoir was included with the ventricular catheter.

Antibiotic Regimen. Intravenous sodium methicillin (Staphcillin) alone or in combination with another appropriate antibiotic was given in a dose of 100 to 150 mg/kg per day for a 48-hour period preoperatively and for a 7-day period following shunt replacement; thereafter oxacillin (Prostaphlin) was given orally 50 to 100 mg/kg per day for an additional 7 days, to total 14 days postoperative therapy. Methicillin is a semisynthetic penicillin not degraded by penicillinase-producing (penicillin-resistant) organisms. Concurrent with systemic antibiotics, intraventricular methicillin in a dose of 3 mg/kg per day, not exceeding 90 mg per day, was injected once daily through the reservoir, diluted with 5 to 10 ml of ventricular fluid by barbotage. The initial dose was
given in the operating room, and subsequent
injections were made daily for 14 days. At
this time all antibiotics were discontinued
and blood cultures drawn 48 hours and 96
hours later.

Case Reports

We have summarized our six cases of in-
fected ventriculaoatrial shunt in Table 1.
Treatment of each case is described below.

Case 1. A boy born on June 16, 1961, had a
lumbar myelomeningocele repaired at 3 days
of age and a ventriculaoatrial shunt placed at
5 weeks. From infancy he suffered multiple
respiratory infections and failed to thrive.
Three blood cultures grown in April, 1965,
produced S. epidermidis, coagulase negative;
there was no hepatosplenaualagaly, hemog-
lobin was 8.2 gm, and white cell count was
9,250 per cu mm. Ten days of intravenous
penicillin and methicillin followed by long-
term oxasoxazole failed to eradicate the
infection. Blood cultures in July, 1965, pro-
duced S. epidermidis, now resistant to penicillin; this was unsuc-
S. epidermidis grew from the valve and tubing.
Antibiotic coverages are noted in Table 1.
During the course of treatment, daily
cerebrospinal fluid specimens ranged in total
protein levels from 24 to 36 mg% and glu-
cose levels from 47 to 65 mg%.

Case 2. A boy born on December 3, 1963,
had a lumbosacral myelomeningocele re-
paired at 15 days of age and a ventriculaoatrial
shunt placed at 7 weeks. On December 6,
1965, the shunt was functioning, but he was
febrile. Three blood cultures grew coagulase-
negative S. epidermidis, sensitive to penicillin
and methicillin; hemoglobin was 9.7 gm,
and white cell count was 14,300 per cu mm.
Two weeks of intravenous and intraventricu-
lar methicillin failed to control the fever.
Four ventricular fluid specimens during this
therapy were sterile, with 0 to 13 white
blood cells, protein of 20 to 69 mg%, and

Case 3. A boy was born on October 19,
1961, and at 3 weeks of age had a shunt
placed for obstruction of the third ventricle.
On March 10, 1965, after a 2-year history of
intermittent fever, he had blood cultures
grown which showed coagulase negative S.
epidermidis, moderately sensitive to penicillin.
Hemoglobin was 6.7 gm, white cell count
9,100 per cu mm, and albuminuria 3+ with
red and white blood cells in the urine sedi-
ment and sterile urine cultures. Blood cul-
tures continued to be positive in spite of
systemic antibiotics and revisions of the shunt.
Ventricular fluid was sterile in June,
1965, protein was 8 mg%, and glucose, 45
mg%. On March 4, 1966, the shunt was com-
pletely replaced by one with a Rickham
reservoir, under antibiotic coverage. The
ventricular catheter cultured coagulase-nega-
tive S. epidermidis, resistant to penicillin.
A postoperative left hemiparesis, due to
difficult insertion of the new ventricular
catheter, resolved slowly.

Case 4. A girl born on January 19, 1956,
had a shunt placed for aqueduct stenosis 6
years later (January 26, 1962). Six blood
cultures in February, 1965, grew coagulase-
negative S. epidermidis, sensitive to penicillin
and methicillin. There was a Grade 2 systolic
murmur, no splenomegaly, a hemoglobin of
11.2 gm, and a white cell count of 7,400 per
cu mm. Three courses of intravenous penicil-
lin and methicillin in high doses failed to
eradicate the infection. On January 28, 1966,
the shunt was replaced by one with a Rick-
ham reservoir, under antibiotic coverage.
The organism was cultured from all sections
of the old shunt. Two months later she de-
veloped a pneumococcal meningitis, from
which she recovered with no evidence of
shunt colonization. The reservoir was used
for intraventricular penicillin treatment
(15,000 units per day) of this meningitis.

Case 5. A boy born on August 9, 1961, had a
lumbar myelomeningocele repaired at 5
days of age and a ventriculaoatrial shunt