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ORIGINAL ARTICLE

Recurrent UTI in Ventriculoperitoneal Shunted Children's

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ABSTRACT

Objective: To determine the rate and the type of recurrent UTI in ventriculoperitoneal shunted children's admitted to Azady Teaching Hospital, Kirkuk.. Methods: From mid 2015 to end of 2020; UTI in ventriculoperitoneal shunted children's . Once infection was suspected , CSF (from shunt reservoir or from ventricular tapping), blood, and urine samples, analysis, and culture taken and empirical antibiotics were recommended.

Results: 25.9% of patients with VP shunts had infections which represents 29.3% of the procedures. 40% of infected patients had recurrent episodes. 59.1% of infections occurred throughout the first two months following insertion. Single pathogen was isolated in each episode. E.coli represented 50% of isolated pathogens compared with 18.2% with Staphylococcus epidermidis.

Conclusions: There is a high incidence of recurrent UTI in ventriculoperitoneal shunted children's in Azady Teaching Hospital, Kirkuk. when compared withother international centres. Gram negative organisms are the most common cause of the infection.

Keywords: Urinary tract infection= UTI ,Renal scar.,BBD = Bladder Bowel Dysfunction; DMSA = dimercaptosuccinic acid; IV

INTRODUCTION

I. Urinary tract infection

In 30% of children with urinary tract anomalies, urinary tract infection (UTI) can be the first sign . If we fail to identify patients at risk, damage to the upper urinary tract may occur these children have permanent renal scarring that may lead to poor renal growth, recurrent pyelonephritis, impaired glomerular function, early hypertension, endstage renal disease, and preeclampsia(1,2,3)

Epidemiology

Table 1. Incidence of pediatric urinary tract infection by age group and gender

Age (y)	Female (%)	Male (%)
1	0.7	2.7
1–5	0.9–1.4	0.1–0.2
6 –16	0.7–2.3	0.04–0.2
18–24	10.8	0.83

Urinary pathogens: Gram-negative rods E coli Pseudomonas aeruginosa Klebsiella spp Citrobacter spp Enterobacter cloacae Morganella morganii Proteus mirabilis Providencia stuartii Serratia spp Gram-negative cocci Neisseria gonorrhea Gram-positive cocci Enterococcus spp Streptococcus group B Staphylococcus aureus Staphylococcus epidermidis Staphylococcus saprophyticus Streptococcus group D Streptococcus faecalis Other pathogens Candida spp Chlamydia trachomatis Adenovirus(24).

1. Classification according to site

Cystitis (lower urinary tract) . Pyelonephritis (upper urinary tract)

2. Classification according to episode

Classifications are first infection and recurrent infection, which is subdivided into unresolved or persistent and reinfection .

3. Classification according to symptoms

Asymptomatic bacteriuria (ABU) and symptomatic UTI includes irritative voiding symptoms, suprapubic pain (cystitis), fever, and malaise (pyelonephritis). In patients with a neurogenic bladder and malodorous urine, it is difficult to distinguish between ABU and symptomatic UTI (4,5,6)

4. Classification according to complicating factors

Diagnostic work-up

1. Medical history

The site, episode, symptoms, and complicating factors are identified by taking the patient's history. This includes questions on primary (first)or secondary (recurring) infection, febrile or nonfebrile UTIs; malformations of the urinary tract (eg, pre- or postnatal ultrasound [US] screening), previous operations, drinking, and voiding habits(7,8,9,10).

2. Clinical signs and symptoms

Fever may be the only symptom of UTI, especially in young children . Newborns with pyelonephritis or urosepsis can present with nonspecific symptoms (failure to thrive, jaundice, vomiting, hyperexcitability, lethargy, hypothermia, and sometimes without fever)

3. Physical examination

4. Urine sampling, analysis, and culture

Before any antimicrobial agent is given, urine sampling must be performe

4.1. Urine sampling

4.1.1. Newborns, infants, and non–toilet-trained children. In newborns, infants, and non–toilet-trained children, there are four main methods for obtaining urine with varying contamination rates and invasiveness. A plastic bag attached to the cleaned genitalia is the technique used most often in daily practice. It is helpful when the culture result is negative. UTI can be excluded without the need for confirmatory culture if the dipstick is negative for both leukocyte esterase and nitrite, or microscopic analysis is negative for both pyuria and bacteriuria . As a result of the high contamination rate and high incidence of false-positive results, urine bag culture alone is not sufficiently reliable for diagnosing UTI. For clean-catch urine collection, the infant is placed in the lap of a parent or nurse holding a sterile foil bowl underneath the infant's genitalia . This is time consuming and requires careful instructing of the parents. There seems to be a good correlation between the results

of a urine culture obtained by this method and by suprapubic bladder aspiration (SPA) . However, the contamination rates were 26% in clean-catch urine compared with 1% in the SPA group in a 2012 study . Bladder catheterisation may be an alternative to SPA, although the rates of contamination are higher The risk factors for a high contamination rate using this technique are patients <6 mo of age, difficult catheterisation, and uncircumcised boys . Therefore, in children _6 mo of age and uncircumcised boys, use of a new sterile catheter with each repeated attempt at catheterisation may reduce contamination . Otherwise, SPA should be the method of choice(11,12,13,14).

Catheterisation is preferable in children with urosepsis when a permanent catheter may be considered in the acute phase. SPA is the most sensitive method for obtaining an uncontaminated urine sample. Using US to assess bladder filling simplifies the aspiration . Bladder puncture causes more pain than catheterisation in infants <2 mo of age . The Eutectic Mixture of Local Anesthetics, an emulsion containing a 1:1 mixture of lidocaine and prilocaine, can be used topically to reduce pain(15,16,17)

4.1.2. Toilet-trained children

In toilet-trained children, a clean voided midstream urine sample has a good rate of accuracy . It is important to clean the genitalia beforehand to reduce the contamination rate .

4.2. Urine analysis

Dipsticks and microscopy are commonly used for urinalysis. Some centres use flow imaging analysis technology. Most dipsticks test for nitrite, leukocyte esterase, protein, glucose, and blood.

4.3. Urine culture

The definition of significant bacteriuria varies slightly.

Table 2 Criteria for urinary tract infections in children from the EAU guidelines on urological infections

Urine specimen from suprapubic bladder puncture	Urine specimen from bladder catheterisation	Urine specimen from midstream void
Any number of CFU per millilitre (at least 10 identical colonies)	_1000–50 000 CFU/ml	_104 CFU/ml with symptoms _105 CFU/ml without symptoms

CFU = colony-forming units.

Modified with permission from the European Association of Urology

5. Blood test

Serum electrolytes and blood cell counts should be obtained for monitoring ill patients with febrile UTI. C-reactive protein has a lower specificity for identifying patients with renal parenchymal involvement , whereas serum procalcitonin (>0.5 ng/ml) can be used as a reliable serum marker . In a severely ill child, blood cultures should be taken as well as US imaging of the urinary tract.

Abdominal ultrasound

hydronephrosis, hydroureters, bladder wall abnormalities, and acute complications of UTI (e.g. renal or perirenal abscesses).

DMSA scan

A DMSA scan is reliable in detecting both acute pyelonephritis and late renal parenchymal scarring. However, it usually does not affect acute clinical management. A DMSA scan is an expensive technique that exposes the patient to radiation. Voiding cystourethrography VCUG is still the gold standard for the exclusion or confirmation of VUR (18).

II. Ventriculoperitoneal (VP)

Ventriculoperitoneal **(**VP) shunt insertion is an operation to place a catheter into a brain ventricle to drain cerebrospinal fluid (CSF) from the ventricular system. This fluid will then drain into the peritoneal space (abdominal cavity). Usually VP shunts are placed to treat hydrocephalus (hydro = water, cephalus = head) that can result from a number of conditions including:

- Subarachnoid haemorrhage,
- Meningitis
- Tumours.

 Normal pressure hydrocephalus .

After the VP shunt insertion is complete, you will be taken to the recovery area where you are closely monitored. Following this period you will be taken to the Neurosciences ward.

A follow up CT or MRI scan is sometimes carried out to verify that the ventricular catheter tip is located in the correct location in the brain(19).

Most patients are discharged within 2-5 days after a straightforward VP shunt insertion.

Risks and complications

The rate for patients requiring shunt revision is 25.8 %. The most frequent reasons for revisions of the shunt are: under drainage, discontinuation, fracture, infection, and over drainage. The annual valve failure rate was found to be 16.2 %.

Shunt malfunction

 Shunt blockage, together with shunt infection, remains the most common cause of shunt malfunction..

 There hasn't been a significant improvement in the level of blockages in recent years. **The rate of shunt blockages is highest in the first year after insertion, when it can be 20-30%. This decreases to approximately 5% per year thereafter**

 Over half of patients who have a shunt fitted will need at least one shunt revision in the following 10 year period.

 Obstruction can occur in any part of the shunt.

Shunt Infection (5-10%)

 This is almost always due to bacteria from the skin getting into the CSF or the shunt at the time of the operation and is remarkably difficult to prevent.

 In VP shunts, infection will usually show itself within a few weeks or months of the operation (usually 2 months), as a shunt blockage with the return of the features of hydrocephalus. There may also be occasional fever and abdominal pain. Redness and swelling may be (20,21).

Abdominal Complications

1. Obstruction.
2. Urinary tract infection

3. Movement of the catheter from the correct position
4. Intestinal injury
5. Shunt migration.

Management

Management of recurrent UTI show by tables

Table3 Oral antimicrobial drugs for pediatric UTI

Drug	Daily dosage (mg/kg/d)	Frequency
Penicillin		
Ampicillin	50–100	q 6 h
Amoxicillin	20–40	q 8 h
Augmentin	20–40	q 8 h
Sulfonamide		
Trimethoprim-sulfamethoxazole	8[a]	q 6 h
Cephalosporin		
Cephalexin	25–50	q 6 h
Cefaclor	20	q 8 h
Cefixime	8	q 12–24 h
Cefadroxil	30[a]	q 12–24 h
Fluoroquinolone		
Ciprofloxacin	20–40[a]	q 12 h
Nalidixic acid	55 mg/kg/day	q 6 h
Other		
Nitrofurantoin	5–7	q 6 h

[a] Dose adjustment required with azotemia.

Table 4 Parenteral antimicrobial drugs for pediatric UTI

Drug	Daily dosage (mg/kg/d)	Frequency
Aminoglycoside		
Gentamicin	7.5[a]	q 8 h
Tobramycin	7.5[a]	q 8 h
Penicillin		
Ampicillin	50–100	q 6 h
Ticarcillin	50–200	q 4–8 h
Cephalosporin		
Cefazolin	25–50[a]	q 6–8 h
Cefotaxime	50–180[a]	q 4–6 h
Ceftriaxone	50–75	q 12–24 h
Cetriazidime	90–150[a]	q 8–12 h
Cefepime	100	q 12 h
Fluoroquinolone		
Ciprofloxacin	18–30[a]	q 8 h

[a] Dose adjustment required with azotemia.

Table 5 Prophylactic antibiotics a Dose adjustment required for azotemi

Drug	Daily dosage (mg/kg/d)	Age limitation
Cephalexin	2–3	None
Nitrofurantoin	1–2	more thane 1 monthe
Trimethoprim-sulfamethoxazole	1–2a	more thane 2 monthe

Surgically correctable causes of recurrent infection

Infection stones
Infected nonfunctional renal segments
Infected ureteral stumps after nephrectomy
Vesicointestinal or urethrorectal fistulae
Vesicovaginal fistulae
Infected necrotic papillae
Unilateral medullary sponge kidney
Infected urachal cyst
Infected urethral diverticulum or periurethral glands (6).

PATIENTS AND METHODS

Over a five year period from mid 2015 till the end of 2020 in Azady Teaching Hospital, Kirkuk , 116 infants and children with hydrocephalus (60 girls and 56 boys) were subjected to 150 VP shunt procedures. VP shunt infection was suspected by two or more of the following clinical findings: fever, recurrent vomiting, poor feeding, depressed consciousness, irritability, seizures, and bulging tense anterior fontanel. Once infection was suspected, CSF (from shunt reservoir or from ventricular tapping), blood, and urine samples, analysis, and culture were taken in addition to other sepsis work up (full blood count, estimation sedimentation rate, C- reactive protein, full blood biochemistry, arterial blood gases, and chest x-ray.(Empirical antibiotics were then commenced pending culture and sensitivity results. Computerized tomography (CT) scanning of the brain was also considered. Once CSF infection had been confirmed, VP shunt was removed and EVD inserted until 3 CSF successive samples became sterile and its protein content got back to normal. A new shunt was then inserted. Ethical approval was gained before collection of patient data.

RESULTS

Thirty patients (25.9%), 16 girls and 14 boys, had 44 shunt infection episodes (29.3%). Table (1) shows ages of procedures and times of infections

Table 6 Ages of procedures and time of infections

Age of 1st procedure		Times of infection (after procedure)	
1d-1m	14	1st 2 m	26
1m-6m	12	2m-1y	12
>6m	4	>1y	6
Total	30		44

Table 7. Original causes of hydrocephalus. Six patients (40%) had more than one episode of shunt infections within one month after shunt insertion

Original cause of hydrocephalus	No and %
IVH	12 (40%)
Isolated aquiduct stenosis	8 (26.7%)
Postmeningitic	6 (20%)
Aquiduct stenosis and spina bifida	4(13.3%)
Total	30 (100%)

Table 8 .show causes of recurrent UTI in ventriculoperitoneal shunted children's

Type of organism	No and %
E coli	22 (50%)
Klebsiella spp	8(18.2%)
Staphylococcus Epidermidis	8(18.2%)
Citrobacter spp	2 (4.5%)
Haemophilus influenza	2 (4.5%)
Candida Albicans	2 (4.5%)
Total	44 (100%)

DISCUSSION

Infections of the urinary tract are among the most common infections in the pediatric population. If not treated promptly and appropriately, pediatric UTI may lead to significant acute morbidity and irreversible renal damage. Children, however, have a wide variety of clinical presentation, ranging from the asymptomatic presence of bacteria in the urine to potentially life-threatening infection of the kidney. A clinician's main goals are early diagnosis, appropriate antimicrobial therapy, identification of anatomic anomalies, and preservation of renal function. Treatment should be based on urine culture. Children noted to have renal scarring after an acute episode of UTI should be followed long-term for signs of hypertension and renal insufficiency(22,23,24).

The incidence of infections in our study wasrelatively high (25.9%) compared to many other studies where the rate of infection varies from 3.2-17% . GNB (gram negative bacteria) represented 81.3% of pathogens in our studycompared to 7-20% in other studies . In contrast, gram positive bacteria (all were S. epidermidis)were isolated in 12.5% in our study compared to 47-80% in other studies . Patients withhydrocephalus secondary to IVH or meningitis were the most infected with GNB . This might be explained by impaired local resistance resulting from past infection or hemorrhage. Though GNB infections can be associated with poor prognosis, there was one case death in our study.. In this study, the highprevalence of GNB infections was not only noticed in patients with UTI, but also in the majority of cases with postoperative sepsis particularly related to urologic diseases.Despite the strict anti-infectious protocols followed in all hospital areas particularly within the operating rooms and intensive care units, resistant strains of GNB particularly P. auerginosa and Klebsiella have been emerging. Empirical abuse of antibiotics, particularly second and third generation cephalosporins, within most of the medical centres in the area is likely to be the main cause of the high rate of GNB infection. Therefore, optimal antibiotic coverage were the cornerstones in the management of UTI shunt infections in our patients. The empirical antibiotic treatment always considered coverage of Pseudomonas and Staphylococcus infections. Vancomycin was the most used antibiotic (40.9%) followed by Meropenam (27.3%). (25).

It could be suggested that initial empirical combination of Ceftazidime and Vancomycin is a proper choice considering the types of infecting pathogens and patterns of microbial resistance. Previous studies had nearly the same suggestions as ours, third generation Cephalosporins and Vancomycin in one study, Vancomycin and flucloxacillin in another(26,27).

CONCLUSIONS

Classification of a UTI is made according to the site, episode, symptoms, and complicating factors. For acute treatment, the site and severity are of the most importance.(28,29,30). Immediate US of the kidney and bladder are necessary in patients with febrile UTI to exclude underlying uropathy. _ Treatment of patients with febrile UTIs should be initiated after urine analysis and culture to confirm the diagnosis. _ SPA and catheterisation have the lowest contamination rate for urine sampling. Using a plastic bag (most commonly used in daily practice), UTI can be excluded if the dipstick is negative for both leukocyte esterase and nitrite or microscopic analysis is negative for both pyuria and bacteriuria.(31.32). Prophylaxis has been shown to be beneficial in preventing new renal scars in infant girls with dilating reflux III and IV. Reflux should be excluded in patients with febrile UTIs. _ In toilet-trained children, BBD (Bladder Bowel Dysfunction) should be excluded(33,34).

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