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Analysis of 3 Cases of Refractory Urinary Tract Infection Caused by Enterococcus Faecium and Literature Review

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Abstract

Objective: To explore the clinical features, drug resistance, treatment and prognosis of refractory urinary tract infection caused by Enterococcus faecium infection.

Methods: A retrospective analysis of 3 cases of Enterococcus faecium infection admitted to the Children's Hospital of Shaanxi Provincial People's Hospital from January 2017 to December 2019, And the clinical manifestations of refractory urinary tract infections caused by it, routine laboratory examinations, mid-stage urine culture and drug sensitivity, urinary ultrasound, magnetic resonance (or CT) examination, treatment process and prognosis, and search and review relevant literature.

Result: The three children in this group were all women, aged 5 years, 2 months, 9 years and 11 years old. One case had renal abscess, one case had acute pyelonephritis, and one case had bladder-ureteritis. Clinical features: 2 cases had fever with a temperature of 38-39.5°C, and children with renal abscess were accompanied by chills; 2 cases had frequent urination, dysuria, and urethral irritation; 1 case of 5-year-old child had only transient urinary retention, All 3 cases were treated with conventional antibiotics orally and intravenously outside the hospital. During the course of 2 cases, the leukocytes were more than 25×10⁹/L, 3 cases had neutrophils above 70%, CRP was high, and 3 cases of mid-stage urine culture were Enterococcus faecium; 2 cases were sensitive to vancomycin and linezolid, Others are resistant. 3 cases had negative blood cultures, 1 case of urinary B-mode ultrasound had a thicker bladder wall, and a slightly thicker wall in the lower right ureter. Considering the inflammatory changes, 1 case had left hydronephrosis and 1 case had left kidney urinary salt crystals. MRI plain scan of both kidneys and ureters + MRU showed: 1 case had a thicker bladder wall, and the wall of the lower ureter was slightly thickened, considering the inflammatory changes. One case had a slight dilation of the upper left ureter and the renal pelvis and calyces. 1 case of CT enhanced scan + CTU showed: 1. Left nodular superior nodules and strip low-density shadow, considering the repeated deformity of the left renal pelvis and ureter with dilation of the ureter (upper renal pelvis is small, hypoplasia); [2]. Abnormal strengthening of the left kidney and a slight thickening of the fascia around the kidney; consider pyelonephritis with abscess formation or cystic lesions. 3. Mild water accumulation in the left kidney and upper middle ureter [4]. There are multiple lymph nodes in the retro peritoneum and the left side of the spine, and some are swollen. Treatment 3 cases were initially ineffective with three generations of cephalosporins, and 2 cases had obvious effect of intravenous infusion of vancomycin based on drug sensitivity. After 7-10 days of treatment, cefepime was changed for consolidation treatment and cured. One case of meropenem treatment improved. Three cases were followed up for 1 year without recurrence. 1 case relapsed 20 days after discharge, intravenous infusion of cefepime for 17 days, and nitrofurantoin was taken preventively for 2 weeks before relapse.

Conclusion: Most of the urinary tract infections caused by Enterococcus faecium infections are refractory upper urinary tract infections, which have many complications, timely and mid-stage urine culture, and urinary tract B ultrasound. Magnetic resonance imaging and hydrography of both kidneys and ureters play an important role in the diagnosis of complications. High drug resistance, timely adjustment of treatment according to drug susceptibility, selection of effective drugs is very important, given a sufficient course of treatment, can improve the prognosis.

Introduction

Enterococcus Faecium, belonging to the Enterococcus family, is a part of the normal flora in the intestines of humans and animals. Under normal circumstances, it belongs to probiotics. If Enterococcus Faecium reproduces in large numbers, it may bring negative effects on human body and cause serious infections, such as urinary tract infection, endocardial infection, meningitis and sepsis.

Clinical Data

The general information

Three cases of refractory urinary tract infection caused by Enterococcus faecium were selected from Children's Hospital of Shaanxi Provincial People's Hospital from January 2017 to December 2019.

Acute pyelonephritis (recurrent), kidney abscess

Female, 11 years old, admitted to the hospital with the chief complaint of "intermittent frequency of urination for 2 weeks and fever for 1 day" on July 16, 2018. Two weeks ago, there was no inducement to induce dysuria, urgent urination, frequency of micturition, accompanied by fever, chills, lumbago. High white blood cells in urinary routine. Blood routine: WBC:6.91×10⁹/L, N0.52L 0.38 PLT 299×10⁹/L, RBC 3.39×10⁹/L, HGB 97g/L, ESR 35mm/h." Given intravenous drip ceftazidime for 10 days according to urinary tract infection in the other hospital", normothermia, no pain in urine, normal urine test and discharged. One day ago, the child had a fever again and her body temperature reached 40°C(104°F), accompanied by chills, conscious lumbago, frequent urination, headache, nausea and vomiting of gastric contents for 3 times. Urgent to our hospital, and outpatient

examination showed WBC $25.86 \times 10^9/L$, N0.88, L0.05, PLT $174 \times 10^9/L$, RBC $3.71 \times 10^9/L$, HGB $102g/L$, CRP $216.79mg/L$. Urinary routine WBC:43.6ul, urinary albumin+, and she was admitted to hospital. Phys exam: poor spirit, T:38.9°C(102°F), P:80cpm, R: 20cpm, W:30kg(66lb), BP:110/65mmHg, no yellow staining, no skin rash and hemorrhagic point, superficial lymph nodes were not touched, neck was not resistant, heart and lung were normal, abdomen was soft, tenderness of the left hypochondriac region, anus perineum of nephro was not touched, the percussion pain in the left renal region was obvious, slightly congestion in the urinary tract, no secretions, no abnormalities in the nervous system. The course of admission and diagnosis: In-hospital examination showed PCT: 7.79 ng/ml, ESR: 98mm/L. Anti-O, liver and kidney function, myocardial enzyme, radioimmunoassay, humoral immunity, mycoplasma pneumoniae and fecal routine were normal. Mid-stream urine culture: Enterococcus faecium, elizabethkingia meningoseptica, eosinophilic /comamonas testosteroni. B-ultrasound of urinary system suggested: urine salt crystallization in left kidney; CT flat sweeping of both kidneys suggested:

- 1) Upper pole of the left kidney was irregular; the longitudinal strip low-density shadow of the medial side of the left kidney extended downward to the upper ureteral plane and recommended that enhanced CT scan + CTU assist.
- 2) The patchy low-density shadow of the left kidney and slight thickening of the perirenal fascia were recommended to be observed by enhanced CT scan.
- 3) Scanned the accessory spleen and a small amount of effusion in the right pleural cavity. Enhanced CT scan of bilateral renal + CT flat sweeping of thoracic suggested (Figure 1).
- 4) Irregular nodules and strip-like low-density shadows of the upper left kidney, duplication of the left renal pelvis with ureteral dilation is more considered (parvina and hypoplasia of the upper renal pelvis), please combine with clinical practice and review if necessary.
- 5) Abnormal left renal enhancement with slightly thickened perirenal fascia; In consideration of pyelonephritis with internal abscess formation or cystic lesions, review is recommended in combination with clinical treatment.
- 6) Mild hydronephrosis of the left kidney and upper and middle part of the ureter.
- 7) Multiple lymph nodes in the retroperitoneum and the left side of the spine, some of them enlarged.
- 8) Scan the accessory spleen.
- 9) Localized emphysema at the lower edge of the right lung, and increased weight in bilateral lung texture; Anti-infection treatment of ceftriaxone was given for 5 days, recurrent fever, temperature is 38.5-39 °C(101.3°F-102.2°F), the urine pain relieved, and then changed the antibiotic of meropenem 20mg/kg, Tid, the next day the temperature was normal, generally got better. After treated for 1 week, no malaise, kidney area tenderness and percussion pain disappeared, the WBC, N, CRP/PCT were normal. blood sedimentation rate was decreased, urinary routine was normal, review of the two middle urine culture pathogenic bacteria growth was not found, the parents refused to kidney, ureter, magnetic resonance (NMR) review, discharged with nitrofurantoin for prevention of profess to convinced, follow-up of 1 year relapse-free, abscess absorption was showed by magnetic resonance examination in local hospital.

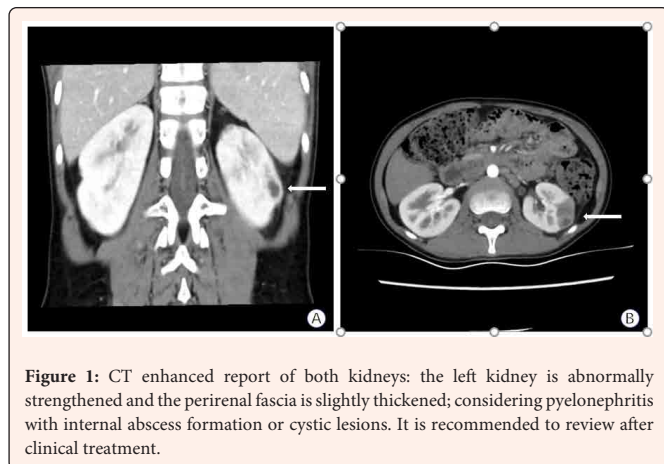


Figure 1: CT enhanced report of both kidneys: the left kidney is abnormally strengthened and the perirenal fascia is slightly thickened; considering pyelonephritis with internal abscess formation or cystic lesions. It is recommended to review after clinical treatment.

Acute pyelonephritis nephropathy and hydronephrosis

Female, 5 years old, with intermittent fever for 1 week, was admitted to hospital on March 25, 2017. One week ago, there was no inducement of fever, the body temperature was 38-39.5°C (100.4-103.1°F), accompanied by nasal congestion, runny nose, light cough, and treated according to the cold by local. She had fever again after the temperature was normal 2 days. Blood routine suggested WBC $26 \times 10^9/L$, N 0.85, CRP 297.45. mg/L, PCT:3.4ng/m. Instatic drops of ceftriaxone sodium. 3 days later, routine blood examination suggested: WBC:9. 12 $\times 10^9/L$,N 0.61.But the temperature didn't go down. One day before admission, there was transient dysuria, no frequency, urgency, dysuria or dysuria, no edema, dizziness or vertigo. She was transported from Shenmu(One of the Chinese cities) to my department. No previous history of chronic urinary tract infection. Phys exam: physical development and nutriment were normal and poor spirit, T:38.9°C .P:100cpm,R:22cpm,W18kg(39.7lb), no yellow stain, rash or bleeding spots on skin, and the superficial lymph nodes were not touched, the neck was not resistant, the pharynx was congested, the tonsils werelarge, the heart and lung were not abnormal, the abdomen was soft, the liver and spleen were not large, the kidney area was not tapped pain, the urethral mouth was congested, there was no secretions, and the nervous system was not abnormal. The course of admission and diagnosis: Blood routine suggested: WBC5.1 $\times 10^9/L$, N 0.7, L0.27 M 0.03, PLT 293 $\times 10^9/L$, RBC 4.16 $\times 10^9/L$, HGB 99g/L. Urinary routine suggested:WBC:118ul, urinary albumin-,CRP36.15mg/L, PCT:0.9ng/ml,ESR:85mm/L. Anti-O, liver and kidney function, myocardial enzyme, kidney immunity, humoral immunity, Mycoplasma pneumoniae and feces were normal. There was no abnormality in EB virus antibody, DNA and peripheral blood. There was no abnormality of coronary artery and cardiac structure in B-mode ultrasound; Urinary B ultrasonography suggested hydrposy of the left kidney and normal of the right kidney, double ureter and bladder. Ceftriaxone (Rostophen) and Niaoganning (a kind of traditional Chinese medicine which is used to cure urinary tract)were to fight infection for 1 week, and the body temperature did not go down. Mid-stream urine culture: Enterococcus faecium and was ensitive to vancomycin, linezolidamide, other drug was resistance. MRI plain scan of both kidneys and ureters + MRU showed: The upper part of the ureter, pelvis and calyces of the left kidney were slightly dilated. Acute pyelonephritis was diagnosed, and the temperature was stable and normal after 2 days of vancomycin replacement. The patient had tinnitus after 10 days of treatment, and the side effects of vancomycin were considered. Cefepime was treated for 11 days with a descending staircase (During the treatment, urine white blood cells decreased slowly and decreased more than 20 cells a week). The temperature of the child was normal and without discomfort. The urine culture repeated examination was normal for 3 times, and the urine routine and the B-ultrasound of the urinary were normal for 2 consecutive times. The child discharged from the hospital on April 21, 2017. After discharge, oral splenoamineptide to increased immunity and preventive dose of furantoin was given. Follow-up visits. After 20 days, and high fever does not retreat again, local treatment was invalid. Urinary routine suggested WBC: 28.9ul. Blood routine and CRP are normal. The B-ultrasound of the urinary suggested: Mild hydronephrosis of the left kidney with dilatation of the upper segment of the left ureter. Entering my department again. After 17 days of treatment with cefepime for recurrence of pyelonephritis, she was discharged after normal review. After discharge, the child was followed up for more than 1 year without recurrence and her development was normal.

Urinary tract infection(bladder-ureteritis)

Female, 9 years old, with intermittent frequency of urination, urgency of urination and dysuria, was admitted to hospital on June 12, 2004. Two months ago, there was frequent urination, urgent urination and painful urination without any inducement, and there was no fever. The symptoms were slightly alleviated by warm boiled water and traditional Chinese medicine urethral cleaning and self-administration of norfloxacin and three gold tablets(a kind of traditional Chinese medicine which is used to cure Urinary tract infection), but repeated, sometimes nocturnal enuresis, and frequent urination, urgent urination and painful urination worsened 1 week ago, urinating more than 10 times a day, accompanied by the feeling of wanting to defecate when urinating, without dysuria. Two days ago, B - ultrasound examination of the urinary system in the outpatient department of our hospital showed that the bladder wall was coarse and thickened. Blood routine suggested WBC:9.23 $\times 10^9/L$,N:0.41,L:0.26,M:0.05,EOS:0.27,P LT331 $\times 10^9/L$,RBC:4.28 $\times 10^9/L$,HGB:12lg.

Urinary routine/CRP/hs-CRP were normal. Intravenous infusion of cefmenoxime failed for 2 days and the child was transferred to hospital. During the illness, no fatigue, night sweat, wasting, good food and spirit, stool appearance was normal. Phys exam: T: 37°C (98.6°F),P: 90cpm, R:22cpm, Bp:112/60mmHg,W : 29kg(63.9lb). physical development and nutriment were normal and poor spirit, no yellow stain, rash or

bleeding spots on skin, and the superficial lymph nodes were not touched, the neck was not resistant, the pharynx was congested, the tonsils were enlarged, the heart and lung were not abnormal, the abdomen was soft, the liver and spleen were not large, the kidney area was not tapped pain, the urethral mouth was congested, there was a small amount of secretions, and the nervous system was not abnormal. The course of admission and diagnosis: Blood routine suggested: WBC $5.1 \times 10^9/L$, N 0.7, L 0.27 M:0.03, PLT $293 \times 10^9/L$, RBC $4.16 \times 10^9/L$, HGB 99g/L, Urinary routine suggested: WBC:118ul, urinary albumin-CRP36.15mg/L, PCT: <0.05ng/ml, ESR: 19mm/L. Anti-O, liver and kidney function, myocardial enzyme, kidney immunity and humoral immunity were normal. Mycoplasma pneumoniae antibody was positive, titer 1:80. Urethral secretion smear detected G+ streptococcus and a small amount of G- bacillus. Fecal routine was normal, EB virus antibody, DNA and peripheral blood were normal. Coronary artery and cardiac structure in B-ultrasound were normal. Urinary system B-ultrasound indicated that left hydronephrosis, right kidney, double ureters and bladder were not abnormal. After admission, the child was given anti-infection treatment of ceftriaxone (Rostophen) + Niaoganning for 3 days. Mid-stage urine culture (two urine samples were collected at the same time and the results were consistent in different hospitals): Enterococcus faecium was sensitive to vancomycin and linezolid, while other drugs were resistant. MRI plain scan of both kidneys and ureters + MRU showed:

- No obvious abnormal signal was observed in both kidneys.
- The bladder wall was thick, and the wall of the lower segment of the right ureter was evenly and slightly thickened. Considering inflammatory changes and recommended to review after treatment.
- Pelvic cavity a small amount of effusion. After 3 days of treatment with vancomycin replacement, frequent urination, urgent urination and dysuria were significantly alleviated. After 7 days of treatment, symptoms disappeared without enuresis. B-ultrasound bladder wall thickening was significantly alleviated, and urine culture was negative. Due to parents' concern about the side effects of vancomycin, the child was treated with cefepime for 7 days. After discharge, oral linezolid was discontinued for 1 week. Follow-up for more than 1 year showed no recurrence and normal development Figure 2.

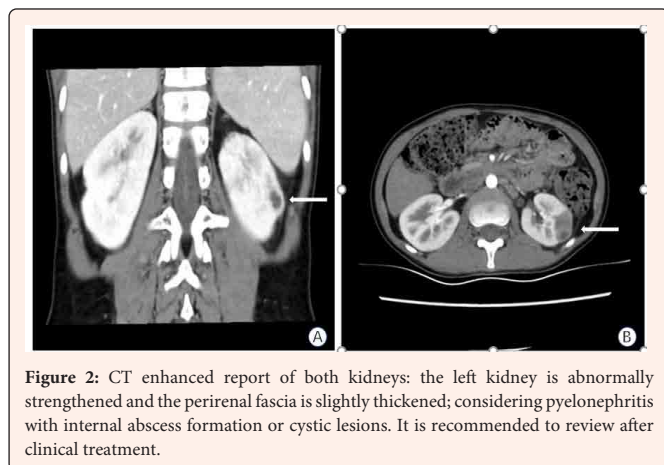


Figure 2: CT enhanced report of both kidneys: the left kidney is abnormally strengthened and the perirenal fascia is slightly thickened; considering pyelonephritis with internal abscess formation or cystic lesions. It is recommended to review after clinical treatment.

Acute pyelonephritis nephropathy and hydronephrosis

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mouth was congested, there was no secretions, and the nervous system was not abnormal. The course of admission and diagnosis: Blood routine suggested: WBC $5.1 \times 10^9/L$, N 0.7, L 0.27 M 0.03, PLT $293 \times 10^9/L$, RBC $4.16 \times 10^9/L$, HGB 99g/L. Urinary routine suggested: WBC:118ul, urinary albumin-CRP36.15mg/L, PCT:0.9ng/ml, ESR:85mm/L. Anti-O, liver and kidney function, myocardial enzyme, kidney immunity, humoral immunity, Mycoplasma pneumoniae and feces were normal. There was no abnormality in EB virus antibody, DNA and peripheral blood. There was no abnormality of coronary artery and cardiac structure in B-mode ultrasound; Urinary B ultrasonography suggested hydronephrosis of the left kidney and normal of the right kidney, double ureter and bladder. Ceftriaxone (Rostophen) and Niaoganning (a kind of traditional Chinese medicine, which is used to cure urinary tract) were to fight infection for 1 week, and the body temperature did not go down. Mid-stream urine culture: Enterococcus faecium and was sensitive to vancomycin, linezolid, other drug was resistance. MRI plain scan of both kidneys and ureters + MRU showed: The upper part of the ureter, pelvis and calyces of the left kidney were slightly dilated. Acute pyelonephritis was diagnosed, and the temperature was stable and normal after 2 days of vancomycin replacement. The patient had tinnitus after 10 days of treatment, and the side effects of vancomycin were considered. Cefepime was treated for 11 days with a descending staircase (During the treatment, urine white blood cells decreased slowly and decreased more than 20 cells a week). The temperature of the child was normal and without discomfort. The urine culture repeated examination was normal for 3 times, and the urine routine and the B-ultrasound of the urinary were normal for 2 consecutive times. The child discharged from the hospital on April 21, 2017. After discharge, oral splenoaminopeptide to increase immunity and preventive dose of furantoin was given. Follow-up visits. After 20 days, and high fever does not retreat again, local treatment was invalid. Urinary routine suggested: WBC: 28.9ul. Blood routine and CRP are normal. The B-ultrasound of the urinary suggested: Mild hydronephrosis of the left kidney with dilatation of the upper segment of the left ureter. Entering my department again. After 17 days of treatment with cefepime for recurrence of pyelonephritis, she was discharged after normal review. After discharge, the child was followed up for more than 1 year without recurrence and her development was normal.

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Urinary routine/CRP/hs-CRP were normal. Intravenous infusion of cefmenoxime failed for 2 days and the child was transferred to hospital. During the illness, no fatigue, night sweat, wasting, good food and spirit, stool appearance was normal. Phys exam: T:37°C (98.6°F), P:90cpm, R:22cpm, Bp:112/60mmHg, W : 29kg(63.9lb). physical development and nutrition were normal and poor spirit, no yellow stain, rash or bleeding spots on skin, and the superficial lymph nodes were not touched, the neck was not resistant, the pharynx was congested, the tonsils were enlarged, the heart and lung were not abnormal, the abdomen was soft, the liver and spleen were not large, the kidney area was not tapped pain, the urethral mouth was congested, there was a small amount of secretions, and the nervous system was not abnormal. The course of admission and diagnosis: Blood routine suggested: WBC $5.1 \times 10^9/L$, N 0.7, L 0.27 M:0.03, PLT $293 \times 10^9/L$, RBC $4.16 \times 10^9/L$, HGB 99g/L, Urinary routine suggested: WBC:118ul, urinary albumin-CRP36.15mg/L, PCT: <0.05ng/ml, ESR: 19mm/L. Anti-O, liver and kidney function, myocardial enzyme, kidney immunity and humoral immunity were normal. Mycoplasma pneumoniae antibody was positive, titer 1:80. Urethral secretion smear detected G+ streptococcus and a small amount of G- bacillus. Fecal routine was normal, EB virus antibody, DNA and peripheral blood were normal. Coronary artery and cardiac structure in B-ultrasound were normal. Urinary system B-ultrasound indicated that left hydronephrosis, right kidney, double ureters and bladder were not abnormal. After admission, the child was given anti-infection treatment of ceftriaxone (Rostophen) + Niaoganning for 3 days. Mid-stage urine culture (two urine samples were collected at the same time and the results were consistent in different hospitals): Enterococcus faecium was sensitive to vancomycin and linezolid, while other drugs were resistant. MRI plain scan of both kidneys and ureters + MRU showed:



Table 1: General information and clinical manifestations of 3 cases.

Disease	Gender	Age	Pathogenesis	Febricity	Urinary irritation
Acute pyelonephritis with renal abscess	female	11 years old	2weeks	Maximum temperature 40°C (104°F)	Frequent and urgent urination
Acute pyelonephritis with hydronephrosis	female	5 years old	1weeks	Maximum temperature 39.5°C (103.1°F)	Only transient dysuria and dysuria
Cystoureteritis	female	9 years old	2 months	-	Frequent urination, urgent urination, urination pain, occasionally nocturnal enuresis

Table 2: Laboratory tests and MRI(CT) of 3 cases.

Disease	WBC (×10 ⁹ /L)	N	CRP (mg/L)	CT or MRI	Deformity
Acute pyelonephritis with renal abscess	25.86	0.88	216.79	Left kidney abscess;	Ureteral duplication
				Left hydronephrosis;	
				Hydroureterosis	
Acute pyelonephritis with hydronephrosis	26	0.85	297.45	The upper ureteral pelvis and calyces were slightly dilated	None
Cystoureteritis	9.23	0.7	36.15	Bladder wall was thick; The wall of the lower segment of the right ureter was uniformly thickened	None

Table 3: Treatment and prognosis of 3 cases.

Disease	WBC (×10 ⁹ /L)	N	CRP (mg/L)	CT or MRI	Deformity
Acute pyelonephritis with renal abscess	25.86	0.88	216.79	Left kidney abscess; Left hydronephrosis; Hydroureterosis	Ureteral duplication
Acute pyelonephritis with hydronephrosis	26	0.85	297.45	The upper ureteral pelvis and calyces were slightly dilated	None
Cystoureteritis	9.23	0.7	36.15	Bladder wall was thick; The wall of the lower segment of the right ureter was uniformly thickened	None

Table 4: Treatment and prognosis of 3 cases.

Disease	Resistance	Effective medicine	Course of treatment	Prognosis	Follow-up
Acute pyelonephritis with renal abscess	Ceftriaxone (Clinical)	Meropenem, Furantoin	Treatment for 2 weeks, prevention for 1 month	Cure	no recurrence
Acute pyelonephritis with hydronephrosis	Ceftriaxone et al	Vancomycin, linezolid, cefepime	Treatment for 2 weeks, prevention for 1 month	Cure	no recurrence for more than 2 years
Cystoureteritis	Ceftriaxone and other cephalosporins, penicillin class	Vancomycin, linezolid, cefepime	Treatment for 2 weeks, prevention for 1 month	Cure	no recurrence for more than 1 years

- i. No obvious abnormal signal was observed in both kidneys.
- ii. The bladder wall was thick, and the wall of the lower segment of the right ureter was evenly and slightly thickened. Considering inflammatory changes and recommended to review after treatment.
- iii. Pelvic cavity a small amount of effusion. After 3 days of treatment with vancomycin replacement, frequent urination, urgent urination and dysuria were significantly alleviated. After 7 days of treatment, symptoms disappeared without enuresis. B-ultrasound bladder wall thickening was significantly alleviated, and urine culture was negative. Due to parents' concern about the side effects of vancomycin, the child was treated with cefepime for 7 days. After discharge, oral linezolid was discontinued for 1 week. Follow-up for more than 1 year showed no recurrence and normal development Figure 3.

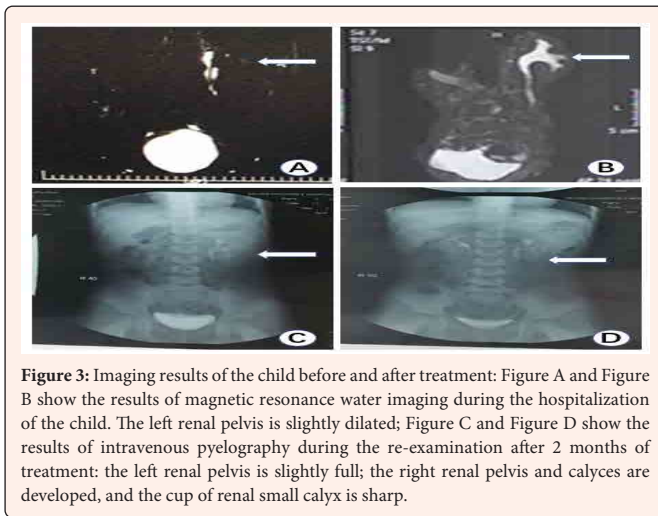


Figure 3: Imaging results of the child before and after treatment: Figure A and Figure B show the results of magnetic resonance water imaging during the hospitalization of the child. The left renal pelvis is slightly dilated; Figure C and Figure D show the results of intravenous pyelography during the re-examination after 2 months of treatment: the left renal pelvis is slightly full; the right renal pelvis and calyces are developed, and the cup of renal small calyx is sharp.

Result

The gender of three cases in our hospital was female. In addition, they were school age and preschool children. One case accompanied by ureteral duplication. Middle urine culture of three cases were enterococcus faecium infection. Ceftriaxone (rostophen) resistance was evidenced by all of clinical experience. In addition, the culture proved that vancomycin and linezolid were effective. One case had tinnitus side effect after using vancomycin. One case of parents concerned side effects and were replaced with cefepime by effective step-down therapy. Two cases were treated with the prophylaxis of furantoin. One case was discharged after 4 weeks of treatment and relapsed 20 days later. After the second admission to the hospital for anti-infection treatment with cefepime for 17 days, there was no recurrence after the prophylaxis of furantoin.

Discussion

Urinary tract infection, a common acute disease in infants and children, is also a common cause of fever in children. In addition, it is the second infections in hospital infections [1]. Complicated urinary tract infection (CUTI) is difficult to treat with low bacterial clearance and high recurrence rate in patients with urinary tract organic or functional abnormality [2]. Children with bladder and ureteral reflux or congenital urinary tract malformation are prone to recurrent urinary tract infections, and long-term repeated use of antibiotics can lead to the emergence of drug-resistant strains. Distribution and drug resistance of pathogenic bacteria are affected by age, region and other factors [3]. According to the different sites of pathogenic bacteria, urinary tract infection can be divided into pyelonephritis, cystitis and urethritis. Pyelonephritis is also called on upper urinary tract infection and cystitis and urethritis are collectively called lower urinary tract infections. In infants under 2 years old, UTI with fever is considered pyelonephritis [4]. For children with UTI younger than 1 year old and/or with basic diseases of urinary tract and significantly elevated blood PCT/ urine β -2-MG and NGAL, the possibility of APN should be highly suspected, and further imaging examination should be conducted as soon as possible to confirm the diagnosis [5]. UTI may be limited to the lower urinary tract or may involve the renal pelvis and kidneys, causing both systemic and local symptoms, such as high fever, vomiting, frequent urination, and lower back pain. Acute

pyelonephritis (APN) is one of the serious bacterial infectious diseases in childhood. In the acute phase, it causes sepsis, bloodstream infection and serious complications of renal abscess. It can also lead to irreversible renal damage, renal interstitial lesions and renal scar formation. A few final development for end-stage renal disease (ESRD) [6-7]. In the diagnosis of UTI, > 5 cells / Hp in centrifugation of urine sediment leukocytes or symptoms of urine sensation were considered UTI, and the diagnosis required the results of cleaning mid-stream urine culture and colony count. Once UTI is diagnosed, attention should be paid to looking for the underlying cause, the particular underlying deformity and particular vesicoureteral reflux (VUR). With the rapid development of microbiological testing technology, great progress has been made in the prevention and treatment of various infectious diseases [8]. The majority of common pathogenic bacteria are Gram-negative bacilli, a few enterococcus and staphylococcus, and Escherichia coli accounts for 60-70% [9]. In recent years, Gram-positive bacterial infection has been on the rise, especially in neonates, the UTI caused by group B streptococcus and Enterococcus faecium is significantly higher than that of other age groups [10]. Neonatal UTI is most commonly infected by blood [11]. Enterococcus faecium, belonging to the Enterococcus family, is a part of the normal flora in the intestines of humans and animals. Under normal circumstances, it belongs to probiotics and can produce a variety of toxins, with a high natural drug resistance rate and easy to produce acquired drug resistance [12]. Some scholars have reported that Escherichia coli is the main pathogenic bacteria of urinary tract infection (UTI) and also the main pathogenic bacteria of acute pyelonephritis (IPN) [13]. Enterococcus has also gradually become the second pathogenic bacterium of UTI in children of China, which can produce a variety of toxins and has high natural drug resistance and easy to produce acquired drug resistance. It has been reported that enterococci with complex urinary tract infection have high drug resistance rates to benzocillin and erythromycin, which should be avoided in the clinical. Fosfomicin and furantoin have low drug resistance rates and can be taken orally, so they can be selected for empirical drug use [14]. Some scholars reported that the gram-positive bacteria causing UTI in Shenzhen Children's Hospital had serious drug resistance, and the drug resistance rate of Enterococcus faecium was higher than Enterococcus faecalis. Enterococcus had a drug resistance rate of only 7.7% to furantoin, which was an option as therapy, and no drug-resistant strains to vancomycin and linezolid had been found [15]. In "the analysis of pathogenic bacteria associated with urinary tract infection in children with indwelling catheterization", Wang Yunzhong et al conducted drug sensitivity test for 17 strains of Enterococcus faecium among 114 UTI children, and all of them were multi-drug resistant bacteria. The drug resistance of Enterococcus faecium was significantly higher than Enterococcus faecalis, and no drug resistance to vancomycin, linezolid or teicoplanin was found in both of them [16]. In "Analysis of Risk Factors and Drug Resistance of Acute Pyelonephritis in Children", Liu Yan et al studied the drug sensitivity analysis of 42 strains of Enterococcus faecium and showed that the drug resistance rate of Enterococcus faecium to vancomycin, linezolid and furantoin was low. However, due to the high concentration of furantoin in the urinary tract, it is not easy to be used in the treatment of APN, and vancomycin should be used with caution in children with renal dysfunction. Therefore, linezolid can be used as the first choice of empirical drug for APN children with enterococcal infection [5]. The course of treatment for urinary tract infection generally advocates 7-10 days for the first occurrence of lower urinary tract infection and 10-14 days for upper urinary tract infection; Two kinds of antibiotics were selected after bacterial culture for 10-14 days, and a small dose of drugs was given for maintenance to prevent recurrence of UTI. Asymptomatic bacteriuria generally does not require treatment. For patients with urinary tract obstruction, vesicoureteral reflux and other deformities, or with previous old renal scar, antibiotics should be treated for 7-14 days, followed by low dose of antibiotics for prevention until the deformity is corrected [17]. Due to the high incidence of sepsis and severe pyelonephritis in newborns and infants, under 3 months old, intravenous antibiotics are recommended and surgical drainage should be considered as the preferred treatment for children with renal abscess or perirenal abscess [18]. For repeated renal ureteral malformation, if there are no clinical symptoms and no renal function impairment, there is no need for special treatment. Regular follow-up is observed and rechecked once every 6-12 months. If the repeated kidney has no function and is accompanied by urinary symptoms, such as urinary incontinence caused by repeated ectopic ureteral opening and dysuria caused by repeated terminal ureteral cyst compression, surgical resection can be used for treatment [19]. Outcome: A clinical study on the incidence of VUR in UTI in children by Xinhua Hospital Affiliated to Shanghai Jiao Tong University showed that the incidence of VUR was 37.7%, 77.78% in children ≤ 2 years old; it is relatively high and has a high VUR grade, which is easy to form renal scar [20]. Preventive antibiotic therapy has always been a hot topic of discussion. It is generally believed that children with febrile UTI, especially infants under 2 years old, should be given prophylactic antibiotics after infection control until further imaging examination is completed. Recommended antibiotic prophylaxis and dosage: Trimethoprim 1-2mg/kg. D, sulfamethylisoximazole 12mg/kg. D, furantoin 1mg/kg. D, cefaclor 20-40mg/kg. Take 1/4 to 1/3 of the total dose at night before bed. Continuous infection will destroy the kidney, and gradually renal scar will appear.



Preventive medication will inhibit bacterial growth, maintain the sterile state of urine, and reduce the occurrence of renal damage [21]. Shen Ying, Capital Medical University Affiliated Beijing Children's Hospital, believes that in the following cases to prevent the use of antibiotics: 1. For new borns or small infants with first onset, after treatment in the acute phase, antibiotics should be replaced and continued prophylaxis until a comprehensive imaging examination is completed to exclude the possible presence of urinary malformation 2. In patients with a history of vesicoureteral reflux, immune tolerance, incomplete urinary tract obstruction, etc., antibiotics should be used until these triggers disappear, thus reducing the risk of urinary tract infection; 3. Antibiotics should also be used prophylactically in children with recurrent urinary tract infections without urinary tract function or anatomical abnormalities. The use of prophylactic antibiotics has been shown to be effective in reducing the incidence of recurrent urinary tract infections in follow-up studies ranging from 2 months to up to 6 years. So as to reduce the incidence of complications. For prophylactic use, antibiotics with high oral availability, effective antimicrobial concentration in urine, less gastrointestinal adverse reactions and well tolerated by children should be preferred. Sulfadiazine, furantoin and cefixime were all mentioned, which may be related to the different drug resistance of bacteria in different regions. Therefore, the selection of prophylactic drugs should be based on the local drug sensitivity spectrum [22].

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