ACUTE URINARY TRACT INFECTION IN CHILDREN IN KHARTOUM STATE: PATHOGENS, ANTIBIOTICS SUSCEPTIBILITY AND ASSOCIATED RISK FACTORS

A thesis to be submitted in partial fulfilment for the requirement of the degree of Clinical MD in Paediatrics & Child Health.

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By:
DR. AMIRA HASSAN OSMAN
M.B.BS(U. of K)

Supervisor:
DR. EL-TIGANI MOHAMED AHMED
Assistant Professor,
MBBS (U of K), MPCH (U of K), M Med Sc. Nephrology (UK)
Department of Paediatrics and Child Health
Faculty of Medicine; U of K.
بسم الله الرحمن الرحيم
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صدق الله العظيم
سورة العلق
Table of contents

Page
Dedication .............................................................................................................. i
Acknowledgement ................................................................................................ ii
English Abstract ................................................................................................. iii
Arabic abstract .................................................................................................... iii
List of abbreviations .......................................................................................... vi
List of tables ....................................................................................................... vii
List of figures ....................................................................................................... viii

Chapter One:
1. **Introduction and Literature Review** ........................................... 1
   1.1 General Consideration ....................................................................... 1
   1.2 Anatomy and Physiology of the Kidney ........................................ 2
   1.3 Function of the Kidney ...................................................................... 4
   1.4 Urinary Tract Infection ...................................................................... 6
      1.4.1 Definition .................................................................................. 6
      1.4.2 Prevalence of UTI ................................................................. 6
   1.5 Host and pathogens ........................................................................... 7
      1.5.1 Predisposing factors related to the host: (Host factor). .......... 7
      1.5.2 The pathogens ....................................................................... 9
   1.6 Pathogenesis of UTI ......................................................................... 16
   1.7 Prevention of UTI ............................................................................ 19
      1.7.1 Male circumcision ..................................................................... 19
      1.7.2 Others prevention .................................................................... 20
   1.8 Clinical Features of UTI ................................................................... 21
      1.8.1 In neonates ............................................................................... 21
      1.8.2 In infants .................................................................................. 22
      1.8.3 In children ............................................................................... 22
   1.9 Classification of UTI ......................................................................... 22
      1.9.1 Clinical classification of UTI ................................................... 22
1.9.1.1 Acute pyelonephritis……………………….. 22
1.9.1.2 Cystitis………………………………………… 23
1.9.1.3 A symptomatic bacteruria……………….. 23
1.9.2 Other Classifications of UTI……………….. 24
1.9.2.1 Complicated urinary tract infection…….. 24
1.9.2.2 Recurrent UTI................................. 25

1.10 Urinary Tract Infection and Vescoureteric Reflux in children .................................................. 25

1.11 Diagnosis of Urinary Tract Infections……………… 28
1.11.1 Methods of urine collection....................... 28
1.11.2 Examination of urine............................. 33
1.11.2.1 Urinalysis........................................ 33
1.11.2.1.1 Macroscopic examination of urine…… 33
1.11.2.1.2 Microscopic examination of urine……. 34
1.11.2.2 Urine culture.................................... 35
1.11.2.3 Identification of uropathogens............... 37
1.11.2.4 Antimicrobial sensitivity test............... 38

1.12 Imaging Studies....................................... 39
1.12.1 Types of imaging studies......................... 40
1.12.1.1 Ultrasonography.............................. 40
1.12.1.2 Voiding Cystourethrogram (VCUG)… 41
1.12.1.3 Dimercapto Succinic Acid (DMSA)…… 42
1.12.1.4 99mIC Diethylene Triamine Penta-Acetic
        Acid (DTPA)....................................... 42
1.12.1.5 Intravenous Urogram (IVU).............. 43

1.13 Management of Urinary Tract Infection.......... 44
1.13.1 Control of acute infection....................... 46
1.13.2 Prophylactic antibiotics.......................... 48
1.13.3 The ongoing care.................................. 48
1.13.4 Prognosis of UTI in children:

  ➢ Justification............................................. 50

  ➢ Objectives.............................................. 51

Chapter Two:
2- Materials and Methods........................................ 52

2.1 Study Design............................................ 52
2.2 Study Area............................................. 52
2.3 Duration of Study..................................... 52
2.4 Study Population and Sampling Technique...... 53
2.5 Sample Size........................................... 53
2.6 Case Definition....................................... 53
2.7 Inclusion Criteria.................................... 54
2.8 Exclusion Criteria .......................................................... 54
2.9 Research Tools and Methodology ................................. 55
  2.9.1 Questionnaire ...................................................... 55
  2.9.2 Methods of urine collection ................................... 56
  2.9.3 Urine transport ..................................................... 58
  2.9.4 Urinalysis ........................................................... 58
  2.9.4.1 Microscopic examination of urine sediment... 58
  2.9.4.1.1 Pyuria ......................................................... 59
  2.9.4.2 Urine culture .................................................... 59
  2.9.4.3 Sensitivity test ................................................ 60
  2.9.4.4 Culture Significance ........................................ 61
  2.9.4.5 Diagnosis of UTI ............................................. 61
  2.9.5 Imaging studies ................................................... 62
  2.9.5.1 Ultrasonography .............................................. 62
  2.9.5.2 Voiding Cystourethro.gram (VCUG) .......... 62
2.10 Research Team .......................................................... 63
2.11 Ethical Consideration ................................................... 64
2.12 Statistical Analysis .................................................... 64

Chapter Three:

3- Results: ........................................................................... 65
3.1 Sociodemographic Characteristics in Children with UTI...... 65
  3.1.1 Age distribution in children with UTI...................... 65
  3.1.2 Gender distribution in children with UTI ............... 68
  3.1.3 Residence distribution in children with UTI ........... 68
  3.1.4 Distribution of UTI patients according to home origin... 68
  3.1.5 Distribution of children with UTI according to parents' education ............................................................. 72
3.2 Weight and Height in Children with UTI .......................... 72
3.3 Distribution of symptoms of urinary tract infection in children with UTI ................................................................. 75
3.4 Male Circumcision in Children with UTI .......................... 77
3.5 Distribution of Risk Factors in Children with UTI ............. 77
3.6 Laboratory Data ........................................................... 81
  3.6.1 Urine macroscopy in children with UTI ............... 81
  3.6.1.1 Distribution of UTI children according to the urine odour... 81
  3.6.2 Urine microscopy ..................................................... 81
  3.6.2.1 Distribution of UTI children according to urine pus cell counts /HPF ......................................................... 81
  3.6.3 Type of isolated bacteria in children with UTI ............ 81
  3.6.4 Bacterial isolated sensitivity to different drugs in the study group ................................................................. 85
  3.6.5 E-coli drug sensitivity to different drugs................... 85
3.6 Abdominal US Finding in Children with UTI .................... 87
3.7 MCUG Finding in Special Group in Children with UTI ....... 90
3.8 Distribution of Gender in Children with VUR ................. 90
3.9 Relationship Between the Presence of UTI and Other Variables. 93
3.9.1 Relationship between the age and the presence of UTI
3.9.2 Relationship between the gender and the presence of UTI
3.9.3 Relationship between parents' education and the presence of UTI
3.9.4 Relationship between the weight and the presence of UTI
3.9.5 Relationship between male circumcision and the presence of UTI
3.9.6 Relationship between the symptoms and UTI
3.9.7 Relationship between risk factors and the presence of UTI
3.9.8 Relationship between odour of the urine and the presence of UTI
3.9.9 Relationship between pyuria and culture proven UTI

Chapter Four:
4- Discussion

4.1 Incidence of Urinary Tract Infection
4.2 Sociodemographic Characteristics of Children With UTI
4.3 Distribution of Symptoms of UTI Among the Study Population
4.4 Relation of male circumcision to UTI
4.5 Weight distribution of children with UTI
4.6 Risk Factors in Children with UTI
4.7 Laboratory Data
4.7.1 Urine culture in relation to pyuria
4.7.2 The pathogens
4.7.3 Drug sensitivity in children with UTI
4.7.4 E.coli drugs sensitivity in children with UTI
4.8 Abdominal ultra sound in children with UTI
4.9 VCUG Abnormalities in Children with UTI

❖ Conclusions
❖ Recommendations
❖ References
❖ Appendix
Dedication

To
My Mother, God bless her

To
My Father, who keeps my feel to the medical knowledge
and makes the learning process exciting and ever new to me.

To
My Dear Husband
And
My lovely kids (Ala’a, Mohamed)
For their patience and love
&

To My Sisters and Brothers
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Abstract

The aims of the study were to determine the pattern of pathogens causing acute UTI in children, their antimicrobial susceptibilities and the associated risk factors and renal tract anomalies.

This prospective, hospital-based study was conducted in Gaafar Ibn Auf Emergency Children Hospital in the period from July to November 2007.

A total of 400 children aged 15 day – 16 years, suspected of having acute UTI, were screened using dipsticks urine tests. Dipstick was positive in 221 children (55.2%) from whom urine samples were sent for culture and in-vitro sensitivity testing.

One hundred out of these 221 patients (45.2%) had significant bacteriuria. Their mean age was 3.4 ± 3.6 SD years and males constituted 53%. Most of the patients were below the age of 5 years (74%) of whom 35 percent were infants.

E. coli was the commonest isolated pathogen (60%) followed by klebsiella, enterococcus faecalis and staph. Aureus in 12%, 10% and 9%, respectively. proteus spp., streptococcus and pseudomonous aeruginosa were the least common organisms (6%, 2%, 1%, respectively).

The in-vitro sensitivity tests showed that the bacterial isolates were highly sensitive to gentamycin (96%), ciprofloxacin (94%), ceftriaxone (90%), cefixime (85%) and cefuroxime (75%). Sensitivity to nalidixic acid, nitrofurantoin and cephelexin was 74%, 70% and 51%, respectively. Pathogens were highly resistant
to co-trimoxazole, amoxicillin-clavulanate and ampicillin in which sensitivity was 29%, 19% and 14%, respectively.

Ultrasound scan (US) was done in 89 patients of whom 29 children (32.6%) had (US) abnormalities. Six out of there 29 children had renal calculi and the remaining 23 had different US abnormalities.

VCUG was done in 15 out of 28 children in whom VCUG is indicated. The result showed low grade (I-II) Vesicoureteric Reflux (VUR) in 5 (33.3%) of them.

Risk factors, with the exception of uncircumcision were not significantly related to occurrence of acute UTI.

**In conclusion;**

- E-coli is the commonest pathogen causing acute UTI in Sudanese children with acute UTI.
- Urinary pathogens are highly sensitive to gentamycin, ceftriaxone, ciprofloxacin, cefuroxime and cefixime. Therefore we recommend all these agents, except ciprofloxacin, as first line drugs for empiric therapy of acute UTI.
- Isolates showed high to moderate sensitivity to nalidixic acid and nitrofurantion, therefore we suggest these drugs for less

- acute cases or for prophylaxis because of their low serum therapeutic levels.
Conventional drugs like cephelexin co-trimoxazole, amoxicillin – clavulanate and ampicillin showed low sensitivity results, therefore we do not recommend their use in empiric treatment of acute UTI.

Renal tract abnormalities were not common in Sudanese children with acute UTI. The detected abnormalities namely VUR are likely to be acquired due to infection rather than congenital.

Therefore we suggest MCUG for UTI cases only in whom this test is indicated.
هذَه الدراسة تُختَب الميكروبات المسببة لالتهاب البول الحاد في الأطفال، وحساسيتها للمضادات الحيوية وتحديد عوامل الخطر المصاحبة لها وتحديد العوامل الخلقية للجهاز الكلوي. هذه دراسة استقصائية اُجريت بمستشفى جعفر بن عوف لأحداث الأطفال في الفترة من يوليو وحتى نوفمبر عام 2007 م.

جُمع 400 طفل يتراوح أعمارهم من 15 يوم إلى 16 سنة متترين بأصابتهم بالالتهاب المجاري البولي الحاد تم الكشف عليه في فحص Dipstick ووجد منهم 231 إيجابي الفحص (55.2%) - هؤلاء المرضى أرسلتم لهم عينات لزراعة البول والحساسية.

مَنَت مِن 221 طفل (45.4%) وجدت عندهم فحص زراعة البول إيجابية (هؤلاء الأطفال غالبية هؤلاء الأطفال المصابين بالالتهاب المجاري البولي الحاد أقل من عمر 5 سنوات (74%).

َو שלכםَ مِن أطفال رَز. إِيِشريشية القولونية وجدت ان البكتيريا الأكثر شيوعا (60%) كسبب للالتهاب المجاري البولي ثم بلها بعد ذلك الكليبيسيه المكورات المعوية البرازية والمكورات العنقودية البرتقالية في (12 %، 10% و9%) على التوالي. البكتيريا المتنقلة والمكورات العقديه والزائفة الزنجبليه هم أقل نسبة (6%، 2% و1%) على التوالي.

وُجد أن البكتيريا المعزولة ذات حساسية عالية للمضادات الحيوية للجيناتيين (96%) سروفوكسين (41%)، سيفتريكون (95%) - سيفوكسين (58%) وسيفروميسين (75%) ووجدت الحساسية للانبيكسك اسيد - النيتروفانتون و السيفوكسين كانت (41%) و (70%) و (30%).

وجد أن البكتيريا لديها مقاومة عالية لكلوراميسازول والاموكسيسلين + كاليفينيك اسيد والأميسيلين (29، 19، 14%) على التوالي.

اجرأت الموجات الصوتية ل 89 مصاب منهم 29 طفل (32.6%) وكانت غير طبيعية.

6 أطفال من 29 طفل وجدتهم حساسية بالكلي و 33 الآخرين لديهم نتائج أخرى. صورة المثانة المبالية أثناء التبول اجرت ل 15 طفل من 28 طفل كانوا مستحقين بالفحص - أوضحت نتائج هذه الصورة الارتفاع المثاني الحالي في 5 أطفال (33.3%) من درجة 

: I

 vários

: II

أظهرت الدراسة أن عوامل الخطر مازل مخاطرًا غير مهمنة لحدوث التهاب المجاري البولي الحاد.

في الخاتمة:

إيشريشية القولونية هي البكتيريا الأكثر شيوعا لالتهاب المجاري البولي الحاد في السودان.
البكتريا المسئولة لهذا الالتهاب هي أكثر حساسية للسبروفولكساسين، سيفيلوركسامول، سيفركسيم، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلوركسامول، سيفيلورкс...
List of Abbreviations

BSU  Bag Specimen Urine
CLED Cystine Lactose Electrolytes Deficient
CSU  Catheter Specimen of Urine
DMSA Dimercapto Succinic Acid (DMSA)
DTPA $^{99m}$Tc Diethylene Triamine Penta-Acetic Acid
GF   Glumerular Filtration
IVU  Intravenous urogram
MIC  Minimal Inhibitory Concentration
MSU  Mid Stream Urine
MCUG Micturating Cystourthrogram
RN   Reflux Nephropathy
SPA  Suprapubic Aspiration
SSP  Species
UTI  Urinary Tract Infection
VCUG Voiding Cystourthrogram
VUR  Vesicoureteral Reflux
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Distribution of UTI children according to home origin</td>
<td>71</td>
</tr>
<tr>
<td>Table 2</td>
<td>Distribution of symptoms of urinary tract infection in UTI children</td>
<td>78</td>
</tr>
<tr>
<td>Table 3</td>
<td>Types of isolated bacteria in children with UTI</td>
<td>84</td>
</tr>
<tr>
<td>Table 4</td>
<td>Bacterial isolated sensitivity to different drugs in the study group</td>
<td>86</td>
</tr>
<tr>
<td>Table 5</td>
<td>E-coli drug sensitivity to different drugs</td>
<td>88</td>
</tr>
<tr>
<td>Table 6</td>
<td>Relationship between parents’ education and presence of UTI</td>
<td>96</td>
</tr>
<tr>
<td>Table 7</td>
<td>Relationship between male circumcision and the presence of UTI</td>
<td>99</td>
</tr>
<tr>
<td>Table 8</td>
<td>Distribution of symptoms in relation to the presence of UTI</td>
<td>100</td>
</tr>
<tr>
<td>Table 9</td>
<td>Relationship between risk factors and the presence of UTI</td>
<td>101</td>
</tr>
</tbody>
</table>
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distribution of study sample according to home dipstick and culture results</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>Age distribution in children with UTI</td>
<td>67</td>
</tr>
<tr>
<td>3</td>
<td>Gender distribution in children with UTI</td>
<td>69</td>
</tr>
<tr>
<td>4</td>
<td>Residence distribution in children with UTI</td>
<td>70</td>
</tr>
<tr>
<td>5</td>
<td>Distribution of children with UTI according to parents' Education</td>
<td>73</td>
</tr>
<tr>
<td>6</td>
<td>Distribution of children with UTI according to weight for age</td>
<td>74</td>
</tr>
<tr>
<td>7</td>
<td>Distribution of children with UTI according to Height for age</td>
<td>76</td>
</tr>
<tr>
<td>8</td>
<td>Male Circumcision in Children with UTI</td>
<td>79</td>
</tr>
<tr>
<td>9</td>
<td>Distribution of Risk Factors in Children with UTI</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>Distribution of UTI children according to the urine odour</td>
<td>82</td>
</tr>
<tr>
<td>11</td>
<td>Distribution of UTI children according to urine pus cell counts /HPF</td>
<td>83</td>
</tr>
<tr>
<td>12</td>
<td>Abdominal US Finding in Children with UTI</td>
<td>89</td>
</tr>
<tr>
<td>13</td>
<td>MCUG Finding in Special Group in Children with UTI</td>
<td>91</td>
</tr>
<tr>
<td>14</td>
<td>Distribution of Gender in Children with VUR</td>
<td>92</td>
</tr>
<tr>
<td>15</td>
<td>Relationship between the age and the presence of UTI</td>
<td>94</td>
</tr>
<tr>
<td>16</td>
<td>Relationship between the gender and the presence of UTI</td>
<td>95</td>
</tr>
<tr>
<td>17</td>
<td>Relationship between the weight and the presence of UTI</td>
<td>98</td>
</tr>
<tr>
<td>18</td>
<td>Relationship between odour of the urine and the presence of UTI</td>
<td>103</td>
</tr>
<tr>
<td>19</td>
<td>Relationship between pyuria and culture proven UTI</td>
<td>104</td>
</tr>
</tbody>
</table>
1. INTRODUCTION AND LITERATURE REVIEW

1.1 General Consideration:

Urinary Tract Infections UTIs represent the commonest genitourinary disease in children and are the second common infections, which affect them\(^1\). UTI is recognized as one of the most common specifically treatable causes of fever in young children \(^2\). UTIs in children are particularly important because their occurrence may be associated with some congenital abnormality of the urinary tract or an error in management. If not corrected, these may lead to recurrent infection causing damage to the urinary tract \(^3\).

Prompt recognition and treatment of children with UTI not only hastens resolution of the acute illness but might also help reducing the incidence of renal scarring and long term sequelae such as hypertension and renal failure associated with childhood pyelonephritis \(^4\).
Up to 80% of children with uncomplicated UTI will have recurrences \(^5\). Renal parenchymal infection and renal scarring are well established complications of UTI in children\(^6\).

Renal scarring is found in 10% to 15% of children with this infection. It has been estimated that of these, about 10% will have hypertension and small number renal insufficiency\(^1,7\).

Initial episodes of urinary tract infections occur more commonly in infancy than any other age \(^8\). Predisposing factors of UTI include congenital posterior value dysfunction and soiling of pathogens that can enter the urinary tract \(^9\).

However, diagnosis of urinary tract infection depends on culturing of clean collected urine specimen. In young non toilet trained children, this typically requires an invasive procedure such as urethral catheterization or suprapubic bladder aspiration \(^10\).

### 1.2 Anatomy and Physiology of the Kidney:

The kidney lies high up on posterior abdominal wall behind the peritoneum, largely under cover of the costal margin. At best only their lower poles can be palpated in the
normally build individual. The normal kidney measures depend on the age of the child and by adult it measures (12 x 6 x 3 cm) and weight 130g\(^{(11)}\).

The kidney has an outer layer which is the cortex, and an inner one which is the medulla. The cortex contains the glomeruli, proximal and distal convoluted tubules and collection ducts. Whereas the medulla contains the straight tubules, the loop of henle, the vasa recta and the terminal collecting ducts.

The histological and functional unit of the kidney is the nephron. Each human kidney comprises about one million nephrons “glomeruli and associated tubules”. In humans, formation of the nephrons is complete at birth and no new nephrons can be formed after birth. Progressive loss of nephrons may lead to renal insufficiency\(^{(11)}\).

Glomerular filtration begins around the 9\(^{th}\) week of foetal life. Following birth, the rate of G.F. increases until growth ceases towards the end of the second decade of life. The glomerular filtration rate of the children doesn’t approximate adult values until the third year of life\(^{(12)}\).
The rate is standardized to the surface area (1.73 m²), 20 ml/min/1.73 m² in the term neonate and 10-13 ml/min/1.73 m² in the infant\textsuperscript{(13)}.

The blood supply to each kidney usually consists of the main renal artery that arises from the aorta. The renal arteries give off twigs to the adrenal glands and upper ureter before dividing into lobar and interlobar arteries, whereas the venous drainage tends to be the reverse of this situation. The blood supply of the kidneys is relatively large and amounts to about one quarter of the cardiac output at rest i.e. 1300 ml/min\textsuperscript{(14)}.

1.3 Function of the Kidney:

The main functions of the kidney are excretion of waste products, and maintenance of fluid. The various renal functions can be summarized as:

a) Regulation of the water and electrolytes content of the body.

b) Maintenance of the body normal acid-base equilibrium of the blood.
c) Retention of vital substances “glucose, aminoacids, phosphate, bicarbonate and protein”.

d) Excretion of wastes metabolic products, toxic substances and drugs.

e) Production of hormones: regarding it’s hormonal function, the kidney is responsible for:

1. Erthropoietin synthesis in response to hypoxia, vasoconstriction, circulating level of products of red cell destruction.

2. Rennin production which increases the rate of production of aldosterone by the adrenal cortex.

3. Formation of 1.25 \((\text{OH})_2\text{D}\) the active form of vitamin D which is responsible for absorption of calcium.

4. Production of prostaglandin \((\text{PGE}_2)\) and \(\text{PGI}_2\) which are powerful vasodilations and may be concerned in the control of renal circulation\(^{(14)}\).
1.4 Urinary Tract Infection

1.4.1 Definition:

Urinary tract Infection (UTI) may be defined as the presence and multiplication of micro-organism in the urinary tract. Although this definition may include viral, fungal and other types of infection, it is generally used to describe bacterial infection\(^{(15)}\).

1.4.2 Prevalence of UTI:

The variability in prevalence of UTI differ among studies with regard to age, sex and race of subject, and to the method of urine collection and the criteria used in the diagnosis of UTI.

Reported prevalence of UTI in infants ranges between 4.1 and 7.5\(^{(16)}\).

Alseed BA, reported a high prevalence of UTI of 11% in malnourished Sudanese children compared with 2.6% in control group\(^{(17)}\).

El Hag\(^{(18)}\), reported a prevalence of UTI of 5.7% in Sudanese children age 3-16 years who were screened for significant proteinuria.
Boys are more susceptible before age of 3 month there after the incidence is substantially higher in girls. At least 8% of girls and 2% of boys will have UTI in childhood\(^{(19)}\).

UTIs are much more common in uncircumcised boys\(^{(20)}\). UTI more prevalent among infant with non identified source of fever than among those infants with condition identified as a possible source of fever\(^{(2)}\).

### 1.5 Host and pathogens:

#### 1.5.1 Predisposing factors related to the host: (Host factor)

Acute UTI is commonly associated with obstruction in the urinary system, and may occur in infancy. However it can occur without evidence of an obstruction lesion. Obstruction like stenosis, fistula, calculus and valve leads to urinary stasis and facilitate bacterial adhesion \(^{(21)}\). One risk factor for UI is vesicoureteral reflux which predisposes or renal infection (pyelonephritis). Pyelonephritis, occurring in 30-50% of the cases principally in young children \(^{(22)}\).
Ali Ahmadzadeh from Pakistan in March 2007 studied 152 children aged one month to 15 years to determine incidence of urinary tract anomalies associated with first UTI and found that VUR was found in 50 (39.6%), 39 girl and 11 boys. Other urinary tract abnormalities were renal stone in 10 (8%) patients, pelvic ureteric junction obstruction in 8 (6.3%), neurogenic bladder in two boys and one girl, double collecting system in two girls, posterior urethral valve in two boys and ureterocele in one girl, respectively (23).

UTI often occur at the onset of toilet training because of voiding dysfunction that occurs at that age (24).

Urethral instrumentations during voiding cystourethrogram or none sterile catheterization may infect the bladder with pathogens (21). Constipation may affect urinary voiding by compression leading to stasis and UTI (25).

Anatomical abnormalities (eg, labial adhesion) this lesion may act as a barrier and cause vaginal voiding. Neuropathic bladder may cause UTIs if there is incomplete bladder emptying or detrusor-sphincter dyssnergia (25).
Previous antibiotics administration can lead to drug resistance and clonal expansion of resistant bacteria\(^{(26)}\).

Pinworm infestation also increase risk of UTI because of itching lead to colonization of preurethral area from fecal flora\(^{(26)}\).

1.5.2 The pathogens:

The gram-negative bacteria are the most common pathogens cause UTI, among them E-coli causes at least 80% of UTI in children\(^{(27)}\), other gram negative bacteria (proteus more common in boys and in children with renal stones). Pseudomonas and klebisiella are probably related to chronic infection and repeated infections\(^{(27)}\). Also enterococcus is a causative agent for UTI.

Bacteriuria by salmonella is generally related to sepsis by salmonella\(^{(28)}\).

The gram positive bacteria are also cause of UTI staphylococcus coagulase-negative are detected as pathogens of urinary tract in newborns. These microganism can reach the urinary tract by the hematogenic pathway \(^{(28)}\).
Adenovirus type II and 12 are related to acute hemorrhagic cystitis. Candida albicans can cause UTI in patients manipulated by catheters or in immunodeficiency\(^{(28)}\).

The distribution of uropathogens in hospitalized patients differ from that in the community, E-coli is found in 50\% of them\(^{(29)}\).

There are a lot of studies done in this area about the pathogens of UTI and antibiotics susceptibility.

Mohamed AB (1994), Sudan reported UTI of 17.2\% in symptomatic under five Sudanese children with significant bacteriuria.

E. coli was the commonest of isolated organism responsible for 69.2\% of infection.

Sensitivity to isolated bacteria to naladixic acid, gentamycin and nitrofurantion was high, and it was low to co-trimoxazole. Radiological evaluation of children showed that 19\% of children had underling urological causes, urinary calculi were the commonest 3/26 underling urological cause detected\(^{(30)}\).
Omer BE (2000), Sudan reported UTI of 60 (29.1%) from 206 Sudanese children with severe malnutrition and it was highest in children with age group 13-24 month.

E. coli were found to be the commonest 47(78.6%) organism that causing UTI. 73.3%, 68.3%, 66.7% and 61.7% of the organisms was sensitive to nalidixic, colistin, nitrofurantoin and gentamycin respectively. Only 21.7% and 11.7% of the organisms were sensitive to co-trimoxazole and ampicillin.²\(^1\)

Gadalla YM (2002), Sudan reported prevalence of UTI in febrile infants was (17.8%) from (444). E. coli 54 (68.4%), followed by coagulase negative Staphylococci 13 (16.5%), Kelbseilla 5(6.3%)%, Coliform 3 (3.8%), Proteus 2 (2.5%) and Pseudomonas 2 (2.5%). Sensitivity to nitrofurantoin were 70.9% to gentamycin 68.4% to nalidixic acid and cephalaxin were 67.1% and 63.3%. Sensitivity to colistin 62%, sensitivity to co-trimoxazole 8.9% and to ampicillin 6.3%²\(^2\).

Messoudi (2004), Tunis studied 200 cases of UTI 58 boys, 142 girls aged between 1 month and 14 years. Found frequency of UTI is 1.85%. Found the most common organism
is Escherichia coli in 75% of cases followed by proteus mirabilis 10% and then klebsiella pneumoniae (6%) E. coli is predominate in girl; and proteus mirabilis and klebsiella pneumoniae are likely in boy. All strains 4% are sensitive to ampicillin, amoxicillin and cefalotin, 33% to amoxicillin + clavulanic acid and 66% to co-trimoxazole.

However 3rd generation cephalosporines and aminoglycosides remain usually active on the majority of strains\(^{(33)}\).

Yusel S, Ozturk B et al(2004) studied the antibiotic resistance of urinary tract pathogens and evaluation of empirical treatment in Turkish children with urinary tract infection, and reported that, the most common pathogen was E. coli 87% followed by klebsiella pneumoniae (10%).

Susceptibility to ampicillin (25.8%) and co-trimoxazole (38.7%).

Nitrofurantion was most active drug against E. coil (2.2% resistance isolate) are followed by amikacin, ceftriaxone and ciprofloxacin\(^{(34)}\).
Wu CY, Taiwan (2004), studied 597 childhood with urinary tract infection to determine the epidemiology, genitourinary (GU) tract anomalies, etiologies, susceptibility of urinary pathogens, and found that the most common pathogen were E-coli (74.7%), followed by proteus spp. (6.7%), and klebsiella ssp. (6.4%), E coli was susceptible to ampicillin in 18% of cases, followed by sulfamethoxazole/trimethoprim (44.8%), gentamycin (75.1%), and cefazolin (76%).

40.7% of patient had genitourinary abnormalities, most common was vesicoureteral reflux; 53% of them. 33.2% of patients with acute pyelonephritis confirm by (DMSA) had VUR\(^{35}\).

Pape L, et al; Germany (2004) studied 100 children with urinary tract infection and found that E coli is found in (47%) of cases followed by enterooccus faecalis 23%, proteus mirabilis 8%, klebsiella 4% and pseudomonas auruginosa 5%. Sensitivity to ampicillin 31%, cephalaxin (76%) cefuroxime (97%), co-trimoxazole (58%) and nitrofurantoin 100\(^{36}\).
Hernandez-Porras M, et al (2004) Mexico; studied microbial resistance to antibiotics used to treat urinary tract infection in Mexican children and found that the most frequent bacteria was E-coli (69.9%) followed by klebsiella pneumoniae (22.8%) and proteus mirabilis (7.1%), infection produced by E coli had low sensitivity to ampicillin (14.5%) and cotrimoxazole (23.3%)\(^{[37]}\).

Mohanad MA (2005), Yemen reported frequency of UTI among children subjected to urine culture was 36.8%, 272 (90.1% of them female) and 30 (9.9%) were male.

Isolated Bacteria is E. coli 201 (66.3%) followed by staphylococcus saprophyticus 45 (14.9%), proteus 15 (4.9%), kelbsiella 12 (3.9%) then enterococcus species 12 (3.9%).

Sensitivity of E. coli to nalidixic acid was 70%, to amoxicillin + clavulanic acid was 29.9%, to co-trimoxazole was 16.4% and to nitrofuruation was 15.9\(^{[38]}\).

In 2005, Qureshi AM, (Abbottabad) Ayub Teaching Hospital Abbottabad studied the epidemiology and resistant pattern of bacterial pathogens in 100 children with UTI. E coli was found the most common microorganism isolated (71%)
followed by klebsiella (13%), proteus (11%), staphylococcus (4%) and pseudomonas (1%). Proteus was isolated from male only\(^{(39)}\).

In China, Schlager TA, et al (2006) studied 152 children of urinary tract infection, he found that the most common pathogen is E-coli (56.2%) followed by Enterococcus faecalis (15.1%) fungi was rarely seen accounting for (2.6%). E coli sensitivity rate less than 50% to ampicillin, amoxicillin-clavulanic acid, co-trimozaxole and cephalaxin but a very high susceptibility rate > 96% to 3\(^{rd}\) generation cephalosporines nitrofurantoin and amixacin. Enterococcus faecalis had more susceptible rate (> 80%)to ampicillin, vancomycin and nitrofurantoin\(^{(40)}\).

Al Momani (2006) Jordon; studied microbiology of urinary tract infection in children, he found that E coli accounted for the vast majority of infection (72%), followed by klebsiella pneumonia (14%), proteus species (9%), staphyloccoccus (4%), and pseudomonas in (1%)\(^{(41)}\).
1.6 Pathogenesis of UTI:

Almost all UTIs are ascending in origin and are caused by bacteria in the GI tract that have colonized the periurethral area. After birth, the periurethral area, including the distal urethra, becomes colonized with aerobic and anaerobic microorganisms\(^{[42]}\). These organisms appear to function as a defense barrier against colonization by potential pathogens. Disturbance of the normal periurethral flora, such as may occur when an upper respiratory tract infection is treated with a broad-spectrum antibiotic, predisposes to colonization of the periurethral area by potential uropathogens\(^{[43]}\).

Data from studies of women with recurrent UTIs support the concept that periurethral colonization with a uropathogen plays an important role in the pathogenesis of recurrent infections\(^{[44,45]}\). These findings have not been confirmed in children\(^{[46]}\). However, children recently treated with antibiotics do have an increased risk of a febrile UTI compared with children with a non-UTI febrile illness who did not have recent antibiotic exposure\(^{[47]}\).
The pathophysiology of UTI reflects a complex interaction between virulence factors of the microorganisms and the host defense\[48\]. The perineal flora is normal inhabitants of the distal urethra. Urine in the proximal urethra, the urinary bladder, and more proximal sites within the urinary tract is normally sterile. Uropathogens must gain access to the urinary bladder and proliferate if infection is to occur. Bacteria in the distal urethra may gain access to the bladder because of turbulent urine flow during normal voiding, as a consequence of voiding dysfunction, or as a result of the use of instrumentation. In any case, normal voiding results in essentially complete washout of contaminating bacteria. Therefore, urinary bladder colonization does not usually occur unless bladder defense mechanisms are impaired or a virulent strain of bacteria has gained access to the bladder.

In the absence of normal bladder emptying, there is proliferation of bacteria in bladder urine and the risk of a UTI. Even with normal bladder emptying, adherence to
uroepithelial cells by virulent organisms such as P-fimbriated \textit{Escherichia coli} may result in a UTI. P fimbriae (or pili) are organelles on \textit{E coli} that mediate attachment to specific receptors on uroepithelial cells and impair washout of the bacteria\cite{49}. The majority of UTIs in neurologically and anatomically intact children are caused by \textit{E coli}. Children with intestinal carriage of P-fimbriated \textit{E coli} are at increased risk for UTI because of colonization of the periurethral area by these pathogens\cite{49}.

Fimbriae can agglutinate by p blood group erythrocytes, which are known as p fimbriae. They are more likely to cause pyelonephritis. Over 90\% of E-coli isolated from children with a first episodes of pyelonephritis expressed pfimbriae compared with 19.2\% of isolated of children with cystitis\cite{50}.

The presence of urothelial cell receptors is probably genitically determined. Hence certain individuals are more susceptible to recurrent UTI than others\cite{51}. 
1.7 Prevention of UTI:

1.7.1 Male circumcision:

Uncircumsided male infants appear to be at increase risk of UTIs in the first three months of life. In study of 100 otherwise healthy infants ranging in age from five days to eight months and admitted to hospital because of a first known UTI (52), most of the UTIs in infants younger than three months of age were in male, but female infant predominated thereafter. The fact that 95% of the male infants in this study were not circumcised lead to speculation that the uncircumcised male has an increase susceptibility to UTI at least early in life. Other retrospective study at Tripler-Army Medical Center (53) showed that uncircumcised boy had a 4.1% incidence of UTI during their first year of life, while girl had an incidence of 0.5% and circumcised male an incidence of 0.2% subsequently. A large retrospective study of infants cared for in U.S. army of hospital supported the theory that circumcision protect against UTIs in young male infant. The periurethral area was found to be more frequently, and more
heavily colonized with uropathogens, especially E-coli, in uncircumcised infants than in circumcised infants\(^{(54)}\).

More recent case control study in the setting of large ambulatory, paediatric service in 144 boys < 5 years of age who has microbiologically proven symptomatic UTI confirm circumcision as decreasing the risk of symptomatic UTIs\(^{(55)}\).

1.7.2 **Others prevention:**

1- Periodic and complete urinary voiding decrease risk of UTI because prevent stasis\(^{(56)}\).

2- Satisfactory hydric regimen increase frequency of micturation leading to urinary voiding\(^{(56)}\).

3- Low PH, the acid vaginal PH is an important inhibitory effect on proteus mirbilis and Pseudomonas Aeruginosa, may explain the high incidence of UTI caused by E-coli\(^{(56)}\).

4- Secretory immunoglobulin A was found to be produced locally in the urea of children with UTI especially those with chronic UTI while serum immunoglobulins are normal, it is probably a protective agents\(^{(56)}\).
5- There is a strong suggestion that breast feeding may reduce the risk of UTI \(^{(57)}\) because of neutral oligosaccharides found in breast milk inhibit bacterial adhesion to uroepithelial cells.

### 1.8 Clinical Features of UTI:

The younger the child the more none specific the symptoms, the clinical manifestations often fail to indicate clearly whether the infection is confined to the bladder or involves the kidneys. The symptoms and signs of UTI vary markedly with age \(^{(58)}\).

#### 1.8.1 In neonates:

Newborn infants with UTI has none specific symptoms, can present with fever, failure to thrive, feeding problem, vomiting and diarrhoea \(^{(59)}\). Prolonged neonatal jaundice is a classical association of bacteriuria in newborn and sepsis.

Verma \(^{(60)}\) reported unusual features of UTI in neonates including massive haematuria as the only presentation symptom, and host with no risk factors for either sepsis or localization of infection in the genitourinary tract.
UTI in neonate can cause metabolic disturbance combined with metabolic acidosis and polyuria\textsuperscript{(61)}.

1.8.2 In infants:

In infancy the most common manifestations is fever\textsuperscript{(62)}. Bonadio et al reviewed 365 consecutive cases of febrile infant, 33 infants (9.3\%) has serious bacterial infection, including 17 infants with UTI. Other none specific symptoms including nausea, vomiting, diarrhoea, irritability jaundice and failure to thrive\textsuperscript{(63)}.

1.8.3 In children:

The classical symptoms and signs associated with UTI usually occur in school aged children and adolescents\textsuperscript{(64)}. Dysuria is a common manifestation, also they may present with increased frequency, urgency, enuresis, general malaise abdominal pain, flank pain and foul smelling of urine\textsuperscript{(65)}.

1.9 Classification of UTI:

1.9.1 Clinical classification of UTI:

1.9.1.1 Acute pyelonephritis:

Is involvement of renal parenchymal disease which characterized by abdominal or lion pain, fever, malaise, nausea, vomiting and haematuria; it result in renal injury
which lead to renal scarring\(^\text{(66)}\). Renal scarring occur by acute Pyelonephritis may occur in renal units with, as well as in those without, VUR\(^\text{(4)}\) that is responsible for acquired renal scarring (in patients with unobstructed urinary tracts). Recent studies shows that some two third of children with acute pyelonephritis do not have demonstrable VUR, that is, they have none reflux pylonephritis\(^\text{(4,67)}\).

1.9.1.2 Cystitis:

Infant and young children with cystitis who have not achieved urine control often present with low grade fever less than 38\(^\circ\)C, discomfort or crying with urination, mild behaviour changes and foul smelling urine, older children with cystitis usually present with urinary urgency, frequency, hesitancy, dysuria and incontinence. No fever or only low grade fever is present, some children have suprapubic pain or tenderness\(^\text{(68)}\) cystitis doesn’t result in renal injury.

1.9.1.3 A symptomatic bacteruria:

Refers to children, usually school aged girls, with significant bacteriuria in the absence of any symptoms, does not require further evaluation of urinary tract or treatment.
An exception, children have vesico ureteral reflux or recurrent UTIS\(^69\).

A symptomatic bacteriuria in children is associated with an increase risk of recurrent symptomatic infection that may result in renal scarring, hypertension or renal insufficiency, however is unusual\(^70\). In 20% to 30% of school aged girls with asymptomatic bacteriuria radiological investigation will reveal upper urinary tract damage, VUR or both\(^70,71\).

Madawi IM in Sudan studied the prevalence of asymptomatic bacteriuria in preschool children and she found that it was \((5.8\%)\)\(^72\).

1.9.2 Other Classifications of UTI:

1.9.2.1 Complicated urinary tract infection:

The patient has conditions that predispose or promote the development or persistence of infection as patient known to have urologic anomaly, flank tenderness, abdominal mass and functional obstruction of urinary tract. Those patient require hospitalization and evaluation for the presence of significant structural abnormalities\(^73\).
1.9.2.2 **Recurrent UTI:**

Refer to patients with at least 2 infections within 6 months or more than 3 infections during a single year in which initial episode is resolved and is followed by another infection\(^{(74)}\).

1.10 **Urinary Tract Infection and Vesicoureteric Reflux in Children:**

In 1973, Bailey coined the term reflux nephropathy, (RN) to describe the coarse renal scarring that results from urinary tract infection (UTI) and vesicoureteric reflux (VUR)\(^{(75)}\). Many children with VUR have abnormal bowel and bladder function, termed dysfunctional eliminated syndromes\(^{(76,77)}\).

VUR is estimated to occur in 1\% - 2\% of children, the incidence being less in black children\(^{(78)}\), it occurs in 30-50\% in children with UTI\(^{(79)}\) and 90\% in those with renal scarring\(^{(80)}\). It is more common in females with exception of infancy, when most studies shown not only a male preponderance, but a more severe VUR\(^{(81)}\). Primary VUR is usually familial. It is inherited as a Mendelian dominant with
partial expression, the gene frequency being 1 in 600\textsuperscript{(82)}. The cause of VUR is a developmental anomaly resulting in an inadequate length of the intravesical submucosal ureter\textsuperscript{(83)}. VUR may also be acquired as a result of oedema and inflammation around ureteric orifice. It may also occur in association with bladder outlet obstruction or neurogenic bladder dysfunction\textsuperscript{(84)}.

All children with documented urinary tract infection, who are less than five years old, especially male infant, should be fully investigated for early detection and treatment of vesicoureteral reflux and renal scars. Children with VUR at risk of scarring, appeared to be those with early presentation, high grade reflux and recurrent UTI, their management should be therefore be vigours\textsuperscript{(85)}. In 1981 international grading system consisting of five grades was established\textsuperscript{(86)}.

Dilating reflux (grade 3-5) has been shown to be significantly associated with Reflux Nephropathy (RN). VUR has anatomical tendency to resolve as intravesical part of the ureter lengthens with growth. By age 10 yrs about 75\% of
VUR has resolved\textsuperscript{(87)}. Rate of resolution is faster in males and slowest in those with highest grades\textsuperscript{(87)}.

Zaki M, Mutair GA, Kuwait studied the prevalence of (VUR) in 172 arab Kuwaiti children with their first febrile UTI and compare this finding with those finding reported from other racial group. 39 child (22\%) has VUR from 174. two-third of cases had mid reflux (grade 1 and II). Females (n=32) had more reflux than males (n=7) (24\% vs. 18\%) 63 patients (36\%) had abnormal (DMSA) renal scans (acute pyelonephritis [AP] or renal scars). Of theses, 76\% were children below 5 years. Abnormal DMSA scans were found in 4 of 38 males (11\%) versus 59 of 136 females (43\%). Abnormal scans in children with VUR were seen in 1 of 7 males (14\%) versus 19 of 32 females (59\%) in total, the combination of abnormal scan with VUR occurred in 1 of 38 males (3\%) and in 19 of 139 females (14\%), where abnormal scan without demonstrable VUR was seen in 3 of 38 males (8\%), versus 40 of 136 females (29\%). This data showed that the frequency of VUR in Arab Kuwaiti children with febrile UTI is midway between Caucasian and other racial groups. In this study, males had a
lower risk profile than females, the latter has higher rate of reflux as well as high rate of abnormal (DMSA) scan\textsuperscript{(88)}.

1.11 **Diagnosis of Urinary Tract Infections:**

The basic for a national diagnostic work up of urinary tract infection is detailed history, examination and standardized examination of the urine, with test strips measuring. Measurement of specific density, microscopic examination of the sediment and determinations of the bacterial count in the urine.

Isolation and identification of pathogens and the preparation of an antibiogram require a special knowledge of microbiological techniques.

Diagnosis of UTI depends on the examination and culture of a carefully collected urine specimen\textsuperscript{(89)}.

1.11.1 **Methods of urine collection:**

Urine can be collected by carefully by using these methods.

Methods currently available for urine collection, from the most to least invasive methods are:

1- Supraretic aspiration (SPA):
This method is used in infants and young children in whom the full bladder is easily palpable above the symphysis pubis. The skin should be cleaned with normal saline. The tab is done in the midline and one centimeter above the pubis. A syringe is used to aspirate as the needle is inserted, 1-2 ml of urine is sufficient for culture\(^{(90)}\). SPA is considered the gold standard methods of urine collection, the least likely to be contaminated, and any growth of atypical urinary pathogen is considered clinically positive for diagnosis of UIT.

A study in 1999 showed a high diagnostic rate of UTI in children below 2 years of age but it is less reliable in children above one year of age\(^{(92)}\).

This methods has few complication, haematuria appear to be the most complication with and incidence of 0.5 – 2\(\%\)\(^{(93)}\), bowel perforation have been reported rarely 0.2\(\%\)\(^{(93)}\).

2- Catheter Specimen of Urine (CSU):

Catheterization is less invasive, slight saver than suprabupic aspiration and has sensitivity of 95\% and specificity of 99\% than it. In a catheterized specimen > 5 x 10\(^4\) ml can define UTI\(^{(93)}\).
Catheterization of the lower urinary tract carries the risk of introducing infection or traumatizing the urethra. The use of number (5) French polyethylene feeding tube in infants or number (8) French tube with proper lubrication in older children minimize the chance of urethral trauma.

3- Bag Specimen Urine (BSU):

This is the easiest and least invasive method, commonly used in neonates and young infants.

A urine bag in an invasive adhesive plastic container, the bag is adhered to the well cleaned dried perineum of the infant, and is prone to provide contaminated specimens if not applied properly and not removed as soon as the urine is passed.

Bag specimen urine sample have a high rate of contamination.

Three papers were identified comparing urine contamination rate of bag specimens with those obtained consistently by (SPA)\(^{94-96}\).

Hardy et al\(^{94}\) performed SPA on all children admitted to children ward with positive growth on BSU. Of the 26 positive
BSU sample, 22 (84.6%) were contaminated. A false positive rate of 50% and a false negative rate of 9% were reported. This corresponds well with a false positive and negative of 57% and 10%, respectively, found by Arouson et al\textsuperscript{(95)}, Saccharow and Pryles\textsuperscript{(96)} performed SPA and BSU on a series of 154 children aged 6 months to 12 years attending a renal outpatient clinic for recurrent UTI. The prevalence of UTI in these patients was 8.3% 45 BSU sample (29%) had intermediate growth. The sensitivity of BSU in this series was 77% and specificity 68% so bag specimen urine sample cannot be recommended in diagnosis UTI\textsuperscript{(97)}.

4- Clean catch urine:

It was defined as urine sample obtained from a child unable to void on command. Clean catch urine can be collected by parents in young children who are not sufficiently unwell to require immediate administration of antibiotics.

This method of obtaining urine sample is preferred by parents, and is one which can easily be taught to perform\textsuperscript{(98)}. Close to 100% success rates for obtaining MSU sample with 5 minutes of a feed in infants has been described by Boehm and
Haynes\(^{(99)}\) using the Perez reflex, this involves holding the infants prone over a sterile urine container and gently stroking the back.

5- Mid Stream Urine (MSU):

Is defined as a urine sample obtained from a child able to void on command, give the patient sterile, dry wide-necked, leak proof container and explain the importance of collecting specimen with a little contamination as possible. In toilet trained children, mid stream urine obtained after cleaning the urethral meatus with clean water, in female the labia should be separated manually to avoid contamination of the urine or contact with skin, while in uncircumcised males, the prepuce must be retracted. The first portion of urine should be discarded, and the mild urine voided directly into sterile container, discarding the last portion. This method of collection of urine is inapplicable to babies, infants, elderly women and patients with neuropathic or poor control of bladder\(^{(100)}\).
1.11.2 Examination of urine:

1.11.2.1 Urinalysis:

1.11.2.1.1 Macroscopic examination of urine

Normal fresh urine is clear and pale yellow to yellow depend on concentration. Urine from patient with acute UTI many have turbid appearance. Urine contain bright red blood with small colts suggests cystitis. Urine with acute infection may have unpleasant odour even when freshly voided. Determination of pH as part of urinary examination is helpful diagnostic method for infection due to urea – splitting organism such as proteus which produce an alkaline pH\(^{101}\).

Probably before doing microscopic urine examination, rapid screening test of urine analysis can carried out with reagent strips, there are strip tests to look for nitrate, leukocytes esterase, protein, glucose, ketones, bilirubin and urobilinogen\(^{102}\).

Negative dip stick for nitrate and leukocytes esterase can rule out UTI except in cases of diluted urine, but
positive result can’t only diagnose UTI because has false positive result.

Dipstick test if positive for either nitrate or leukocyte esterase or both in symptomatic children, the diagnostic sensitivity for UTI is 83%, The specificity is 85%, the probability of UTI with positive test is 58%, the probability of UTI with negative test is 5%\textsuperscript{(103)}.

1.11.1.2 Microscopic examination of urine:

The urinary cast, crystals, red blood cells, while blood cells are best looked for in deposited urine after centrifugation\textsuperscript{(104)}.

(A) Pyuria:

Pyuria is defined by the presence of 5-10 white blood cells per high power field microscopy in centrifuged urine\textsuperscript{(105)}.

Inflammation secondary to infection is the commonest cause of pyuria such as none specific bacterial gastroeintritis, respiratory infection, but sterile pyuria is caused by dehydration, trauma, stones or renal tuberculosis and chemical inflammation\textsuperscript{(106)}. 
Turner and Coulthard, confirmed that pyuria may occur in 9% of febrile children without UTI\(^{(107)}\).

Also 25-50% of patient with urinary tract infection do not show significant pyuria and this may be due to diluted urine\(^{(108)}\).

(B) **Haematuria:**

In all cases of haematuria microscopic examination of fresh urine should be done to confirm the presence of red blood cells. Fresh urine is also better for identification of red cell or heme granular casts which form strong pointer to the renal source of haematuria\(^{(109)}\).

**1.11.2.2 Urine culture:**

Is in direct method for isolation and identification of microorganism from culture identification of colonial morphology, biochemical reaction, staining reaction, immunological reactions and the susceptibility of microbial species to antimicrobial agents\(^{(110)}\).

(i) **Cultural methods:** For quantitative counts, the calibrated loop direct streak method is used\(^{(111)}\). In this method and inculating loop of wire, of standardize
size is used to take up a fixed, known volume of urine (0.002 ml) and streaked out on a culture media. This incubated at 37°C (18-24 hrs)\(^{(112)}\).

There are screening culture tests have been proposed. In one such a method dip-slide-tube or spoon. An agar coated vehicle is dipped into freshly voided urine, specimen and after overnight incubation, the colonial growth is counted and compared with density photographs of known colony\(^{(112)}\).

Other screening culture method is the pour plate method which consist of the preparation of serial dilutions of the urine in sterile water or saline from which a prescribed volume may be pippted into tubes of melted agar medium. These tubes are than poured into Petri dishes. After an overnight incubation period the colony count may be estimated\(^{(113)}\).

\((ii)\) \textit{Culture media types:}

Cystine Lactose Electrolytes Deficient (CLED) agar, MacConkey agar, blood agar and nutrient agar are the media used in urine culture\(^{(114)}\).
1.11.2.3 **Identification of uropathogens:**

After isolation of microorganism in CLED media and classification to lactose fermentor and none lactose fermentor, gram stain done after that which classify bacterial agent to gram positive cocci and gram negative bacilli, if they are gram positive cocci then catalase and coagulase test done to differentiate between staph spp. and streptococcus, if they are gram negative bacilli fermentor then biochemical set done (urease, citrate, indole and sugar test) if they are none lactose fermentor oxidase test is done it is positive this is pseudomonas spp., if the oxidase test is negative means other members of enterobacteriaceae\(^{110}\).

Staph species and Escherichia coli are opaque while streptococci-spp is translucent. Klebsiella species are mucoid in appearance. Pseudomonas pyocyanae produce green colonies. Proteus species produce swarming growth on CLED agar, but it is inhibited on MacConkey and blood agar.

Escherichia coli and Klebsiella are lactose fermentors and produce or yellowish colonies on CLED agar, while
proteus spp and pseudomonas are non-lactose fermentor and produce pale blue or green colonies\(^{(110)}\).

The serological identification and animal inoculation are not routinely used in uropathogens identification. In general practice coliform bacilli may include proteus, Escherichia coli, Klebsiella, pseudomonas and other coliforms\(^{(115)}\).

1.11.2.4 **Antimicrobial sensitivity test:**

Two methods for this:

(i) Disk diffusion method:

This method uses filter paper disks, which have been impregnated with various antimicrobial agents of specific concentrations. They are carefully spaced on agar culture plate that has been inoculated with a culture of bacterium to be tested.

The plate should be incubated at 37\(^\circ\)C and read after 18-24 hrs of zone of growth inhibition\(^{(116)}\).

Two approaches were used in this method, in the first approach several disks of various strength were required to interpret sensitivity in the basis of presence of a zone around the disk. The second approach involved the use of a single
disk, the zone of inhibition being measured and compared to tables showing the degree of sensitivity, associated with specified zone sizes, or visually compared to that of a control organism. The term sensitive implies that an infection caused by microorganism tested may be expected to respond favorably to the indicated antimicrobial for that type of infection and pathogen. Resistant microorganism on the other hand are not inhibited completely by the therapeutic concentration\(^{117}\).

(ii) Dilution methods:

This used to measure the Minimal Inhibitory Concentration (MIC), the lowest concentration that prevents visible growth of the organism under standardized sets of conditions\(^{118}\).

1.12 Imaging Studies:

The purpose of imaging studies is to find any structural abnormalities of urinary tract like obstruction and stones, to localize UTI, to detect any renal scaring and to document the presence or absence of reflux.
1.12.1 Types of imaging studies:

1.12.1.1 Ultrasonography:

Ultrasonography is a method for screening of children at the time of their first UTI because of its ability to detect major anomalies and dilatation of the urinary tract\(^{(119)}\). It will give basic information of the urinary tract. The shape, size, and position of kidneys can be determined with considerable accuracy, the degree of echogenicity of the substance and the sharpness of cortico-medullary differentiation provide a clue to the presence of diffuse parenchymal disease or damage. Hydronephrosis, uroterocoeles, bladder dilatation and trabeculation are reliably detected\(^{(120)}\).

Ultrasonography cannot generally be recommended for detection of reflux nephropathy after UTI because of low sensitivity and specificity\(^{(121)}\).

In Canada, Mahant S, et al. (2002), studied the sensitivity, specificity, and predictive values of renal ultrasound findings for vesicoureteral reflux (VUR) in 162 children under 5 years of age admitted with first UTI. The prevalence of VUR was 22%. Ultrasound findings were
positive for VUR in 14 of 35 patients with confirmed VUR on VCUG, and positive in 30 of 127 patients without VUR on VCUG. Of 21 patients who had a normal ultrasound but showed VUR on VCUG, 14 had grade II reflux, five grade III reflux, and two grade IV reflux. The sensitivity and specificity of ultrasound were 40% and 76%, respectively. The positive predictive value of ultrasound in suggesting VUR was 32%; the negative predictive value was 82%. Renal ultrasound findings are neither sensitive nor specific for VUR in children with a first UTI\(^{(122)}\).

### 1.12.1.2 Voiding Cystourethrogram (VCUG):

Practice guideline from the American academy of pediatrics recommended ultrasonography and voiding cystourethrogram in all children two months to two years of age with a documented first febrile Urinary Tract Infection (UTI)\(^{(123)}\), because this the major risk period of scarring from vesicoureteric reflux.

The VCUG is the most traumatic type of imaging investigation for UTI\(^{(124)}\).
1.12.1.3 Dimercapto Succinic Acid (DMSA):

Renal scans have been used to evaluate children with UTIs since 1980, and their sensitivity and specificity for pyelonephritis have been well documented in animal models\(^{(125)}\).

A substantial number of defects on DMSA scans occur in the absence of reflux (62 – 82\%)\(^{(126)}\). This has led some to recommend that if renal scarring is to be avoided, a renal scan should be the initial investigation in a child with UTI to detect those at greatest risk of persistent scar if possible, the DMSA should be delayed for 6 weeks after UTI.

1.12.1.4 99mTc Diethylene Triamine Penta-Acetic Acid (DTPA):

These isotopes are good for confirming obstruction and calculation of differential kidney function as the radionuclide is taken up by the kidneys and excretion curves are generated\(^{(127)}\).
1.12.1.5 Intravenous Urogram (IVU):

This has been superseded by the ultrasound, but may be requested if there is an ill-defined abnormality on the ultrasound examination, or if DMSA is not readily available\(^{(127)}\).

1.13 Management of Urinary Tract Infection:

The aim of treatment after establishing the diagnosis, should be to control acute infection, to relieve symptoms, to detect predisposing factor and prevent further infection, that is to say to prevent recurrence. Also to protect renal function\(^{(128)}\) through prevention of renal scarring in children, therefore an early diagnosis and immediate and effective antibiotic therapy of acute pyelonephritis is necessary especially in the first years of life.

Furthermore recurrence of UTI should be prevented in children at high risk of developing renal scarring (vesicoureteric reflux, obstruction of urinary tract, injured kidneys, bladder dysfunction)\(^{(129)}\).

The approach to the treatment of UTI in children is based on clinical severity, site of infection, age of the patient and patient compliance.
1.13.1 **Control of acute infection:**

Symptomatic UTI in neonates is frequently associated with sepsis and substantial mortality and, therefore after complete studies for sepsis, should be treated with parenteral antibiotics for seven to ten days, usually using a combination of ampicillin and aminoglycoside\(^{130}\) or cephalosporines.

Young infant with UTI, children with clinical evidence of acute pyelonephritis, and children with upper urinary tract infection associated with urologic abnormalities or surgical procedures often require hospital admission and intravenous antibiotic therapy, therapy can be initiated with the combination of aminoglycoside and cephalosporines\(^{130,131}\) for 14 days course of treatment.

The recently introduced aminoquinolones are not generally recommended for children and should be reserved for infections with multiple resistance pseudomonas aeruginosa\(^{131}\). In the presence of renal insufficiency, dosages of antibiotics excreted in the urine must be modified.

In children with symptomatic lower UTI with or without reflux, oral therapy may be initiated with amoxicillin,
ampicillin, sulfisoxazole acetylene, a combination drug containing trimethoprim and sulfamethoxazole, nitrofurantion, or cephalosporines.

Controversy exists about the need for antibiotic treatment of asymptomatic bacteriuria\textsuperscript{(132)}, treat children with asymptomatic if they are younger than five years, have urinary tract structural abnormalities, or if symptomatic UTI develop. It is usually treated by seven to ten days antibiotics uncomplicated UTI in children has been reported with three days course of antibiotics\textsuperscript{(133)}. Cure and recurrence rates in children treated with short course therapy were comparable in some studies to those achieved with conventional seven to ten days treatment. The advantage of short term therapy is better compliance, fewer side effect, cost saving and less likelihood of alternating fecal flora or selecting for bacterial resistance.

The use of short coarse therapy for UTI in children is still controversial, however Moffat and co-workers\textsuperscript{(134)} critically reviewed 14 published trials of short course (< 4 days) versus conventional (7-10 days) therapy and found there was in sufficient evidence to support the use of short course therapy
until further data are available, this method of treatment should be reserved for selected patients with asymptomatic bacteriuria and girls older than five years with clinical finding of lower urinary tract infection, a documented normal genitourinary tract and poor compliance. A urine culture should be done three to seven days after the completion of therapy to exclude relapse. Relapses usually occur within a week of completing therapy, are caused by the same bacteria, and often signify upper tract infection (135). In contrast, the recurrence of UTI occurs from weeks to months after an infection and commonly caused by different species of bacteria (135).

In every child with documented UTI or bacteriuria, two or three documented infection in a year indicates the need for prophylaxis therapy.

1.13.2 **Prophylactic antibiotics:**

Chemoprophylaxis is recommended for children awaiting surgical relief of urinary tract obstruction and selected cases with neuropathic bladder who have repeated symptomatic UTI and in cases of catheterization of urinary
tract for any reason (136) and the long term benefit of prophylaxis have not been adequately evaluated, even for children with vesicoureteric reflux (137).

The decision to stop prophylaxis may be made based on trial period without treatment, or for children with vesicoureteric reflux two negative cystograms (138). The optimum duration of prophylaxis is unknown.

Antibiotic prophylaxis may be continued for six month to two years in selected cases with persistent vesicoureteral reflux, prophylaxis may need to be extended for several years because of potential risk of new scar formation (139).

The two most commonly used drugs are trimethoprim and nitrofurantoin (140), both given in a single night dose of 1-2 mg per kg per day, or one third of normal therapeutic dose once a day.

Broad spectrum antibiotics are usually infective for prophylaxis because the bacteria become resistant to these agents.
1.13.3 The ongoing care:

Most children with UTI in whom the urinary tract is structurally and functionally normal should be followed carefully.

Counseling of parents and patients to try establish more normal pattern of voiding and defecation may be helpful in controlling recurrences.

Urine culture should be performed one week after the termination of treatment of any UTI to ensure that urine remains sterile \(^{(13)}\), and then to follow up urine culture periodically for 1-2 year even when the child is asymptomatic.

In children with vesicoureteral reflux, follow up evaluation should be performed at least annually, at which time the child’s height, weight, and blood pressure should be recorded \(^{(141)}\).

1.13.4 Prognosis of UTI in children:

The overall prognoses in children with urinary tract infection is favourable, provided prompt and adequate treatment when diagnosis is established \(^{(142)}\).
James Larcombe\(^{(143)}\) reported that after the first infection, about half of the girls have a further infection in the first years, and three quarters within two years and no figures in boys. Renal scarring occurs in 5-15% of children within one to two years of their first UTI. The incidence of new renal scars rises with each episode of infection. A combination of recurrent UTI, severe (VUR), and the presence of renal scarring at the first presentation is associated with the worst prognosis.
JUSTIFICATION

1. Several recent studies have shown changes in the pattern of pathogens and their antibiotics sensitivities. This might have an impact on the selection of empirical treatment for children with acute UTI.

2. Some studies have shown that renal tract anomalies especially VUR associated with acute UTI are more common in white than black races. No similar study was done in Sudan.
OBJECTIVE

1. To study the pattern of pathogens in acute UTI in children in Khartoum State.

2. To study the antibiotic susceptibility of the pathogens causing acute UTI.

3. To study the associated risk factors in children with acute UTI.
Chapter Two

2- MATERIALS AND METHODS

2.1 Study Design:

Prospective hospital based study.

2.2 Study Area:

This prospective hospital based study was conducted in Gaafar Ibn Auf Pediatric Emergency Hospital.

This hospital was selected because it serves a large children population from Khartoum State and other nearby areas.

Gaafar Ibn Auf Emergency Hospital consist of emergency waiting ward for short stay in which children usually stay for 24 hrs and then transferred to inpatient paediatric wards. Also there is other section for cold cases treated as out-patient.

2.3 Duration of Study:

The study was conducted in 5 month, during the period from the first of July 2007 to the last of November 2007.
2.4 Study Population and Sampling Technique:

All children having symptoms of UTI being admitted or seen in the above mentioned hospital during the study.

2.5 Sample Size:

The statistician calculated that at least 60 sample of positive urine culture need to be analyzed, so I have 100 positive urine culture.

2.6 Case Definition:

All suspected cases of acute UTI coming to the casualty in the age from day I to 16 years, with symptoms include fever, crying and burning on micturation, urgency, increased frequency, dripping of urine, diarrhoea, vomiting, poor of feeding, haematuria, jaundice and abdominal pain.

a) Four hundred cases were screened by dip stick for nitrate test and/or leukocyte esterase. 221 children were found to be positive and their urine tested for bacterial growth and sensitivity.

b) Hundred children with proven UTI; their bacterial growth more than 100,000 /CFU were included in
the study population to determine pathogens, antibiotic susceptibility and associated risk factors.

2.7 Inclusion Criteria:

All children with acute symptoms of UTI in the age group from day 1 to 16 yrs.

2.8 Exclusion Criteria:

- These children and/or parents who refuse to include in the study.
- Children who received antimicrobial agents.
- Children who had undergone bladder catheterization with 48 hrs.
- All recurrent cases of UTI were excluded such as known cases of renal stones, spinal dysfunction and urinary tract abnormalities like known cases of posterior urethral valve, vesicoureteral reflux and bladder abnormalities also any girl has vaginal discharge.
2.9 Research Tools and Methodology:

2.9.1 Questionnaire:

- A questionnaire was designed and completed containing data regarding sociodemographic characteristics, medical history (about symptoms of UTI, risk factors of UTI and if there was past history of UTI), clinical examination for evidence of infection and laboratory finding.
- The axillary temperature was recorded in degrees Celsius using mercury thermometer.
- Genitourinary system was examined, looking for circumcision, and any genitourinary abnormalities.

Anthropometric measurement:

- Body weight older children weighted in light clothes without shoes, the weight was measured by using a stand on both room scale in kilograms and to reading was taken to the nearest 0.1 kg and compared to the international NCHS standards while infant were weighted in the nude.
- Length recommended in infant 1-2 yrs old. The child was made laid in a flat wooden table with the head within the same horizontal plan of the feet and the body straight. The feet and the head will be perpendicular to the table and marks will be done on both sides of the head and feet. The distance between the marks will be read to nearest 0.1 cm with a none stretchable tape.

- Height: obtained with the child standing without shoes, with heels and back in contact with an upright wall using height steadimeter, the height was measured in centimeter (cm) and the reading was taken to the nearest 0.1 cm, the height was compared with the National Centre For Health Survey (NCHS) standard.

2.9.2 Methods of urine collection:

Urine sample were collected in this study by three methods: (i) urinary catheterization, (ii) clean catch specimen and (iii) mid stream urine specimen.

(i) Urinary catheterization:

This done by using of number (5) French polyethylene feeding tube in infant or number (8) French tube with proper
lubrication in older children minimize the chance of urethral trauma.

(ii) **Clean catch specimen:**

Clean catch specimen this obtained from a child unable to void on command. Before collection of the urine sample; infant were either breast feed or offered some fluids to drink, mothers were told to clean the genitalia with tap water and shown how to retract the labia in female or the prepuce in uncircumcised male and to dry it. Within 5 minutes of a feed in infant using Perez reflex; this involve holding the infant prone over a sterile urine container and genitaly stroking the back.

(iii) **Mid stream urine specimen:**

Mid stream urine is defined as urine sample obtained from a child able to void on command, give patient sterile, dry wide-necked, container and explaining the importance of collecting specimen without contamination, it obtained after cleaning the urethral meatus with clean water, in female the labia should be separated manually to avoid contamination of the urine or contact with skin, while in uncircumcised males,
the prepuce must be retracted. First portion of urine should not be taken, and mid urine voided directed into sterile container. The last portion of urine also was not taken.

2.9.3 Urine transport:

Urine containers were labeled with the date, the name, serial numbers and the times of collection. The urine should be transported to the laboratory within 30 minutes. It can be kept in a refrigerator at 4°C for one to two hours, and within one to two hours sample were transported in a cool container to the laboratory for analysis and culture, if there is delayed in delivery of more than two hours, then transported in a container with boric acid at concentration of 0.18 ml of urine(144).

2.9.4 Urinalysis:

Urine colour was described macroscopically immediately after collection.

2.9.4.1 Microscopic examination of urine sediment:

Deposit was prepared by centrifuging of urine for 2-3 minutes at 1000 round per minute (r.p.m.) and discarding the supernatant. The deposit was shaken and one to two drops
were poured on the centre of glass slide, then covered with cover glass and examined by high power field for pus cells.

2.9.4.1.1 Pyuria:

In this study pyuria is defined as presence of more than 5 pus cells per high power field microscopy in centrifuged urine specimen (for male and female).

Children in this study were divided into 2 groups according to the numbers of pus cells in centrifuged urine specimen /HPF.

Group I include children with pus cells 0-4/HPF

Group II include children with pus cells 5 > HPF

2.9.4.2 Urine culture:

All samples of urine were taken by calibrated loop of 0.002 ml which was used to inoculate plates containing CLED media. All plates were incubated at 37° C and examined 18-24 hrs for colony count and bacterial identification. The colony count was defined as the approximate number of bacteria per milliliter of urine.
After isolation of bacteria they were identified by gram staining and special biochemical reaction which are sugar fermentation, indole, urease test and citrate test.

2.9.4.3 Sensitivity test:

Sensitivity test was done for all samples with positive culture by using disk diffusion test in which multipaper discs were impregnated with standardized quantity of antimicrobial and put on surface of Diagnostic Sensitivity Test (DST). Agar plat that has been inoculated with the organism to be tested, the antimicrobial agents diffuses from paper disk through the agar in continuously decreasing gradient.

After 18-24 hours of incubation, concentric zone of inhibition around the paper disk was measured. A large zone of inhibition compared to the control indicates susceptibility of the organism to the antimicrobial.

Antimicrobial agents which were used:

1- Co-trimoxazole
2- Cephalaxin
3- Ampicillin
4- Nalidixic acid
5- Cefixime
6- Nitrofurantoin
7- Gentamycin
8- Ceftriaxone
9- Ciprofloxacin
10- Amoxicillin/clarvulanic acid
11- Cefuroxime

2.9.4.4 Culture Significance:

Bacterial counts in this study were divided according to urine culture results into three groups.

(A) Less than 10,000/CFU of single type of organism per milliliter was considered negative.

(B) Account of 10,000 – 100,000/CFU of single type of organism per millimeter were considered as suggestive of infection.

(C) Account of more than 100,000/CFU of single type of organism per milliliter was considered positive for diagnosis of UTI.
2.9.4.5 Diagnosis of UTI:

The diagnosis of UTI in this study was based on culturing urine which was collected by clean catch, midstream urine and catheterization, the collection was done once for each child. And UTI is defined by the presence of bacterial growth more than 100,000 CFU of single type of organism per millimeter.

2.9.5 Imaging studies:

Choice of imaging studies in children with proven UTI in this study are:

2.9.5.1 Ultrasonography:

Ultrasound in this study done for cases with positive culture for UTI except 11 cases, it is done in Khartoum advanced Diagnostic Centre by expert person to detect any structural abnormalities of urinary tract, obstruction and stones.

2.9.5.2 Voiding Cystourothrogram (VCUG):

Voiding cystourethrogram done in this study:
1- According to imaging guidelines of American Academy of Pediatric in which VCUG done for every child with febrile UTI from 2 month to 2 years of age\(^{(1,2,3)}\).

2- Any patient with UTI has family history of (VUR).

3- If there are ureter dilatation, pelvicureteric dilatation (PCD) and hydronephrosis in abdominal ultrasound.

Twenty eight children including the above criteria, but VCUG was done for 15 children.

### 2.10 Research Team:

- Author completed questionnaire, conducted full clinical examination and collect urine sample.

- A lab technician (all the laboratory work was done by a qualified lab technician in National Laboratory Health.

- Radiologist.

- Statistician
2.11 Ethical Consideration:

Letters were issued from paediatric department directed towards National Laboratory Health and Gaafar Ibn Auf Emergency Teaching Hospital.

Verbal consents were taken from the parents of each child or caretakers.

2.12 Statistical Analysis:

Data was collected and a master sheet was completed. The data was analyzed using Statistical Package of Social Science (SPSS) computer program version 15.0 for analysis – p value < 0.05 will be significant.
Chapter Three

3- RESULTS

In this study 400 children, suspected for having UTI, were screened by dipstick using nitrate test and/or leukocyte esterase. Two hundred and twenty one patients (55.2%) were found to be positive by dipstick. Urine from these 221 children was tested for bacterial growth and sensitivity test. Hundred children (45.2%) were proven to have UTI as shown in (Figure 1).

3.1 Sociodemographic Characteristics in Children with UTI:

3.1.1 Age distribution in children with UTI:

The age of the children with proven UTI was between 15 days to 14 years divided into three groups. Mean age was 3.4 ± SD (3.6) years. Thirty nine children (39%) were between 1 – 5 years, 33 children (33%) < 1 year and 26 children (26%) were between 5-16 years as shown in (Figure 2)
Fig (1) Distribution of the study sample according to dipstick and culture results (n=400)

- Dipstick positive: Culture Positive 45.2%, Culture Negative 54.8%
- Dipstick negative: 55.2%
Fig. (2): Age distribution in children with UTI
(n = 100)

Mean ± SD: 3.4 ± 3.6
Range: 15 days to 14

- <1 yr: 35%
- 1-5 yr: 36%
- 5-16 yrs: 26%
3.1.2 Gender distribution in children with UTI:

Figure (3) shows that more than half the cases of UTI were males, 53 (53%), while the females were 47(47%), and the male : female ratio was 1.13 : 1.

3.1.3 Residence distribution in children with UTI:

The majority of children with UTI were residing in Khartoum State, which divided into: Khartoum constituted 34 children (34%), Khartoum North which constituted 12 children (12%) and Omdurman which constituted 11 children (11%) with UTI. Children residing outside Khartoum State (up country) were 34 (34%) as shown in (Figure 4).

3.1.4 Distribution of UTI patients according to home origin:

Majority of UTI children families 46(46%) were from Central Sudan, 39(39%) were from Western Sudan, 8(8%) were from Northern Sudan, 4(4%) from Eastern Sudan, and 3(3%) from Southern Sudan as shown in (Table 1).
Fig (3) Gender distribution in children with UTI (n=100)

53% Male
47% Female
Fig (4) Residence distribution in children with UTI (n=100)

<table>
<thead>
<tr>
<th>Residence</th>
<th>Percent</th>
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<tr>
<td>Khartoum</td>
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<tr>
<td>Upcountry</td>
<td>34</td>
</tr>
<tr>
<td>Khartoum North</td>
<td>12</td>
</tr>
<tr>
<td>Omdurman</td>
<td>11</td>
</tr>
</tbody>
</table>

Residence
Table 1:  Distribution of UTI children according to home origin  

\((n = 100)\)

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<th>Origin home</th>
<th>Frequency</th>
<th>Percentage (%)</th>
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</tr>
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<td>North</td>
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<td>8</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
3.1.5 Distribution of children with UTI according to parents' education:

About 23 of the fathers (23%) and 49 of the mothers (49%) completed their primary school, 14 of the fathers (14%) and 23 of the mothers (23%) were illiterate, and 47 of the fathers (47%) and 20 of the mothers (20%) completed secondary school, 8 of the fathers (8%) and 5 of the mothers (5%) have completed post-secondary school, and 5 of the fathers (5%) and 3 of the mothers (3%) completed the Quran school, as shown in (Figure 5)

3.2 Weight and Height in Children with UTI:

Regarding assessing of growth of study group by using the Z-score for the weight for age, it was found that 50 children (50%) had normal weight, 28 children (28%) were mild underweight, 14 children (14%) had moderate under weight, and only eight children were severe under weight as shown in (Figure 6)
Fig (5) Distribution of UTI children according to parents’ education (n=100)

Parents’ Education

<table>
<thead>
<tr>
<th></th>
<th>Father’s Education</th>
<th>Mother’s Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illeterate</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>Primary</td>
<td>26</td>
<td>23</td>
</tr>
<tr>
<td>Secondary</td>
<td>47</td>
<td>49</td>
</tr>
<tr>
<td>Post Secondary</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Quran School</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>
Fig. (6) Distribution of children with UTI according to Weight-for-Age Z-Score (n=100)
Using the Z-score the height was assessed for age, 72 of the children (72%) with UTI found to be normal, 17 children (17%) had mild stunting, 6 children (6%) had moderate stunting and only 5 children (5%) had severe stunting as shown in (Figure 7).

3.3 Distribution of symptoms of urinary tract infection in children with UTI:

Crying during micturition or burning micturition was the main presenting symptom found in 91 children (91%) with UTI, 48 children (48%) were presented with fever, refusal of feeding was a presenting symptom in 31 children (31%) children. Vomiting was presenting in 28 children (28%), and dribbling of urine + incontinence during day or night found in 28 children (28%), abdominal pain was found in 26 children with UTI (26%).
Fig. (7) Distribution of children with UTI according to Height-for-Age Z-Score (n=100)
Diarrhea was presenting in 12 children (12%), hematuria was found in 10 children (10%), urgency was found in 7 children (7%), increased frequency was found in 4 children (4%), chills were presented in two children (2%), and cloudy urine in one child (1%) as shown in (Table 2).

3.4 **Male Circumcision in Children with UTI:**

Out of 53 male children with UTI, 41 male (77.4%) with UTI were uncircumcised. Only 12 children (22.6%) were circumcised, as shown in (Figure 8).

3.5 **Distribution of Risk Factors in Children with UTI:**

Non-documented past history of UTI was found in 14 children (14%) with UTI, constipation was found in 12 children (12%) with UTI and 5 children (5%) with UTI had pinworm infestation as shown in (Figure 9).
**Table 2: Distribution of symptoms of urinary tract infection in UTI children**

(n = 100)

<table>
<thead>
<tr>
<th>Origin home</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crying or burning micturition</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>Fever</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Refusal of feeding</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Vomiting</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Dribbling of urine + incontinence</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Abdominal pain, colic, back pain</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Dirarrhoea</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Haematuria</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Urgency</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Increased frequency</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Chills</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Cloudy urine</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Fig (8) Male circumcision in children with UTI (n=53)
Non-documented past history of UTI
Constipation
Pinworm infection

Fig. (9): Distribution of risk factors in children with UTI
(n = 100)
3.6 Laboratory Data:

3.6.1 Urine macroscopy in children with UTI:

3.6.1.1 Distribution of UTI children according to the urine odour:

Sixty six children (66%) with UTI had odourless urine, while 34 children (34%) had odour smell as shown in (Figure 10).

3.6.2 Urine microscopy:

3.6.2.1 Distribution of UTI children according to urine pus cell counts /HPF:

Seventy eight children (78%) with UTI had pyuria (≥ 5/HPF), while 22 children (22%) with UTI had no pyuria (<5/HPF) as shown in (Figure 11).

3.6.3 Type of isolated bacteria in children with UTI:

Table (3) shows the isolated bacteria in children with UTI, Escherichia coli was the commonest bacteria isolated, it was found in 60 children (60%) with UTI. Klebsiella ssp was found in 12 children (12%), Enterococcus was isolated in 10 children (10%), 9 specimen (9%) showed the growth of Staphylococcus, Proteus was isolated in 6 children (6%) with UTI, Streptococcus was isolated 2 children (2%) and Pseudomonas was isolated in one child (1%).
Fig (10) Distribution of UTI children according to urine odour (n=100)

Odourless 66%

Odour 34%
Fig (11) Distribution of UTI children according to urine pus cell counts per HPF (n=100)

0-4 \ HPF
22%

\geq 5 \ HPF
78%
Table 3: Types of isolated bacteria in children with UTI

(n = 100)

<table>
<thead>
<tr>
<th>Isolated organism</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Proteus</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Streptococcus</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
3.6.4 Bacterial isolated sensitivity to different drugs in the study group:

Ninety six specimens (96%) of urine cultures were sensitive to gentamycin, 94 (94%) to ciprofloxacin, 90 (90%) to ceftriaxone and 85 (85%) to cefixime. Sensitivity to cefuroxime, naladixic acid, nitrofurantion and cephalaxin was 75 (75%), 74 (74%), 70 (70%) and 51 (51%) respectively. Only 19 (19%) were sensitive to amoxicillin + clavulanic acid and 14 specimens (14%) were sensitive to ampicillin in children with UTI as shown in (Table 4).

3.6.5 E-coli drug sensitivity to different drugs:

All children with E-coli, 60 (100%) were sensitive to gentamycin, 59 (98.3%) were sensitive to cefixime and ceftriaxone.

Fifty seven E-coli (95%) were sensitive to ciprofloxacin, while 48 (80%) were sensitive to nalidxic acid, 47 (78.3%) were
Table 4: Bacterial isolated sensitivity to different drugs in the study group  
(n = 100)

<table>
<thead>
<tr>
<th>Drug</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gentamycin</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Cefixime</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Naldixic acid</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>Nitrofurantion</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Cephalaxin</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>Co-trimoxazole</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Amoxicillin + Clavulanic acid</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>
sensitive to nitrofurantion, 44 (73.3%) were sensitive to cefuroxime, 29 (48.3%) were sensitive to cephalaxin and 13 (21.7%) were sensitive to co-trimoxazole. Only 3 (5%) and two of E-coli (3.3%) were sensitive to ampicillin and amoxicillin+ clavalanic acid, respectively as shown in (Table 5).

### 3.6 Abdominal US Finding in Children with UTI:

Ultrasound was done in 89 children with UTI. Sixty out of these 89 children (67.4%) had normal abdominal ultrasound. Abnormalities of abdominal ultrasound was found in 29 children (32.6%). Six children (5.6%) with UTI had renal stones, two children (2.2%) had hydronephrosis, only one (1%) had ureteric dilatation and 18 children 22.2% had others finding as shown in (Figure 12).

Three children (3%) had PCD (pelvic ureteric dilation) and 11 children with UTI abdominal U/S was not done for them.
**Table 5: E-coli drug sensitivity to different drugs**

(n = 60)

<table>
<thead>
<tr>
<th>Drug</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gentamycin</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>59</td>
<td>98.3</td>
</tr>
<tr>
<td>Cefixime</td>
<td>59</td>
<td>98.3</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>57</td>
<td>95</td>
</tr>
<tr>
<td>Naldixic acid</td>
<td>48</td>
<td>80</td>
</tr>
<tr>
<td>Nitrofurantion</td>
<td>47</td>
<td>78.3</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>44</td>
<td>73.3</td>
</tr>
<tr>
<td>Cephalexin</td>
<td>29</td>
<td>48.3</td>
</tr>
<tr>
<td>Co-trimoxazole</td>
<td>13</td>
<td>21.7</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Amoxicillin + Clavulanic acid</td>
<td>2</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Fig (12) Abdominal U/S findings in children with UTI (n=89)

- Normal: 67.4%
- Others: 20.2%
- Hydronephrosis: 2.2%
- Renal Stones: 5.6%
- Ureteric Dilatation: 1.1%
- PCD: 3.4%
3.7 MCUG Finding in Special Group in Children with UTI:

MCUG done for 15 children with UTI, 8 of them male (53.3%) and 7 of them female (46.7%).

Nine children (60%) had normal VCUG. 6 of the children (40%) had abnormal VUCG, 5 of these children (33%) had VUR, three children with VUR (20%) had VUR grade I and two children (13%) had VUR grade II. One child (7%) had posterior urethral stricture as shown in (Figure 13).

3.8 Distribution of Gender in Children with VUR:

Five children (33.3%) had VUR diagnosed by VCUG, three of them (60%) were female and two of them were male as shown in (Figure 14).
Normal 60%

Posterior urethral stricture 7%

VUR 33%

Grade I 20%

Grade II 13%

Fig (13) MCUG findings in special group of children with UTI (n=15)
Fig (14) Distribution of gender in children with VUR (n=5)

- Female: 60%
- Male: 40%
3.9 Relationship Between the Presence of UTI and Other Variables:

3.9.1 Relationship between the age and the presence of UTI:

UTI was found commonly in the age group 1-5 years and less than one year and there was statistically significance difference between the age and the presence of UTI P value (0.008) as shown in (Figure 15).

3.9.2 Relationship between the gender and the presence of UTI:

Figure (16) showed that more than half children with UTI in this study were male, and the presence of UTI was not affected by gender (P = 0.8)

3.9.3 Relationship between parents’ education and the presence of UTI:

In this study it was found that the presence of UTI was not affected by parents’ education. P value = 0.05). (Table 6)
Fig. (15): Relationship between age and presence of UTI (n = 221)
Statistically significant, $p = 0.008$
Fig (16) Relationship between the gender and the presence of UTI (n=221) (Statistically not significant, p=0.8)
Table 6: Relationship between parents’ education and presence of UTI

(n = 221)

<table>
<thead>
<tr>
<th>Type of education</th>
<th>Fathers’ education</th>
<th>Mothers’ education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UTI</td>
<td>No UTI</td>
</tr>
<tr>
<td></td>
<td>No  %</td>
<td>No  %</td>
</tr>
<tr>
<td>Illiterate</td>
<td>14  14</td>
<td>9  7.4</td>
</tr>
<tr>
<td>Primary</td>
<td>26  26</td>
<td>44  36.4</td>
</tr>
<tr>
<td>Secondary</td>
<td>47  47</td>
<td>50  41.3</td>
</tr>
<tr>
<td>Post secondary</td>
<td>8  8</td>
<td>10  8.3</td>
</tr>
<tr>
<td>Quran school</td>
<td>5  5</td>
<td>8  6.6</td>
</tr>
<tr>
<td>Total</td>
<td>100 100</td>
<td>121 100</td>
</tr>
</tbody>
</table>
3.9.4 **Relationship between the weight and the presence of UTI:**

In this study one half of children with UTI had normal weight and 28% had mild underweight, so there is no statistical relationship between the weight and presence of UTI. P value 0.2. (Figure 17)

3.9.5 **Relationship between male circumcision and the presence of UTI:**

77.8% of children with UTI were uncircumcised and it was found that there is relationship between UTI and circumcision (P = 0.04). (Table 7)

3.9.6 **Relationship between the symptoms and UTI:**

Table (8) illustrated that crying + burning micturition and fever were statistically significant with the presence of UTI, P value 0.01 and 0.004 respectively.

3.9.7 **Relationship between risk factors and the presence of UTI:**

The presence of UTI was not affected by the risk factors in this study group. P value > 0.05 (Table 9)
Fig. (17) Relation between the Weight and the presence of UTI (n=221) (Statistically not significant P=0.2)
Table 7: Relationship between male circumcision and the presence of UTI

(n = 120)

<table>
<thead>
<tr>
<th>Male circumcision</th>
<th>UTI</th>
<th>No UTI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>12</td>
<td>22.2%</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>39.4%</td>
</tr>
<tr>
<td>No</td>
<td>42</td>
<td>77.8%</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>60.6%</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>66</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Table 8: Distribution of symptoms in relation to the presence of UTI

(n = 221)

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>UTI n = 100</th>
<th>No UTI N = 121</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Crying or burning micturition</td>
<td>91</td>
<td>91</td>
<td>94</td>
<td>77.7</td>
</tr>
<tr>
<td>Fever</td>
<td>48</td>
<td>48</td>
<td>82</td>
<td>67.8</td>
</tr>
<tr>
<td>Refusal of feeding</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>25.6</td>
</tr>
<tr>
<td>Vomiting</td>
<td>28</td>
<td>28</td>
<td>33</td>
<td>27.3</td>
</tr>
<tr>
<td>Incontinence + dripping of urine</td>
<td>28</td>
<td>28</td>
<td>20</td>
<td>16.5</td>
</tr>
<tr>
<td>Abdominal pain, colic, back pain</td>
<td>26</td>
<td>26</td>
<td>25</td>
<td>20.7</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>12</td>
<td>12</td>
<td>13</td>
<td>10.7</td>
</tr>
<tr>
<td>Haematuria</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>7.4</td>
</tr>
<tr>
<td>Urgency</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>5.8</td>
</tr>
<tr>
<td>Increased frequency</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Chills</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cloudy urine</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 9: Relationship between risk factors and the presence of UTI

(n = 221)

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>UTI</th>
<th>%</th>
<th>No UTI</th>
<th>%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past history of UTI</td>
<td>14</td>
<td>54</td>
<td>12</td>
<td>46</td>
<td>9.35</td>
</tr>
<tr>
<td>Constipation</td>
<td>12</td>
<td>67</td>
<td>6</td>
<td>33</td>
<td>0.057</td>
</tr>
<tr>
<td>Pinworm infection</td>
<td>5</td>
<td>45</td>
<td>6</td>
<td>55</td>
<td>0.98</td>
</tr>
</tbody>
</table>
3.9.8 **Relationship between odour of the urine and the presence of UTI:**

Figure (18) illustrated that there is statistically significance between the odour urine and the presence of UTI. P = 0.00.

3.9.9 **Relationship between pyuria and culture proven UTI:**

There are 22 children with culture proven UTI had 0-4 pus cells/HPF and constituted 22%, while 78 (78%). Children with UTI had ≥ 5 pus cells/HPF, so significant proven UTI, p value = 0.000. (Figure 19)
Fig. (18) Relationship between odour of the urine and presence of UTI (n=221) (Statistically significant, p=0.00)
Fig. (19) Relationship between pyuria and culture proven UTI

<table>
<thead>
<tr>
<th>Pus cell counts</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4HPF</td>
<td>22</td>
</tr>
<tr>
<td>5 or more</td>
<td>78</td>
</tr>
</tbody>
</table>

- Positive UTI
- Negative UTI
4 - DISCUSSION

4.1 Incidence of Urinary Tract Infection:

This study shows UTI in (45.2%) of the study population this result is higher than other studies done in Sudan.

Mohamed AB (30) reported UTI of 17.2% in symptomatic under five Sudanese children with significant bacteriuria, also Gadalla YM (32) reported (17.8%) of UTI in febrile Sudanese infants.

Lower percentage were reported by El Hag (18) and messaoudi(33).

This higher incidence of UTI in this study can be explained by the fact that, children in this study screened first by dip stick examination and then they were negative excluded from study, so all the study population were screened first then urine culture done for them. Other explanation of high percentage, that Sudan has high incidence of malnutrition and gastroenteritis which are known predisposing factor (31).
4.2 Sociodemographic Characteristics of Children With UTI:

More than one third of children with UTI (35%) were at the age less than one year, and this finding is similar to what was reported in the study done by WUGY\(^{(35)}\). and it was different from Omer BE\(^{(31)}\) who reported that UTI was highest in children with age group 13-24 month.

- Males constituted more than half of the total children with UTI (53%). and this comparable with other studies from Sudan\(^{(31, 32, 72)}\). This is because males are more likely to born with structural abnormalities of urinary tract.

- In Sudan boys are usually circumcised at an age over one year, and in the study group more than one third of children with UTI were less than one year, and this may explain high rate of UTI in male than females. Also in the study group the number of males more than females, also this may be explanation to high rate of UTI in males than female.

- More than one third (34%) of children with UTI were residing outside capital (semi urban) area where the low to moderate
social class predominate, and they come to the study area, where the medical services is free.

- According to the home origin more than one third (46%) of children with UTI were displaced from central Sudan, and (39%) from western Sudan. This finding may be explained by poor hygiene and low socioeconomic status in those areas, as comparable with Gadella (32) YM who found that more than one third of infants with UTI were originally from western Sudan.

- There was no relationship between parents’ education level and the incidence of UI. These finding were different from Gadalla YM (32), who found that the mothers’ education and UTI are related.

4.3 Distribution of Symptoms of UTI Among the Study Population:

Crying and burning micturition were the commonest symptoms and constituted (91%) of children with UTI, and this finding is higher comparable with other studies (31, 32).
Fever was reported in near one half of children with UTI (48%) and found in more than one half of children without UTI this result is lower than other studies\(^{(23, 38)}\).

Refusal of feeding was found in (31%) of children with UTI and this result was higher than Gadalla YM\(^{(32)}\). finding. Vomiting was found in (28%) of children with UTI and this result was lower than Gadalla YM\(^{(32)}\) finding.

4.4 **Relation of male circumcision to UTI:**

The majority of children with UTI were uncircumcised, was comparable with other studies from Sudan \(^{(31,32,72)}\) and studies from outside Sudan \(^{(52-55)}\) only one fifth of children with UTI were circumcised.

4.5 **Weight distribution of children with UTI:**

In this study weight was not statistically significant to the presence of UTI, this result is different as comparable with other studies in Sudan \(^{(17,31,32)}\).
4.6 **Risk Factors in Children With UTI:**

Risk factors which were studied in children with UTI were constipation, pinworm infestation and none documented past history of UTI and was found to be not significant and there was no study found comparing this point.

4.7 **Laboratory Data:**

4.7.1 **Urine culture in relation to by pyuria:**

With this study we found that 22% of children who had a pyuria < 5 HPF had positive urine culture with colony count more than 100,000. This result show that culture proven UTI without by pyuria and this result was high than reported by Gadalla YM \(^{(32)}\).

In this study we found pyuria (defined as five pus cells or more) in (78%) of children positive urine culture and (38%) of children with negative urine culture, this result are comparable with anther study which confirmed that pyuria may occur in 9% of febrile children without UTI \(^{(107)}\). sterile pyuria may be due to viral in inflammation of the urinary tract.
So pyuria alone is not enough for making diagnoses of UTI.

4.7.2 The pathogens:

The commonest isolated organism in this study was E. Coli accounting for (60%) of the pathogens causing UTI, this finding was previously reported from Sudan and other countries (30-41)

The second pathogens isolated was kelbesialla and this result was comparable by study done by Yusel S, et al (34), Gourshi AM (39) and Almomani (41)

Enterococci was isolated in 10% of children with UTI and this result was high comparable by other studies (17,31,32,38,72) and it was similar finding reported by Papel et al (36) and Schlager TA, et al (40)

Staphylococcus aurous was the third isolated organism in (9%) of cases with UTI and this result lower than finding reported by Gadalla YM (32) and Modawi IM (72), while it is higher than reported studies of Gourshi AM (39) and Al Momani (41). Protus was isolated in (6%) of children with UTI
and this result is higher according to the reported studies \(^{(32,38)}\) and it’s lower according to other reported studies \(^{(31,33,39,41)}\).

Streptoccoces was found in (2\%) of children with UTI. Pseudomonas was isolated in (1\%) of children with UTI and this is lower than reported studies by Gadalla YM \(^{(32)}\) and Papel et al \(^{(36)}\).

4.7.3 **Drug sensitivity in children with UTI:**

There is high sensitivity to gentamycin, ciprofloxacin, ceftriaxone, cefixime, cefuroxime, nalidixic and nitrofurantoin.

The sensitivity of cephalaxin was \(\geq1\%\).

The most important finding in this study is increased frequency of resistance to the common urinary tract antibiotics (Ampicillin, Amoxicillin-clavulanic acid and Co-trimoxazole) this result is similar that report in Sudan \(^{(30,31,32)}\) and other studies from outside Sudan \(^{(33,34,37,38,40)}\).

The lower sensitivity of these drugs can be explained by the wide spread miss use of the drugs in the diarrheal and respiratory diseases in this country.
4.7.4 **E. coli drugs sensitivity in children with UTI:**

All children with E. coli were sensitive to gentamycin. E. coli found to have high sensitivity rate (98.3%) to ceftriaxone and cefixime, and this is comparable with the study of Schlager TA, et al \(^{(33,34,40)}\)

Naidixic acid and nitrofurantoin have sensitivity of (78.3%) and (73.3%) respectively. Mohanad MA \(^{(38)}\), reported the same sensitivity to naladixic acid and lower sensitivity of E. coli to nitrofurantoin (50.9%).

E. coli sensitivity rate is less than (50%) in Ampicillin, Amoxicillin clavulanic acid, Co-trimoxazole and cephalaxin. and this is comparable with reported study done by Schlager TA, et al \(^{(40)}\)

Sensitivity of E. coli to Ampicillin, Co-trimoxazole and Amoxicillin clavulanic acid was very low and this is comparable with these studies \(^{(37,38,40)}\)

4.8 **Abdomenal ultra sound in children with UTI:**

Abdomenal US was normal in (67.4%) in children with UTI ultra sound done for them, this result is higher as comparable with other studies \(^{(30,31,72)}\).
Renal stones was found (5.6%) this was lower comparable with result finding of Mohammed AB\textsuperscript{(30)}, and Ali Ahmadzadeh\textsuperscript{(23)}

Hydronephrosis was found in (2.2%) and ureteric dilation (1%).

4.9 **VCUG Abnormalities in Children with UTI:**

VCUG finding is found normal in 60% of children with UTI in whom this investigation was indicated. More than one third of children, whom VCUG done for them had VUR, this result is lower comparable with other studies\textsuperscript{(23,88)}

VUR found in this study in female (60%), more than male, and VUR found in this study only grade I and II.

These low grade VUR cases are likely to be secondary to UTI rather than congenital VUR which are usually high grade. Congenital VUR cases are rare in black races as compared to white races\textsuperscript{(88)}.

In this study VUR in children with UTI is detected in only 5 patients (5%), this because VCUG was done in only 15 patients out of 28 in whom VCUG is indicated; therefore the true incidence of VUR in children was acute UTI can not be
calculated, however some report are shown low incidence of VUR in Arab children with acute UTI as compared with Caucasian.
CONCLUSION

- UTI in children in Khartoum State is common in those below 5 years of age.
- With the exception of uncircumcision, no other risk factor is significantly associated with occurrence of acute UTI.
- E-coli is the commonest pathogen isolated from urine culture of children with acute UTI.
- In vitro sensitivity urine cultures showed high sensitivity to gentamycin, ceftriaxone, ciprofloxacin, cefixime and cefuroxime but very low sensitivity to co-trimoxazole, amoxicillin-clavulanate and ampicillin.
- Renal tract abnormalities were not common in Sudanese children with acute UTI. The detected abnormalities namely VUR are likely to be acquired due to infection rather than congenital.
- Our results are comparable to local, regional and international reports.
**RECOMMENDATIONS**

- Gentamycin, ceftriaxone and cefuroxime are suggested as the first line drugs for the parenteral empirical antibiotic therapy for acute UTI.
- Cefixime is the first drug suggested for oral empirical therapy.
- Ciprofloxacin can be only used for infection with serious pathogens e.g. pseudomonas or those UTI for patients with multiple drug resistance.
- Nitrofurantion and nalidixic acid can be used in asymptomatic cases or for prophylaxis because of their low therapeutic serum level.
- Conventional drugs like cephalaxin co-trimoxazole, amoxicillin – clavulanate and ampicillin are not recommended for empirical treatment because of the high bacterial resistance to these agents.
- We recommended VCUG for children with acute UTI only in whom this test is indicated.
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Acute urinary tract infection in children in Khartoum State: pathogens, antibiotics susceptibility and associated risk factors

1) Patient serial No. ( )

2) Name: ........................................................................................................

3) Age: (numbers)
   1. < 1 yr ( ).
   2. 1-5 yrs ( ).
   3. 5-16 yrs ( ).

4) Sex:
   1. Male ( )
   2. Female ( )

5) Residence:
   1. Khartoum ( ).
   2. Khartoum North ( ).
   3. Omdurman ( ).

6) Origin home:
   1. North ( ).
   2. South ( ).
   3. West ( ).
   4. East ( ).
5. Central ( )

7) **Father education:**
   1. Illiterate ( )
   2. Primary ( )
   3. Secondary ( )
   4. Post secondary ( )
   5. Quran school (Khalwa) ( )

8) **Mother education:**
   1. Illiterate ( )
   2. Primary ( )
   3. Secondary ( )
   4. Post secondary ( )
   5. Quran school (Khalwa) ( )

9) **Male Circumcision:**
   1. Circumcised ( )
   2. Not circumcised ( )

10) **Symptoms:**
    1. Fever ( )
    2. Chills ( )
    3. Convulsions ( )
    4. Diarrhoea ( )
    5. Vomiting ( )
    6. Refusal of feeding ( )
    7. Abdominal pain, colic, back pain ( )
    8. Crying or burning micturition ( )
    9. Dribbling of urine ( )
   10. Incontinence during day or night ( )
   11. Increase frequency ( )
   12. Urgency ( )
13. Heamaturia ( ).

11) **Risk factors:**
   1. Constipation
   2. Pinworm infestation
   3. Past history of UTI

12) **Physical examination:**
   1. Wt. .................Kg ( )
   2. Length or height .............cm ( )
   3. Temperature: ( )

13) **Abdominal examination:**
14) **Urinary macroscopy:**
   1. Dip stick result: Positive
      i. Nitrate ( )
      ii. Leukocyte esterase ( )
      iii. Both of the above ( )

   2. Colour:
      i. Yellow ( )
      ii. Red ( )
      iii. Cloudy ( )
      iv. Cloudy red ( )

   3. Smell:
      i. Odour ( )
      ii. Odourless ( )

15) **Urinary microscopy:**
   1. Pus cells:
      i. 0 – 4/HPF ( )
ii. $\geq 5$/HPF

2. Bacterial-count:
   i. $< 10,000$ CFU/ml.
   ii. $10,000 – 100,000$ CFU/ml.
   iii. $> 100,000$ CFU/ml.

16) Organism isolated:
   1. E. coli ( )
   2. Staphylococci ( )
   3. Pseudomonas ( )
   4. Proteus ( )
   5. Streptococci ( )
   6. Klebsiella ( )
   7. Enterococci ( )
   8. Others ( )

17) Drug sensitivity:
   1. co-trimoxazole ( )
   2. nitrofurantion ( )
   3. nalidixic acid ( )
   4. cephalaxin ( )
   5. amoxicillin+clavulanic acid ( )
   6. gentamycin ( )
   7. cefuroxime ( )
   8. ceftriaxone ( )
   9. cefixime ( )
   10. ciprofloxacin ( )
   11. Ampicillin ( )

18) Other investigation:
   1. Abdominal Ultrasound
      1. Normal
2. Renal stones
3. PCD
4. Hydronephrosis
5. Others

2. MCUG
   1. normal
   2. VUR
      a. grade I
      b. grade II
      c. grade III
      d. grade IV
      e. grade V

3. Posterior urethral valve
4. Others