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## Urinary tract infection : a study of one hundred recent cases

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URINARY TRACT INFECTION  
A STUDY OF ONE HUNDRED RECENT CASES

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Submitted in Partial Fulfillment for the Degree of  
Doctor of Medicine

College of Medicine University of Nebraska

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## URINARY TRACT INFECTION: A STUDY OF ONE HUNDRED RECENT CASES

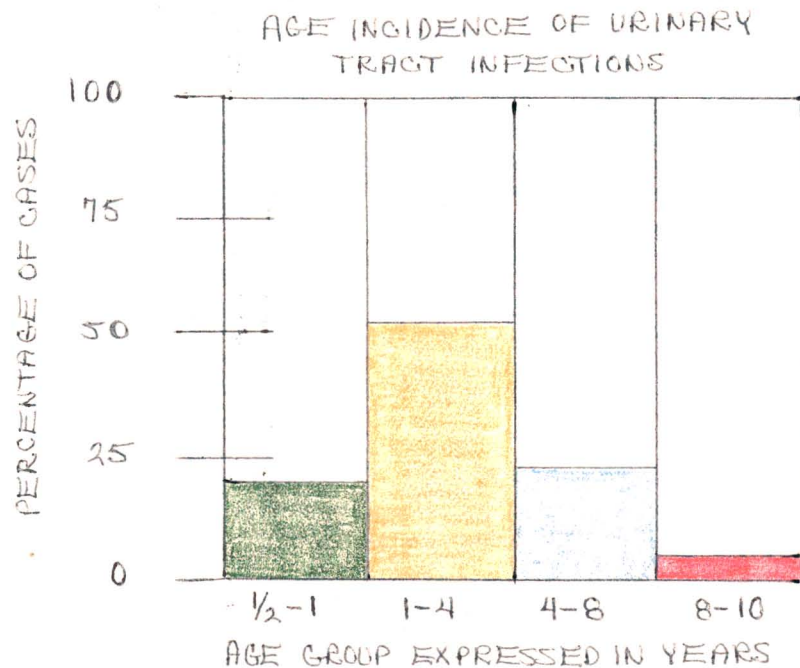
Urinary tract infection has always been a very serious problem in pediatric patients. Urinary tract infection ranks second in incidence of pediatric hospitalizations, being superceded only by upper respiratory infections. The symptomatology of this disease process is often either not evident or misleading. Therefore this disease process becomes one of the most important and most difficult diseases which will confront the physician who cares for pediatric patients. This paper is a review of pertinent literature, primarily from the period 1957-1963. The literature is then correlated with one hundred recent pediatric case histories from the University of Nebraska Hospital and the Childrens' Memorial Hospital of Omaha, Nebraska.

The incidence of urinary tract infections that is most commonly quoted in the literature is from three to four percent of all pediatric hospital admissions. In a study by Staffon and Engle between ten to twenty percent of all autopsies in selected hospitals revealed active pyelonephritis. Of these cases, approximately twenty-five percent were diagnosed prior to autopsy. They also discovered that thirty to sixty percent of people who had chronic urinary tract disease had suffered urinary infections in childhood.<sup>1</sup>

Age and particularly sex tend to play important roles in the pathogenesis of the disease. The sex distribution is thought to have a direct relationship to the anatomical variation in the length

of the urethras of the male and female. In a series of 1279 pediatric urinary tract infections the disease was found to be two and three tenths times more common in females than males.<sup>2</sup> In another series of thirty-one cases the disease was two and one tenth times more common in females than males.<sup>3</sup> One series reports as high as nine times more females than males affected.<sup>4</sup> The incidence does not only follow a sex distribution but also seems to have some relationship to age. This is shown by Burke whose age incidence in one hundred cases is shown in Table I.

Table I<sup>5</sup>



Many times the exact etiology can not be determined in a given case of urinary tract disease. However a general classification of etiologic factors of "secondary pyelonephritis" is:<sup>6</sup>

1. Instrumentation
2. Altered architecture of the nephron (intrarenal obstruction)
3. Extrarenal obstruction
4. Pregnancy
5. Diabetes
6. Calculus or nephrocalcinosis
7. Congenital anomalies of the genitourinary tract
8. Traumatic injury
9. Hypogammaglobulinemia
10. Properdin deficiency
11. Defective general resistance
12. Foci of infection, a source of bacteremia.

Of the twelve items listed above, number seven probably has received the most attention in medical literature. One of the more extensive studies on congenital urinary tract anomalies was carried out by Helmholtz in 1927. He reviewed cases of patients with congenital anomalies of the urinary tract at Mayo Clinic for a period of six years. His findings are listed in Table II.

Table II<sup>7</sup>

<u>ABNORMALITY</u>	<u>NO. OF CASES</u>
Renal Anomalies	
Hydronephrosis.....	14
Ectopic kidney.....	1
Unilateral kidney.....	1
Polycystic kidney.....	1
Simple cyst of kidney.....	1
Ureteral Anomalies	
Duplication of ureters.....	3
Dilated ureters.....	9
Left ureter opening into bladder sphincter.....	1
Urethral Anomalies	
Posterior urethral stricture.....	4
Recto-urethral fistula.....	2
Bladder Disorders	
Neuromuscular dysfunction.....	22
Exstrophy.....	34

Probably the most discouraging aspect of this disease is the manner in which it is presented to the practitioner. As mentioned previously the symptomatology is often vague and misleading and may vary with the different age groups.

In 1961 Burke presented the symptomatology of one hundred selected cases of urinary tract infections. He found that when the patients were less than one year old that the most prominent symptoms were not related to the urinary system. In the twenty-three cases of this age group anorexia, fever, and vomiting were the most prominent symptoms. Abdominal pain was the most common symptom in children old enough to complain of it. The relative incidence was sixty-three out of seventy-seven patients. Vomiting was the presenting symptom in thirty-two cases and occurred in fifty-three cases of the total one hundred. Fever was present in eighty-three children, and of these eighty-three, four had febrile convulsions. Of the common urinary symptoms, dysuria was found in forty-one and was the presenting complaint in twenty-eight. Frequency and urgency were found in thirty-two cases being the presenting complaints in twenty-eight. Thirteen had nocturnal enuresis, and ten had macrohematuria. Burke also found that children with recurrent attacks tended to show the same patterns of symptomatology.<sup>5</sup>

Other series would generally tend to concur with Burke's findings. DeLuca reviewed a series of 1279 cases of recurrent urinary tract infections but categorized the symptomatology in only rough generalizations. He states that in children less than one year old,

feeding difficulties, failure to thrive, and severe weight loss were found. In children one to three years old, fever of unknown origin, failure to do well, and enuresis in those who had been previously toilet trained were very common. In the children over three years old, urinary symptomatology was the most common with enuresis occurring with one of the accompanying symptoms -- frequency, dysuria, flank pain, suprapubic pain, or vague abdominal discomfort -- in over fifty percent of cases.<sup>2</sup>

It is difficult for the practitioner to be able to diagnose urinary tract infections in children. The old, time honored method of using pyuria as a means of positive diagnosis has been shown in many cases to be wholly inadequate since the pyuria is often only intermittent. Rubin, in studying urines of patients with pyelonephritis, found that five or more leukocytes per high powered field in an uncentrifuged specimen was a convenient breaking off point for diagnosis of a urinary tract infection.<sup>6</sup> Some people have considered five plus leukocytes per high powered field in a centrifuged specimen as indicative of urinary tract infection. However, Kass demonstrated that in only one-third to one-half of the patients with five or more leukocytes per high powered field was there a true bacilluria present. Only two percent of these patients had colony counts of over one hundred thousand organisms per milliliter of urine.<sup>8</sup>

At present the most reliable indication of infection in the urinary tract appears to be the finding of bacteria in the urine in



significant numbers. Many studies have shown at least ninety-five percent correlation between the clinical diagnosis of pyelonephritis and the presence of one hundred thousand or more bacteria per milliliter of urine. It has also been demonstrated in many studies that these urine specimens may be taken by midstream or by catheterization with accuracy. However catheterization tends to introduce infection into the urinary tract. When DeMaria was performing his study he found that with a single catheterization, four percent of the patients developed a subsequent pyelonephritis.<sup>9</sup> In those patients with indwelling catheters, ninety-five percent developed pyelonephritis within four days. Most of these occurred within the first day after insertion of the catheter.<sup>8</sup>

The results of a study by Brumitt of quantitative cultures of urines in childhood demonstrated that over one hundred thousand bacterial colonies per milliliter of urine are necessary to confirm the diagnosis of urinary tract infections. In contamination of specimens due to faulty collection technique, the bacterial counts almost always remain below one thousand. In some fifteen cases with original counts of slightly greater than one thousand, repeat cultures demonstrated less than one thousand colonies per milliliter of urine.<sup>10</sup> However, one must be cautioned that the bacterial counts may give false impressions when large volumes of urine are excreted, the patient has undergone antibacterial therapy, complete obstruction prevents the entrance of bacteria into the urine, or when the pH of the urine is detrimental to the bacterial growth.<sup>8</sup>

Along with the colony counts the organism must be identified. Two relative large studies of cases by DeLuca (1279 cases) and by Keefer (477 cases) are compared below in Table III.

Table III<sup>2,11</sup>

<u>ORGANISM</u>	<u>PERCENT OF TOTAL</u>	
	DeLuca	Keefer
<u>E. coli</u> .....	72.....	49.7
<u>Proteus</u> .....	12.....	7.2
<u>A. aerogenes</u> .....	6.....	12.7
<u>P. aeruginosa</u> .....	4.....	14.8
<u>Staph. aureus</u> .....	4.....	12.2
<u>Streptococcus</u> .....	2.....	1.3
<u>Enterococcus</u> .....		1.6
<u>H. influenza</u> .....		0.5

Specific treatment of urinary tract infections varies so much that it will not be included in this paper in detail. After the diagnosis is made and a culture and sensitivity is done, an agent specific to the organism present is used. Sulfonamides are generally used when E. coli is found. If the patient does not respond, then tetracyclines and/or streptomycin are used. A. areogenes, Proteus of paracolon groups usually respond to streptomycin and/or tetracyclines also. For P. aeruginosa polymyxin or colymycin is used. For those organisms of the Staphylococcal group, erythromycin will usually suffice.<sup>9</sup> Other agents in common use are furadantin and mandelamine. The duration of treatment is a controversial point. Most evidence seems to point to the fact that when the treatment is carried over a long period of time, the recurrence rate is greatly reduced. For instance in one of the large studies, the patients

were divided into two groups. One group of 579 patients was treated with therapeutic levels of specific antimicrobial agents for three to thirty days. Of this group 309 had no measurable renal damage, and eleven of them had to undergo nephrectomy. Seventy-eight patients were lost in the followup. In the second group of 479 patients, the treatment with the antimicrobial agents lasted only five to nine days, but it was followed by long term maintenance doses of sulfonamides for six months. Of this group ninety percent remained free of infection after six months. Forty-three persons in this group were treated for three recurrent episodes. However, after two additional years of therapy thirty-seven became free of infection. Sixty-seven of the total of this group were lost in the followup.<sup>2</sup> However, as mentioned, not all people would agree to this mode of therapy. Burke states that he could find no relationship between duration of treatment and the rate of recurrence.<sup>5</sup>

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## A STUDY OF ONE HUNDRED RECENT CASES

The information for this study was taken from a systematic review of one hundred clinical charts of patients between zero and fourteen years of age with a final diagnosis by the clinician of some type of urinary tract infection. Twenty-five cases over the last five years at the University of Nebraska Hospital and seventy-five cases over the last three years at the Childrens' Memorial Hospital were selected for study. The clinical laboratory values cited are the highest recorded values for each individual patient. The information on the symptomatology of the patients was gathered from all portions of the clinical chart.

The diagnoses as listed on the clinical charts are reviewed.\*

Cystitis.....	42
Pyelonephritis.....	32
Urinary tract infection.....	14
Urethritis.....	9
Pyelitis.....	3
Trigonitis.....	1

Of the one hundred cases reviewed ten percent have returned for hospitalization because of a recurrence of a urinary tract infection. This figure should indicate that urinary tract infections play a major role in the care of pediatric patients.

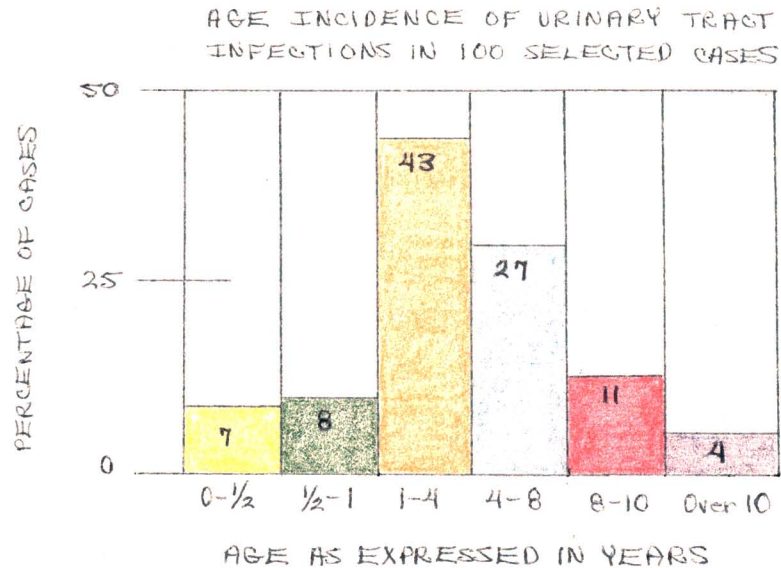
Because age apparently plays such an important role in the incidence and symptomatology of this disease, this factor is summarized. The age groups are divided into six categories in order to

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\* Several charts contained more than one diagnosis.

see the relative incidence of this disease in the various age groups, and to analyze the relative frequency of the various symptoms in the respective age groups. Table IV is a summary of these factors.

Table IV



As was mentioned in the review of literature, sex also plays an important part in the etiology because of the anatomical variations. This can be very aptly demonstrated when one considers this limited study of only one hundred cases demonstrated eighty-two percent of the cases were found in females and only eighteen percent occurred in males.

An interesting sidelight recorded in this study was the incidence of coexistent sources of infection during the hospitalization other than urinary tract infections. This study revealed that twenty-five percent of the patients suffered from some form of an upper respiratory infection, two percent had gastroenteritis and

three percent had otitis media. One patient had a cellulitis of the iliac crest.

The symptomatology of these one hundred cases covers a wide range of complaints. When reviewing the charts, the complaints were taken from all portions of the charts including the history, physical, nursing notes, and progress notes. These findings are recorded in Table V. (Refer to page 14.)

In order to predict the incidence of various symptoms in the respective age groups an incidence/age ratio was calculated --

$$\left( \frac{\text{No. of a particular complaint within age group}}{\text{No. of cases in that particular age group}} \right)$$
 In the children

zero to one year of age the most common complaints are of no specific nature -- fever, anorexia, and irritability. Fever still plays the most important role in the one year old to the four year old group. There is also a marked increase in the incidence of frequency. Fever progressively decreases in incidence with the increasing age groups while the "typical" urinary complaints of frequency, urgency and dysuria increase in frequency. This is demonstrated in the age group over four years of age.

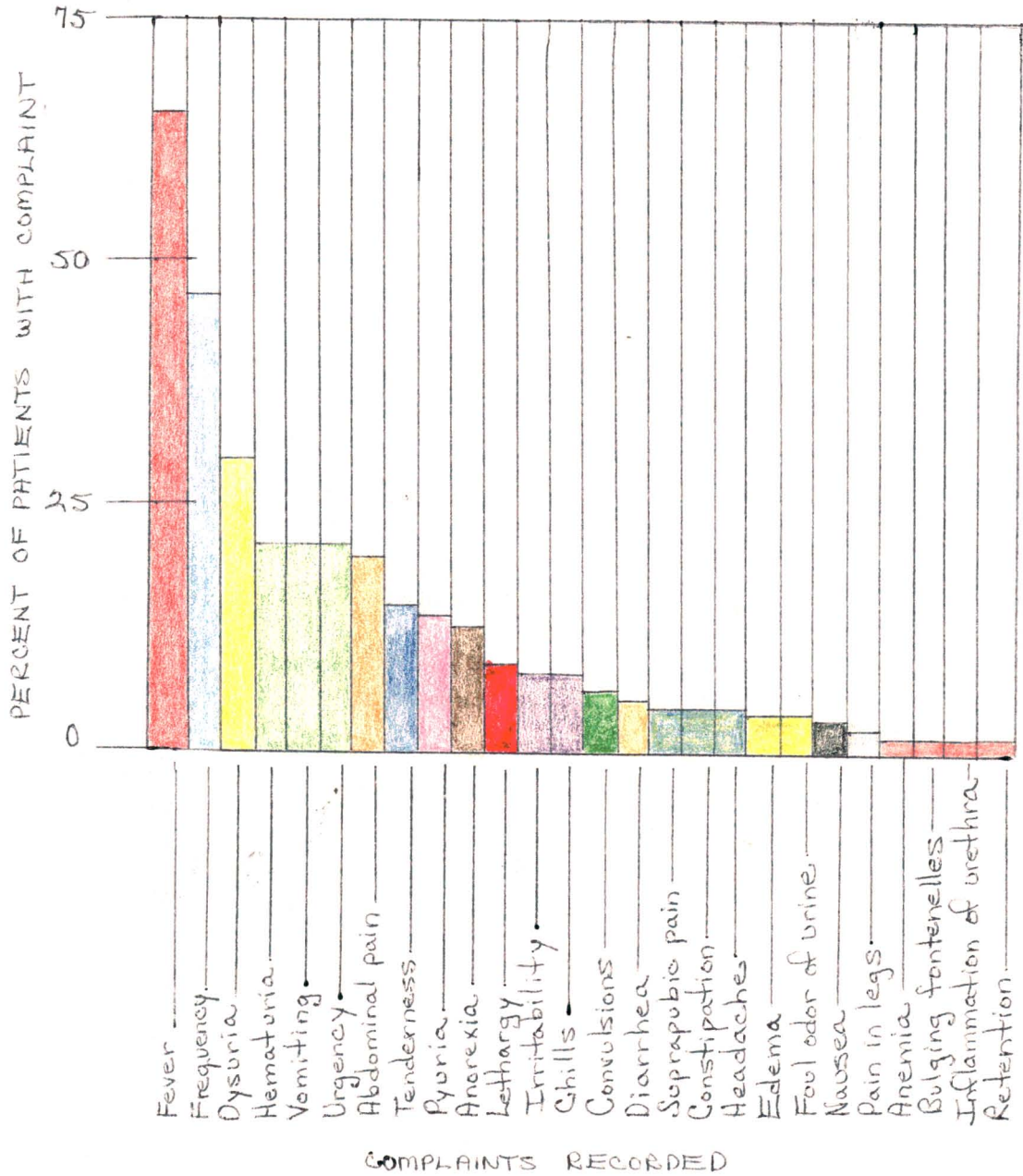
Note was also taken of all admission blood pressures. Although several were elevated upon admission all returned to normal during hospitalization. It is felt that many elevations were due to apprehension due to strange environment, and so forth.

When the complaints are categorized according to the systems predominating, the urinary complaints comprise forty-seven percent of the total number of complaints while nineteen and six tenths percent were in the gastrointestinal category.



Table V

SYMPTOMATOLOGY OF 100 SELECTED CASES

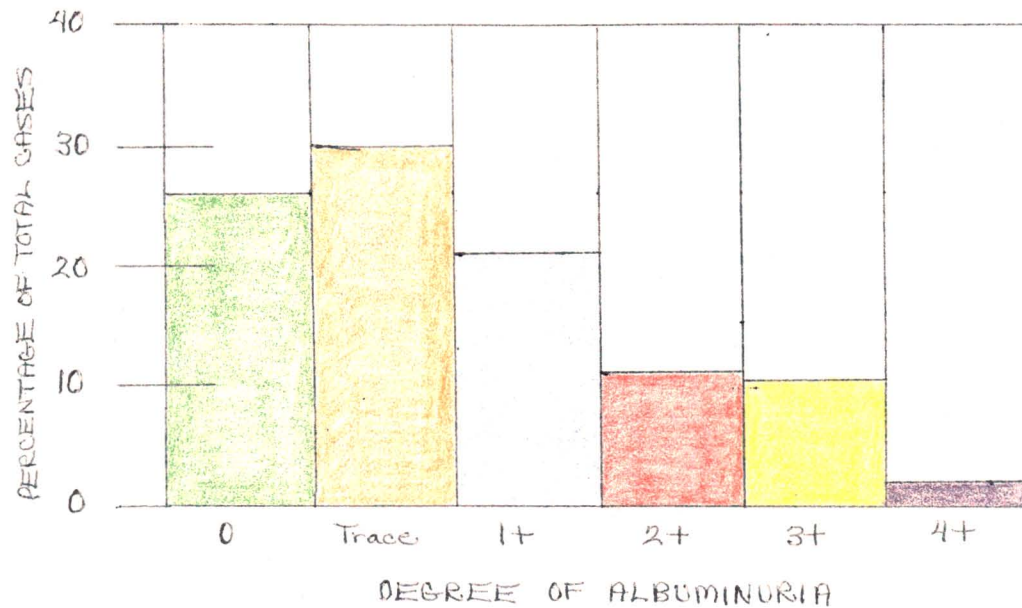


As for the diagnostic procedures performed in these cases, some of the laboratory procedures used are reviewed. The laboratory values used are the highest values in cases where more than one of the same procedure was performed. The reason for this being that, as mentioned in the review of literature, many times the values are intermittently low or within the normal range.

The peripheral white blood count in these selected cases varied from those within the normal range all the way to over thirty thousand. These white counts were divided into four categories according to the numbers found. The first category was considered to be in the normal range -- from four to ten thousand. Thirty-eight percent of the total cases were included within the normal range. The second or elevated range was from ten thousand to twenty thousand and contained forty-four percent of cases. The third category was the markedly elevated range of over twenty thousand which contained fourteen percent of the cases. In four percent of the cases, no laboratory values were recorded. Based on this series of cases over one-half of the patients with urinary tract infections can be expected to have elevations in the peripheral white blood count at sometime during the hospitalization.

Analysis of the various components of the urinalysis revealed some interesting facts. Over one-half of these cases demonstrated either no albumin or only a trace of albumin throughout the entire hospital stay. (Refer to Table VI.)

Table VI



The white cell count of the microscopic examination of urine was divided into the following categories for purposes of analysis: zero to five cells per high powered field or not significant, five to ten cells per high powered field or questionably significant, ten to one hundred cells per high powered field or significant, and over one hundred cells per high powered field as definite pyuria. A summary of the selected cases is as follows: fourteen percent were not significant, sixteen percent were questionably significant, thirty-four percent were definitely significant, and thirty-six percent had definite pyuria. It is evident that of the total number of patients seventy percent are in the abnormal range, with about one-half of these in the definite pyuria classification. This would appear to correlate with the peripheral white blood count findings.

Fifty-six percent of the cases had blood urea nitrogen determinations. The normal for this test was considered to be less than twenty milligrams percent. Of these cases forty-three percent were normal throughout hospitalization, and thirteen percent were elevated to some degree.

The study of culture and bacterial colony count was also revealing. Out of the one hundred cases reviewed eighty-nine cases had cultures performed. Six of these also had colony counts. Of the eighty-nine cultures twenty-five cases demonstrated no evidence of growth after forty-eight hours, forty-five cases demonstrated pure cultures of only one organism and nineteen cases demonstrated mixed infections. The range and incidence of organisms cultured are shown in Table VII.

Table VII

<u>ORGANISM</u>	<u>PERCENT OF TOTAL</u>
<u>E.coli</u> .....	42.2
<u>Proteus</u> .....	18.5
<u>Staphylococcus</u> .....	11.6
<u>A. aerogenes</u> .....	11.6
<u>Streptococci</u> .....	5.6
<u>Pseudomonas</u> .....	4.2
<u>Neisseria</u> .....	2.1
<u>Hemophilis</u> .....	1.1
<u>Achromabacter</u> .....	1.1
<u>paracolon organisms</u> .....	1.1

The colony counts were not too conclusive in this series since only two cases revealed counts greater than one hundred thousand colonies of bacteria per milliliter of urine. Therefore an attempt was made to correlate the positive cultures with the degree of pyuria.

TABLE VIII, A

SIXTY-FOUR CASES WITH POSITIVE URINE CULTURES

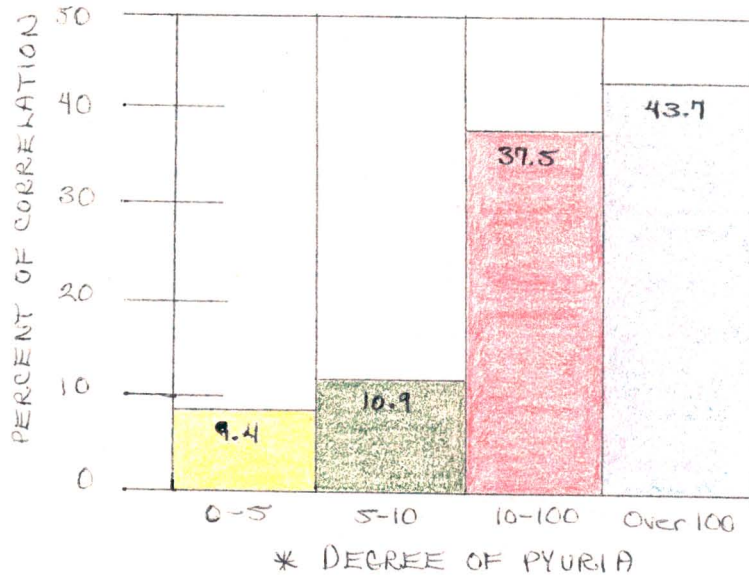
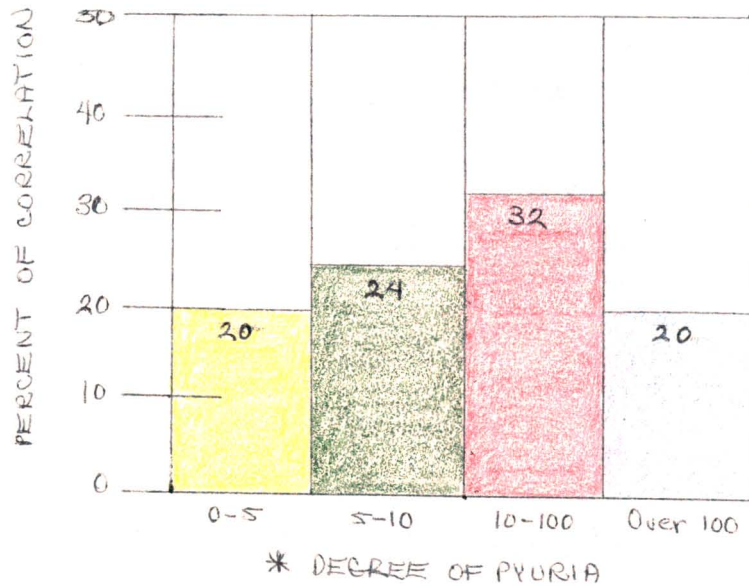


TABLE VIII, B

TWENTY-FIVE CASES WITH NEGATIVE URINE CULTURES



\* Number of leukocytes per high powered field in centrifuged urine specimen.

From Table VIII, A, it can be seen that pyuria definitely correlates with positive urine cultures with pathologic pyuria occurring in eighty-one and two tenths percent of the cases. However fifty-two percent of the negative urine cultures demonstrated pathologic pyuria.

Special diagnostic studies performed consisted of cystoscopic studies and the radiographic studies -- intravenous pyelogram, cystogram, cystourethrogram, and retrograde pyelogram. The total number of patients with one or more of these studies was sixty-seven. The number of studies were as follows:

Intravenous pyelogram.....	44
Retrograde pyelogram.....	12
Cysto and/or urethrogram.....	18
Cystoscopy*.....	6

The positive findings of these diagnostic studies are revealed in the table below.

Residual.....	3
Thickened bladder mucosa.....	10
Urethral stenosis.....	5
Reflux.....	3
Irritability of calices.....	4
Ureteral-pelvic juncture constriction....	2
Impaired tubular function.....	4
Hydronephrosis and hydroureter.....	5
Trabeculated bladder.....	1
Double kidney.....	1
Horseshoe kidney.....	1
Bladder neck obstruction.....	1
Enlarged kidney.....	1
Bladder calculi.....	1

Much attention is always paid to the congenital anomaly studies. The following is a list of the "apparent" congenital anomalies demonstrated by the above diagnostic studies:

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\* not inclusive of the retrograde pyelogram studies

Urethral stenosis.....	5
Bladder neck obstruction.....	2
Reflux.....	2
Incomplete opening of labia minora.....	2
Ureteral-pelvic juncture constriction.....	2
Hypospadias.....	1
Spina bifida.....	1
Double kidney.....	1
Horseshoe kidney.....	1

SUMMARY:

A study of one hundred recent pediatric clinical case histories of patients with urinary tract infection is reviewed and compared with recent literature on this subject.

The study reveals the importance sex plays in the incidence of urinary tract infections. The incidence in various age groups is also reviewed. A summary of all findings both historical and physical is presented and correlated with the various age groups.

A study of the laboratory procedures is made correlating the urine leukocyte counts with the urine cultures. A summary is made of the peripheral leukocyte counts. The frequency of organisms found upon culturing of the urine and upon performing urine bacterial colony counts is also listed.

Finally a number of special tests such as cystoscopy, intravenous pyelogram and other related diagnostic measures are listed, and the pathology obtained by these studies is presented.