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## Radiological and clinical pyelonephritis

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RADIOLOGICAL AND CLINICAL PYELONEPHRITIS

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RADIOLOGICAL AND CLINICAL STUDY OF PYELONEPHRITIS  
AT THE UNIVERSITY OF NEBRASKA HOSPITAL: REVIEW  
OF 43 CLINICAL RECORDS

INTRODUCTION

"Illnesses starting with pain in the back run a difficult course"  
---Hippocrates.

Some two thousand years after Hippocrates made his observations, Richard Bright associated these signs with disease of the kidneys<sup>(8)</sup>. Following this beginning new concepts of the various entities of Bright's disease were apparent by the end of the century.

It was during this time that radiology, an important adjunct, was first employed in the study of the urinary system. According to Braasch<sup>(3)</sup> it was Tuffier who first attempted to x-ray the urinary tract in 1897. Voelcker and von Lichtenberg<sup>(3)</sup>, in 1906, called attention to the use of pyelography as an aid to the diagnosis of hydronephrosis. Braasch described radiological changes found in the pelvis and ureter as a result of inflammation, such as pyelonephritis, 1914.

In England, Gibson (1928), emphasized the frequency with which chronic pyelonephritis caused renal failure<sup>(8)</sup>. Longsope and Wink-enwerder reviewed this subject in 1933<sup>(8)</sup>. The pathological distinction of chronic pyelonephritis from other diseases of contracted kidneys was described by Weiss and Parker<sup>(8)</sup> in 1939.

McMannus<sup>(9)</sup> states, "thus is the most prevalent of all renal

diseased by autopsy<sup>9</sup>. He found that nearly all adults at autopsy show a microscopic focus of chronic pyelonephritis and in many cases the degree is marked. Sanjurjo and Fortuno<sup>(10)</sup> found histological evidence of this disease in 4.6 per cent of 2,800 consecutive autopsies.

Wesson<sup>(12)</sup> emphasizes that the diagnosis of renal infection usually cannot be based on one criterion but must be made by careful correlation of x-rays with clinical and laboratory studies.

The purpose of this study is to correlate the radiological with the clinical findings from 43 patients records at the University of Nebraska Hospital. These 43 cases were selected from 147 patients who were diagnosed as having pyelonephritis and dismissed from the University Hospital during the years of 1958 and 1959. Those patients, not having radiological studies made of their urinary system, were eliminated from the study.

The group is comprised of 24 female and 19 male patients. Their ages ranged from 11 to 87 years old. The average age was 52.5 years and the mean age was 53 years old. Thirty were evaluated as chronic and 13 patients as acute pyelonephritis.

Twenty-six patients composed of 15 males and 11 females patients had x-rays of the urinary system which were interpreted as abnormal. This is group A. The remaining 17 patients, consisting of 4 male and 13 female patients, had radiological findings which were interpreted as normal. These will be recognized as group B.

## SYMPTOMS

The symptoms of pyelonephritis or symptoms accompanying the disease are multiple and frequently difficult to recognize. Although a combination of symptoms was often present among the patients studied the prominent and outstanding complaints were selected and compiled in order of frequency and according to respective groups.

As seen in table 1 lumbar pain, chills and fever, and low abdominal pain were the most frequent symptoms leading to a diagnosis of pyelonephritis. This order was followed by dysuria, hematuria, nausea and vomiting, and pyuria. Sanjurjo and Fortuno<sup>(10)</sup> recorded a similar order of symptoms in a study of 256 patients with chronic pyelonephritis.

There is no significant trend in this series of symptoms that would enable one to predict which patient would present with abnormal x-ray findings.

Table 1. Symptoms leading to diagnosis of 43 patients with pyelonephritis

	Group A	Group B	Total
1. Lumbar pain	13	5	18
2. Chills and fever	8	6	14
3. Low abdominal pain	10	4	14
4. Dysuria	6	4	10
5. Hematuria	6	3	
6. Nausea and vomiting	4	4	8
7. Pyuria	4	1	5
8. Nocturia	3	2	5
9. Headache	1	2	3
10. Edema	1	2	
11. Fatigue	2	1	
12. Anorexia	2	1	3
13. Weight loss	1	0	1
14. Pain radiating down leg	0	1	1

## INFORMATION FROM HISTORIES

Table 2 demonstrates that patients of group A have had a previous urinary disease, or diseases in which urinary complications are common more frequently than group B.

Group A gave a history of previous urinary disease in 53.8 per cent of the cases. In comparison group B revealed this history in only 17.7 per cent. Those giving a history of kidney stones were all common to group A. One patient had hyperparathyroidism and showed radiologically calcific deposits in the region of the kidney parenchyma bilaterally. Diabetes was present in 11.6 per cent of the total.

Histories, as usual, lend much to any point of differential or correlation. In evidence of chronicity radiological studies should in all probability be done in search for those which are amendable.

Table 2. Information from histories

	Group A	Group B	Total
1. History of renal disease	14	3	17
2. Incontinence	6	2	8
3. Urinary retention	5	1	6
4. Kidney stones	4	0	4
5. Diabetes	3	2	5
6. Neurogenic bladder	2	0	2
7. Hyperparathyroidism	1	0	1

## PHYSICAL EXAMINATION

On physical examination 36 patients had findings which are thought to be due to or associated with their renal pathology. (See table 3).

The two most commonly encountered physical conditions were CVA tenderness and hypertension. This incidence of CVA tenderness appears to be higher than generally found in the literature. Hypertension is seen to be four times more frequent in group A. This is a substantial trend but not, in total, a condition associated with radiological abnormalities. McManus<sup>(9)</sup> writes that it does tend to mark the chronic pyelonephritis patient but that not all cases of hypertension show radiologic evidence of urinary tract abnormality. He also notes that severe pyelonephritis can exist without hypertension.

Retinal exudates and A/V nicking was found substantially more often in group A. For these and other physical findings see table 3.

Table 3. Physical findings in 36 patients with pyelonephritis

	Group A	Group B	Total
I. CVA tenderness	11	9	
2. B. P. greater than 140/90	8	2	10
3. Increased temperature	5	3	8
4. Abdominal tenderness	4	2	
5. Lethargy	3	2	5
6. Retinal changes	4	1	
7. Prostatic hypertrophy	2	0	
8. Pitting edema	2	0	2
9. Flank Mass	1	0	
10. Visiculo-vaginal fistula	1	0	1
11. Periorbital edema	0	1	1
12. Urethral stenosis	1	0	
13. Nephroptosis	1	0	1



## LABORATORY DATA

### Blood studies

Routine blood studies were done on admission. Five records were missing this information. The recorded values of the combined groups showed that 60.5% of the patients were anemic and that the remaining 39.5% had essentially normal hemoglobin values.

Female patients of group A had hemoglobin values ranging from 9 grams % to 14.1 grams % with an average of 11.8 grams percent. Those of group B had values of 10.8 grams % to 14.1 grams % with an average of 11.9 grams % or essentially no difference between the two groups.

Male patients of group A had values varying from 11.4 grams % to 15.0 grams % with an average of 13.5 grams %. Group B had two male patients with hemoglobin values of 7.9 grams % and 13.1 grams %. This is an average of 10.5 grams %. However, one of these is exceptionally low and with this small series no significance is implied.

It is interesting to note that all male patients with more than 14 grams % hemoglobin are of group A. Four of these six patients were diagnosed as having chronic pyelonephritis.

Leucocytosis with a white blood cell count of over 10,000 was observed in 47.4 % of the cases. A left shift was evident in a like per cent.

In reviewing this study it is shown that anemia is a frequent occurrence in cases of pyelonephritis. No correlation to radio-

logical differences was ascertained. (See table 4.)

Table 4. Routine blood studies

	Group A	Group B	Total
1. Females under 12 gm % hgb	5	7	
2. Females 12 gm % hgb or over	4	5	
3. Males under 14 gm % hgb	7	4	11
4. Males 14 gm % hgb or over	6	0	6
5. Leucocytosis (10,000) or over	10	8	18
6. Left shift (8 or more staffs)	8	10	18
7. Toxic granulation	3	3	6
8. Anisocytosis	2	1	3
9. Hypochromia	1	1	2

Blood urea nitrogen and nonprotein nitrogen levels

Twenty-seven patients were tested for BUN and or NPN blood levels. Those tested consisted of 18 from group A and 9 from group B. Table 5 shows that 62.9 % of the cases who had these determinations had values elevated above the accepted normal range.

In group A 11 patients had BUN evaluations done with 8 results being above 20 mg %. Of 11 NPN tests in this group 9 were above 40 mg %. Elevated BUN or NPN values were present in 83.3 % of all patients tested in group A.

In contradistinction group B had 22.2 % of those tested showing abnormally elevated values. These values, as seen in table 5, are not of such magnitude as those of group A.

This series demonstrates that patients with elevated BUN and NPN levels tend to show, more frequently, abnormal radiological findings.

Table 5. BUN and NPN determinations

Group A			Group B		
Case	BUN	NPN	Case	BUN	NPN
1.	43.7	206.0	1.	23.0	-----
2.	26.0	55.0	2.	30.0	60.0
3.	140.0	-----	3.	13.0	-----
4.	71.0	110.0	4.	16.0	-----
5.	-----	56.5	5.	11.0	-----
6.	145.0	-----	6.	34.0	-----
7.	-----	52.0	7.	-----	35.0
8.	-----	38.0	8.	-----	24.5
9.	24.0	-----	9.	13.0	34.5
10.	-----	82.0			
11.	-----	45.0			
12.	-----	210.0			
13.	23.0	-----			
14.	-----	63.0			
15.	16.0	-----			
16.	43.5	-----			
17.	11.0	39.5			
18.	63.0	-----			

Urine analyses

One of the most important tests in patients suspected of pyelonephritis is that of the urine. Table 6 and 7 contain individual urine analyses. The results of the sugar, acetone, and PH tests are found in the text only. Nearly all of the patients had repeat urine analysis at frequent intervals during their hospitalization. Only initial results are compiled in this presentation. One record was devoid of the urine examination.

Studying these analyses I note that 6 patients of group A are recorded as having dark straw colored urine. Only one of group B

is so described. Though the incidence is somewhat greater in A than B no definitive correlation is based on this incomplete descriptive differentiation.

Table 6. Urinalyses of 26 patients with abnormal x-rays\*

	Color	Trans	Sp. G.	Protein	RBC's	Pus. C.	Casts	Cryst.	Bact.
1.	S	Clr	1.009	1 plus	----	8-10	-----	-----	-----
2.	S	Cldy	-----	-----	2-3	8-10	-----	-----	-----
3.	DS	Cldy	1.014	3 plus	pack	8-10	-----	urate	-----
4.	S	Cldy	1.005	4 plus	100	30-35	rc,hy,gr	-----	-----
5.	S	Cldy	-----	1 plus	100	5-10	hyaline	-----	-----
6.	DS	Cldy	1.025	-----	pack	15-16	wbc	-----	mod.
7.	S	Clr	1.005	2 plus	----	1-3	-----	-----	-----
8.	S	Cldy	1.009	1 plus	0-2	pack	hy, gran	-----	-----
9.	DS	Cldy	1.019	-----	Occ.	1-3	hyaline	-----	-----
10.	DS	Cldy	1.010	trace	----	pack	-----	-----	pack.
11.	S	Cldy	1.014	-----	----	pack	-----	-----	-----
12.	S.	Clr	1.012	-----	----	Occ.	-----	urate	-----
13.	S	Clr	1.018	3 plus	1-2	----	-----	CaOx	-----
14.	DS	Cldy	1.017	3 plus	1-3	2-6	hy, gran	urate	-----
15.	S	Cldy	1.008	1 plus	Occ.	pack	-----	-----	mod.
16.	S	Cldy	1.017	-----	----	pack	-----	t.sul.	-----
17.	S	Clr	1.001	trace	3-5	----	cylind.	-----	-----
18.	S	Cldy	1.011	2 plus	----	30-35	epith.	-----	-----
19.	DS	Cldy	1.011	3 plus	15-20	2-4	-----	-----	mod.
20.	S	Cldy	1.009	4 plus	100	5-10	epith,wax	urate	-----
21.	S	Cldy	1.020	trace	----	----	-----	-----	-----
22.	S	Cldy	1.011	2 plus	----	pack	-----	-----	mod.
23.	S	Cldy	1.026	-----	2-4	25-30	-----	-----	-----
24.	S	Cldy	1.025	trace	Occ.	25-30	-----	-----	-----
25.	S	Cldy	1.015	1 plus	20-25	----	hy, gran	-----	mod.
26.	S	Cldy	1.015	4 plus	10-12	----	-----	urate	-----

\*Key

S - straw	rc - red cell
DS - dark straw	hy - hyaline
Clr - clear	gr - granular
Cldy - cloudy	mod - moderate
	t.sul.- triple sulfate
	pack - packed
	Occ. - occasional
	cylind - cylindruria

Transparency of the urine was very nearly uniformly affected in both groups. The urine was described as being cloudy in 35 of the 42 recorded urine analyses.

The specific gravity is generally considered to be lowered in pyelonephritis. To evaluate these statistics properly one should know, more thoroughly, the control and timing of these collections. The average specific gravity for each group was 1.013 and would justify the impression of a lowered specific gravity in cases of pyelonephritis.

Acid urine is generally present in this disease. The reaction was acid in all cases but 2 of group A.

Sugar tests were positive in 4 specimens. Three samples were acetone positive. Both groups were represented in these tests.

Protein tests were positive in 26 cases or 62 % of all initial urine analyses. Group A had 19 protein positive tests containing a trace of 4 plus. Group B had 7 which were protein positive in amounts of a trace to 3 plus. The distribution is not specific to any one group.

Urine specimens which had more than an occasional red blood cell represented 54 % of the cases in group A. Group B showed rbc's in 12.5 % of the microscopic examinations. These figures indicate a trend toward abnormal x-rays in patients with hematuria.

Pus cells of 5 or more per high power field were reported in 29 cases. There is no substantial difference between the groups.

Kipnis (7) and his colleagues reported that the degree of bacteria and pyuria was no index of the severity of the pyelonephritis in that the structural damage was variable and inconsistent.

Table 7. Urinalyses of 16 patients with normal x-rays\*

	Color	Tran	Sp.G.	Protein	RBC's	Pus C.	Casts	Cryst	Bact.
1.	S	Clr	1.010	-----	-----	-----	-----	-----	-----
2.	S	Cldy	1.013	-----	3-8	4-6	-----	-----	-----
3.	S	Cldy	1.018	-----	-----	2-5	-----	urate	-----
4.	S	Clr	1.018	-----	-----	0-2	-----	-----	-----
5.	DS	Cldy	1.005	-----	100	50	-----	urate	mod.
6.	S	Cldy	-----	trace	-----	2-4	-----	-----	-----
7.	S	Cldy	1.014	-----	Occ.	20-25	-----	-----	-----
8.	S	Cldy	1.012	1 plus	Occ.	pack	-----	-----	pack
9.	S	Cldy	1.007	-----	-----	30-40	-----	-----	-----
10.	S	Cldy	1.015	1 plus	Occ.	50-60	-----	-----	-----
11.	S	Cldy	1.013	-----	Occ.	5-10	-----	-----	pack
12.	S	Cldy	1.024	-----	-----	80-90	-----	-----	-----
13.	S	Cldy	1.016	2 plus	-----	70-75	-----	-----	mod.
14.	S	Cldy	1.010	1 plus	-----	clumps	-----	-----	-----
15.	S	Cldy	1.010	3 plus	-----	40-50	wbc	-----	-----
16.	S	Cldy	1.015	1 plus	Occ.	3-4	-----	urate	-----

\*Key

S - straw

occ. - occasional

DS - dark straw

pack - packed

clr - clear

cldy - cloudy

Casts in themselves do not imply organic disease of the kidney. They have about the same clinical significance as renal albuminuria, therefore, probably indicate some pathologic change in

the kidney<sup>(11)</sup>. Group A had 10 patients with casts in their urine. There were 6 hyaline and 4 granular cast containing specimens. Other casts of more serious nature were found in single urine samples and were represented by red blood cell, white blood cell, waxy, and epithelial cell casts. Group B had one urine with white blood cell casts. The occurrence of casts were definitely more frequent in those with abnormal radiological findings.

Urate crystals were common to both groups. Calcium oxalate and triple sulfate crystals appeared in one case each of group A.

Ten cases in both groups contained bacteria in amounts described as moderate to packed.

Renal cells were found in one case of group B. Epithelial cells occurred in 14 patients of both A and B.

Oval fat bodies were present in one specimen of group A.

### Bacteriology

Routine urine cultures were done on all patients. Mixed infections were encountered in 18 cases or 41.8 per cent. Table 8 shows in order of frequency the various organisms isolated as reported by the laboratory.

Escherichia coli and Hemolytic Staphylococcus were the two most commonly responsible organisms for the pyelonephritis.

Sanjurjo and Fortuno<sup>(10)</sup> reported E. coli the most common organism

isolated in a study of 289 cases of chronic pyelonephritis.

In all urines cultured seven or 18.5 per cent of them were sterile. Williams<sup>(13)</sup> reported 13 cases of sterile urine in 16 patients with chronic pyelonephritis. He was, however, able to culture bacteria from all patients following septic renal biopsy.

There is no bacterial distinction between the two groups.

Table 8. Organisms cultured from 43 cases of pyelonephritis

	Group A	Group B	Total
1. E. coli	5	7	12
2. Hemolytic Staph.	8	4	12
3. Nonhemolytic Strep.	7	1	8
4. Diphtheroids	3	4	7
5. Gram neg rods	3	2	5
6. Hemolytic Strep.	5		
7. Anerobic Strep.	1	3	4
8. Proteus	3	1	4
9. Aerobacter	3		3
10. Pseudomonas	2	1	3
11. Staph. aureus	3		
12. Nonhemolytic Staph.	1	1	2
13. Coliform	1	1	2
14. Yeast	1	2	3
Totals.....	46.....	25.....	71
Sterile urine .....	4.....	3.....	7

#### Renal function tests

Two female patients of group B with chronic pyelonephritis had PSP excretion tests with values at 40 per cent of normal.



A female patient of group A with chronic pyelonephritis and probable polycystic disease had a urea clearance of 23 per cent below the allowed variation.

One seriously ill male patient of group A showed a significantly high cast and cell count by the Addis method. In retrospect it would have been a valuable asset to have had routine renal function tests and Addis counts as Sanjurjo and Fortuno<sup>(10)</sup> had in their study of pyelonephritis.

#### RADIOLOGICAL IMPRESSIONS

Table 9 and 10 show the individual radiological impressions of the 26 patients suffering from pyelonephritis who had abnormal x-ray findings. Table 9 and 10 represent the male and female patients respectively.

In group A there were 15 male patients or 57.7 per cent. This is in contrast to group B which had only 23.5 per cent male patients.

The average age of the patients in group A was 61.5 years. This is compared to the 38.8 year average of group B.

Table 11 shows the frequency of the abnormal radiological findings. Calculi were seen in 8 or 30.8 per cent of the cases. This abnormality was divided evenly between the sexes.

Contracted calyces and pelves was the second most common change seen in this group. Five males and two females were in this 26.9 per cent.

Table 9. Radiological impressions of 15 male patients

	<u>KUB</u>	<u>IVP</u>	<u>Retrograde</u>
1.	Distended urinary bladder	Rt hydroureter	.....
2.	Indefinite imp.	Contracted calyces and pelvis	Contracted infundibulum
3.	.....	Poor concentration	Slightly dilated pelves and ureters
4.	Normal	Normal	Sharp angulation of ureter, right kidney enlarged (hydronephro.)
5.	Normal	Irreg bladder, diverticuli, enlarged prostate	.....
6.	.....	Calculi, poor concentration	Displacement of kidney (suggestive of mass)
7.	Staghorn calculus	Staghorn calculus, hydronephrosis, poor concentration	hydronephrosis
8.	.....	Displacement of kidney (suggestive of tumor)	Renal cyst, seperation of calyces, bladder diverticuli & trabec.
9.	Bilateral infundibular narrowing	Bilateral infundicular narrowing	.....
10.	.....	No visualization of rt kidney	Left kidney enlarged (hypertrophic kidney)
11.	.....	Bilateral blunting of calyces	.....
12.	Calculi	Calculi, elongation & widening of calyces, (polycystic disease)	Calculi, multiple filling defects, (polycystic disease)
13.	.....	Bilateral blunting of calyces	Urethro diverticulum (urethro-cutaneous fistula), spasm of calyces
14.	.....	.....	Absence of left kidney
	.....	.....	Staghorn calculus, blunting calyces, dilation of pelvis, (hydronephrosis)

Hydronephrosis was seen in 19.2 per cent of all cases.

Kiil<sup>(6)</sup> indicates that hydronephrosis is generally due to inflammation or an obstruction.

Poor dye concentration was also evident in 19.2 per cent of all patients x-rayed.

The kidney of chronic pyelonephritis, the small contracted kidney, was identified in only 3 or 11.5 per cent of the total number of cases.

Table 10. Radiological impressions of 11 female patients

	KUB	IVP	<u>Retrograde</u>
1.	.....	.....	Bilateral calyceal cysts
2.	Calculi	.....	Contraction of left kidney
3.	.....	.....	Bilateral polycystic disease
4.	Calculi	Hydronephrosis, pressure defect ureter-pelvic junction	.....
5.	.....	.....	Hydronephrosis
6.	Suggestive of polycystic disease	Rounded filling defects, polycystic disease	Normal
7.	Contracted kidneys	Contracted kidneys	.....
8.	.....	Poor concentration	.....
9.	Bilateral calculi	Poor concentration	.....
10.	Calculi	Narrowing of calyces	Calculi
11.	.....	.....	Spasm left calyces & pelvis, no evidence of rt kidney

Chronic pyelonephritis was diagnosed in 24 or 92.3 per cent of the patients in group A. This was the diagnosis in only 35.3 per cent of the cases of group B. This study indicates that chronicity does tend to produce a higher per cent of radiological abnormalities. Dow<sup>(4)</sup> writes that radiology plays no significant part in acute phases of pyelonephritis. He does indicate that most patients with chronic pyelonephritis show abnormalities that can be detected by radiologic procedures.

Table 11. Frequency of abnormal radiological impressions

	<u>Cases</u>	<u>%</u>
1. Calculi	8	30.8
2. Contraction of calyces and pelves	7	26.9
3. Hydronephrosis	5	19.2
4. Poor concentration	5	19.2
5. Contracted kidneys or kidney	3	11.5
6. Polycystic disease	3	11.5
7. Unilateral nonvisualization of kidney	3	11.5
8. Displacement of kidney by probable mass	2	7.7
9. Renal cyst	2	7.7
10. Sharp angulation of ureter	2	7.7
11. Bladder diverticuli and trabeculation	2	7.7
12. Hypertrophic kidney	1	3.8
13. Urethro-cutaneous fistula	1	3.8

#### SUMMARY

An analysis of 43 clinical records was made to correlate the clinical picture with that of the radiological. These patients were selected from 147 cases of pyelonephritis diagnosed and dismissed from the university of Nebraska Hospital during the years of 1958 and 1959. These 43 patients had radiological studies made of their urinary systems.

## CONCLUSIONS

Radiological abnormalities were present in 60.5 per cent of the patients studied. Male patients represented 57.7 per cent of the above figure.

Chronic pyelonephritis was the diagnosis in 92.3 per cent of the cases with evidence of radiological abnormalities.

Symptoms were a nonconclusive index to the possible x-ray findings.

An extended history of renal disease increased the frequency of altered structure in the urinary system as shown by roentgenology.

Elevated BUN and NPN levels were four times more frequent in patients with radiological evidence of urinary disease.

Anemia and leucocytosis was common to both groups of patients.

Patients with significant hematuria and high cast counts were prone to have radiological evidence of urinary pathology.

*E. coli* and Hemolytic *Staphylococcus* were the two most common organisms cultured from the urinary system and were nonspecific in correlative value.

Calculi were the most frequent abnormal radiological findings. Contracted kidneys was fifth in order of frequency.

It is evident that radiological studies are an important adjunct in the diagnosis of pyelonephritis and in the definitive determination of the perpetuating factors.

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