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## Pyelitis during pregnancy: a study

Milton J. Groat  
*University of Nebraska Medical Center*

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PYELITIS DURING PREGNANCY  
A STUDY

M. J. GROAT

1932.

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## INTRODUCTION

This dissertation is not original in so far as personal experience or practical application is concerned. In this work is instilled a multitude of works, a conglomeration of all the available material time would allow me to collect. It is original in its composition and mode of approach.

Let me add that in this paper I have tried, as far as possible, to form an honest and personal opinion as to the conclusions, but in so much as I have had none of the practical, clinical, experience that the contributors to it have had, I wish to be excused if I draw conclusions by the vote method of "the eyes have it."

The choosing of this subject was not original with me. It was the suggestion of a faculty member. However, I am deeply interested in the subject, as, it seems, is the entire "Obstetrical Profession," judging from the available material. There seems to be so many divergences of opinion that it is confusing to the student, such as I, and it turns out to be a case of "do your own work, apply your own treatment, draw your own conclusions, and let the other fellow do the same."

Still Hofbauer(1) says: "the scientific interest in pyelitis during pregnancy is waning in spite of the fact that the most important questions in reference to etiology have not been answered." I am inclined to agree with this, though many words have been written, and many brains have tried to solve its problem.

## DEFINITION

According to Osler(2), pyelitis is an inflammation of the pelvis of the kidney and the conditions which result from it. According to this, a pyelitis may cause a nephritis, in which instance symptoms and subsequent reactions would be materially changed. In this paper I have attempted to show cases of simple pyelitis, though occasionally pyelonephritis would be a better terminology for the case in question.

Pyelitis during pregnancy has been spoken of as an incidence rather than a specific disease. In the words of DeBeaufond(3), "the term pyelitis should be reserved for the suppurative reaction, but with the exception of the very acute cases it is often impossible to determine this phase, as the three stages (referred to later) can only be separated with difficulty. The symptoms do not vary to any great degree, and the lumbar pain due to passage of crystals cannot be differentiated from the pain of pyelitis. For this reason I consider it as a functional disorder, rather than a true morbid entity."

I am inclined to disagree with this, as there are seen cases wherein the morbidness is proven. For a personal definition I will say: "An infection of the pelvis of the kidney and the conditions which result from it, occurring during pregnancy."

## HISTORY

The history of pyelitis during pregnancy reveals it to be a disease of recent discovery. From the literature it is seen to have been isolated as a true morbid entity about 1892-1893. Danforth(4) stated that Smellies Midwifery, published in 1752, described pyelitis. Royer(4) in 1842 also described it in detail. Benda(5) reports that Kaltenbach in 1871 was the first to describe pyelitis gravidarum as a separate disease. Kruse(6) in his inaugural dissertation (Wurzburg 1889) foresaw its existence.

It is largely owing to the efforts of Vinay(7) and others of the French school that pyelo-nephritis of pregnancy has been isolated as a specific "accident" of gestation. Reblaub (8), in a paper read before the Congress of Surgery in 1892, deserves the honor of separating the disease from other urinary disturbances and describing its origin and clinical course.

In 1899 Reed(6) of Chicago reported cases and classed it as relatively rare. At that time this statement was truthful and honest, but with the advent of modern cystoscopy in the early 1900's and with the advance of medical knowledge and aids in diagnosis, it is found to be not so rare. Luchs (9) states that according to some authors it is found in about .7% of all pregnant cases and as a rule in the second half of pregnancy. Benda(5) reports almost 1% of all pregnancies have pyelitis during its course.

At the time of Reeds(6) paper, Olshausen reported twenty-five cases, Vinay nine, Novac eleven, Reblaub three, over the period from 1893-1899. It is quite possible, however, that

due to the youth of the subject and its discovery, that physicians failed to recognize it and thus other cases passed unnoticed.

I have secured a translation of the original papers written by Reblaub(8) and Vinay(7). Their reports are of interest in an historical way as they demonstrate how much was missed at the time and how medical science has progressed in methods of diagnosis, even though still far from perfection.

In April, 1892, Reblaub(8) reported five cases of pregnant women. One was diagnosed cystitis, but subsequent examination showed only pus and colon bacillus in the urine. The only symptoms presented were frequency of urination and a right side lumbar pain with enlarged kidney revealed at examination.

Another case was insidious in onset and cleared up under rest, but showed the same symptoms as above.

A third case was sudden in onset with backache, fever, and severe diarrhea. Influenza epidemics at that time led to a diagnosis of intestinal influenza. Subsequent examination showed the above symptoms and led to the correct diagnosis.

Two other cases led to nephrotomies as a means of treatment. One was completely cured. The other died of opposite side (left) hydro-nephrosis.

Reblaub(8) believed: "that in all of these cases there was an infection of the kidney and the renal pelvis during the course of renal retention. Compression of the ureters by the gravid uterus has been known for some time and many

autopsies have been reported in which this compression was verified."

So also did Vinay(7) report similar cases. In 1893 he presented two cases, both of which had the "chief symptoms which characterized acute pyelitis." Later the same year he presented four more cases demonstrating variable symptoms all pointing to pyelitis.



## ETIOLOGY

With this brief dissertation on the history of the disease let us consider what has been done to disclose its cause. To the ordinary physician, the one interested in therapeutics; the one less interested in the "why" of the disease; the one primarily interested in treating, aiding, and curing his patient it might be sufficient to say: "stasis resulting in infection" or visa versa "infection resulting in stasis." And therein arises the question of "which comes first the hen or the egg," the stasis or the infection. Stasis per se is a broad term. Following are a few of the opinions which are given in the literature of today as to its cause.

### STRICTURE

This work is taken from Guy L. Hunner(10) and includes such a large number of cases that it is worthy of note. Covering a study of 2000 cases the following resume of facts were recorded:

1. Most strictures are due to intrinsic inflammation and conditions of the ureteral wall resulting in narrowing of the lumen.
2. The developmental errors of fetal life account for some strictures.
3. Wide and narrow calibre strictures is a misnomer, as a stricture may permit good drainage for days or weeks and yet within an hour cause severe renal colic. Hunner adds that premenstrual or menstrual congestion, added congestion of pregnancy, inflammation of neighboring organs etc., are

added factors to cause a further narrowing of an already narrowed ureter.

The etiology of stricture was concluded to be caused most commonly by foci of infection, especially infected teeth, tonsils, or sinuses. Less common foci are the gastro-intestinal tract, gall-bladder, appendix, and cervix. The reasons for thus believing, according to Hunner, are that most strictures are located near groups of lymph glands, namely the broad ligament and bifurcation of the anterior iliac vessels.

Hunner found that in 20% of stricture cases there was a pyelitis. In 50% there is slight evidence of urinary disease.

The importance of Hunner's work in relation to the problem "Pyelitis during Pregnancy" is self-evident. Hunner estimated that of 35 cases he had of pyelitis during pregnancy all but one had ureteral stricture. His conclusions are that: (1) stricture is present before pregnancy; (2) pyelitis primarily due to stricture may clear up spontaneously, even under the added load of pregnancy; (3) it is erroneous to believe that the ureters are promptly restored to normal after delivery, if these cases are associated with stricture.

Hunner's work has been greatly flayed and many have doubted the possibility of there being so many strictures consistently and still be no dilatation. This study and the consequent conclusions is one answer to the reason for ureteral compression during pregnancy and while it is greatly disputed there is enough evidence of stricture to at least consider it in the etiology of a subsequent pyelitis. It

is my personal opinion that these cases represent pyelitis occurring solely because of the stricture and infection from foci, and not the type that is usually seen.

#### DILATATION

Since the first cases reported of this disease, and consequent study, stasis and dilatation have been recognized.

Reblaub(8) and Vinay(7) and others of the old school (1892-1899) believed the etiology to lie in the fact that there is a stagnation of urine during pregnancy; and thought it to be the primary factor in its production, a theory well-founded, well proven and much in belief today. In the words of Reed(6) "it is justifiable to assume that all accessory conditions which add bulk to the pelvis, or the presence of inflammatory exudate, can become predisposing causes of pyelitis by favoring ureteral compression. Halbertsma, Leyden and others demonstrated many times statistically that compression of the ureters is common in pregnancy." At that time it was correlated with eclampsia. At one maternity hospital it was concluded that all women who died during pregnancy or shortly after delivery had dilated ureters. Work of others since then has thoroughly corroborated this conception.

Many are the men of the present day who advocate the theory of dilatation, though it has come to be so common a belief that it is probably erroneous to call it a theory. Two men have particularly gone deeper than the simple mechanics of dilatation and searched more closely for its cause.

One of these men is Hofbauer(1). He has studied the disease in regard to etiology on the basis of physiology.

Hofbauer based his work on the problems of dilatation of the ureters and infection of the urine from the standpoint of histological and immunological views. Fourteen cases were studied at autopsy and from these he reports the following findings:

1. In the juxta-vesical portion of the urinary tract hypertrophy was found, varying in different segments. In some cases a definite difference was found between the right and left side. The muscle bundles were definitely widened and new and numerous fibro-blasts were found. Baird(17) of Glasgow reports that this same finding was present in 61 cases studied at autopsy by him.

2. The intra-vesical portion showed, besides hypertrophy of the muscular bundles, a formation of wide connective tissue bundles immediately surrounding the ureter.

3. The trigonum vesicae showed considerable thickening of the musculature, particularly between ureteral openings.

4. The upper pelvic segment showed enlargement of muscle bundles only slightly pronounced.

Hofbauer considers that these changes cause urinary obstruction in pregnant women and that these hyperplastic changes narrow the lumen of the ureter. That this would cause dilatation above this point and consequent infection from stasis and foci of infection is Hofbauer's belief.

Duncan and Seng(11) of Montreal hold a slightly different viewpoint, and dispute some of Hofbauer's conclusions.

Duncan's(11) work covers the study of 78 women, 42 ante-partum and 36 post-partum, all cases being free from any evidence of renal infection. His method of approach was a detailed study of the urinary tract from the urethral orifice to the pelvis of the kidney. Generally the urine was examined.

One of the most important findings by Duncan is the change of the vesical trigone. He reports congestion of the mucosa, apparent early, usually at the eighth week in multipara and the tenth week in primipara. As in all pelvic organs it was progressive with the pregnancy. At about the same time the following appeared:

Lengthening of the vesical trigone, from uretero-vesical orifice to the inter-ureteric ridge and a broadening of the base of the triangle so that in many cases the ureteral orifices were really further apart than in the bladder of the non-pregnant woman.

Duncan's impression was that a crowding upward of the trigone occurred giving less room than usual.

With this elevation, the floor of the bladder fell away rapidly and acutely so that it became a valley. This congestion and elongation and elevation of the trigone are most pronounced in the last trimester.

There were no changes in the ureteral orifices, except the widening of their proximity as mentioned above.

The ureteral dilatation noted at the time of Reblaub and Vinay was found in Duncan's series as early as the sixth week in multipara and the tenth week in primipara.

He found that the majority of 36 cases showed either right, left, or bilateral dilatation in the absence of disease over periods of as little as twenty-one months and as long as nine years post-partum. This fact is of significance in regard to prognosis.

A study of stasis made on these women was made by means of skiagraphs at intervals up to one hour after instillation of sodium iodide into the ureters and pelves.

In the ante-partum cases the left ureter and renal pelvis emptied themselves within seven minutes (normal) with double the frequency of the right. Right side stasis in mild, moderate and marked degree out-numbered the left side in a proportion of four to three.

Stasis as such appears at about the twentieth week or four and a half months. Multipara showed a heavier percentage of stasis than did primipara. Post-partum cases required one-half the time to empty the renal pelvis and ureters.

The inference drawn from this observation and study, contrary to DeLee(12) (Shields) is that the uterus and its contents play some part in maintaining stasis. DeLee(12) states that this is due to compression of the uterus.

In a discussion of these facts Duncan points out that there is interference with ureteral and renal drainage. Agreeing with the findings of Hofbauer(1) that there is muscular and fibrous hypertrophy and hyperplasia more marked in the pelvic and vesical portion of the ureter during pregnancy, he disputes their being the cause of dilatation. First he considers that this is physiologic is protecting the ureter from kinking, aiding in maintaining ureteral

tone and peristalsis. Graves and Davidoff(13) exhibited that the pacemaker for ureteral peristalsis really lies in the pelvis of the kidney, where a definite head of pressure is maintained. In any obstruction to this, the primary result is a physiologic dilatation, which, if continued, the obstruction is overcome and physiologic drainage continues; or if the obstruction is further continued, over-distention results. This brings about a definite loss of tone in the ureter which is reflected on the renal pelvis. Stasis is the inevitable result.

As the cause of this physiologic hypertrophy and hyperplasia found in the ureters during pregnancy Duncan(11) ascribes: (1) the increased vascularity in the cervix and parametrium. This needs no discussion, nor is it denied by any; (2) general pelvic over-crowding by the growing uterus; (3) marked congestion and distortion of the vesical trigone. This latter is noticed and mentioned by many other writers notably, Falls(14), Curtis(15), Mirabeau(16), and others. Hofbauer(1) does not mention the cause of this phenomena. Duncan concludes:

1. Physiologic forces external to the ureter cause obstruction to drainage.

2. In pregnancy there is a constant right sided ureteral dilatation, while right hydro-nephrosis is only slightly less frequent.

3. Left ureter and kidney pelvis escape this more than the right.

4. Bilateral hydro-ureter and hydro-nephrosis were frequent.

5. Multipara showed these conditions earlier, more frequently and in more marked degree than primipara.

6. Stasis is definite and almost universal in antepartum women. In post-partum women it is still persistent in less degree over a prolonged period of time.

7. Justification is seen for the term "hidden infection" as evidenced by coliform bacillus in normal pregnant women's urine.

8. Every pregnant woman has obstruction to some degree, a definite dilatation of the ureters and renal pelvis with a well defined stasis.

It can be seen that there is a wide diversity of opinion as to the cause of dilatation and the subsequent infection. Findings of other men prove the fact that dilatation is present, but whether it is a morbid condition or one which needs other conditions to make it so is still a question for argument.

Thus Baird(17) studied 1000 cases in the Glasgow Maternity and Women's Hospital. He found that 42.5% had an incidence of urinary infection. 16.3% were pyelitis, 9.9% were toxemic, and 16.3% were cases of slight urinary infection with no effect on the obstetrical condition.

Baird(17) attributes the cause to urinary stasis, secondary to dilatation and kinking of the ureter. As stated above he found in 61 cases at autopsy "markedly hard and rigid character to the juxta-vesical portion of the ureters". Of 13 primiparas, 13 had right side dilatation and 10 had left side. Of 13 multipara, 12 had right side and 9 left side



dilatation. This brings up the question of right sided preference, which will be discussed in a separate paragraph.

In his studies of stasis and delayed excretion Baird (17) used a dye known as Abrodil (Bayer). This is an intravenous method of pyelography. In 43 pregnant women there was a delay of excretion, the majority being right sided. He also found that the more extreme the delay the further along in pregnancy were the patients.

Of very recent studies there is one of note which should be mentioned in this respect. Wm. F. Mengert and Harry P. Lee(18) at the University Hospital, Iowa City, Iowa, presented a series of cases, 41 in number, which were submitted to intravenous pyelography, both ante- and post-partum. They determined the dilatation of the calyces, pelves and ureters and classified them. They concluded that there is some degree of dilatation on the right side in all ante-partum patients, and on the left side in 71%. Brake-mann(19) believes the changes of the urinary channels in pyelitis gravidarum are best understood if they are compared with normal, which has been done in Duncan's work. Brake-mann's opinion is with the "mechanical school." "The explanation rests on the topographic-anatomical relations of the ureters, and the physiology of the smooth musculature." He is physiologic in respect to the ureteral tone, saying that "due to its constant tonicity it may be maintained over shorter or longer periods of time in any degree of contrac-

tion or relaxation. The actual tonicity of the ureter balances the actual pressure of the urine in the renal pelvis. This is called 'gliding tonicity.'

Now add to this the physiologic tumor of pregnancy, due to its peculiar position in the small pelvis (left uterine margin forward, right backward, and uterine body leaning to the right and backward), and it is easily seen how it may compress the right ureter. Brakemann then states that the resultant retention of urine, with secondary dilatation of the abdominal part of the right ureter aggravated by the physiologically increased renal function during pregnancy, is the natural effect of this condition.

Brakemann's experiments cover (in this article) only three cases, and while they are but a few, the mechanical factor is certainly to be considered in this etiology. He concluded that pyelitis occurring during pregnancy was obviously from a mechanical cause. In pyelitis without pregnancy it is an effect of the paralyzing influence of bacteria and toxins on the smooth musculature.

Sennewald(20) took pyeloureterograms of 27 cases in one year. All cases showed a considerable dilatation of one or both ureters, predominantly the right one. In all cases taken before delivery the dilatation was present above the rim of the pelvis.

The above discussion proves, to my mind, the presence of dilatation in the ureters of the pregnant woman. It is right sided in a frequency of 3-1 and according to "comparison statistics" is more prevalent in multipara. Prather

and Crabtree(21) find that it occurs 48% in primipara. Different statistics will vary, according to the authors.

The question arises as to why pyelitis cases during pregnancy should have such a marked tendency to occur on the right side. This also noticed in regard to the dilatation of the ureters.

In the time of Reblaub(8) and Vinay(7) it was considered as being due to the peculiar position of the pregnant uterus, there being a tendency to lean toward the right. As Brakemann(19) states above- "left uterine margin forward, right backward, and uterine body leaning to right and backward." Seitz(22) explains that "the ureters are compressed especially strongly at the site of entrance into the small pelvis, above the innominate line, especially on the right side on account of the axis rotation of the uterus." He believes that this explains the greater frequency of pyelitis on the right side.

De Beaufond(3) reports that intestinal atony (referred to later) usually occurs on the right side and partly explains the prevalence of a pyelitis on that side.

Thus we see that both mechanical and physiological schools have an explanation for the right sided preference. My opinion is that mechanical factors are very important in the right sided preference, but to believe that it is the sole cause would be to deny physiological forces as playing any part in the cause of pyelitis.

ELEMA

Falls(14) quotes Mirabeau, the French authority, "there

is an edema of the mucosa of the ureter and trigone of the bladder in normal pregnant women which I believe to be due to the general congestion of the pelvic organs associated with the pregnant state. This edema and obstruction also gives rise to dilatation of the ureter which is observed consistently anatomically."

Duncan(11) also found in his experiments congestion of the mucosa of the urethra, and trigonum vesicae. He ascribes this as due to the pressure from the increased size of the uterus.

#### ALTERATION OF NUTRITION. ATONY OF THE UTERUS.

Seitz(22) gives a different aspect on urinary stasis. Recognizing the mechanical factor as playing a goodly part he adds two other causes: (1) changed nutrition; (2) changed innervation.

Changed Nutrition. Seitz'(22) conception is that the bladder and ureters are involved in the reaction which a fertilized ovum produces in the female body. This produces a change in the nutrition of the urinary apparatus. "A severe hyperemia of the mucous membrane develops (apparently the edema seen by Mirabeau), a certain hypertrophy of the parietal elements; also an active growth and an extension (Sellheim)." The change in the blood supply may be recognized during cystoscopic examination on the uniform velvet-red color, and the "extension" by increased capacity. The result of this, even in normal conditions is a slightly tortuous course of the ureters besides a dilatation.

Changed Innervation. Seitz(22) believes that the innervation and the equipoise between sympathetic and parasymp-

pathetic excitation is also changed by pregnancy. There usually is a shift in the sense of an atony. This decreased innervation of the ureters and of part of the bladder, coupled with mechanical factors, impairs the regular outflow of urine, favors stasis, and thus decomposition of the renal excretion within the body.

This atony is recognized by many authors. Baird(17) reports a case demonstrating early atony at three months. Indigo carmine dye used as experimentation appeared at six, seven, and eight months with increasing concentration and less time after injection. The patient had a favorable progress and recovered.

Benda(5), in a series of studies on pregnant women and non-pregnant women worked from the angle of nerve supply and nerve tone of the ureters. His examinations and experiments, using drugs to cause the artificial atony, lead him to believe that in the first half of pregnancy, in which sympathetic tonus is decreased, as a rule there results an increase in the number of discharges from the ureter; while in the second half of pregnancy, during which vagus tonus is increased there is a decrease in the number of discharges. If the activity of the kidney remains unchanged this would necessarily cause stangation of urine in the kidney pelvis. Thus he concludes that pyelitis during pregnancy is not caused chiefly by a mechanical factor, but chiefly by a neuro-muscular one.

Brakemann(19) in his study does not take this into consideration, saying that ureteral tone is maintained until compression and a physiologically hyperactive

kidney relaxes muscle tone.

Stoeckel(23) in his work assumes that atony is true in consequence of pregnancy, resulting in insufficiency of the ureterostium. Thus infective organisms may pass from the bladder into the ureters and may be retained there due to the weakness of the ureteral peristalsis which is incapable of ejecting the individual agents.

#### REDUNDANCY AND KINKING.

Duncan(11) found this phenomena very definitely both ante- and post-partum. He states it was more frequent and in greater degrees in prenatal skiagraphs. Kamniker(24) says when the amount of urine in the ureter gradually increases, the increased internal pressure leads to a loss of the normal S-shape of the ureter, the curves become more acute and more pronounced and there results strong kinkings and even loop formation.

Falls(14) in an experiment on ten pregnant women free from disease, corroborated Curtis(15) suggestion that residual urine is present in many gynecological conditions and suggested it may be a cause of pyelitis during pregnancy. Falls found that the average residual urine in the ten women was 4 cc. In eight out of ten a hanging drop demonstrated bacteria. There was a positive culture in six out of ten. Colon bacillus found six times and staphylococcus albus four times, and always in symbiosis. Four specimens give a negative culture. His conclusion was that in pregnant women, otherwise normal, there is usually residual urine in the bladder containing organisms capable of pro-

ducing pyelitis. This would tend to show that the infection is ascending. These findings, coupled with the other urinary changes previously mentioned, would easily allow pathologic changes to occur.

As has been stated before (Duncan-11) there is an elevation of the vesical trigone and a consequent falling away of the floor of the bladder so that it became a valley. Duncan(11) states that this may be responsible for the findings of Fall(14) and Curtis(15), though in his series of cases no such finding was noted. This would be more especially liable to occur during the last trimester of pregnancy, when congestion, elongation, and elevation of the vesical trigone are most pronounced.

#### PATH OF INFECTION.

It is generally recognized that infective organisms enter in one of four ways: (1) through the blood from some local infected area; (2) through the lymph stream from some local infected area; (3) ascending lymph spaces in the ureteral wall; (4) ascending from the bladder through the ureter. These four might be condensed into ascending and descending, but for purposes of discussion we will include all four.

Here arises the question of the organism responsible for the infection. Most authors concede that the organism is the colon bacillus in from 30-70%. There are those who find the staphylococcus and streptococcus and rarely the gonococcus. The preponderance of the colon bacillus in the infection is one of the great questions today.

One answer to the question is the increased permeability

of the intestinal wall during pregnancy. This is in accord with the increased congestion of all organs during pregnancy (Luchs-9; Seitz-22). References to this question will be made from time to time in the succeeding discussion.

Hemotogenous route. This mode of infection is possible in the cases where the bacterium coli is present in the blood. Luchs(9) directs attention to Barth who could demonstrate histologically the hemotogenous mode of infection in some cases studied by him. Seitz(22) reports that this descending mode of infection is far more frequent than formerly supposed. The colon bacillus reaches blood far more frequently than in the non-pregnant state. The atony determined in the ureter is also frequently encountered in the lower portions of the intestine in the form of obstipation. Luchs (9) mentions obstipation as usually being associated with pregnancy. The French authorities(Falls-14) assert the same, naming the focus of infection as usually being the intestinal tract, particularly when a coexisting chronic constipation is present. In support of this view they point to positive blood cultures, which however, have been reported only in cases of active infection.

This, perhaps supported by a changed permeability of the walls of the intestine favors the passage of the colon bacillus into the blood. First there will be a bacteremia due to colon bacillus. Then, on account of the weakness of the innervation and mechanical obstruction to outflow, stasis and decomposition of the urine in the renal pelvis and ureter results; and within a short time the bacteremia will have changed into a pyuria. This conception is one answer to the



question as to whether the infection precedes the obstruction and dilatation or follows it.

De Beaufond(3) is in accord with this intestinal stasis being present in pregnancy, and throws a chemical light on the process. He states that the fermentation due to colon bacillus acts on nitrogenous substances and gives rise to crystallizable substances capable of passing into the urine and mechanically injuring the apparatus. These reactions can be divided into three stages: (1) the stage of irritation with the presence of crystals in the urine; (2) the stage in which the white cells are also found; (3) the stage of suppuration in which in addition to the white cells and crystals, bacteria are found, usually the colon bacillus. This theory accounts for his view of pyelitis during pregnancy being a functional disorder, as his cases have been temporary with a return to normal following delivery and intestinal regulation.

Shields(12) states that over 90% of cases have bacillus coli communis as the infecting agent. The most of the authors today believe that the blood stream is the route of infection, although in comparatively few instances has it been possible to isolate the bacilli from the blood stream. Thus we see that many are in accord with the path of infection being from the intestines via the blood stream.

Lymphogenous route. Of equal importance and in equal belief is the theory of lymphogenous infection. Since the work of Francke (Shields-12), who made an extensive study of the lymphatics of the large bowel, the lymphatic route of infection has received a good deal of consideration.

Francke by injecting the lymphatics of the large bowel

was able to prove that the lymphatics on the right side pass over the capsule of the kidney. According to Stahr (12), the lymphatics of the kidney capsule communicate with the deep lymphatics of the kidney. Francke believes, therefore, that there exists on the right side, and probably on the left, communication between the large bowel and the kidney by way of the lymphatics.

Levin(25) mentions lymph spaces in the ureteral wall as a path of infection for the organisms, and to me it seems highly probable that such is possible. However, I can find only this one author who mentions it, so will leave it with the word that it is one of the possible modes of infection either ascending or descending.

#### ASCENDING INFECTION.

For ascending infection to take place, Luchs(9) states that it is necessary that there be a penetration of coli bacillus from the intestine. This has been proven by the increased permeability of the intestinal wall during pregnancy. Also such slight injuries as congestion of the intestinal contents or even a state of hunger may enable the penetration of bacteria through the intestinal wall. (Meyer and Betz-26, and Luchs-9)

In order to prove that an ascending infection may take place we must prove that the sphincter vesical internus and the ureteral ostium are permeable to bacteria. Let us then dwell on the fact that in pregnancy the passive hyperemia of the pelvic organs causes a loosening of the tissues which affects also the urethra and neck of the bladder and

decreases the tight closure of the sphincter, facilitating in this manner the ascendance of bacteria. (Luch-9). A question of importance then arises: "Does pregnancy lead to such an injury of the ureter that it would cause an insufficiency of the ostia?" Luchs(9) studied this problem by the combined method of exact chromocystoscopy and ureteral catheterization on fifty pregnant women.

His findings were significant:

1. In only 9 of the 50 cases was there an undisturbed ureteral function.
2. The dilatation spoken of above was found in 40 (19 on the right side and 21 bilateral).
3. One case showed slowing of the excretion though no dilatation was demonstrable.

Luchs concludes that "the demonstration of an ostium insufficiency in the presence of a high degree of ureteral dilatation supports the theory of ascending infection in pyelitis of pregnancy." In general it may be summarized that the conditions favoring an ascending infection in the last months of pregnancy are present in more cases than those in which pyelitis actually occurs. Therefore the ascending pyelitis of pregnancy is only the infectious stage of the demonstrable changes conditioned by pregnancy.

DeLee(12) takes the stand that bacteriuria is found in a large percentage of cases of healthy pregnant women. He ascribes this as due to constipation. Falls(14) and Curtis (15) found this also in a large percentage of their cases. How then does the infection reach the kidney pelvis when

the natural physiologic peristalsis of the ureter is downward?

Many years ago it was proven by Goldschmidt, Lewis, Markus(12) and others, that under certain conditions anti-peristaltic movement may take place in the ureter, causing the contents of the bladder to be propelled into one kidney. By means of a series of cystograms made in normal persons by filling the bladder with opaque mediums Kretchmer (27) was able to demonstrate regurgitation in both normal and pathologic bladders. Thus we have the organism and the mode of its ascent in the ascending type of infection.

#### IMMUNOLOGY

Dresel(Ingraham-28) of Johns Hopkins undertook studies of the opsonic index in pregnant women with different strains of bacillus coli. In 6 out of 53 a marked decrease in the immune reaction of the serum could be noted as the opsonic index fell sharply. This observation indicates that in about one out of every nine pregnant women, conditions are present which facilitate infection.

Falls(14) noted the relative rarity of puerperal sepsis following delivery of pyelitis cases, and this led him to study the immune reactions of the serum. Colon bacillus were cultivated from the urines of typical cases, and widal reactions run, with normal pregnant women as controls. There was a positive widal reaction in all cases in a dilution of 1:40. Also the babies serum inhibited growth of the organism on agar plates.

Hofbauer(1) has asked this question of himself and

studied it from an immunological view. He states that "numerous clinical observations such as the presence of phagocytic cell complexes in and under the mucosa in the presence of a slight degree of dilatation of the urinary pelvis, indicate a variation in local resistance." A number of authors have pointed out that a high degree of dilatation of the pelvis is accompanied by a decrease in local resistance of the tissues. Accompanying this there is the appearance of large monocytes, histiocytes and lymphocytes. Hofbauers' studies over two years have shown that there is a biological reaction during gestation and labor which is accompanied by the formation of a typical phagocytic cell apparatus and the creation of conditions for local immunity. This cellular reaction acts as a preventative for the penetration of bacteria. A paralysis of this mode of protection or a solution in its continuity as a result of over-distention of the kidney pelvis leads to the formation of a portal of entry for bacteria into the vascular apparatus or parenchyma of the kidney. My own conclusions from these observations are that any general disease, acute or chronic will lower the resistance of the individual and allow the organism to enter the kidney. Chronic emaciating diseases such as cancer(Ingraham-28) tuberculosis, etc., will lower this resistive mechanism also.

Staphylococcus-streptococcus and gonococcus infection.

Few are the authors who have found these organisms as the lone cause of the infection in pyelitis during pregnancy. Falls(14) in his experiments found staphylococcus albus four

times, but always in symbiosis with colon bacillus. The factor of focal infection causing this condition seems to me not to be so important from the organism standpoint. Tonsils, teeth, and sinuses are rarely infected with colon bacillus, yet we find these mentioned as causes of pyelitis. In general I would state that those cases of pyelitis in which the causative organism is not the colon bacillus are most surely from focally infected sources. Otherwise they are a part of the picture that causes local resistance to be lowered by requiring attention themselves as regards the localized phagocytic cell wall spoken of by Luchs (9). They would tend to produce poor nutrition, constipation, obstipation, etc., themselves, even in the absence of pregnancy.

Gonococcus are rarely found to be the cause of a pyelitis occurring during pregnancy. Occasionally they are found, however, and in those cases I would attribute the mode of infection as being ascending, probably from a cystitis, either in the lymph spaces of the ureteral wall or upward through the ureter itself.

Luchs(9) conclusion that the ascending pyelitis of pregnancy is only the infectious stage is one answer to our question- "does the infection occur before the stasis, or does the contrary hold true?" Based on the findings of DeLee(12), Curtis(15), Falls(14), and others who state that there is a bacteriuria present in pregnant women, and that it is usually the colon bacillus, one might conclude that the infection is primary. However, the actual onset of pyelitic symptoms does not occur until the second trimester

or later ( $4\frac{1}{2}$  months usual onset), and by this time dilatation, decreased function, etc., has already occurred. Also there is that particular class of women who demonstrate bacteriuræa, dilatation, decreased function, etc., who are never affected by the disease pyelitis. This would lead me to believe personally, that it is a matter of individual resistance and ability to ward off infection. To the patient with the chronic sore throat, bad sinuses, bad teeth, chronic constipation and the added burden of pregnancy, I would be inclined to add to her list--pyelitis. However, as we know, all patients do not react the same. My conclusion is that, added to the proven facts of stasis and infection present in the pregnant woman, a weakened resistance, poor hygiene and poor food--- pyelitis will occur.

These last might be classed as predisposing causes, and have been recognized by various writers. Thus Levin(25) considers the pressure and distortion and dilatation of the ureter as primary, the infection secondary. Venous congestion, chronic partial obstruction from old cicatrix, exposure to cold, wet, acute infections, generalized lowered resistance are other predisposing causes spoken of by various authors.

What then, can we say definitely as to which comes first, infection or stasis, and consequent disease. In my own mind I can picture the etiology and onset of a typical case. Let me relate:

The woman is a primipara, and has had no previous history of kidney disease. She becomes pregnant and in the usual manner congestion of the pelvic organs begins. It

may be stated that at times previous to pregnancy she has shown constipation. About the eighth to tenth week the patient begins to show the usual symptoms of morning nausea and vomiting. This is allayed, many times, by usual treatment of diet and rest; and it is then discovered that she is becoming constipated more severely. It must be remembered that during all this time there is taking place the physiological hypertrophy of the uterus, its torsion to the right and the accompanying changes in the urinary tract such as hypertrophy, residual urine, pressure on the ureter from the uterus, and most certainly an increased kidney function. Dilatation of the ureter results. As yet we find no symptoms, the urine being negative, though the woman may complain of slightly increased desire to urinate. About the twentieth to twenty-fourth week the patient catches cold, her constipation has become no better in the meantime, and it is discovered that she has not heeded advise as to careful hygienic care, or has not received it. Then comes the symptoms of a pyelitis, striking the patient either suddenly or insidiously over a period of 24-48 hours. This is a graphic sketch of the forces at play which cause a pyelitis to occur during pregnancy. The physiology is present, the mechanism is present, the organism is present and the decreased resistance is present. Thus I conclude that, in regard to stasis--it occurs before infection.



## SYMPTOMOLOGY

The symptoms of pyelitis fall within a set--usually diagnostic if one is looking for it, but easily confused with other conditions. I am arbitrarily dividing pyelitis into two groups: (a) pyelitis insidious in onset; (b) pyelitis acute in onset. These two divisions might also be classified as chronic and acute.

### INSIDIOUS ONSET.

Malaise, headache and nausea are the chief symptoms presented in this type of pyelitis. The patient usually gives a history of nausea, slight but persistent in the first five or six months, then increasing in severity, and probably accompanied by vomiting. A proper diagnosis at this time is difficult--but necessary, as untreated cases may go on to premature labor or abortion.

Following this list of symptoms we find the more diagnostic aids, such as a dull pain over the abdomen and back. The history reveals that this has been increasing in severity for some time past. This pain may be unilateral or bilateral. If unilateral, as seen from the study of etiology, it is more predominantly on the right side. To my mind this pain coincides with the dammed up urine finally reaching a point where the kidney function is decreased and drainage is most impaired. The pain may radiate down the ureter or ureters, and in some cases may show a localized area over McBurney's point. This latter may confuse the diagnosis with appendicitis, but history and laboratory findings will help rule this out.

Coincident with this pain there may be a rise in temperature, some cases reaching 104 degrees, others reaching only 101 as their maximum. Chills may also accompany this.

One of the chief complaints which marks the disease as being insidious is that urination has gradually become more frequent. Nocturia may accompany this complaint also. Frequently a burning sensation is noticed. Then with the onset of the severe symptoms these complaints become very marked. Occasionally they remain at the same degree. With this severity there also occurs the typical signs of an infection, such as fever, rapid pulse, headache, and general malaise. Weakness is complained of by many of these patients, beginning about the third month and progressing until finally the patient may be bed-ridden and generally emaciated.

Eisendrath(29) has divided the symptoms into three different types clinically. He believes that the variation in virulence of the organism causes the difference in the severity of the clinical pictures. The three types:

1. Mild. In these cases there may be no symptoms, attention only being directed to the kidney infection by the persistent pyuria or bacteriuria.

2. Moderately severe, in which we have the symptoms as spoken of above, such as pain and tenderness over one or both kidneys and in the lower abdomen. Fever is usually remittent but may be continuous.

3. Severe cases. In this type the symptoms of kidney and ureters retire in the background and the clinical picture becomes more and more that of a severe bacteremia

without localizing symptoms, unless a pyo-nephrosis or a perinephritic abscess develops.

Eisendrath also says that two findings vary greatly in individual cases: (1) symptoms referable to the bladder. (2) the degree of evidence of infection as found in examination of the urine. That this is true may be seen when we consider that some cases show no frequency or burning, and that some show few pus cells, traces of albumin and a few or no bacteria.

Occasionally when the symptoms have reached a marked point the kidney on the affected side may be palpated.

With the onset of the more severe symptoms, time plays an important part. The patient may be up and around, but have a constant dull aching pain over the kidney region occasionally intervened by a sudden sharp pain. Temperature, malaise, burning and frequency are present then also. This may last for hours to days until the patient is finally bed-ridden, showing the symptoms of the severe type as outlined by Eisendrath(29).

Butler(30) states that the symptoms depend on obstruction of the ureter or the severity of the infection. "There may be no symptoms when the ureters are not blocked by pus, mucus, fetal pressure or edema in the ureter. Plugging of the ureter, followed by absorption of toxins may give the typical symptoms of severe sepsis. Pain may be absent, especially when there is no obstruction in the ureter. There is usually frequent urination, which may or may not be painful. The pain is usually located in the back."

## ACUTE ONSET

This form develops with sudden pain in the lumbar region, with a temperature of 99-104 degrees, with a history of some frequency and burning on urination for hours or days before. Nausea and vomiting are rather common.

Pains may simulate labor pains, appendicitis, or there may be tenderness early in the disease on pressure in the kidney region and along the ureter. As stated above, the pains may be unilateral or bilateral, but they are usually unilateral and on the right side.

Then there is variation in the symptoms, varying with the severity: malaise, headache, the symptoms of an infection, emaciation, and general body aches. It must be borne in mind that different patients react differently to the same disease. Thus it is seen clinically that two patients with the same disease (pyelitis) will give different symptoms and onset, etc. For instance, in some there is nothing but fever, nausea, malaise and headaches, while in others the right sided pain and frequency of urination are the main complaints. In general it could be said however, that the majority of the acute cases give back pain and abdominal pain as the chief symptoms.

## PHYSICAL EXAMINATION

This also will vary with different individuals. It is surprising to note that many pyelitis cases have colds in the head (acute rhinitis) or give a history of having just gotten over a cold. In so far as the head, neck, and chest are concerned we may say that they are essentially

negative in regard to using any abnormal findings to diagnose pyelitis. Tonsils, teeth, and sinus infections are frequently found but are important only in so far as etiology is concerned.

Inspection will show most cases to be "sick looking"; there will be lividness, flushed face, or in other words the typical signs of an infection. Dry lips and even rapid breathing may be present.

Palpation over the abdomen will, in the majority of cases, elicit tenderness over the affected side. As stated above there may occasionally be increased tenderness over McBurney's point. Palpation will also elicit some rigidity of the muscles over the kidney region. There is usually none over the entire abdomen, though in some cases of bilateral pyelitis there may be.

Pain on palpation in the back and over the kidney region is almost constantly present. Occasionally the kidney may be palpated, and tenderness is also elicited on deep palpation.

Pain on palpation over the bladder may occasionally be noted. This may be due to an old cystitis or a cystalgia from reflex irritation.

#### LABORATORY FINDINGS

Blood Findings. In the literature reviewed by me, little was said as to the blood findings in pyelitis during pregnancy. Falls(14) states that there is a characteristic picture presented in cases observed by him.

Leucocytosis. This is nearly always present and is

usually low, rarely exceeding 15,000 except in severe cases. Falls' average in 19 cases was 9,000.

Hemoglobin. This averaged low, being 63%, showing a rather marked secondary anemia. The hemoglobin was lower in those patients suffering from acute symptoms.

Red Blood Cells. This also shows the secondary anemia, the red cell count averaging 3,300,000.

In a series of six cases taken from the records at the University Hospital I have compiled an average similar to that made by Falls(14).

Hemoglobin. I find that this average is 70%, with high and low points being 85% and 60%.

Red Blood Cells. This coincided pretty well with Falls' average, being 3,000,000 with high and low points of 4,500,000 and 2,900,000. There was in all these cases poikilo- and anisocytosis.

Leucocytes. This count averaged 14,200, but I report one severe case in which the count was 26,000; 22,000; 21,000; and 13,000 on different days during the course of the disease, and corresponding with recovery a decline in the white blood cell count.

In all cases polymorphonuclear cells predominated, the average being 85%, sometimes reaching as high as 90% or as low as 69%. It was noted that resistance was directly proportional to the height of the poly percentage.

Urine. Herein lies one of the main diagnostic aids in pyelitis.

One of the important urinary findings is the odor.

It consistently has a putrid odor.

Invariably the reaction of the urine is acid. In the literature I could not find a single case reported in which the urine was alkaline, nor in my own six cases, prior to medication.

The specific gravity is usually low varying between 1.010 and 1.014-18.

On inspection of the urine the color is usually seen to be darker than normal. It is usually cloudy, especially in the event of an active virulent infection.

Albuminuria is present in varying degrees ranging from a trace to three plus. It must be remembered that different laboratory technicians read albumin differently, so it is wise to see the test at least once yourself in order to determine the extent of the albuminuria. It is my opinion that those cases showing a high degree of albuminuria are those with the most virulent infection and are the sicker. Also they are the patients most liable to a poor prognosis as regards the extent of damage to the kidney. This must be borne in mind when treating these cases and in giving them a prognosis.

Microscopic Examination. This will tell the clinician more than any other sign, save one, and that one is cystoscopic examination. Pus cells will be seen in practically all cases. A few red cells will be seen but these are not numerous unless there be extensive destruction in the kidney substance.

Bacteria are invariably present and vary between being

purely bacilli, purely cocci, or a mixture of the two. As seen above the most usual organisms will be bacilli. In this respect we may mention cultures of these organisms. They will be seen to be of the colon bacillus group in the majority of cases, and while the infection is already proven without this data, it is of value in learning the etiology. If the organisms be cocci, the staphylococcus will predominate.

Kidney epithelium will be seen in a great many cases, and in a few where the disease is better termed pyelonephritis, casts may be discovered.

Crystals, debris, etc., will be noted, but are of no diagnostic value.

#### Cystoscopic and Pyelo-ureterograms (X-Ray).

This is one of the most important diagnostic and symptomologic aids in this disease. Prior to the time of X-Ray and the cystoscope, diagnosis was made solely on symptoms and urinary findings. Now, by means of this instrument we are able, not only to more easily make a diagnosis, but to tell which kidney is affected or if both are affected.

Cystoscopic. Usually the bladder mucosa is normal, though inflammation may show in some areas. In these cases the symptoms given will point to this inflammation, there being pain in the bladder. The trigone will have dropped away, as seen by Duncan(11), and as a general observation the capacity of the bladder may be seen to be lessened.

More usually, if inflammation is noted it is seen around one or both ureteral openings depending on a uni- or bilateral infection. This is only an occasional finding.



Ureteral Catheterization. On insertion of the ureteral catheter there may or may not be difficulty in entering the ureteral opening. In general it may be stated that the majority of cases elicit difficulty in entering the opening, but that once it is in, the remainder of the catheter enters easily.

In those cases in which there are tortuosities or kinks difficulty is found in pushing the catheter any further, and indeed, it is most times impossible. At this point one must differentiate between ureteral calculi and kinks, tortuosities or redundancy.

The urine examination of each kidney is thus possible by ureteral catheterization. The urine will show the findings mentioned above, coming from the urine of the affected kidney or kidneys as the case may be. Coincident with the taking of a urinalysis there should be run a phenosulphophthalein test to determine the extent of kidney damage. As was seen by Falls(14), Duncan(11), Baird(17), and others, there is a definite decreasing of kidney function on the affected side. In cases of bilateral pyelitis the functions of each kidney will vary depending on the amount of damage to the individual kidney. In the cases studied by me there was a variation of from a trace to 10% P.S.P. returned in fifteen minutes time. This is an almost universal finding.

X-Ray at the time of ureteral catheterization should be done routinely. Dilatation and hydronephrosis are not so easily seen at this time, but calculi, kinking, tortuosities, redundancy and direction of the ureters is easily determined.

Pyeloureterogram. Opaque media such as sodium iodid,

(6cc. average amount used in each kidney) are injected into each ureteral catheter and an X-Ray again taken. Another method, used by Mengert(18) and others, is intravenous pyelography. Abrodil was used by Baird(17) in his studies. This is not attendant with the affects of trauma that cystoscopic examination causes.

In this way dilatation is noted and also hydro-nephrosis and the condition of the calices. In the majority of cases, as seen from our studies on etiology there will be a dilatation of the ureter on the affected side. Slightly less frequently will be found a hydro-nephrosis, blunting of the calyces, or distention and dilatation of the kidney pelvis. Kinking, calculi, etc., will also be diagnosed by these measures. It may be well to set down here the findings found in pyeloureterograms in order of their frequency: 1. Dilatation. 2. Hydro-nephrosis. 3. Dilatation of kidney pelvis and blunting of the calyces. 4. Kinking and tortuosity. 5. Calculi. 6. Redundancy.

#### DIFFERENTIAL DIAGNOSIS.

This is not especially difficult if we take into consideration all laboratory and physical and observatory finding. According to Levin(25) the differential diagnosis depends almost entirely on urinary cystoscopic findings. I am inclined to disagree with this, if the physician be a good clinician.

1. Beginning pneumonia is differentiated by history, examination of the sputum and physical examination of the abdomen as well as complete examination of the urine. This might also apply to acute pleurisy.

2. Pelvic infection is differentiated by history, character of pain, urinary findings and bimanual examination-- the last being strictly aseptic. Cystoscope findings are helpful, but not finally necessary. Twisted pedunculated tumors are differentiated in the same way.

3. Gall-bladder disease simulates this condition many times. It may be differentiated by indigestion, history, examination of the stools, careful urinary examination and perhaps by X-Ray. (Graham-Cole.)

4. Cystitis. This cannot be differentiated except by use of the ureteral catheter to rule out any infection in the higher tract. However, the patient will give a history pointing to bladder pain, and the typical signs of cystitis if such a disease has been present for some time.

5. Appendicitis. This offers the most difficult of differential symptoms. This is especially true since pyelitis and appendicitis may accompany each other. Most careful analysis of the history and physical and other signs must be made. Liek(31) reports a severe case of appendicitis which was diagnosed pyelitis, and the mistake was made in spite of the author's great experience in diagnosing and treating appendicitis. The patient delivered in the hospital four days after the onset of right sided pain, temperature, urinary examination disclosing bacillus coli. However, the fifth day after the onset the patient showed symptoms of diffuse peritonitis. An emergency operation revealed an abscess in Douglas's cul-de-sac with the appendix in it. In the further course the patient developed an

abscess the size of an apple in the left abdomen which was incised on the sixteenth day after appendectomy. Ileus on the thirteenth day was overcome with high enemas and flushing of the stomach. A second abscess between intestinal loops caused a second peritonitis, but was cured by a second enterostomy in the old scar. The second week after recovery from this a retro-peritoneal abscess occurred requiring renewed laparotomy and a long hospitalization.

The author reproaches himself, even though the diagnosis and subsequent treatment of pyelitis was well-founded. His belief is that if he had paid more attention to the subjective symptoms and the underlying indigestion, and also to the course; and if he had been more puzzled by the abortion in the seventh month for which this slight pyelitis was not a sufficient cause; and if he had made another catheterization after delivery; and if he had made vaginal examinations and revealed the first abscess, he would have prevented perforation and peritonitis.

As can be seen, this is an unusual case, and is full of "ifs." However, it might easily occur to anyone, so this differential diagnosis is most important. Complete urinary examination and careful study of subjective complaints are essential.

#### DIAGNOSIS

Most authorities agree on one essential point in making a final diagnosis of pyelitis, that is that cystoscopy and ureteral catheterization are essential. To this may be added X-Ray, but the latter is not strictly necessary

if careful ureteral catheterization and subsequent urinary examinations are done.

It is my opinion, from experience in two cases, and from the teachings of two men, that catheterization and X-Ray are important, but are not the primary instrument in diagnosis. It has been observed that violent reactions have occurred on patients who have been subjected to such measures, and in most cases the diagnosis could have been made and a conservative treatment saved the patient from the trauma that accompanies cystoscopic examination. Positive diagnosis depends first on the recognition of signs and symptoms of an infection, as shown by fever, increase in pulse rate, headache, backache, flush and general malaise. Secondly on the evidence of urinary infection as shown by the presence of pus in the urine and localization of the kidney as the site of the origin of the pus, by means of exclusion. This latter can be done by questioning the patient as to subjective symptoms.

Then, given the patient with a diagnosis still in doubt, cystoscopic examination and the resultant findings will be of definite value. As seen above (Mengert-18 and Baird-17), intravenous pyelography will be of definite aid and will save the patient from any undue trauma, though it will not give a functional examination of each separate kidney.

Functional examination, "P.S.P." is very important in aiding in the diagnosis and can be used both before cystoscopic and during.

The course of the disease varies very much, but the

onset is usually sudden though the condition has usually progressed some time before its recognition and treatment. In general we may say that the sooner diagnosis is made, and the sooner adequate drainage is reestablished, the sooner the recovery.

#### PROGNOSIS

As to recurrence in future pregnancies there is much discussion pro and con. In my opinion, made so because of what I have read, I think that a woman having pyelitis on one pregnancy, especially if she is a primipara, is openly liable to a similar attack in future pregnancies.

It must be borne in mind that only .7% of all pregnant show clinical signs of pyelitis during pregnancy; and that a great majority of them show dilatation, and bacteriuria with no evidence of an active infection. This dilatation and bacteriuria persist after delivery for a variable length of time--ranging from twenty-one months to nine years as seen by Duncan(11) and Baughman(32). Given then, a woman with pyelitis in one pregnancy, is not that patient going to be prone to another attack, especially if the next one occurs within a few months or years following the first pregnancy? This is their belief. Duncan(11) has shown persistent dilatation of the pelvis of the kidney in 72.2% on the right side and 52.7% on the left side. Helmholtz (from Duncan-11) emphasized this and believes that the dilatation produced in a first pregnancy has an influence in the production of greater frequency in multipara.

Mengert(18) shows that in normal patients, involution

of the urinary tract is usually complete within 9-11 days post-partum. That this is true of the normal cases is easily shown, but Hofbauer(1) shows that in a large number of cases of pyelitis the following pregnancy is predisposed to a pyelitis because of an incomplete involution process in the ureteral wall following the first affection, and an abnormal connective tissue proliferation during the preceding process.

Thus we see that some believe that there is no "immunity" bestowed on the afflicted, but rather a predisposition to it in the succeeding pregnancies.

Falls(14), on the other hand, thinks that the woman does not necessarily have a return of symptoms in subsequent pregnancies. This is also true, admitted even by the above school. Falls' opinion however, is that women with one pyelitis seem to have a better prognosis, even though there may be just as many organisms in the urine as before. His explanation lies in an increased resistance, both local and general, on the part of the mother, due to the development of immune bodies. He recalls two cases in which the titer of the agglutinins in the serum was high during a second pregnancy, though there was no clinical manifestation of the disease. This might also be explained as due to better care given the patient in a subsequent pregnancy, and the teaching of a patient how to care for herself and prevent the development of a low resistance.

De Beaufond(3) and Sennewald(20) hold somewhat to the same idea. De Beaufond's conception of pyelitis (a functional disease) leads him to believe that it becomes completely and

spontaneously cured following delivery. "If the symptoms do not retrogress progressively following delivery, some organic cause should be suspected."

Sennewald(20) finds the dilatation of the ureter persistent after the uterus has involuted. However, such cases examined months after delivery show dilatation completely disappeared. He concluded that this is a temporary phenomena of pregnancy. As regards the dilatation, his cases show that this is true, but as regards the possibility of a recurrence, it proves nothing.

#### Effect on the mother.

One of the chief questions a physician will be asked on diagnosing this condition is: "How will the mother fare through the disease?" Seitz(22) gives four factors which has developed prior to the pregnancy and has become chronic. This type is difficult to treat as the organism has become very virulent, and the factors causing stasis are what might be called "well set." Secondly, pyelitis not due to colon bacillus, and forms due to mixed bacteria. Thirdly, severe bilateral pyelitis with a high degree of septicemia. Fourth, cases which are concurrent with severe disturbances in the innervation of the gastro-intestinal tract. "Hypertension gravidarum and paralytic ileus, accompanied by pyelitis are two great indications for elective emergency caesarean section."

#### Effect on the child.

This is also one of the questions asked the physician, sometimes a hard question to answer. Few writers have included this in their discussion. From Falls(14): "Some



idea of the significance of the infection for the baby can be derived from the figures of Mayer and Chauffard, who state that one-third of all cases are premature." Leavitt (33) says that 40% of all cases result in miscarriages. In forty cases Falls noted a fetal mortality of 28% due either to spontaneous abortion in the earlier months or death following in a few hours after premature delivery. In addition 17% of the patients came to the hospital with a diagnosis of pyelitis and threatened abortion. Their symptoms were followed to delivery. "It is safe to say that some of these, at least, did not go to term, and of the babies born at or near term a few, at least, did not survive the first year." (14) Therefore, when asked this question it is well to remember the above and give a guarded prognosis.

## TREATMENT

The discussion of treatment is necessarily varied according to different author's private therapy, the type of case presented and common sense procedure.

For purposes of discussion I will divide the treatment into that as applied to three types of cases:

I. Simple dilatation of the ureter and pelvis with or without kinks in the ureter.

II. Dilatation of the renal pelvis with blunting of the calyces from continued infection and increased pressure.

III. Real destruction in kidney pelvis.

These three different types are the same as those described by Butler(30). They might also be classed as Mild, Moderate and Severe.

As seen from this outline there are different types of treatment that might apply to each type of pyelitis. The treatment might then be further divided into types as regards the method of treatment. This gives us two schools of treatment, namely, the radical school and conservative school.

To discuss treatment of pyelitis in as few words as possible one might say that it has but one object--to restore adequate drainage. Subsequent to this, treatment of the infection.

### Conservative treatment.

This type might also be called "expectant," and is generally employed in those cases of the first two types, where the infection has not gone so far as to endanger the

life of the mother or child.

Rest in bed is an essential. In fact this is spoken of as the chief therapeutic agent of any disease. Keep the patient quiet. The patient should lie, if possible so that the weight of the fetus will be removed from the affected side, this position being on the side which is not affected. This brings up the question of postural drainage, a popular method now used where expectant treatment is employed. Fowler's position, in which the patient is in a semi-erect position with the head and shoulders raised, is one of the common methods employed. Added to this position, a lying on the unaffected side and frequently drainage may be re-established, or at the least aided.

An argument against the postural method is, that with this position the gravid uterus would most certainly be liable to fall back on the brim of the pelvis and would not aid in drainage, but would hinder. This treatment should probably be left to the individuals choice.

Fluids. In all cases fluids should be forced. At least 200 cc. an hour, or more if possible. This may be taken as water, orange juice or any of the fruit juices.

Diet should be soft or liquid--that which is generally called a bland diet. Low protein and restricted salt should be the keynote of the diet. Examples of foods commonly used are: Sweetened unsalted butter, rice cooked in milk, sage, baked potatoes, puddings, gruels, vegetables without salt, fruit, weak tea, lemonade, milk. Coffee should be restricted. An alternative dry diet has been useful in the hands of Seitz(22).

Sennewald(20) uses Preissnitz compresses to the kidneys for the alleviation of pain, and high enemas for good bowel movement. Bowel elimination is one of the important points to be observed in treating pyelitis, as the etiology of many cases lies in poor bowel movement. Mild laxatives may also be used, the particular type being the choice of the individual physician.

Conservative treatment medicinally.

These measures usually correspond to the individual physician, most of them having their own particular ideas about the drug that works best in their hands.

Levin(25) states that Urotropin used properly in an acid urine, accompanied by an altered position, will alone cure mild cases. Most authors have employed this method of treatment at some time or another, but have added an alkali such as sodium phosphate, sodium citrate, sodium bicarbonate, etc. A popular method of treatment along these lines is the use of acriflavine gr. ss with sodium citrate gr. V or X given T.I.D. for a period of days and then a change to urotropin and sodium bicarbonate aa gr. V.T.I.D. The more severe of the mild cases may require gr. X of urotropin. Treatment of this kind, if symptoms are subsiding, and the patient is improving, should be continued until the urine has been negative for two or three examinations. Instructions should be given the patient to return if the symptoms begin to return. Linden flower tea is given by many authors in conjunction with urotropin.

Alleviation of pain may be an important factor in some

patients. Hot application, such as the electric heating pad, hot water bottle, or a hot flax-seed poultice over the entire area is of good avail. Medicinally, codeine gr. ss, and aspirin gr V every four hours is of definite value.

Hofbauer(1) has advocated the use of hypophyseal extract, saying it is useful in controlling inflammation of the urinary tract because of its specific antiphlogistic effect. An injection of obstetrical pituitrin  $\frac{1}{2}$  ampule T.I.D. stimulates the ureter to strong peristaltic movements and assures an emptying and drainage of the congested, infected urine. He states that the influence of pituitrin here is similar to that produced by it on the uterine muscle, but by clinical observations it has not been seen to cause termination of pregnancy. It is my opinion that the use of this drug should be set aside for those particularly adept, and experienced in its effects.

Hexamethylamin (urotropin) is advocated by Hay(35), McDonald(34), and others. Hay(35) mentions especially those patients with pus in the urine, and mild or absent symptoms. "Hexamethylamin gr. V. T.I.D. should be pushed, along with large volumes of water." McDonald(34) gives a prescription used by him that has been effective in mild or moderate cases:

R/	Hexamethylamin	gr. V
	Sodium Benzoate	gr. X
	Sodium Citrate	gr. V
	Elixir Buchu q.s.ad	drams II.

M. et S. Drams II T.I.D. in full glass of water.

Hexylresorcinol, a recent agent, has been seen to clear

up infections with bacillus coli as the cause, if the colon count is not especially high.

This might be said to include all of the conservative treatment though there are those who call themselves of this school that use mild operative procedures.

Radical treatment.

There is that class of cases wherein the above measures have failed, and it is well to bear in mind the following points before instituting further measures. (Eisendrath-29): (1) there may be an obstruction in the ureter (calculus, stricture, twist); (2) pyelitis may have existed for many years and resulted in changes in the ureteral wall and of the renal pelvis, with the resultant dilatation of the lumen; (3) some of the strains of bacillus coli, and especially some staphylococcus, are very resistant to bacteriacidal agents. When these possibilities have been thought of, direct methods are applied. Again think of the following and do not apply radical procedure unless: (1) conservative treatment has failed; (2) if the type is very severe when first seen. In this case do not lose any time with the more conservative measures. Eisendrath's(29) treatment in these cases is by pelvic lavage and catheterization until negative smears have been obtained. Caulk (from Eisendrath-29) believes that catheterization will cure all cases except where renal pelvis and ureter are dilated because of long standing infection.

Sennewald(20) has a method of his own, used in some severe cases seen by him. He first irrigated the pelvis with 1 cc. of 2% silver nitrate on each side, and left the catheter in place for 24 hours. Linden flower tea, urotropin 1 gm. T.I.D. and Preissnitz compresses to the kidney and high enemas accompanied this. In some of his cases he had a 48 hour exacerbation. After the exacerbation he followed with his own method of treatment: Intravenous drop infusion of salt solution and 10 cc. cytotropin intravenously. In severe cases he gives as much as 3-4 liters of physiological salt solution. This causes a physiological irrigation which sometimes brings about prompt defervescence, and usually will stop vomiting. For nutrition 300 cc. grape sugar solution is given in 24 hours. This is followed daily with the addition to the routine of 2 cc. eupylin(intravenously) and heart tonics if needed. As seen by the routine, this applies to those very severe cases with high temperature, high pulse, and septicemia.

Sennewald(20) believes that catheterization and irrigation is required for milder cases. Others also hold to this view, notably McDonald(34), Danforth(4), Baughman(32), Butler(30). Again the medicaments used vary with different authors.

One of the chief antiseptics used for pelvic lavage is silver nitrate, 1-2%. Some authors begin with very weak silver dilutions(1-1000) and progressively

approach 2% silver nitrate(29). Sennewald(20) has studied the effect of silver solutions and believes it to be too strong so has discontinued its use altogether. 1-2 cc. of the solution is considered a sufficient quantity for one irrigation.

2% argyrol, 2% protargyrol, or 2% mercurochrome are other antiseptics used for pelvic lavage.

Ureteral catheterization and 24 hour drainage is a common method employed when the case is first seen. Lavage precedes and follows its instillation. Seitz (22) recommends its use for several hours, as it brings the temperature back to normal in nearly all cases, and elimination of pus ceases.

The usual use of catheterization and lavage is in those moderately severe cases, which have persisted for several days or weeks before treatment has been instituted. The usual method is to catheterize and lavage the pelvis, and accompany this by urotropin, acriflavine or the other urinary antiseptics, by mouth, and to also use dietary measures.

There then arises the arguments from the conservative school as to the wisdom and actual usefulness of this operative method of procedure as a means of curing and aiding patients. From different authors' views and from some of my teachings, it is my opinion that this will excite too much trauma and make the patient sicker, and so therefore should not be employed unless the condition is becoming worse under expectant treatment.



Kretchmer and Heany(27) (from Hay - 35) state that "passing ureteral catheters is prone to excite infection in stagnated urine and their use for other than minimum diagnostic purposes is questionable." That this is at least partially true cannot be denied and it is my opinion and advice to withhold any such procedure in the mild and moderate cases unless the symptoms do not subside in a reasonable length of time on conservative treatment. In other words, as Baughman (32) states: "the method of drainage has to be determined with each case." Various authors have their own methods, but basically they are similar to those of Sennewald, being conservative in the respect that they aim to save the mother and yet continue pregnancy in its normal course.

What then, are we to do with those cases that do not respond to either conservative or radical treatment?

Keys(Hay-35) says: "if catheterization and lavage fail, the choice of procedures lies between terminating pregnancy and a nephrectomy." Most authors have shown that this disease rarely progresses to a state where such measures are necessary, but such cases do occur, and it many times taxes the physician to make a correct decision. Sennewald(20) believes that all cases can be saved without these measures unless they are cases complicated by ileus or colon bacillus sepsis.

It may be stated in general that there is a place for both nephrectomy or induction of labor, in different forms of the disease. If the child is near term, and

adequate facilities are present for its care after delivery, the choice would most certainly be induction of labor and delivery.

If the child is not enough developed, and if the patient is enough desirable of having the child to endure the operation and resultant consequences then nephrectomy should be elected. Some authors advocate nephrectomy in cases that are unilateral and severe enough to call for abortion, saying that induction of labor may only encourage the delay of proper surgery. (Butler-30, McDonald-34). Others reserve such a procedure (nephrotomy or nephrectomy) for cases with focal abscesses or pyelonephritis. As stated by Butler(30) in his third type of pyelitis (real destruction of kidney substance) "the condition will not clear up after delivery and in these cases it might be wise to remove the diseased kidney."

Caesarean section as a method of terminating pregnancy has been advocated by many, their reason being that in pyelitis cases with induction, and delivery from below, puerperal sepsis may easily follow. Falls(14) has shown that "in the light of clinical observations, backed up by immunological studies, it is questionable whether this operation is ever indicated for this reason. Furthermore, in patients with severe febrile reactions it is usually very easy to induce labor by any of the recognized methods if necessary, owing to the irritability of

the uterus under those circumstances.

In view of this observation, my opinion is that caesarean section is not indicated unless there are other indications, such as contracted pelvis, large baby, old primipara, etc. If the patient has had a number of babies, and if each pregnancy has been accompanied by pyelitis and in increasing severity, it might be well to do a caesarean and sterilization, but this would lie in the patient's choice.

Thus we see that pyelitis if seen early can be carried through successfully by expectant and semi-radical treatment. Radical treatment is reserved for those severe cases, usually ones seen late in the course of the disease. Operative interference is reserved for those on whom conservative and radical treatment has failed.

## CASE REPORTS

To illustrate the facts brought out in this thesis I have made a study of six cases of typical pyelitis occurring during pregnancy. Two of these I have seen and watched progress. The other four were taken from the University Hospital records. I have chosen all cases that have had cystoscopies performed, in order that I may bring out the facts concerning the urinary tract that have been brought out in the above discussion.

### Case I

Mrs. L. No. 24283, age 17, para I, white, six months pregnant.

Entrance complaints: (1) pain in both sides and in the back )2) weakness (3) gas on stomach.

History: This pain began ten days before entrance and developed suddenly with a severe, sharp, stabbing pain in the back which radiated around the abdomen. This pain lasted only a short time, but recurred at intervals and the patient continued to get worse, became weak, and was unable to walk around. She felt nauseated at times, and belched up sour gas. She did not vomit and noticed no chill. For three or four days before entrance the pain was dull and persistent. The patient thought she had a fever. The patient was up and around for the week before entrance, but the dull pain persisted and headache accompanied it. The back pain became worse at night. No bladder symptoms

accompanied the complaints.

Previous history: Jaundice at birth. Had influenza twice during the seventh year. Had occasional sore throats, and frequent colds (history reveals that she had one for two weeks previous to entrance). Teeth were at one time very bad, but have been taken care of. Her feet swell up after she has been on them all day long. Constipation is marked, and had been present for three or four years before entrance.

Physical examination: This showed that the tonsils were slightly injected. There was a slight degree of tenderness in the right kidney region. No rigidity and no pain in the right side of the abdomen. Further history elicited that the patient had lately noticed frequent urination, but no pain on urination.

Urine examination: Macroscopic disclosed slightly cloudy urine. Microscopic--pus cells and bacilli. Chemistry was negative. For reasons of diagnosis, study of etiological factors, and a method of treatment the patient was given cystoscopy without anesthesia.

Cystoscopic: The instrument entered readily, finding the bladder capacity very much diminished due to the uterine tumor. The bladder mucous membrane was slightly congested, otherwise normal throughout. The left ureteral orifice was normal. The right ureteral orifice was marked by a small patch of reddened mucous membrane in which the border of the

orifice could not be clearly made out.

Ureteral catheterization: The catheters passed readily to both kidney pelves.

Left ureteral urine: Clear, putrid odor; microscopic examination revealed nothing, and chemistry was negative.

Right ureteral urine: Cloudy, and putrid odor. Microscopic examination revealed pus cells and many short bacilli.

Phenosulphophthalein test showed fifteen percent returned in fifteen minutes from the left ureter and only a trace from the right ureter.

X-Ray: There were no abnormal shadows in the urinary tract.

Pyelogram: The left side was normal. The right showed the kidney pelvis to be incompletely filled by the opaque media only 3 cc. of which were injected. There was, however, sufficient filling to indicate a moderate degree of hydro-nephrosis and some clubbing of the minor calyces, only two or three of which appear.

Subsequent examination of the urine showed: acid urine, pus cells, and bacilli. Albumin ranged from one plus to a trace.

Blood findings showed hemoglobin 70%, red blood cells 3,500,00 and white blood cells 8,700, with polymorphonuclear leucocytes of 80%.

The patient was carried through the attack before the cystoscopy by use of acriflavine gr. ss and sodium bicarbonate gr. XXX T.I.D. This was given for six days

and then the cystoscopy was performed, as the patient was getting better, and it was thought that she might suffer no ill effects from the procedure. Following this the patient was given five days of urotropin and sodium acid phosphate as gr. X T.I.D.

The patient was dismissed after eleven days while still showing pus cells in the urine; and given alternate acriflavine and urotropin with alkalies as mentioned above. The patient was not followed to delivery.

#### Case II

Mrs. L. No. 33550, age 26, white, para IV, six months pregnant.

Entrance complaints: (1) pain in the sides of the right and left abdomen. (2) pain in the back, both right and left. (3) weakness, occasional headache, dizziness. (4) nocturia three to four times a night. (5) cloudy urine.

History: The patient had severe morning sickness beginning about the sixth week of the present pregnancy and lasting for three months. About one month before entrance she was wakened one morning about three a.m. with a sharp pain in the right side and mid-abdomen. The pain was persistent and did not radiate. By morning it had migrated to the right mid-back and lumbar region. It was intermittently better and worse after that time. Four days before entrance she had a similar attack on the left side. After the latter attack she was weaker and had frequent headaches and noticed cloudy urine.

Sweat severely from the time of onset.

Past history: Had sore throats two to three times each winter. Heart burn after eating greasy foods. Sometimes the skin became yellow. Had intermittent diarrhea and constipation "for some years."

Physical examination: Infected teeth and sub-auricular adenitis was present at that time. The abdomen and back were tender around the kidney region. No rigidity. The abdomen was tympanitic and distended. Fever was present as evidenced by the flushed skin.

Cystoscopic examination: This showed the bladder to be normal, though decreased in capacity.

Ureteral catheterization: Right kidney urine was cloudy and had many pus cells, bacilli and cocci. Chemistry disclosed one plus albumin. Left kidney urine was cloudy and had a few pus cells and bacilli. Chemistry disclosed one plus albumin.

Phenosulphophthalein: eight percent in fifteen minutes from the right kidney and five percent in fifteen minutes from the left.

X-Ray: Left ureter was laterally displaced where it crossed the brim of the pelvis. It was within the limits of normal size. The right ureter was irregularly dilated and showed a sharp curvature at the level of the fourth lumbar vertebra. The kidney appeared normal in position and there was no gross evidence of hydro-nephrosis. This led to a diagnosis of bilateral pyelitis and the above method of diagnosis was also used as part



of the treatment. Citrocarbonate drams I, Q.I.D. were given for six days. On the fifth day the patient complained of a diarrhea and paregoric drams I B.I.D. was added to this list. On the sixth day treatment was changed to urotropin gr. X and boric acid gr. I Q.I.D. The symptoms subsided on the tenth day, and the patient was released on the thirteenth day after entrance. She was not followed to delivery.

### Case III

Mrs. W. No. 33862, negro, para V, four months pregnant.

Entrance complaints: (1) pain in the right back (2) pain on urination (3) chill and fever. All these complaints dated to a beginning about four or five days before entrance.

History: Two months previous to the present attack she was in another hospital unable to void. She vomited five to six times daily at that time. Her stay was four weeks long.

At present entrance she had slight dull pain in the right loin and short bearing down pains in the abdomen.

History of pregnancies is interesting. The patient became pregnant three months after marriage and aborted at the fifteenth week, after having severe vomiting for three weeks previous to that time. Six months later was again pregnant and by keeping the bowels open delivered normally. Two years later was pregnant again

and had severe vomiting but delivered normally. One year later was again pregnant, had no vomiting but lots of pain in the abdomen, chest, and her usual nervousness was aggravated. Delivered a five pound baby at this pregnancy. The last pregnancy was eight months after the previous one, and progressed as seen above.

Past history: Reveals also a chronic inflammation in the throat, and a constant post-nasal discharge. Constipation has been marked for "some years" and a diagnosis of spastic colitis was at one time given her.

On entrance the patient was given salol gr. II Q.I.D. and citrocarbonate drams I T.I.D., with petrolagar for the bowels. The temperature gradually fell. Nine days after entrance a catheterized specimen of urine still showed six to twenty pus cells per high power field. Fifteen days after entrance the patient was given cystoscopy. Colon bacilli were found in the urine at all times.

Cystoscopic: Bladder negative.

X-Ray and Pyeloureterogram: The kidney pelves appeared normal in size, contour and position. There was no gross blunting of the minor calyces. Both ureters showed a sharp angulation at the level of the third lumbar vertebra. The calibre of the right ureter appeared somewhat greater than normal. There were no calculi.

Ureteral urine: right ureteral urine was cloudy, showed many bacilli, and pus cells. Chemistry disclosed two plus albumin. Left ureteral urine was cloudy, showed cocci, and pus cells. Chemistry disclosed two plus albumin.

Phenosulphophthalein test showed no return from the right ureter in fifteen minutes and five percent in fifteen minutes from the left.

The patient improved and was dismissed to return one month later with the same symptoms and a moderate general emaciation.

Caesarean section and sterilization was performed. The patient ran an eight day temperature after the operation, followed by a nine day temperature-free course. She was dismissed with no symptoms of pyelitis.

#### Case IV.

Mrs. G. No. 36583, para I, age 19, white, four and a half months pregnant.

Entrance complaints: (1) chills and fever, (2) right sided abdominal pain (3) pain over the kidney region.

History: The patient had two such attacks before entrance. Burning on urination had been present for the past two years previous to entrance. This showed evidence of a cystitis.

Past History: Constipation has varied with normal bowel movement. This fact may easily be one of the etiological factors in causing the complaints for which she entered the hospital at this time.

Physical examination: There was an upper respiratory infection present at that time, with evidence of a congestive obstruction. Several teeth were missing and there were several bad teeth remaining. Abdominal examination elicited nothing aside from the entrance complaints. Cystoscopic examination was given immediately.

Cystoscopic: Bladder mucosa normal throughout.

Ureteral catheterization: Right ureteral urine was slightly cloudy, occasional pus cells, epithelial cells, and a few long slender bacilli, the type not determined. Phenosulphophthalein test showed a trace returned in fifteen minutes. Left ureteral urine was essentially negative. Phenosulphophthalein showed a return of fifteen percent in fifteen minutes.

X-Ray: There was a shadow a centimeter in diameter in the region of the right kidney pelvis. The relationship left no doubt as to it being a urinary calculus.

Pyeloureterogram: The left ureter and kidney were normal. The right was definitely hydro-nephrotic. The ureter immediately below the pelvis was extremely tortuous and definitely folded on itself. The opaque media covered the previously mentioned suspicious shadow.

This patient was given a poor prognosis due to the tortuosity of the right ureter, right kidney pelvis dilatation and the suggested obstruction due to calculus.

Urine examination showed a one plus albumin, acid reaction and many pus cells and red blood cells. Bacilli were numerous.

The blood examination showed a moderate anemia--hemoglobin was 70%, red blood count 3,700,00 and the white blood count 12,900.

The patient was given acriflavine gr. ss, and urotropin gr. X with alkalies, alternating, and gradually improved. Was dismissed eighteen days after admission with instructions to drink lots of water, practice the knee-chest position exercise and to raise the head of the bed.

Five months later this patient delivered in the University Hospital, a seven pound three ounce boy--normal delivery and with no complications. The patient states that she had had no return of the previous symptoms between her dismissal five months previous and the delivery of the baby. At delivery she still showed pus cells in the urine and a trace of albumin. She was again placed on acriflavine gr. ss T.I.D. as a prophylactic measure and showed a normal post-partum course.

#### Case V.

Mrs. B. No. 35847, age 29, white, para III, four months pregnant. This patient is of interest to us as regards pyelitis, because of the apparent etiology of the disease.

Entrance complaints: (1) enlargement of the abdomen with masses in the mid-line, and to the right;

(2) pain in the right lower quadrant; (3) cessation of menses four months previous to entrance.

History and onset: This was dated at one year previous to entrance, when a mass was felt in the abdomen. This continued to grow in size and lately a second mass was felt. This followed the cessation of the menses four months previous to entrance. The patient had pain for the past year, noticed more when she was lying down. With an attack of pain it was noticed that the urine output increased.

Past history: Childhood diseases, measles, whooping cough. Typhoid fever in 1918. Had noticed swelling of the feet during her pregnancies (edema). Had been constipated for "many years."

Operations: Tonsillectomy five years previous. Skin tumors were removed from her back fifteen years ago.

Menstrual history: Menstruation began at the age of fifteen and had always been irregular coming at intervals of four to six weeks, occasionally at a three week interval.

Patient had noticed nocturia since the enlargement of the abdomen.

This patient was studied thoroughly and a diagnosis of pregnancy complicated by fibro-myoma of the uterus finally given. She was operated and six pound fibroma removed from the left and front side of the uterus. The pregnancy continued.

In our discussion here the tumor is not the main interest, but the subsequent events. Six days after

operation the patient had two chills, the temperature jumped to 104 degrees, and the urine was loaded with pus. Pneumonia was ruled out with X-Ray examination. The patient had no other complaints except headache. The temperature ran an intermittent course, and for two days had no diagnosis. Finally on a basis of fever, elevation of pulse, and pus in the urine with a few bacilli, pyelitis was diagnosed.

The patient was placed on acriflavine gr. ss and urotropin gr. X with alkalies and put in the Fowler position. Urologists advised against pyelography because of her morbid condition. Twenty-six days of hospitalization and the patient was dismissed, temperature-free and feeling well. The urine still showed albumin a trace, and 2-10 pus cells per high power field.

This patient delivered normally in the University Hospital five months later, in spite of the seriousness of her condition previously. There had been no return of the pyelitic symptoms during that time, but the patient states that she was always tired and weak, and thought she noticed a frequency of urination.

This case is of interest to us, as it shows how the pyelitis was begun. It is my opinion that the tumor held the fetus from pressing on the ureters, and with its removal, the natural tendency was for the gravid uterus to fall on the brim of the pelvis. Also the fact that the patient necessarily was low in

resistance due to the operation and the previous illness, pyelitis was easily set up.

Case VI.

Mrs. M. No. 24186, para II, white, age 23, six months pregnant.

Entrance complaints: (1) pain in lower right quadrant of the abdomen; (2) chills and fever.

Summary history: The patient was six months pregnant and was able to give no history of previous urinary difficulty, beyond a moderate degree of frequency and nocturia as is generally seen during the second trimester. Two nights previous to entrance, the patient was seized with a sudden severe pain which she localized somewhere in the right flank. That same night she noticed she had an added degree of frequency of urination with some burning. The next morning she had a chill and the pain in the right flank continued and became very severe at times. The last two days before entrance she had severe chills. There was no noticeable relief from the pain, and fever while in the hospital was as high as 104 degrees. The question of acute appendicitis was raised because of the localization over McBurney's point, and reference to surgery was made for a differential diagnosis.

Past history: Patient had the usual childhood diseases. History of sinus infection and a chronic post-nasal discharge and chronic constipation are the only



other items of importance.

Physical examination: There was a slight serous nasal discharge. Abdominal examination showed a tumor of pregnancy extending slightly above the umbilicus. There was no rigidity over McBurney's point, but there was a little more tenderness over the right half of the abdomen than the left, and a distinct area of tenderness over the right kidney.

Urine examination showed it to be cloudy and full of pus cells and bacilli.

Cystoscopy: The capacity of the bladder was markedly diminished due to the size of the gravid uterus. The examiner was unable to study the bladder mucosa throughout. The trigone was slightly inflamed and edematous. The ureteral orifices appeared puffy with a greater degree of redness about the right than the left. These findings correspond to those found by Duncan(11), Hofbauer(1), Sennewald(20) and others.

Ureteral catheterization: The catheters passed readily up both sides, that on the right meeting with a sudden obstruction somewhere in the upper third of the ureter. Urine returned readily from both sides. Right ureteral urine showed it to be cloudy and full of pus cells and short bacilli. Left ureteral urine showed it to be cloudy, but otherwise negative.

Phenosulphophthalein showed only a trace returned in fifteen minutes from the right ureter. There was twenty percent from the left ureter.

X-Ray: Plain plate with the catheter in place

showed the right catheter obstructed in its progress in the upper third of the ureter but no definite pathology was seen.

Pyelogram: Right--using four cc. of 30% sodium iodide showed the ureteral catheter obstructed by a sharp angulation in the upper third of the ureter just before it entered the kidney pelvis. The kidney pelvis appeared large with calyces distinctly shown, but the kidney pelvis was not completely filled. There seemed to be a definite kink as nearly as could be made out by observing one plane only.

Urine examination chemically showed albumin two plus, many pus cells and red blood cells. A culture of the urine disclosed colon bacillus.

The leucocyte count was high, 13,200, and a mild degree of anemia was manifest by a hemoglobin of 70% and a red count of 3,000,000.

Catheterization seemed to help the patient considerably. Acriflavine gr. ss and sodium bicarbonate gr. XXX T.I.D. was given for the first seven days of hospitalization. The last three days this was changed to urotropin and sodium acid phosphate aa. gr. V. T.I.D. After ten days of treatment the patient was dismissed temperature-free, but showing red and white blood cells in the urine with a three plus albumin. She was given the above two prescriptions and told to alternate them T.I.D. until she felt that they could be discarded. Accompanying this she was instructed to take a low protein and restricted salt diet and to practice the Fowler

position. She was not followed to delivery.

These cases demonstrate very well what has been discussed in the main theme.

Etiology is seen in all cases, to lie, partially at least, in poor bowel elimination, and in foci of infection. The latter is evidenced by the head colds, bad teeth, and sinus infections found in the above patients.

Stricture was not found in any of these patients.

Dilatation of the ureter was seen in three cases. Hydro-nephrosis was seen in three cases. Kinks and sharp angulations of the ureter was seen in four cases. Bladder inflammation, dropping back of the trigone, and lessened capacity was also seen in all cases. Two cases were bilateral, with most of the symptoms referable to the right side. Four were unilateral and all right sided.

Bacilli were seen to be the causative organism in all cases, and in the two cases of bilateral pyelitis, cocci were seen in conjunction. Only one of the cases had culture report and this was returned positive for bacillus coli. It is highly probable that were cultures taken on the other cases, they would also be reported as due to colon bacilli.

Symptoms show these cases to all be of the acute type, striking the patient suddenly and coinciding for the most part with those symptoms mentioned in symptomatology above.

Diagnosis and differential diagnosis was not difficult in these cases and was made on a history of symptoms and subsequent urinary and cystoscopic examination. Differential diagnosis was made on case number six from appendicitis, by the lack of indigestion symptoms, no vomiting, no great rigidity over the abdomen and a positive urine examination.

All cases were treated conservatively. There arises again the dispute as to whether cystoscopic examination is conservative. In all of these cases, there were twenty-four and forty-eight hour periods of nausea, vomiting and high fever immediately following the cystoscopic examination. Again let me say that cystoscopic examination should not be done unless diagnosis is very difficult, unless such treatment is indicated, or unless the findings are especially needed for work and research or your own. Certainly a private patient is going to thank you more if you save them any undue trauma and sickness; and this can be done by omitting cystoscopy.

## CONCLUSIONS

What can be generally concluded from the above discussion? Though I know that the various authors I have used as contributors to this paper know better and more scientifically how to make conclusions from their work and data, I am attempting to form a personal opinion in all cases.

1. Stricture. This occurs in many cases, but in my mind they must be "picked." Certainly this plays a role in stasis and consequent infection. However, stricture necessarily is present before the onset of pregnancy as is shown by the facts above. It remains for the general foci of infection, decreased resistance and intestinal stasis to infect one of these cases.

2. Dilatation. This occurs in all cases of pregnancy in which there is no previous stricture. It is definitely an etiological factor in pyelitis during pregnancy. It begins as early as the sixth week in multipara and tenth week in primipara. There is a preponderance of dilatation of the right side of three-one.

3. The urinary apparatus undergoes hypertrophic and congestive changes simultaneous and progressive with pregnancy.

4. The uterus enlarging plays a definite part in mechanical compression of the ureters beginning about the third month of pregnancy.

5. Stasis is definite and almost universal in antepartum women. In post-partum women it is still persistent in less degree over prolonged periods of time. This

latter conclusion was discussed under prognosis.

6. Atony of the ureter occurs in cases in which pregnancy occurs. It is a result either of changed innervation and nutrition, or mechanical from increased pressure from above, or a combination of the two.

7. Residual urine and bacteriuria occurs in the majority of pregnant women, even in the absence of disease symptoms.

8. Redundancy and kinking occurs as a result of increased pressure from above and congestion from below, pulling the ureter out of line, accompanied by the important factor of atony and dilatation.

9. There is definitely required a lowered resistance of the particular patient in order to make it possible for pyelitis to occur, even in the face of the above facts actually being present.

10. Colon bacillus is most often the causative organism in a pyelitis during pregnancy.

11. Hemotogenous infection is most commonly the route of infection in pyelitis of pregnancy; lymphatic extension from the intestine being second.

12. Involution is coincident with uterine involution if no disease has intervened.

13. Symptoms are usually acute, striking the patient suddenly, but the factors bringing on the symptoms are usually insidious in onset.

14. Diagnosis can be made, and should be made, without the use of the cystoscope. If pyelogram is required

by the individual physician, it is recommended that they use intravenous pyelography.

15. Differential diagnosis is not extremely difficult, but is highly important.

16. Prognosis for the mother is good. Prognosis for the baby is poor. As to recurrence in succeeding pregnancies, the patient is more liable to have a return of symptoms than not.

17. Conservative treatment is best in the hands of most physicians. Barring a serious condition of the patient, or the desire for study of the urinary tract, radical treatment should not be employed.

18. Caesarean section is not indicated for the prophylaxis against puerperal sepsis. If delivery be required, induction of labor is the choice.

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