

## Renal Disease in Pregnancy

The following section is entitled “**Renal Disease in Pregnancy.**” This section deals with some of the basic concepts important in caring for renal disease during pregnancy. The section begins with a *learner handout* with space for the learner to make their own notes. The *learner handout* is followed by the *teaching script* for the educator. The section then concludes with several cases for discussion and a brief bibliography for this topic.

**RENAL DISEASE IN PREGNANCY**

**RENAL DISORDERS  
IN PREGNANCY**

---

---

---

---

---

---

---

**General**

**Pregnancy is associated with anatomic and physiologic changes in the urinary system.**

---

---

---

---

---

---

---

**Anatomic Changes**

**The smooth muscle relaxation effects of progesterone in pregnancy lead to dilatation of the renal pelves, calyces, ureters and the appearance of hydronoephrosis.**

---

---

---

---

---

---

---

## RENAL DISEASE IN PREGNANCY

### Anatomic Changes

This physiologic hydronephrosis and resulting urinary stasis causes:

- Difficulty in making the distinction from true obstruction.
- Predisposes pregnant woman to lower UTI and pyelonephritis.
- Predisposes to the development of renal calculi.

---

---

---

---

---

---

---

---

### Physiologic Changes

Glomerular filtration rate increases by 50% during pregnancy.

- the average creatinine in pregnancy is 0.5 mg/dl.
- the average creatinine clearance is 150 ml/min.
- medication with renal clearance may need more frequent dosing.

---

---

---

---

---

---

---

---

### Physiologic Changes

Urinary protein excretion increases

- the upper limit of normal increases from 150 mg/24 hours to 300 mg/24 hours,

Glycosuria is common and can occur in the absence of diabetes in normal pregnancy.

Amino aciduria is common in normal pregnancy.

---

---

---

---

---

---

---

---

## RENAL DISEASE IN PREGNANCY

### Physiologic Changes

Plasma bicarbonate is decreased by 4mEq/L as renal compensation for the mild respiratory alkalosis in pregnancy. Plasma urate is decreased because of the increased GFR and decreased tubular reabsorption.

---

---

---

---

---

---

---

---

### Urinary Tract Infections in Pregnancy

All pregnant women require screening for urinary tract infection. Asymptomatic bacteriuria should be treated in pregnancy because of the high risk of ascending infection. Treatment of UTI in pregnancy should be with a 7 to 10 day course of antibiotics. One or 3 day courses should not be used.

---

---

---

---

---

---

---

---

### Pyelonephritis in Pregnancy

Pyelonephritis in pregnancy should always be treated as an inpatient.

- It carries a significant risk of preterm labor.
- There is a 10% risk of pulmonary edema.

The recurrence rate of pyelonephritis in pregnancy is high.

- All women who develop pyelonephritis in pregnancy should receive prophylactic antibiotics for the remainder of the pregnancy,

---

---

---

---

---

---

---

---

## RENAL DISEASE IN PREGNANCY

### Acute Renal Failure

**The approach to acute renal failure in pregnancy is the same as in the nonpregnant individual**

**The differential diagnosis also includes:**

- Acute tubular or cortical necrosis from septic abortion and obstetrical hemorrhage.
- Acute fatty liver of pregnancy.
- Preclampsia.
- Hemolytic uremic syndrome.
- Idiopathic postpartum renal failure.

---

---

---

---

---

---

---

---

### Pregnancy in Women with Chronic Renal Disease

**The prognosis for pregnancy in women with chronic renal disease is dependent more on the degree of renal impairment than the underlying disorder.**

**The presence of hypertension increases the risks of morbidity with pregnancy.**

---

---

---

---

---

---

---

---

### Mild Renal Impairment

**Pregnancy in women with mild renal impairment (creatinine <1.5 mg/dL) is associated with good maternal and fetal outcome.**

---

---

---

---

---

---

---

---

## RENAL DISEASE IN PREGNANCY

### Moderate Renal Impairment

**Pregnancy in women with moderate renal impairment (creatinine 1.5 mg/dL to 3.0 mg/dL) carries several risks:**

- Renal functional deterioration during gestation,
- Fetal loss.
- Preterm labor.
- IUGR.
- Preclampsia occurs in one-third of these pregnancies.

---

---

---

---

---

---

---

---

### Chronic Renal Failure

**Women with severe renal impairment (creatinine >3mg/dL) are often infertile.**

**If conception does occur, the fetal loss rate exceeds 50%.**

---

---

---

---

---

---

---

---

### Proteinuric Renal Disease

**Urinary protein excretion may increase markedly in pregnant women without progression of the underlying parenchymal renal disease.**

---

---

---

---

---

---

---

---

## RENAL DISEASE IN PREGNANCY

### Renal Biopsy in Pregnancy

Renal biopsies can and should be done when indicated in pregnancy.

Indications include rapid deterioration in renal function without obvious cause and symptomatic nephrotic syndrome.

The morbidity of biopsy is the same as in nonpregnant individuals if blood pressure is controlled and indices of coagulation normal/

---

---

---

---

---

---

---

---

### Dialysis in Pregnancy

Hemodialysis and peritoneal dialysis can be successfully carried out during pregnancy.

The fetus tolerates uremia in the mother poorly so dialysis may need to be done more frequently.

Patients with severe renal disease may require the earlier initiation of dialysis for fetal concerns.

---

---

---

---

---

---

---

---

### Renal Transplantation

Women with successful renal transplants generally have good pregnancy outcomes.

Medications that prevent rejection should be continued during pregnancy.

---

---

---

---

---

---

---

---

## RENAL DISEASE IN PREGNANCY

### Nephrolithiasis

Renal calculi are among the most common causes of abdominal pain requiring hospitalization during pregnancy.

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

# RENAL DISORDERS IN PREGNANCY

## *Teaching Script*

### **Pregnancy Related Changes in Renal Physiology**

Pregnancy is associated with significant anatomic and physiologic changes in the kidneys and the urinary collecting system.

Anatomic changes are largely due to the generalized smooth muscle relaxation that occurs during pregnancy as an effect of progesterone. This leads to dilatation of the ureters, calyces, and the renal pelves, which gives the appearance of hydronephrosis on ultrasound. The dilatation can be marked and is often more pronounced on the right. The distinction between this physiologic hydronephrosis and obstructive uropathy is often difficult to make. The presence of ureteral jets (i.e., the flow of urine into the bladder where the ureters implant into the bladder) can be a useful way to distinguish between physiologic hydronephrosis of pregnancy and true obstruction. The laxity of the urinary collecting system leads to urinary stasis, which contributes to a pregnant woman's predisposition toward developing urinary tract infections. There is a higher frequency of vesico-ureteric reflux in pregnancy so if a pregnant woman does develop a lower urinary tract infection, it is more likely to ascend and develop into pyelonephritis. The relative urinary stasis also promotes the formation of kidney stones, which are seen more frequently in pregnancy.

There are also physiologic changes that occur during pregnancy. Glomerular filtration rate increases by 50% during pregnancy so that the average creatinine clearance of a pregnant woman is 150 mL/minute (2.5 mL/s) and the average creatinine in pregnancy is 0.5 mg/dl (45 $\mu$ mol/L). These changes need to be considered in the interpretation of tests of renal function during pregnancy. A creatinine that is above 0.8 mg/dl (71 $\mu$ mol/L) is considered abnormal in pregnancy and should prompt investigation for underlying renal disease. As well, medications that have renal clearance may require more frequent or higher doses in pregnancy.

Urinary protein excretion increases during pregnancy. The upper limit of normal for urinary protein changes from a prepregnant level of 150 mg/24 hr to 300 mg/24 hours. The increases in GFR as well as changes in tubular function cause glycosuria and amino aciduria to be a common finding during normal pregnancy. Glycosuria can happen even in women with normal carbohydrate metabolism. Plasma urate levels decrease in pregnancy (normal is up to 5.0 mg/dl) due to the increased GFR and decreased tubular reabsorption.

When interpreting acid base status during pregnancy, it must be remembered that the normal plasma bicarbonate level in pregnancy is decreased by approximately 4 mEq/L as compensation for the mild respiratory alkalosis that normally occurs during pregnancy.

### **Urinary Tract Infections in Pregnancy**

The most common renal disease to occur in pregnancy is pyelonephritis. Pregnant women are at an increased risk for pyelonephritis because of the previously discussed changes in the urinary collecting system. Studies have shown that treatment of asymptomatic bacteriuria in pregnancy greatly reduces the incidence of pyelonephritis. Therefore, the recommendation is that asymptomatic bacteriuria should be treated in pregnant women. This is markedly different from the recommendations in nonpregnant women that suggest that only symptomatic UTI's be treated. All pregnant women should have a urine culture at the beginning of pregnancy to screen for asymptomatic bacteriuria. If asymptomatic bacteriuria ( $>10^4$  bacterial colonies/mL of urine) is present, then bacterial colonization should be treated with a 7-10 day course of the appropriate antibiotic. Single dose antibiotic regimens should not be used in pregnancy.

Pregnant women with pyelonephritis have a dramatic increase in the risk for preterm labor and a 10% incidence of pulmonary edema. Therefore, if pyelonephritis does develop during pregnancy, it should always be treated as an inpatient. The recurrence rate of pyelonephritis during pregnancy is approximately 10%. The use of daily prophylactic antibiotics during the remainder of the pregnancy for women who have had an episode of pyelonephritis substantially reduces this risk.

### Acute Renal Failure in Pregnancy

The approach to the patient with acute renal failure during pregnancy is the same as it would be for the nonpregnant individual. The usual prerenal, renal and postrenal causes all need to be considered carefully. However, there are some unique pregnancy-related causes of acute renal failure that should be mentioned. Acute tubular necrosis and acute cortical necrosis can occur in pregnant women related to septic abortion or significant postpartum hemorrhage. The incidence of this complication has decreased in recent years with the availability of legalized abortion and the improvement of obstetrical care. Acute fatty liver of pregnancy has also been associated with a significant risk of acute renal failure. The mechanism is obscure but may be related to hemodynamic factors such as in hepatorenal syndrome. Severe preeclampsia can cause acute renal failure by several mechanisms. Acute tubular necrosis can occur as a result of severe renal artery vasospasm. Preeclampsia also causes a characteristic lesion in the glomerulus known as glomerular endotheliosis. Hemolytic uremic syndrome seems to occur at an increased incidence in the postpartum period and needs to be considered in the woman with progressively decreasing renal function and hemolysis after delivery. A specific entity known as *idiopathic postpartum renal failure* has been described and is felt by some to be part of the disease spectrum of hemolytic uremic syndrome and thrombotic thrombocytopenic purpura.

### Chronic Renal Disease and Pregnancy

For women with renal disease, the course of pregnancy is most dependent on the degree of renal impairment and the presence or absence of hypertension. In general, women who only have mild renal insufficiency (creatinine <1.5 mg/dL (132 $\mu$ mol/L)) can expect a good maternal and fetal outcome. For women with moderate impairment in function (creatinine 1.5 mg/dL to 3.0 mg/dL (265 $\mu$ mol/L)), pregnancy carries a number of risks. These women may have deterioration in renal function during gestation that may not be completely reversible after delivery. They are also at an increased risk for intrauterine growth restriction, preterm delivery and fetal loss. Preeclampsia will occur in up to one third of patients with moderate renal insufficiency. The presence of hypertension substantially increases the risk of these complications further.

Women with a creatinine  $>3$  mg /dl are often infertile. If conception does occur in such individuals, the fetal loss rate exceeds 50%. Pregnancy in these women can often lead to end stage renal failure requiring dialysis.

Patients with underlying renal parenchymal disease often have marked increases in urinary protein excretion during pregnancy. This can occur without any progression of the underlying disease. Therefore, worsening proteinuria during gestation in these patients should not automatically be attributed to worsening glomerular disease or preeclampsia. If renal function is preserved, then the prognosis for the pregnancy is good despite often massive proteinuria.

### **Renal Biopsy in Pregnancy**

A renal biopsy in pregnant women with well-controlled blood pressure and normal indices of coagulation carries the same morbidity as in nonpregnant patients. Therefore, renal biopsies can and should be done for the same reasons in the pregnant woman as the nonpregnant individual. The usual indication is sudden deterioration of renal function without an obvious underlying cause or symptomatic nephrotic syndrome.

### **Dialysis and Pregnancy**

Dialysis can be done safely during pregnancy. Both hemodialysis and peritoneal dialysis have been utilized safely during pregnancy with good pregnancy outcomes. Peritoneal dialysis appears to be the preferred method of dialysis during pregnancy probably because it avoids the dramatic intravascular fluid shifts and swings in blood pressure that can be seen with hemodialysis. The fetus tolerates uremia in the mother poorly. Therefore, dialysis should be done more frequently. As well, dialysis should be initiated earlier in a woman who is approaching end stage renal disease and becomes pregnant. Therefore, the usual indications for dialysis need to be liberalized in the pregnant woman for optimal care of her fetus.

### **Renal Transplants and Pregnancy**

Women who have had successful renal transplants are candidates for pregnancy. Anti-rejection drugs need to be continued during the pregnancy and are surprisingly well tolerated by

the fetus. For those women with renal transplants who carry beyond the first trimester, 93% will have a good pregnancy outcome.

### **Urolithiasis in Pregnancy**

Lastly, it is important to remember that renal calculi are seen with an increased incidence during pregnancy. In fact, nephrolithiasis and urolithiasis are among the most common non-obstetrical causes of abdominal pain requiring hospitalization during gestation. Renal calculi in pregnancy tend to cause less severe symptoms than in nonpregnant patients.

# RENAL DISEASE IN PREGNANCY

## *Case Discussion*

### Case #1

You are asked to see a 19 year old G<sub>1</sub> woman at 32 weeks gestation in consultation for “worsening renal function”. She was admitted to hospital 2 days ago with the concern that she had preeclampsia as she has proteinuria and hypertension. On reviewing her chart, you find out that her blood pressures now range from 140-165/85-100. At 18 and 22 weeks gestation, her blood pressure was recorded at 130/80. She has never had her blood pressure measured prior to this pregnancy. Her creatinine is 1.4 mg/dL (124 $\mu$ mol/L) with a BUN of 26 mg/dL (9.2 mmol/L). No previous values are available and since admission they have been stable. Her urinalysis dips positive (2+) for protein and glucose but is otherwise normal. Her serum glucose is 100 mg/dL (5.5 mmol/L). A 24 hour urine for creatinine clearance and protein is pending.

***What do you think of her creatinine and urinalysis?***

***What do you think of the blood pressures?***

***How do you explain the glycosuria?***

Aside from the elevated creatinine, there is no other laboratory evidence of pre-eclampsia. Her CBC, uric acid, and AST are all normal. Urine microscopy shows only a few granular casts. Urine culture is negative.

You go to see the patient and do a complete history and physical on her. She has not seen a doctor in 10 years. As a child she had frequent urinary tract infections with enuresis. She denies any medication use including NSAIDs. Her family history is remarkable only for a sister with lupus. There is no family history of renal disease. She denies headache, epigastric pain, and visual changes. She does complain of increased urinary frequency but without urgency or dysuria. She has noted lower limb edema but has not noted any facial or hand swelling. Her physical exam is normal aside from a blood pressure of 160/95 and nontender, symmetric lower limb edema. You judge her to be euvolemic.

***What do you think of her urinary frequency and edema?***

***What is the differential diagnosis of her elevated creatinine and proteinuria?***

***How would you distinguish between pre-eclampsia, chronic hypertension and primary renal disease?***

A renal ultrasound is done and the radiologist reports bilateral grade 2 hydronephrosis. This puzzles you because the patient is completely comfortable and voiding regularly.

***How do you explain the hydronephrosis?***

***How can you distinguish physiologic hydronephrosis from obstruction on ultrasound?***

The patient's 24 hour urine comes back with a total protein of 4 g per day and her creatinine clearance is 60 mL/min (1.0 mL/s).

***What do you think of these values?***

***What further laboratory testing would you order at this time?***

***Should she be delivered?***

She remains in the hospital under close observation for three days. Her obstetrician confirms that she has a healthy size fetus with good fetal tracings. The decision is made that this is likely chronic stable renal disease and not an acute process or pre-eclampsia. Several laboratory tests including C3, C4, ASOT, HepBsAg, HepCAb, ANA, ANCA, HIV testing are still pending. She is sent home with close follow up planned.

***If this is chronic renal disease, why might her previous urinalyses have been normal earlier in the pregnancy?***

***If this is chronic renal disease what are the risks of this pregnancy to the mother? To the fetus?***

She fails to show up for her follow up appointments until 4 weeks later when her urinalysis dips 2+ again but her creatinine is now 1.9 mg/dL (1.67 $\Phi$ mol/L). She feels "fine" and her exam and other lab work (including her pre-eclampsia labs) are unchanged. She is readmitted to the hospital and you are re-consulted. A 24 hour urine shows her creatinine clearance to be 40 mL/min.(0.67 mL/s) and her 24 hour urinary protein to be 7 grams.

***If her creatinine and proteinuria continue to worsen in the absence of other evidence of pre-eclampsia, could and should this woman have a renal biopsy while still pregnant?***

***If she deteriorated to a point where dialysis is necessary, what would be the preferred method of dialysis in this patient?***

The decision is made to induce the patient. She delivers a healthy 6 pound (3000 gm) baby girl by an uncomplicated vaginal delivery. Postpartum her blood pressure remains elevated but her creatinine comes down to a consistent 1.3 mg/dL (115 $\Phi$ mol/L) and her proteinuria is present only intermittently on dipstick. Her 24 hour urine 4 weeks after delivery shows a creatinine clearance of 75 mL/min.(1.25mL/s) with a 24 hour urine protein of 300 mg.

## RENAL DISEASE IN PREGNANCY

### *Case Discussion*

#### **Case #2**

**Adapted from ACP workshop syllabus**

A 21-year old G<sub>2</sub>P<sub>1</sub> woman presents at 11 weeks gestation with a two week history of intractable nausea and vomiting. Her blood pressure is 130/80 mmHg and the remainder of her physical exam is unremarkable. Laboratory evaluation reveals a creatinine of 1.9 mg/dL (168 $\mu$ mol/L) and a BUN of 19 mg/dL (6.7mmol/L). With intravenous hydration, these drop to 1.2 mg/dL (106 $\mu$ mol/L) and 11 mg/dL (3.9mmol/L) respectively. Urinalysis is remarkable only for 2+ proteinuria. A 24 hr urine collection reveals her creatinine clearance to be 58ml/min.(1mL/s) and her protein excretion to be 750 mg of protein/24 hours. Serum albumin is 2.6 g/L, cholesterol 198 mg/dL (5.12mmol/L), and ANA is 1:40 with normal serum complement levels.

On further questioning the patient states that proteinuria was discovered on school physical exam one year ago, but she never had any followup for it.

***She wants to know what effect her renal disease is going to have on her pregnancy?  
What do you tell her?***

***What effect will the pregnancy have on her renal disease?***

At 31 weeks gestation the patient is admitted to hospital with preterm labor. Her blood pressure is measured at 145/95 mmHg. Her serum creatinine is found to be 1.5 mg/dL (133 $\mu$ mol/L) and urinary protein has increased to 21.5 gm/24hr.

***What is responsible for the increases in blood pressure and proteinuria and how would you establish this?***

***How would you manage this patient?***

## RENAL DISORDERS IN PREGNANCY

### *References*

- Abe S. Pregnancy in IgA nephropathy. *Kidney International* 1991; 40:1098-1102.
- Abe S, Amagasaki Y, Konishi K, Kato E, Sakaguchi H, Iyori S. The influence of antecedent renal disease on pregnancy. *Am J Obstet Gynecol* 1985; 153:508-14.
- Andriole VT, Patterson TF. Epidemiology, natural history, and management of urinary tract infections in pregnancy. *Medical Clinics of North America* 1991;75(2):359-73.
- Armenti VT, Ahlswede KM, Ahlswede BA, et al. Outcome in 154 pregnancies in cyclosporine treated female transplant recipients. *Transplantation* 1995 57:502-6.
- Biesenbach G, Zazgornik J. Incidence of transient nephrotic syndrome during pregnancy in diabetic women with and without pre-existing microalbuminuria. *Br Med J* 1989; 299:366-7.
- Combs CA, Kitzmiller JL. Diabetic nephropathy and pregnancy. 1991; 34(3):505-15.
- Cunningham FG, Cox SM, Harstad TW, et al. Chronic renal disease and pregnancy outcome. *Am J Obstet Gynecol* 1990 163:453-59.
- Davison JM. Dialysis, Transplantation, and Pregnancy. *American Journal of Kidney Diseases* 1991; XVII (2):127-32.
- Elliott JP, O'Keeffe F, Schon DA, Cherem LB. Dialysis in pregnancy: a critical review. *Obstetrical and Gynecological Survey*, 1991; 46(6):319-24.
- Fukuda O, et al. Acute glomerulonephritis during the third trimester of pregnancy. *Int J Gynecol Obstet* 1988; 26:141-44.
- Hayslet JP. Postpartum renal failure. *N Engl J Med* 1985; 312(24):1556-59.
- Hemmelder MH, de Zeeuw D, Fidler V, et al. Proteinuria: a risk factor for pregnancy-related renal function decline in primary glomerular disease. *American Journal of Kidney Diseases* 1995; 26(1):187-92.
- Hendricks SK, Ross SO, Krieger JN. An algorithm for diagnosis and therapy of management and complications of urolithiasis during pregnancy. *Surg Gynecol Obstet* 1991 172:49-54.
- Hou SH, Grossman SD, Madias NE. Pregnancy in women with renal disease and moderate renal insufficiency. *The American Journal of Medicine* 1985; 78:185-94.

Hou S. Peritoneal dialysis and haemodialysis in pregnancy. *Bailliere's Clinical Obstetrics and Gynaecology* 1987; 1(4):1009-25.

Hou, SH. Pregnancy in women on haemodialysis and peritoneal dialysis. *Bailliere's Clinical Obstetrics and Gynaecology* 1994; 8(2):481-99.

Javier-Perez A. Renal thrombotic microangiopathy in a pregnant patient with membranoproliferative glomerulonephritis. *Nephron* 1988; 49:86-7.

Jones DC, Hayslett JP. Outcome of pregnancy in women with moderate or severe renal insufficiency. *N Engl J Med* 1996; 335:226-32.

Jones DC. Pregnancy complicated by chronic renal disease. *Clin Perinatol* 1997 24(2):483-96.

Jungers P, Houillier P, Forget D, Henry-Amar M. Specific controversies concerning the natural history of renal disease in pregnancy. *American Journal of Kidney Diseases* 1991; XVII (2):116-22.

Katz AI, Davison JM, Hayslett JP, Singson E, Lindheimer MD. Pregnancy in women with kidney disease. *Kidney International* 1980; 18:192-206.

Kimmerle R, Zass RP, Cupisti S, et al. Pregnancies in women with diabetic nephropathy: long-term outcome for mother and child. *Diabetologia* 1995 38:227-35.

Kitzmiller JL, Brown ER, Phillippe M, Stark AR, Acker D, Kaldany A, et al. Diabetic nephropathy and perinatal outcome. *Am J Obstet Gynecol* 1981; 141:741-51.

Krane NK. Acute renal failure in pregnancy. *Arch Intern Med* 1988 148:2347-57.

**\*Lindheimer MD, Cunningham FG: Renal diseases complicating pregnancy. Cunningham, MacDonald, Gant, Leveno, Gilstrap, Eds. Williams Obstetrics Supplement 1994; 6S:1-14.**

Lindheimer MD, Katz AI. Gestation in women with kidney disease: prognosis and management. *Bail Clin Obstet Gyn* 1994 8(2): 387-404.

Lindheimer MD, Grunfeld JP, Davison JM. Renal disorders. Barron and Lindheimer eds. Medical Disorders During Pregnancy 2nd Ed, St. Louis. Mosby. 1995 p 37-62.

Lindheimer MD and Davison JM. Renal biopsy during pregnancy: To b or not to hb? (Editorial) *British Journal of Obstetrics and Gynecology*. 1987; 94:932-4.

Maikranz P, Katz AI. Acute renal failure in pregnancy. *Obstetrics and Gynecology Clinics of North America* 1991; 18(2):333-9.

Mackay EV. Pregnancy and renal disease. A Ten-Year survey. Aust NZJ Obstet Gynaec 1963; 3:21-4.

Packham DK, North RA, Fairley KF, Ihle BU, Whitworth JA, Kincaid-Smith P. Pregnancy in women with primary focal and segmental hyalinosis and sclerosis. Clinical Nephrology 1988; 29(4):185-92.

Packham DK, North RA, Fairley KF, Kloss M, Whitworth JA, Kincaid-Smith P. Primary glomerulonephritis and pregnancy. Quarterly Journal of Medicine 1989;71(266):537-53.

Peckham D, Fairley KF. Renal biopsy: indications and complications in pregnancy. British Journal of Obstetrics and Gynecology. 1987; 4:935-9.

Reece EA, Coustan DR, Hayslett JP, Holford T, Coulehan J, O'Connor TZ, Hobbins JC. Diabetic nephropathy: pregnancy performance and fetomaternal outcome. Am J Obstet Gynecol 1988; 159:56-66.

Redrow M, Cherem L, Elliott J, Mangalat J, Mishler RE, Bennett WM, et al. Dialysis in the management of pregnant patients with renal insufficiency. Medicine 1988; 67(4):199-208.

Registration Committee of the European Dialysis and Transplant Association. Successful pregnancies in women treated by dialysis and kidney transplantation (report). 1980; 87:839-45.

Rizzoni G, Ehrich JHH, Broyer M, Brunner FP, Byrnger H, et al. Successful pregnancies in women on renal replacement therapy: report from the EDTA Registry. Nephrol Dial Transplant 1992; 7:279-87.

Schieve LA, Handler A, Hershow R, et al. Urinary tract infection during pregnancy: its association with maternal morbidity and perinatal outcome. Am J Public Health 1994 84:405-10.

Sibai BM, Ramadan MK. Acute renal failure in pregnancies complicated by hemolysis, elevated liver enzymes, and low platelets. Am J Obstet Gynecol 1993; 168:1682-90.

Sturgiss SN, Davison JM. Perinatal outcome in renal allograft recipients: prognostic significance of hypertension and renal function before and during pregnancy. Obstetrics & Gynecology 1991; 78(4): 573-77.

Sturgiss SN, Davison JM. Effect of pregnancy on long term function of renal allografts. American Journal of Kidney Diseases 1992; XIX(2):167-72.