A Successful 39-Week Pregnancy on Hemodialysis: A Case Report

CNE Continuing Nursing Education

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Pregnancy in women on hemodialysis is very uncommon, and rates of spontaneous abortion, hypertension, pre-eclampsia, polyhydramnios, pre-term labor, and premature birth are high. This article documents a successful 39-week pregnancy in a woman who conceived at Stage 5 in chronic kidney disease and who started hemodialysis at 7 weeks gestation. The dialysis prescription included 3-hour treatments 5 times weekly. Blood urea nitrogen levels and fluid removal by ultrafiltration were managed according to the recommendations in the available literature. Erythropoietin and IV iron were utilized liberally for her worsening anemia. She was closely monitored by a multidisciplinary team at the dialysis center and by the perinatologist in her health care system. Pre-term labor and premature birth were avoided; however, she developed hypertension, pre-eclampsia, and polyhydramnios. She delivered a healthy female by scheduled cesarean section. There is limited data on management of this minority population, and much can be learned regarding mineral metabolism, safety and use of medications, control of hypoalbuminemia, and care practices to reduce the incidence of maternal complications and premature birth.

Goal:
To increase awareness about pregnancy in women on hemodialysis for nephrology nurses and other healthcare professionals.

Objectives:
1. Discuss management practices as cited in the literature review in caring for a pregnant patient on hemodialysis.
2. Outline the first, second, and third trimester CKD treatments, including delivery procedure, as presented in the case study.

Women living with significant renal insufficiency or renal failure achieve pregnancy rarely or uncommonly, and successful pregnancy outcomes remain remarkable, especially in women dependent on dialysis (Bagon et al., 1998; Hou, 1999; Hussain, Savin, Piering, Tomasi, & Blumenthal, 2005; Okundaye, Abrinko, & Hou, 1998). Medical and nursing personnel in many nephrology departments and dialysis centers have no experience with the management and care of a patient on dialysis who is pregnant (Bagon et al., 1998; Okundaye et al., 1998). In 1998, Okundaye and colleagues claimed that no individual dialysis center had enough experience to develop guidelines for the management of the pregnant woman on dialysis. Since then, however, several case studies, case reports, expert reviews, and retrospective studies have been published and were reviewed by the authors of this case report. For example, Hou and Grossman (2007) presented clear management recommendations for the patient on dialysis who is pregnant. They described management of hypertension, use of antihypertensive medications, fluid volume control, dialysis regimens, dialysate solutions, and treatment of anemia and pregnancy complications.

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Literature Review

The incidence of pregnancy in women with chronic kidney disease (CKD), particularly those on dialysis, was researched in works from 1975 through 2007. Ackrill, Goodwin, Marsh, Stratton, and Wagman (1975) stated that their case report was only the third published on a successful pregnancy, and that although a live birth was possible, there was significant danger to the mother and fetus. Hou (1994a) conducted a survey of 206 dialysis units in which 1,281 women of childbearing age received care. One and one-half percent (1.5%) of these women became pregnant during the 2-year study period, and 37% gave birth to a live infant. With

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one exception, all births were premature. Forty-four percent (44%) of these pregnancies were lost to spontaneous abortion, most frequently in the second trimester. Ginsburg and Owen (1993) described pregnancy incidence as rare (0.9%) in women on hemodialysis. Giatras, Levy, Malone, Carlson, and Jungers (1998) conducted a literature review for their case study and identified 120 pregnancies in patients on dialysis published between 1971 and 1998. These authors estimated the incidence of pregnancy was between 0.75% and 7%. They noted that data collection is most likely incomplete due to pregnancies that are spontaneously lost before they are confirmed. Holley and Reddy (2003) reviewed studies from 1992 to 2003 and agreed that the pregnancy rate can be estimated at 1% to 7%, and they found that births of surviving infants ranged from 30 % to 50%. These authors also noted that it wasn't clear in 2003 whether the incidence of pregnancy was increasing because there were no comprehensive prospective studies; researchers and experts have had to rely on surveys, retrospective reviews, and case reports for data. Hou and Grossman (2007) stated that the frequency of pregnancy in American women on dialysis is approximately 0.5% per year, and 60% to 70% are successful if the mother reaches the second trimester. If dialysis is begun after conception, these authors estimated the likelihood of a live birth at 75% to 80%. Imbasciati and colleagues (2007) indicated that pregnancy in women with significant renal insufficiency in CKD Stages 3 to 5, whether or not on dialysis, remains a rare event, and therefore, data are limited to small studies and case reports. These researchers suggested that large multicenter or even multinational studies might provide needed data. Finally, in a recent editorial comment, Lindheimer and Davison (2007) noted that despite relative infertility, women on dialysis can and do conceive, and successful live birth rates are increasing.

The authors' upstate New York, hospital-based, renal care center manages dialysis care for approximately 275 patients on incenter hemodialysis, home hemodialysis, and peritoneal dialysis. A case report is presented in this article, as well as a related literature review on DL, the authors' first patient on hemodialysis who was pregnant, and her successful delivery of a healthy daughter at 39 weeks gestation.

Case Report: Medical and Surgical History

DL was initially diagnosed with chronic interstitial nephritis by renal biopsy in 2003. She is African-American. Her family history is positive for an unknown type of kidney disease in extended family, hypertension (HTN) in both maternal and paternal grandparents, diabetes in her father, and esophageal cancer in her mother, who died at age 47. Her medical history includes asthma, acid reflux disease, obesity, fracture of left tibia and fibula, and smoking. She had reduced her smoking from one-half pack to 2 to 3 cigarettes per day in 2006. DL had two successful full-term pregnancies in 1993 and 1997, and three first trimester pregnancy losses prior to her renal disease diagnosis in 2003. She is allergic to penicillin. Her surgical history includes repairs of the left leg fracture and two cesarean sections.

DL's CKD progressed to Stage 5 by October 2006 when she was seen by the nephrology medical director in the CKD clinic. She was 33 years old, felt reasonably well except for some fatigue, and continued to work and take care of her children. Her serum creatinine was 5.9 mg/dL, corresponding to a glomerular filtration rate (GFR) of 11. Her hematocrit (Hct) was 29.9%; serum albumin was 3.4 g/dL. Her blood pressure (BP) was 120/74, her weight was 122.7 kg, her lungs were clear, and she had no detectable peripheral edema. She attended a patient education class regarding dialysis choices, chose hemodialysis, and agreed to a referral to a vascular surgeon for fistula creation. DL reported a missed menstrual period to the surgeon; the pre-operative human chorionic gonadotropin (hCG) blood test result was 131,265 the first week in December. She was immediately scheduled to start dialysis on December 6, pelvic ultrasound confirmed a 7.2 week-old fetus, and an arteriovenous (AV) catheter was placed for hemodialysis access. Her fistula surgery was cancelled.

Hemodialysis Prescription

The medical director immediately initiated a search for current management guidelines for the patient on dialysis who is pregnant and placed DL on medical disability from her job for the duration of her pregnancy. Recommendations for more frequent dialysis sessions and the known risks of spontaneous abortion, pre-term labor and delivery, and pregnancy complications were discussed with DL at length. She and her husband were clear in their expressed desire to continue this pregnancy. DL was referred to the perinatologist in the authors' hospital system and had her first visit with him and his nurse practitional(NP)/nurse manager on December 13.

Initial literature review revealed general agreement that hemodialysis frequency should be increased during pregnancy, with differences of opinion on the numbers of hours and days per week of treatments. Jungers and Chauveau (1997) stated that daily dialysis sessions had been proposed as a way to keep blood urea nitrogen (BUN) levels low, thereby reducing azotemia in the fetal environment and allowing for slower, gentler ultrafiltration (UF). Giatras and colleagues (1998) developed a renal/obstetric protocol of four-hour dialysis sessions 4 times weekly, which were designed to keep their patient's predialysis BUN less than 50 mg/dL. The patient's persistent headaches during dialysis prompted a reduction to three and one half-hour sessions after 28 weeks gestation. She delivered a live infant at 33 weeks. Vidal et al. (1998) presented a case study of four women, all of whom

delivered live infants at 27 to 34 weeks. They began with three-hour sessions six times weekly for each patient, and made eventual increases in time when required to maintain BUN at less than 37 mg/dL. Molaison, Baker, Bordelon, Brodie, and Powell (2003) reported that BUN levels in their patient were maintained at less than 50 with six times weekly dialysis sessions ordered; however, the patient missed treatments every month and averaged 13 to 14 hours per week of dialysis. She delivered a live infant at 31 weeks.

Holley and Reddy (2003) suggested that based on their literature review, pregnant women beyond 16 to 20 weeks gestation generally require dialysis 16 to 24 hours per week to maintain a predialysis BUN of less than 50 mg/dL, an appropriate goal for higher infant birth weight and improved chances of survival. Haase et al. (2005) reported a prospective study of five pregnant patients in their center. These authors stated they could find no systematic nephrology and obstetric treatment approach in the literature, and they developed a protocol to control predialysis BUN by prescribing "as much dialysis per week as the women were able to tolerate, but at least 24 [hours]/week" (p. 2538). Their protocol was designed to reduce predialysis BUN and limit polyhydramnios, reduce shifts in fluid volume, limit electrolyte imbalance, and prevent hypotension during dialysis. They reported reduction of interdialytic BUN to 22 to 50 mg/dL by the end of their patients' pregnancies. All patients delivered live infants between 30 and 37 weeks gestation.

Case Report: Hemodialysis

Hemodialysis was started for DL as soon as her pregnancy was diagnosed at seven weeks. Diaylsis was started with 5, 3-hour sessions per week; to maintain the weekly BUN levels less than 50 mg/dL, increasing dialysis time was possible. BUN levels were ordered predialysis on Mondays since she did not dialyze on Sundays. Initial orders by the medical director included a 2 mEq/L potassium, 2.5 mEq/L calcium, 35 mEq/L bicarbonate dialysate solution, a Baxter Exeltra™ 210+ High Flux dialyzer, and use of a Crit-Line™ monitor with each dialysis session to monitor and limit blood volume change and record hemoglobin and hematocrit (H&H) levels. Protocol BP readings were ordered, with maintenance of systolic BP at or greater than 120 to prevent dialysis-induced hypotension, which is considered by several authors reviewed to be a cause of fetal distress and possibly pre-term labor (Ackrill et al., 1975; Davison, 1991; Hou, 1999; Okundaye et al., 1998). The NP was responsible for establishing and changing estimated dry weight (EDW) by weekly and PRN physical assessments, pre- and post-dialysis weights, blood volume measurements, BP, and DL's signs and reported symptoms (Holley & Reddy, 2003; Hou, 2003; Hou & Grossman, 2007).

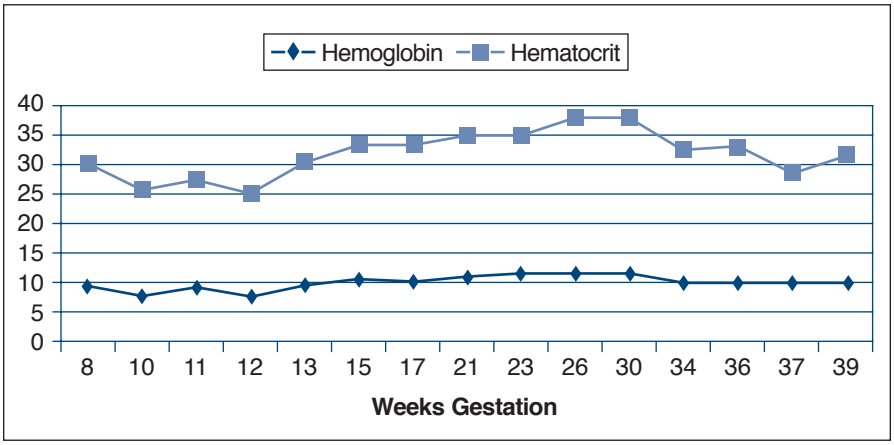
First Trimester

DL began hemodialysis with continued patient education regarding her need for increased dialysis time, the process and purposes of the dialysis treatment, monitoring of laboratory values and their meanings, and the use, care, and safety precautions for her tunneled AV catheter. Brookhyser, Kinzer, and Pahre (1996) stressed dialysis care consistency and limiting the number of staff caring for the pregnant patient. A care team for DL and her family was formed, which included the nephrologist, one dialysis center NP, the nurse manager and a core group of nurses who would dialyze her, one dietitian, and one social worker. The NP communicated the initial referral information to the perinatologist and perinatal center NP; thereafter, weekly and PRN laboratory results, EDW and fluid status information, BP ranges, and any signs and symptoms believed to be significant were sent. Guidelines for DL's fluid status determination, EDW, gentle ultrafiltration, acceptable BP levels, and the reporting of any signs and symptoms were discussed with core group nurses and provided to them in writing. The NP worked individually with the nurses as they became more comfortable with DL's needs and proficient in her care.

Initial medications ordered were IV Epogen, oral ferrous sulfate ($FeSO_4$) and Diatx® Zn as DL's daily vitamin supplement. DL's Hgb and Hct (H&H) the first week on dialysis were 9.5 g/dL and 29.9% respectively. The goal of the authors was to maintain DL's hemoglobin level at 10 to 11 gm/dL (Bagon et al., 1998; Hou, 1994b; Malik et al., 2005). The anemia of CKD can worsen significantly during pregnancy with expected plasma volume expansion and the patient's limited ability to increase her red blood cell (RBC) production; exogenous erythropoietin is recommended commonly in the literature the authors reviewed (Giatras et al., 1998; Hou, 1999, 2002; Jungers & Chauveau, 1997). Hou and Grossman (2007) reported that use of erythropoietin has become common practice with patients on dialysis who are pregnant, and significantly larger doses may be required. Erythropoietin is a pregnancy category C drug, and although data are limited, Hou and Grossman (2007) noted there have been no reports of congenital anomalies in infants whose mothers were taking erythropoietin from early in pregnancy. Epoetin alfa (Epogen®) 2,000 units IV during each dialysis treatment was ordered and gradually increased as DL's H&H decreased during weeks 8 through 12 of her pregnancy. RBC transfusions were required twice for drops in H&H to 7.7 g/dL and 25.8%, and 7.5 g/dL and 25.2% between weeks 10 and 12. Pelvic ultrasound ruled out bleeding or hematoma, stool testing for occult blood was negative, and hemoglobin variant screening identified no abnormal hemoglobin. DL's TSAT was 12%; ferritin level was 55.7 ng/mL. She was asked to take $FeSO_4$ 325mg orally 2 to 3 times per day as tolerated.

It was hoped that DL could be dialyzed heparin-free; however, by week 11 of her pregnancy, her dialysis system was clotting and requiring saline flushing of 50 to 100 mL recur-

Figure 1
Hemoglobin and Hematocrit Values During Pregnancy



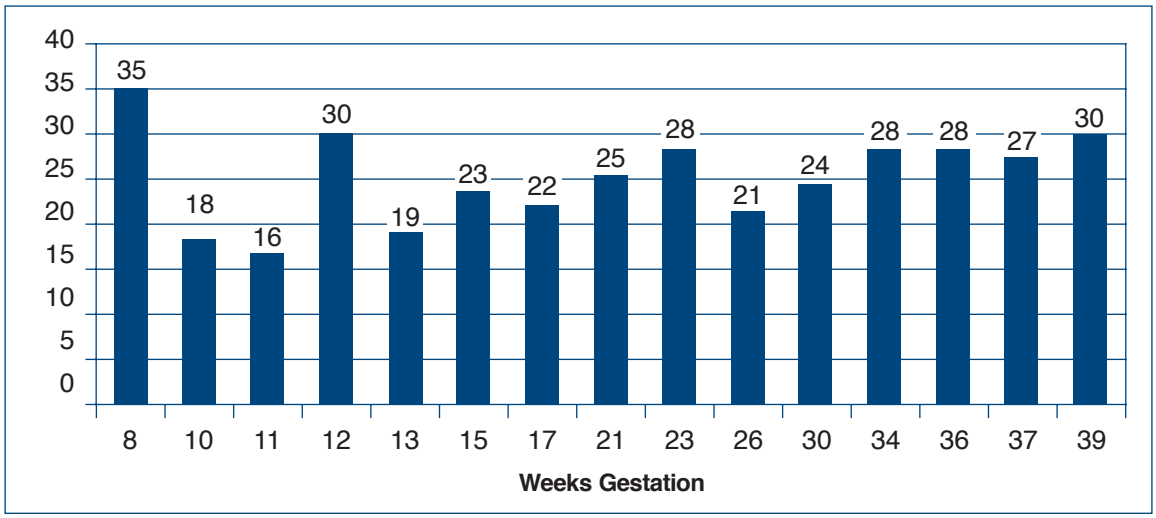
rently during each treatment. Heparin was recommended as safe by the perinatologist and was explored in the literature. There was general agreement in the case studies and expert reviews that heparin appears to be safe and has been commonly utilized in the smallest doses required for prevention of extracorporeal circuit clotting (Giatras et al., 1998; Holley & Reddy, 2003; Hou, 1999; Malik et al., 2005). Hou (1999) recommended heparin-free dialysis only for women experiencing bleeding problems. A heparin-loading dose of 1,000 units at the start of every dialysis treatment during week 11 was ordered; however, this was not sufficient, and the dose was increased to 2,000 units with an additional infusion of 1,000 units per hour during the second and third hours of each treatment. This dose was effective for the remainder of DL's pregnancy. Heparin 1,000 units/mL was also started to fill the AV catheter lumens after an incident of venous port clotting.

DL started dialysis at an EDW of 118 kg; she had lost 4.7 kg since becoming pregnant. She gained little or no weight the first two weeks on dialysis, had no appreciable edema, and her lungs were clear to auscultation. Very gentle dialysis treatments were performed with minimal to no UF goals while maintaining her BP at 120/60 or greater. The determinations of EDW, changes in weight as pregnancy advances, and how much fluid is being retained at any time are recognized as very challenging tasks (Brookhyser et al., 1996; Hou, 2002; Hou & Grossman, 2007; Shemin, 2003). Volume-controlled UF with frequently adjusted UF goals and EDW assessments are recommended, and assessments of target weight each week must include estimations of fetal and placental growth, as well as blood volume changes and solid weight gains (Bagon et al., 1998; Brookhyser & Wiggins, 1998; Holley & Reddy, 2003). DL's EDW was raised to 119 kg during week 10. Morning sickness was an intermittent problem affecting her appetite, and her weight fluctuated between 117 kg and 121 kg during the next four weeks.

Weekly pre-dialysis BUN levels ranged from 16 to 35 mg/dL throughout the first trimester; therefore, 3-hour treatments five times weekly were continued. The potassium level in the dialysate was changed to 3 mEq/L. The patient's intact parathyroid hormone (iPTH) level was 436 pg/mL when she started dialysis; this dropped to 263 by the end of her first trimester. The plan was to avoid treating with medication during the pregnancy if the level remained under 600. Both calcitriol and paricalcitol are category C drugs; Brookhyser et al. (1996) reported discontinuation of IV calcitriol due to the lack of information and speculation that the large doses normally given to patients on dialysis might affect a fetus' parathyroid development. They did use oral calcitriol with their case study patient to maintain her normal 1,25 dihydroxycholecalciferol levels. Hou (1999) reported that 1,25 vitamin D products are often continued in oral or IV form, "although their effect in pregnancy is not well understood" (p. 247). The authors did not find information regarding paricalcitol use in patients on dialysis who were pregnant. DL's serum-adjusted calcium levels remained between 9.2 and 10 mg/dL, and her calcium x phosphorus product range was 33 to 50 throughout her pregnancy. DL's H&H rose to 9.8 g/dL and 30.7% by the start of the second trimester (see Figure 1). The Epogen dose had been gradually increased to 8,000 units each treatment. DL's BP remained between 120/72 and 142/81 at dialysis. The perinatologist and his nursing staff saw her every two weeks. He monitored fetal growth and heart rate by ultrasound, with reassuring evaluations. He planned to increase the frequency of visits after she reached 24 weeks gestation. DL accepted oxygen at 2L/min via nasal cannula and rested on her left side much of the time during dialysis.

DL had received initial dietary education prior to starting dialysis. The dietitian began an assessment of her nutritional status and needs during the first week of treatments. They discussed diet history, usual meal patterns, food likes and dislikes, her early pregnancy nausea, and weight loss. Her serum albumin had decreased to 3.0 g/dL. Proteinuria measurement was 2,724 mg/24 hours. Her protein and calorie needs for pregnancy were calculated using ideal body weight plus 10 grams of protein. A liberal protein intake of 1 to 1.5 g/kg/day has been recommended in the literature to maintain adequate stores and because the greater frequency of dialysis treatments tends to reduce BUN levels (Brookhyser & Wiggins, 1998; Haase et al., 2005; Wiggins, 2002).

Figure 2
BUN Value Before Dialysis Treatment



She was allowed liberal potassium and phosphorus-rich foods since levels were well within normal limits with increased dialysis frequency, and no phosphate binders were prescribed (Brookhyser & Wiggins, 1998; Shemin, 2003; Vidal et al., 1998). Oral fluid intake was liberal as well, since urinary output was substantial, weight gains were zero to minimal amounts, and she had no apparent edema. DL was enrolled in New York's WIC program, a supplemental nutrition program for pregnant, postpartum, and breastfeeding women and their infants and young children.

The social worker met DL on her first day of dialysis to begin assessment and provide support to her and her family. Beginning dialysis with a new, unplanned pregnancy was recognized as a doubly challenging, major life transition. The psycho-social assessment process included DL's understanding of her diagnosis, treatment expectations, her coping skills, home and family environment, the support system available to her, and her adjustment to the demanding dialysis routine and loss of her wage-earner role. DL's strengths and weaknesses were assessed and discussed with her, and community resources were explored to assist her and her family. She was guided through the disability benefits process, her husband and children were adjusting to her treatment schedule, and she was coping positively throughout her first trimester.

Second Trimester

Morning sickness subsided; however, DL found the oral $FeSO_4$ difficult to comply with and experienced constipation. IV iron use was researched, and the authors confirmed that it was safe to use with the perinatologist. Hou and Grossman (2007) found that iron requirements are greater in patients on dialysis who are pregnant and have used IV dosing. Oral iron absorption is poor in patients on hemodialysis, and IV iron is recommended to achieve a TSAT of 30% to 50% (Giatras et al., 1998; Haase et al., 2005). Oral iron was discontinued, and IV iron sucrose injection (Venofer®) (category B) 100 mg for 2 doses was started, then 50 mg weekly, with weekly monitoring of H&H and monthly monitoring of iron stores.

DL's pre-dialysis BUN levels ranged from 17 to 30 mg/dL through the second trimester; urea reduction ratio (URR) range was 53.8% to 70.8% (see Figure 2). Her initial treatment schedule was continued, and Epogen dosing was increased to 10,000 units per treatment, then decreased gradually as H&H rose by week 27 to 11.9 g/dL and 38.5%. She had two elevations in her white blood count (WBC) in the first two trimesters; she denied symptoms, and blood and urine culture results were negative. WBC counts returned to within normal limits spontaneously.

DL's EDW gradually increased to 126 kg by week 24; she had experienced weight gains of 0 to 2 kg between treatments with no apparent edema. Gentle UF was effective for fluid removal. OB ultrasounds revealed an active, growing fetus with appropriate amniotic fluid levels. She saw the perinatologist every two weeks, and she continued to walk daily and care for her home and family.

BP levels began to rise after week 15, ranging from 130s/70s to 150s/80s through week 20, and then increased gradually at times to the 150s/90s by week 27. By week 26, DL had developed 1+ to 2+ edema in her lower extremities; the dialysis team began to carefully increase her UF rate as tolerated to relieve the edema. The authors' review of the literature did not reveal ideal BP levels to achieve or elevated levels at which to begin considering antihypertensive medication. Jungers and Chauveau (1997) stated that many nephrologists agree on more aggressive treatment of HTN when it is pre-existing or develops

early in pregnancy, but optimal BP levels are still being debated. They reported their best fetal outcomes were achieved with a diastolic BP between 80 and 90 mmHg. "There are no careful studies of hypertension among pregnant dialysis patients" (Holley & Reddy, 2003, p. 385). HTN in the patient on dialysis who is pregnant is the most common and most frequently reported maternal complication, affecting to some degree up to 40% to 80% of women (Hou & Grossman, 2007; Shemin, 2003). Hou (1999) reported that more than half of patients on dialysis who are pregnant and who have HTN have BP levels exceeding 170/110 at some time during pregnancy, and many require antihypertensive medication. The occurrence of HTN in these women is often difficult to understand because it may be secondary to the use of Epogen, to the pregnancy itself, and/or to the underlying renal disease (Giatras et al., 1998). Holley and Reddy (2003) and Shemin (2003) recommended fluid volume control with careful UF goals that consider expected pregnancy weight gains to manage HTN. This is recognized as difficult, and hypotension must be avoided. Hou (2003) argued that "the magnitude of the volume expansion, and thus, the appropriate increase in target post-dialysis weight, is not known and is probably not uniform for all patients" (p. 377). Frequent physical assessment to identify fluid overload and determine EDW is the best approach to reduce BP elevations, as is common practice with the general dialysis population (Hou, 2003). When the patient remains hypertensive with effective fluid control, alpha-methyldopa, labetolol, and hydralazine are considered to be safe (Holley & Reddy, 2003; Hou & Grossman, 2007; Jungers & Chauveau, 1997). Calcium channel blockers have been used in severe HTN (Holley & Reddy, 2003; Hou, 1999). Diuretics are avoided to prevent fluid volume contraction; and ace inhibitors and angiotensin receptor blockers are contraindicated due to their association with fetal malformations and death (Hou & Grossman, 2007; Pryde, Sedman, Nugent, & Barr, 1993; Saji, Yamanaka, Hagiwara, & Ijiri, 2001).

Dialysis was continued with gradually increasing UF goals as BP levels allowed to reduce the edema; DL's EDW was increased to 128 kg by week 28. The perinatologist did not wish to treat her BP with medication because he was concerned this might mask developing signs of pre-eclampsia. He had increased her OB evaluation frequency to weekly with nonstress tests and OB ultrasounds. Liver function tests were added to DL's weekly laboratory studies. She was instructed to report any upper abdominal discomfort, nausea, or right-sided epigastric pain, and to rest at home whenever possible.

DL's serum albumin level decreased significantly during her second trimester from 2.6 g/dL at week 13 to 2.1 g/dL at week 21. She reported relief from the nausea of her first trimester by week 14. Her phosphorus and potassium levels remained within normal limits, with liberal protein and potassium food sources allowed. The dietitian met with her frequently; she stressed the importance of a daily variety of high quality protein food sources for meals and snacks, including DL's personal choices and the foods provided by the WIC nutrition program. DL insisted her appetite was good with three full meals and snacks daily. Her serum albumin remained between 2.1 and 2.3 g/dL with the addition of liquid protein supplements.

The social worker continued to meet with DL during dialysis treatments to offer support and counseling. DL wanted to travel in April to visit family. She agreed to a shortened trip requiring only two dialysis treatments out of town, and this was allowed by the perinatologist. The social worker arranged the dialysis treatment appointments, and the NP telephoned a report with treatment orders, UF guidelines, and precautions to the receiving dialysis center's nurse manager and nephrologist. DL and family traveled during week 26 with no complications.

Third Trimester

DL's edema increased with a weight gain of 4 kg between weeks 27 and 29. Nurses increased her UF rate gently according to each day's estimation of fluid retention. This decreased the edema temporarily, and her BP remained below 160/100. The perinatologist determined that she was developing pre-eclampsia and ordered bed rest as much as possible. He indicated he would continue to avoid use of antihypertensive medications if possible. The authors' literature review revealed that because pregnancy is uncommon in women with kidney disease and data are limited, there is uncertainty about the extent to which kidney disease affects the development of pre-eclampsia (Fischer, Lehnerz, Hebert, & Parikh, 2004). Superimposed pre-eclampsia is a frequent complication in women with kidney disease but is a difficult diagnosis to make; there are no reliable therapies to prevent it (Hou, 1999; Jungers & Chauveau, 1997). Malik et al. (2005) reported that any worsening of hypertension occurring in the second half of their patients' pregnancies was considered to be pre-eclampsia. These authors identified 8 pregnancies out of 12 with this complication, resulting in four live births.

The social worker arranged transportation for DL for all treatments and appointments, and explored community and social services resources for needed infant items. The dietitian worked with her on limiting sodium content and higher phosphorus-rich foods as her serum phosphorus level rose to 5.2 mg/dL. Intact PTH also rose from 423 pg/mL at week 29 to 628 pg/mL by week 34. The decision was made not to treat with medication until delivery, and DL controlled phosphorus levels to below 5 mg/dL thereafter. The nurse manager and NP scheduled a conference with the nurse managers of the labor and delivery, maternity, NICU units, and perinatal center to inform them of DL's needs and complications so they could prepare for her hospital admission.

Gestational diabetes was diag-

nosed during week 30. DL was instructed in chemstrip testing; she reported all fasting glucose levels as less than 114 mg/dL with an occasional 2 hour pc reading greater than 150 mg/dL. BP levels remained unchanged during the next four weeks. Liver function test results were within normal limits, her weight fluctuated between 128 and 131 kg, and edema in her hands and lower extremities remained persistent at 1+ to 2± 4. Fetal heart rate testing and OB ultrasounds revealed an active, growing fetus with normal amounts of amniotic fluid until week 34, when polyhydramnios was identified. This complication is noted to be very common among women on dialysis, possibly related to the removal of solutes during treatments that may result in decreases in oncotic pressure, leading to shifting of more fluid into the amniotic cavity (Brookhyser & Wiggins, 1998; Malik et al., 2005).

Hou (1999) and Jungers and Chauveau (1997) reported that the fetus with normal renal function is exposed to the mother's higher BUN levels; this probably causes an osmotic diuresis into the amniotic space, resulting in or aggravating polyhydramnios. It was further noted that polyhydramnios might be an important contributing factor to premature labor and birth (Bagon et al., 1998; Haase et al., 2005; Hou, 1999), and prematurity "is the greatest cause of morbidity and mortality in the infants of women with renal disease" (Hou, 1999, p. 248). Bagon et al. (1998) reviewed the records of five pregnancies in patients on dialysis; four had polyhydramnios, and all women delivered premature infants of low birth weight due to preterm labor or deterioration in fetal or maternal condition. In the study by Malik et al. (2005), polyhydramnios was identified in 4 of 12 pregnancies, which resulted in premature, low birth weight infants in those four pregnancies. The maintenance of lower BUN levels with increased dialysis frequency and slow, steady UF are recommendations for decreasing the occurrence of polyhydramnios (Bagon et al., 1998; Haase et al., 2005; Jungers & Chauveau, 2007). UF rates were adjusted during each treatment according to measurements of weight gain, level of edema, and BP. Pre-BUN levels ranged from 23 to 39 mg/dL.

DL's perinatal center appointments had been increased to twice weekly with fetal heart rate monitoring and biophysical profiles. She had been reporting mild, transient Braxton Hicks contractions periodically since mid-second trimester. The perinatologist scheduled her for cesarean section at 39 weeks.

At week 37, DL's routine weekly CBC revealed a WBC count of 15,000. She denied any symptoms of illness, appeared well, and was afebrile. Blood cultures were drawn, and one vial was positive the next day for gram-negative bacilli. The nephrologist, perinatologist, and infectious disease specialist immediately agreed on hospital admission, and she was admitted to the labor and delivery unit. Amniocentesis results the following day determined the fetus to be immature. DL received IV aztreonam and cefipime for serratia marcescens bacteremia and continued to feel well; the source of the infection was suspected to be either her AV catheter or a pelvic area site. Her activity was restricted to bed rest in the hospital, and dialysis included more aggressive UF to control her edema, HTN, and increasing polyhydramnios measurements. Fetal ultrasonic biophysical profile scores were 8 out of 8 every one to two days with variable amniotic fluid index measurements.

Delivery and Recovery

DL delivered a 5 lb, 7oz (3,317 grams) daughter at 39 weeks by scheduled cesarean section; her newborn's apgar scores were 6 and 8. The infant was initially admitted to the NICU and transferred within 48 hours to the newborn nursery. DL started metoprolol for her HTN; she and her baby did well and were discharged to home in five days. She developed a fever two weeks after delivery, and blood cultures again were positive for serratia. Her AV catheter was replaced, a pelvic abscess was identified and drained, and she recovered readily. She had an AV fistula created after her postpartum recovery was complete.

Discussion

Pre-term labor is universal and almost invariable for pregnant women on dialysis, and premature birth with low birth weight remains the greatest obstetrical problem for this minority population (Bagon et al., 1998; Hou, 2002; Shemin, 2003). Even when daily dialysis is provided with successful management of anemia, electrolyte levels, and control of HTN, only 75% to 80% of these pregnancies reach the second trimester and result in surviving infants (Hou, 2003). Hou and Grossman (2007) reported that the 80% prematurity rate is commonly related to premature labor, maternal HTN, and fetal distress. These infants are often small for gestational age, though it is unclear whether this results from the azotemia or the HTN. Haase et al. (2005) reported their study as the first prospective study and successful multidisciplinary management of five pregnant women on dialysis. These authors formulated treatment protocols that included increased dialysis frequency with carefully monitored UF, prevention of hypotension, increasing doses of Epogen, avoidance of potentially dangerous medications, and close prenatal monitoring. They utilized the recommendations of Giatras et al. (1998) and Hou (1999) in developing their protocols, and stated that their standardized guidelines led to their five patients' successful outcomes. Three of their patients developed pre-term labor, and all delivered live infants between 30 and 37 weeks weighing 1,240 to 2,465 gm. They suggested that these favorable results might help guide therapy for other patients on dialysis who are pregnant.

The existing literature is based largely on single case studies, small samples of women, retrospective reviews, and therefore, limited data

analysis; much is not known about this minority population (Fischer et al., 2004; Lindheimer & Davison, 2007). However, the authors are grateful for the information in the literature reviewed and based their treatment guidelines on the advice of the many authors referenced in this article. This case report is offered as documentation of a successful pregnancy outcome and avoidance of preterm labor despite the complications of HTN, pre-eclampsia, and polyhydramnios that this patient experienced. Evidenced-based practice is important even though data are limited and risks to patients on dialysis who are pregnant remain high.

Several studies in the literature review stressed the importance of forming and maintaining a multidisciplinary team in the dialysis care and management of pregnant patients, and they advised ongoing communication between team members to discuss patient needs and status details (Brookhyser & Wiggins, 1998; Holley & Reddy, 2003; Hou, 2002; Molaison et al., 2003; Vidal et al., 1998). Following this advice allowed the authors to provide optimal medical, nursing, nutritional, and social work care for the patient. The nurse manager's decision to immediately assign a core group of nurses to dialyze DL allowed the NP to educate them on the guidelines being followed as they were providing care, and allowed nurses and the NP to adjust that care together and evaluate its effect daily. The acute care dialysis nurses were educated on DL's status and treatment guidelines prior to her hospital admission. The nurses' attention to BP levels, frequent changes in EDW assessment, UF decisions, and their consistent care of the patient may have played an important role in the prevention of pre-term labor.

Conclusion

A great deal has been learned with this first-time care opportunity, and the authors are fortunate to have had a highly motivated patient who was committed to following their facility's treatment guidelines during their learning process and who adhered to her demanding dialysis schedule. The authors are also fortunate to be part of a regional medical center system that provides a perinatologist and perinatal center staff, and a Level 3 NICU with neonatologists in close proximity to the dialysis center. Much remains to be learned about optimal care and management of pregnant women on dialysis. The information on management of mineral metabolism, particularly calcium and use of vitamin D products, is not yet clearly defined and agreed upon. Safety of the various phosphate binders is not known. Proteinuria and hypoalbuminemia, even with consistently increased protein intake and supplementation, is a significant problem for which the authors could find no known solution or effective treatment. A full understanding of the specific effects of uremia on the growing fetus is still not known, and optimal, recommended pre-dialysis BUN levels vary in the reviewed literature. These are just a few of the issues needing extensive study. Future research is needed to provide a better understanding of how the risks of HTN, pre-eclampsia, polyhydramnios, pre-term labor, and premature birth can be reduced for women living with CKD and dialysis.

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ANSWER/EVALUATION FORM

A Successful 39-Week Pregnancy on Hemodialysis: A Case Report

Mary Coyle, MS, FNP; Elyn Sulger, BSN, RN, CNN, CNA-BC, CPHQ, LNC; Cindy Fletcher, MSW, LMSW; Diane Rouse, MS, RD, CDN

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1. What would be different in your practice if you applied what you have learned from this activity?

_____

_____

_____

_____

_____

_____

GOAL To increase awareness about the care of women who are pregnant and who are on hemodialysis.

Please note that this continuing nursing education activity does not contain multiple-choice questions. This posttest substitutes the multiple-choice questions with an open-ended question. Simply answer the open-ended question(s) directly above the evaluation portion of the Answer/Evaluation Form and return the form, with payment, to the National Office as usual.

Evaluation	Strongly disagree				Strongly agree
2. By completing this offering, I was able to meet the stated objectives					
a. Discuss management practices as cited in the literature review in caring for a pregnant patient on hemodialysis.	1	2	3	4	5
b. Outline the first, second, and third trimester CKD treatments, including delivery procedure, as presented in the case study.	1	2	3	4	5
3. The content was current and relevant.	1	2	3	4	5
4. This was an effective method to learn this content.	1	2	3	4	5
5. Time required to complete reading assignment: _____ minutes.	1	2	3	4	5

I verify that I have completed this activity _____
(Signature)