OBSTETRICS

Acute pyelonephritis in pregnancy: an 18-year retrospective analysis

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OBJECTIVE: We sought to describe the incidence of acute pyelonephritis in pregnancy, and to assess its association with perinatal outcomes in an integrated health care system.

STUDY DESIGN: A retrospective cohort study was performed using medical records on 546,092 singleton pregnancies delivered in all Kaiser Permanente Southern California hospitals from 1993 through 2010. These medical records include the perinatal service system along with inpatient and outpatient encounter files. Adjusted odd ratios (ORs) and 95% confidence intervals (CIs) were used to estimate associations.

RESULTS: The incidence of acute antepartum pyelonephritis was 0.5% (2894/543,430). Women with pyelonephritis in pregnancy were more likely to be black or Hispanic, young, less educated, nulliparous, initiate prenatal care late, and smoke during pregnancy. Pregnancies of women with pyelonephritis compared to those without were more likely to be complicated by anemia (26.3% vs 11.4%; OR, 2.6; 95% CI, 2.4—2.9), septicemia (1.9% vs 0.03%; OR, 56.5; 95% CI, 41.3—77.4), acute pulmonary insufficiency (0.5% vs 0.04%; OR, 12.5; 95% CI, 7.2—21.6), acute renal dysfunction (0.4% vs 0.03%; OR, 16.5; 95% CI, 8.8—30.7), and spontaneous preterm birth (10.3% vs 7.9%; OR, 1.3; 95% CI, 1.2—1.5). Most of the preterm births occurred between 33-36 weeks (9.1%).

CONCLUSION: We characterize the incidence of pyelonephritis in an integrated health care system where routine prenatal screening for asymptomatic bacteriuria is employed. Maternal complications are commonly encountered and the risk of preterm birth is higher than the baseline obstetric population.

Key words: perinatal outcomes, pregnancy, preterm labor, pyelonephritis

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Acute pyelonephritis is one of the most common nonobstetric indications for antepartum hospitalization and is estimated to complicate up to 2% of all pregnancies in the United States.[1] While still common in developing countries, during the past few decades, the incidence of acute pyelonephritis during pregnancy has decreased substantially in developed countries. Pyelonephritis in pregnancy occurs mostly before delivery, with all but 10-20% of cases diagnosed in the second and third trimesters.[2,3] Nearly one quarter of affected women will have ≥1 recurrences during the same pregnancy.[4] Women with asymptomatic bacteriuria, defined as a urine culture from midstream collection with a single isolate of >100,000 colony-forming units of a uropathogen[2] are at increased risk of developing pyelonephritis in pregnancy compared to women without bacteriuria. Screening for and treatment of asymptomatic bacteriuria in pregnancy reduces the risk of subsequent pyelonephritis from approximately 20-35% to 1-4%.[3] Other potential risk factors that have been identified include multiparity, diabetes mellitus, urinary tract stones or malformations, and low socioeconomic status.[4,5] Untreated pyelonephritis can lead to increased risk of maternal and fetal morbidity and mortality including maternal fever, acute respiratory distress, acute renal failure, stillbirth, and preterm birth.[5]

The purpose of this study is to describe the recent trends in acute pyelonephritis among pregnant women, to accurately characterize at-risk mothers, and to examine whether acute pyelonephritis is associated with increased risk of perinatal outcomes in an integrated health care system. Previous reports in the literature describing pyelonephritis in pregnancy have been set in urban university environments.[6-8]

Materials and Methods

This was a retrospective cohort study of pregnant women delivering singletons in Kaiser Permanente Southern California (KPSC) hospitals from 1993 through 2010 (n = 546,092). KPSC is one of the largest integrated health care systems in the United States with approximately 31,000 annual deliveries, and providing comprehensive care to >3.4 million residents of Southern California.

We extracted medical records compiled electronically from all KPSC facilities. To ascertain exposures and outcomes, we used a unique maternal medical record number to link 4 different electronic medical records: the perinatal

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services system, maternal and infant hospitalization records, maternal outpatient health care encounters records, and laboratory records. The perinatal services system records contain maternal sociodemographic (age, race/ethnicity, education) and behavioral (smoking during pregnancy, timing of prenatal care initiation) characteristics as well as birthweight and gestational age at delivery from the infants' birth certificate. The maternal and infant hospitalization and outpatient physician encounter records include *International Classification of Diseases, Ninth Revision* (*ICD-9*), *Clinical Modification* (*ICD-9-CM*) codes from which we derived maternal medical history, obstetrical history, and procedures for services throughout KPSC. Microbiology laboratory records of each acute pyelonephritis patient were reviewed for the presence of uropathogens in the culture results. The study was approved by the KPSC Institutional Review Board.

Variables that were evaluated as potential confounders or mediators included maternal age (<20, 20-29, 30-34, ≥35 years); race/ethnicity categorized as non-Hispanic white (white), non-Hispanic black (black), Hispanic, Asian/Pacific Islander, and other race/ethnicity; maternal education (<12, 12, and ≥13 years of completed schooling); maternal smoking during pregnancy (yes/no); timing of initial prenatal care (first trimester, later or none); parity (0, 1, ≥2); medical conditions (chronic hypertension and pregestational diabetes); gestational diabetes; and birth year (1993 through 1995, 1996 through 1998, 1999 through 2001, 2002 through 2004, 2005 through 2007, and 2008 through 2010). Since the annual incidence rates for acute pyelonephritis were low, we chose to combine 3 years of records for statistical stability.

We used (*ICD-9*) codes 590.x to identify acute pyelonephritis. This and all subsequent diagnoses were made clinically and confirmed by laboratory tests. The outcome of interest examined in this study were: anemia (anemia complicating pregnancy childbirth or the puerperium; *ICD-9* codes 648.2x), septicemia (systemic inflammatory response syndrome; *ICD-9* codes 995.9x), acute renal failure (an abrupt or rapid decline in renal filtration function; *ICD-9* codes 584.x and 669.x), respiratory distress (*ICD-9* codes 518.8x), spontaneous preterm birth (a premature labor and delivery occurring at 20-36 completed weeks of gestation [grouped into blocks of 20-28, 29-33, and 34-36 weeks of gestation]), stillbirth (the intrauterine death of an infant >20 completed weeks of gestation), chorioamnionitis (an inflammation at the maternal-fetal interface; *ICD-9* codes 762.7x and 658.4x), preeclampsia (hypertensive disorder >20 weeks of pregnancy, combined with proteinuria and/or edema; *ICD-9* codes 642.4 and 642.5), and neonatal death (the death of a live born infant within 28 days of life). The exposure variable of interest was acute antepartum pyelonephritis (*ICD-9-CM* codes 590.1x).

We validated the accuracy of the *ICD-9-CM* coding by abstracting a random sample of 400 medical records. For this validation study, pregnancies resulting in low birthweight or premature births were oversampled to ensure adequate number of these risk factors to be reviewed. Because we applied a stratified sampling approach, the accuracy measures were estimated using weighted analyses. Abstracted records were compared with diagnosis codes collected electronically. After adjusting for sampling fractions, the estimated sensitivity, specificity, and positive and negative predictive values were 97%, 99%, 97%, and 99% for anemia; 100%, 99%, 92%, and 100% for chorioamnionitis; 82%, 95%, 74%, and 97% for group B streptoccus infection; 92%, 98%, 80%, and 99% for gestational fever; and 97%, 97%, 68%, and 100% for preeclampsia, respectively. These findings support the validity of the diagnosis codes in our study.

Gestational age data are based on a clinical estimate of gestational age and were categorized into 3 groups: 20-28, 29-33, and 34-36 weeks as well as term birth (37-42 weeks).

From 1993 through 2010, there were 546,092 singleton live births and fetal deaths recorded in all KPSC hospitals. We sequentially excluded births at <20 weeks' gestation (n = 1707), and early termination of pregnancy (n = 922). After exclusions, a total of 543,463 singleton pregnancies at ≥20 weeks of gestation remained for analysis.

Statistical analyses

We estimated the incidence of acute pyelonephritis diagnosis among singleton pregnant women delivered in all KPSC hospitals. Second, we compared the maternal demographic and behavioral characteristics between women with and without acute pyelonephritis using the χ^2 test. Differences with $P < .05$ were considered statistically significant. Third, logistic regression models were applied to examine the associations between maternal characteristics and acute pyelonephritis before and after adjusting for several potential confounding factors. Fourth, we further examined the association between acute pyelonephritis and perinatal outcomes after accounting for the effects of potential confounding factors listed in Table 1. The analyses were also stratified by spontaneous preterm birth into 3 groups defined above and by low birthweight (<1500 g and 1500-2499 g) categories to determine if associations were modified by these factors. The strength of the associations was explored based on the odds ratios (ORs) and their 95% confidence intervals (CIs). All analyses were performed using software (SAS, version 9.2; SAS Institute, Cary, NC).

RESULTS

During the 18-year study period, 2894 cases of acute antepartum pyelonephritis were identified, for an incidence level of 5.3 per 1000 births. Rates gradually increase from 4.6 per 1000 births in 1993 to 5.9 per 1000 births in 2010, reflecting a relative increase over the time period of 29%; P value for linear trends < .001. Most cases of acute pyelonephritis were diagnosed in the second and third trimester of pregnancy, accounting for 90.8% of cases in this analysis. Women were hospitalized for a mean of 2.8 days (SD 1.7). Women who were diagnosed with acute antepartum pyelonephritis were more likely to be younger, have fewer years of education, be of black or Hispanic ethnicity, smoke during pregnancy, initiate prenatal care late in