(T40.0–T40.4, T40.6); deaths that were both pregnancy associated and involved opioids contained a combination of these codes. We calculated pregnancy-associated mortality ratios, expressed as deaths per 100,000 live births, for all deaths and for those involving opioids; ratios were calculated separately for all residents, non-Hispanic whites, and non-Hispanic blacks.

We also calculated the distribution of pregnancy-associated deaths involving opioids by time of death and *International Classification of Diseases*–defined opioid type (eg, heroin [T40.1]; other natural/semisynthetic [T40.2]; methadone [T40.3]; and other synthetic [T40.4]). This study was classified as exempt by the Harvard School of Public Health Institutional Review Board. Materials to reproduce the analysis are available at https://github.com/MJAlexander/opioid-maternal.

RESULTS: Between 2007 and 2016, the pregnancy-associated mortality ratio increased 34% (31.7 to 42.3). Concurrently, pregnancy-associated mortality involving opioids more than doubled in terms of both the rate (1.3 to 4.2; Figure) and the percentage of all pregnancy-associated deaths (4% to 10%). These increases were most pronounced for white women despite their lower risk of all-cause, pregnancy-associated mortality compared with non-Hispanic black women (Figure).

The majority (70% in 2016) of pregnancy-associated deaths involving opioids occurred during pregnancy or within 42 days of pregnancy termination. The share of deaths involving methadone or natural/semisynthetic opioids (excluding heroin) declined substantially, and by 2016, 78% of deaths involving opioids were due to heroin or other synthetic opioids, up from 17% in 2007.

CONCLUSION: Similar to trends in opioid-related mortality in the general population,[3] we find a substantial increase in pregnancy-associated mortality involving opioids between 2007 and 2016. The patterns we observe, including rising trends among white women and increases in deaths involving heroin and other synthetic opioids, also mirror the broader opioid epidemic.[4]

Data from this study come from death certificates, which are known to include reporting errors related to both pregnancy status and use of opioids.[2,5] Despite this limitation, the findings indicate that interventions are urgently needed to reverse these concerning trends. ■

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Savings with expanding use of the levonorgestrel intrauterine device and fewer benign hysterectomies

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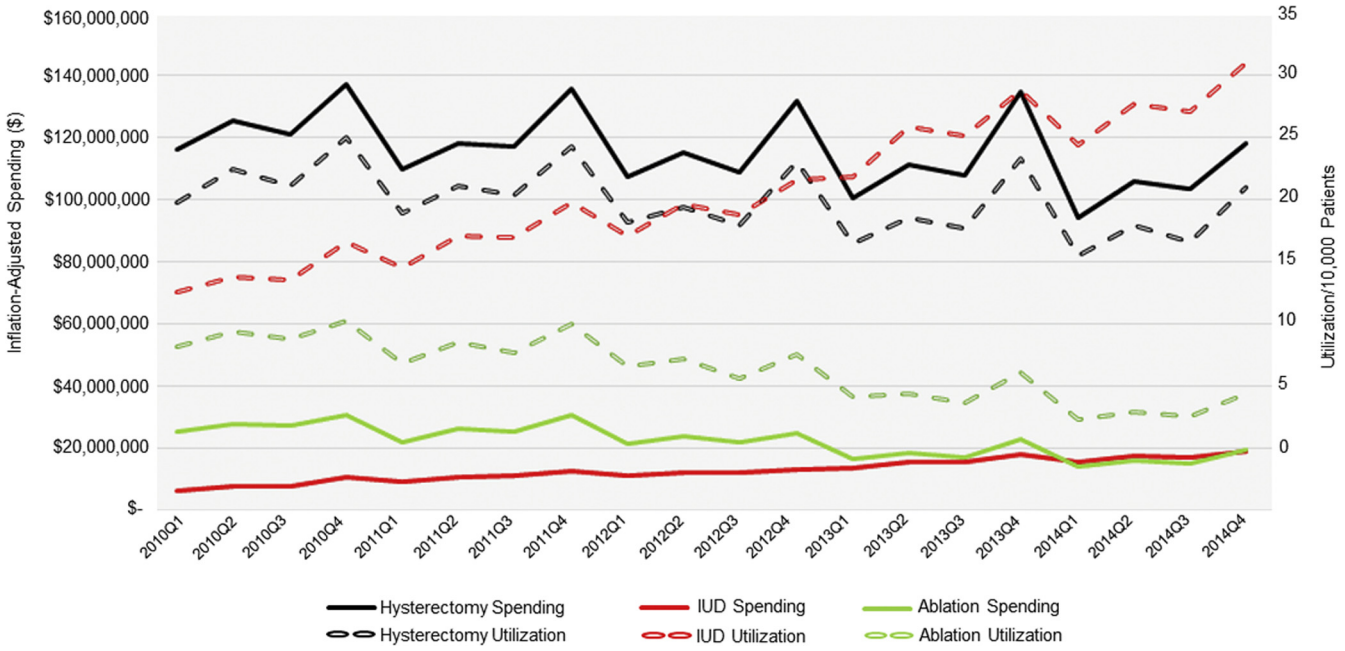
OBJECTIVE: Due to the effectiveness of levonorgestrel (LNG)-intrauterine devices (IUDs) in managing menstrual bleeding and pelvic pain disorders, professional associations recommend their use before hysterectomy.[1] Among commercially insured women, we observed overall decreases in hysterectomy utilization of 9–17% for abnormal uterine bleeding, uterine leiomyoma, and endometriosis from 2010 through 2013.[2] We hypothesized that these decreases in hysterectomy utilization were associated with a concurrently increasing use of LNG-IUD and described financial implications of these changes.

STUDY DESIGN: This is a retrospective cohort analysis of women aged 35–54 years with commercial insurance in the Health Care Cost Institute (HCCI)—an independent, nonprofit research institute with claims data for >50 million individuals nationwide. LNG-IUD insertion was identified with an *International Classification of Diseases, Ninth Revision* (*ICD-9*) procedure code for IUD insertion and a National Drug Code specific for an IUD containing LNG (Supplementary Table). Hysterectomies for bleeding and pain disorders were identified with *ICD-9* procedure and

FIGURE 1
Spending and utilization rates for levonorgestrel-IUD, hysterectomy, and endometrial ablation



Levonorgestrel-intrauterine device (IUD), hysterectomy, and endometrial ablation utilization and spending among commercially insured women aged 35–54 years, 2010 through 2014. Q, quarter.

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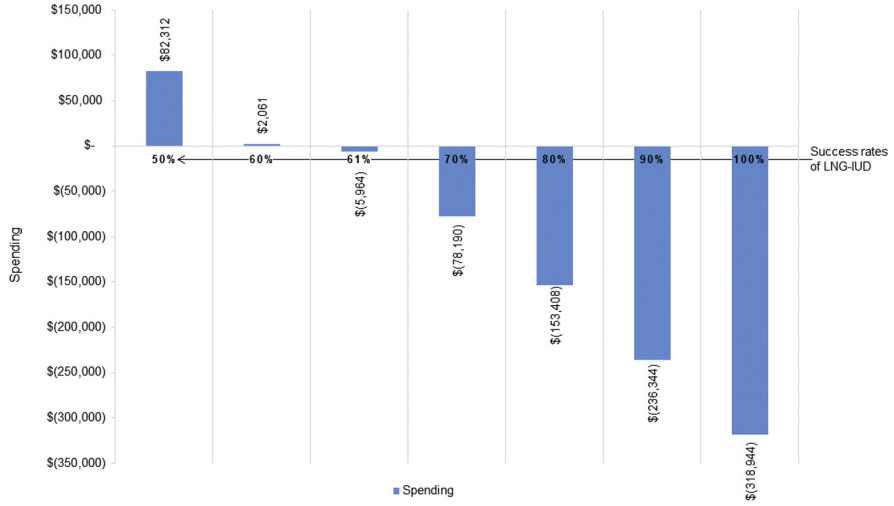
diagnostic codes. Endometrial ablations were identified with *ICD-9* procedure and *Current Procedural Terminology* codes. Quarterly utilization rates were adjusted for seasonal variation with autoregressive moving average modeling and for inflation with the medical consumer price index. Changes in utilization and spending for LNG-IUDs, hysterectomy, and endometrial ablation were assessed with generalized linear regression models. Change in number of

FIGURE 2
Savings with levonorgestrel IUD use as a function of its success rates in avoiding surgery



Spending per 100 levonorgestrel (LNG)-intrauterine device (IUD) insertions for LNG-IUD, hysterectomy, and endometrial ablation, analyzed by success rates of LNG-IUD.

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hysterectomies and endometrial ablations per 100 LNG-IUD insertions was calculated. Cost-effectiveness was modeled with a sensitivity analysis in which success rates for LNG-IUD in avoiding hysterectomy ranging from 50−100% were considered.

RESULTS: From 2010 through 2014, there were 6.82 million and 6.48 million women aged 35−54 years in the HCCI. Annual counts of LNG-IUD insertions increased (45,347−75,276) with concomitant decreases in hysterectomies (64,225−52,574) and endometrial ablations (33,435−18,575). Utilization rates and spending are illustrated in Figure 1. Per 10,000 women, the annual utilization rate of LNG-IUD insertion increased from 16.8−28.0, while the rates for hysterectomy decreased from 23.7−19.9 and those for endometrial ablation decreased from 12.3−7.1. Annual spending for LNG-IUDs increased from $32 million−69 million; those for hysterectomy decreased from $500 million−422 million; and those for endometrial ablation decreased from $111 million−64 million. For every 100 LNG-IUDs inserted, there with 31.5 fewer hysterectomies and 45.3 fewer endometrial ablations with savings in spending of $87 million (−13.6%). A sensitivity analysis indicates cost-effectiveness when hysterectomy and endometrial ablation are avoided in at least 61% of women (Figure 2).

CONCLUSION: From 2010 through 2014, among commercially insured women who are 35−54 years old, there was an annual savings of $87 million related to increasing LNG-IUD use and decreasing use of hysterectomy and endometrial ablation. It is not possible to determine if LNG-IUD was inserted for contraception, control of bleeding and pain, or both. Nonetheless, the medical and financial benefits of increasing LNG-IUD utilization are apparent. Fewer women resort to expensive, invasive treatment and savings are realized. We are unable to determine which women who received LNG-IUD went on to hysterectomy due to inadequate symptom control. While this is a limitation of our analysis, there is evidence that spending related to hysterectomy and its complications are greater than those related to LNG-IUD use, even if hysterectomy is eventually needed.[3] In this population, assuming that all LNG-IUDs are inserted for menstrual disorders, LNG-IUDs are cost-effective if at least 61% are able to avoid hysterectomy or endometrial ablation. ■

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SUPPLEMENTARY TABLE

Coding to identify procedures and diagnoses

Systems, devices, and conditions	Codes
Encounter for IUD insertion (*ICD-9*)	V25.11, V25.13
American Hospital Formulary Service National Drug Code for IUD	
52 mg LNG-IUD	50419042101, 50419042301, 50419042308 (Mirena); 52544003554, 00023585801 (Liletta)
19.5 mg LNG-IUD	50419042401, 50419042408, 50419042471 (Kyleena)
13.5 mg LNG-IUD	50419042201, 50419042208, 50419042271 (Skyla)
Diagnoses (*ICD-9*) for abnormal uterine bleeding, pelvic pain, and leiomyomata	
Abnormal uterine bleeding	621.4, 626.2, 626.4, 626.5, 626.6, 626.7, 626.8, 626.9, 627.0, 627.1
Endometriosis or pelvic pain	220, 221.0, 221.8, 221.9, 617.0, 617.1, 617.2, 617.3, 617.4, 617.5, 617.6, 617.8, 617.9, 620.0, 620.1, 620.2, 620.3, 620.4, 620.5, 620.6, 620.7, 620.8, 620.9, 625.0, 625.3, 625.5
Leiomyomata	218.0, 218.1, 218.2, 218.9, 219.0, 219.1, 219.8, 219.9
Endometrial ablation	
ICD-9 procedure code	68.23
CPT codes	58353, 58356, 58563

CPT, *Current Procedural Terminology*; *ICD-9*, *International Classification of Diseases, Ninth Revision*; *IUD*, intrauterine device; *LNG*, levonorgestrel.

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