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Counseling About Medication-Induced Birth Defects with Clinical Decision Support in Primary Care

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Abstract

Background: We evaluated how computerized clinical decision support (CDS) affects the counseling women receive when primary care physicians (PCPs) prescribe potential teratogens and how this counseling affects women's behavior.

Methods: Between October 2008 and April 2010, all women aged 18–50 years visiting one of three community-based family practice clinics or an academic general internal medicine clinic were invited to complete a survey 5–30 days after their clinic visit. Women who received prescriptions were asked if they were counseled about teratogenic risks or contraception and if they used contraception at last intercourse.

Results: Eight hundred one women completed surveys; 27% received a prescription for a potential teratogen. With or without CDS, women prescribed potential teratogens were more likely than women prescribed safer medications to report counseling about teratogenic risks. However, even with CDS 43% of women prescribed potential teratogens reported no counseling. In multivariable models, women were more likely to report counseling if they saw a female PCP (odds ratio: 1.97; 95% confidence interval: 1.26–3.09). Women were least likely to report counseling if they received angiotensin-converting enzyme inhibitors or angiotensin receptor blockers. Women who were pregnant or trying to conceive were not more likely to report counseling. Nonetheless, women who received counseling about contraception or teratogenic risks were more likely to use contraception after being prescribed potential teratogens than women who received no counseling.

Conclusions: Physician counseling can reduce risk of medication-induced birth defects. However, efforts are needed to ensure that PCPs consistently inform women of teratogenic risks and provide access to highly effective contraception.

Introduction

It is estimated that one of every six women in the United States receives a prescription for a potentially teratogenic medication each year.[1,2] Given that almost half of U.S. pregnancies are unplanned,[3] it is important for physicians to inform women of teratogenic risks when such medications are prescribed. This is particularly true because birth defects are most likely to occur when teratogenic medications are used early in pregnancy, before many women are aware they have become pregnant. Although women commonly depend on their clinicians to inform them when a medication may pose a risk to a pregnancy,[4,5] receipt of prepregnancy health counseling is reported by only 30% of U.S. women who give birth.[6] As a result, approximately 6% of U.S. pregnancies are exposed to potentially teratogenic medications,[7,8] and concern about having used a prescription medication early in pregnancy is one of the most common reasons women contact teratogen counseling hotlines.[9]

The majority of potentially teratogenic medications are prescribed by primary care providers (PCPs).[1,2] However, little is known about the counseling women receive from PCPs when potential teratogens are prescribed. We previously reported that an intervention that provided PCPs with clinical decision support (CDS) designed to address risks of medication-induced birth defects only slightly increased the

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percentage of women who had family planning services documented in their electronic medical record (EMR) when potentially teratogenic medications were prescribed.[10] However, as counseling services are incompletely documented in the EMR, the goal of this study was to assess patient-reported counseling about teratogenic risks. We hypothesized that when PCPs received CDS, women would be more likely to report that they were counseled about risks of medication-induced birth defects and their contraceptive options. We also hypothesized that women who reported having been counseled about teratogenic risks would be more likely to use contraception.

Materials and Methods

Intervention design

This CDS intervention has been described previously.[10] Briefly, between October 2008 and June 2009, 41 physicians from two practices (operating four clinics: three suburban, community-based family practice; one urban, academic general internal medicine) received CDS designed to increase PCP counseling about risks of medication-induced birth defects when a potential teratogen was prescribed. These alerts were triggered by medications that were felt by experts to pose a significant risk in early pregnancy (Appendix 1). During the last 9 months of this study, CDS alerts were deactivated for half of the study physicians; this allowed comparison of visits receiving no alerts to those continuing to receive alerts.

Data collection and outcomes

All women aged 18–50 who visited a physician at one of the four clinics during the study period were invited to complete a survey (online or by phone) 5–30 days after their visit. Interested participants provided signed informed consent and received survey access instructions at the time of their clinic visit. Upon completion, participants received a $10 gift card. Women were also asked for permission to review their medical records, but participation was not contingent on granting such permission. This study was approved by the University of Pittsburgh Institutional Review Board.

The 75-question survey collected information regarding participants' demographic and reproductive characteristics, as well as details about their clinic visit. Participants who reported receiving a prescription at their visit were asked, "At your last visit, did your doctor spend any time discussing the chance that a medication you are using can cause birth defects?" and "Did your doctor tell you that you may want to avoid becoming pregnant while using any of the medications that were prescribed to you?" If a patient answered yes to either question, she was coded as having received counseling regarding medication-induced birth defects. Patients were also asked, "At your last visit, did your doctor talk to you about birth control?" If a patient answered yes to any of these three questions, she was coded as having received counseling regarding medication-induced birth defects and/or contraception at their visit. This composite measure was our main outcome of interest. Those who reported receiving counseling were asked about their satisfaction with this counseling; four response options were offered, ranging from very satisfied to not satisfied. Additionally, all participants were asked if, after their clinic visit, they sought additional information on their medication from any of the following sources: the Internet, a pharmacist, an obstetrician/gynecologist, a drug safety call center or teratology information service, or the package insert. Finally, women were asked about their pregnancy intentions and to specify which contraceptives they used with last intercourse. When considering contraceptive use, we examined (a) no use of contraception; (b) use of barrier or behavioral methods (condoms, diaphragm, spermicide, withdrawal, or the rhythm method); (c) use of hormonal contraception (contraceptive pills, patch, ring, or injections); or (d) use of highly effective reversible (HER) (intrauterine or subdermal) contraception.

For those who granted permission to review their medical records, we abstracted identified EMR data from the clinic visit and linked these records to survey data. These data included all medications prescribed (which were then categorized as either potentially teratogenic or safer medications), the gender of the prescribing physician, the number of previous visits to the practice, and whether or not the physician was the patient's usual PCP. We also recorded any history of surgical sterilization, menopause, or infertility, and all "active" contraceptives (i.e., contraceptive prescriptions ordered at the time of the clinic visit and previously provided prescriptions that had not expired; presence of a HER contraceptive; procedure orders for injectable or HER contraception). We considered visits with any of the following to have EMR-documented evidence of provision of family planning services: contraceptive counseling, family planning referrals, pregnancy tests, or new or renewal prescriptions for contraceptive medications or devices. For comparison, we abstracted de-identified EMR data from all other women between the ages of 18–50 who visited study clinics during the same time period.

Statistical analyses

We calculated the survey response rate, and compared the characteristics of women who did and did not complete surveys. We then excluded surveys from women who declined permission to link their survey to their EMR data and from women who were not able to become pregnant [i.e., those who had undergone surgical sterilization (tubal ligation or hysterectomy), had been through menopause, had a partner with a vasectomy, or had a history of infertility], as reported in either the survey or EMR data. We also excluded women who said they did not receive a prescription at their appointment (even if the EMR data indicated otherwise).

We produced descriptive statistics and then investigated the rate of counseling and other outcomes of interest for three types of clinic visits: (1) visits in which a potentially teratogenic medication was prescribed while the CDS system was active, (2) visits in which a potentially teratogenic medication was prescribed while PCPs were no longer receiving CDS, and (3) visits in which a safer medication (i.e., a medication not considered to have potentially teratogenic effects) was prescribed. Because this CDS intervention was delivered to physicians, we adjusted our p values for clustering by PCP using generalized mixed effects regression models with a random effect for physician. To test for significant differences between groups, we used post-estimation chi-squared tests.

We then used mixed-effects logistic regression models to investigate which medication types and which patient and physician/visit characteristics were associated with reported receipt of counseling. Dichotomized patient characteristics included: age over 30 years, white race/ethnicity, married or living as married, college degree, sexually active in past 3 months, or pregnant or trying to get pregnant. Dichotomized physician/visit characteristics included visit with the patient's usual PCP, visit with a female PCP, and new patient visit. Finally, we examined the relationships between reported receipt of counseling, information seeking behavior, and contraceptive use after the studied visit. We report the residual intraclass correlation coefficient (ICC) for PCP-provided counseling. All analyses were conducted using Stata/IC 11.2IC.

Results

A total of 10,029 female patients of reproductive age had a visit with a participating PCP during the study period and were invited to participate. Overall, 19% ($n=1,859$) of women consented to participate and completed surveys.

Women completed surveys a median of 7 [interquartile range = 5; mean = 9.5(±6.2)] days after visiting a study clinic. Patients who completed surveys were more likely to be white (91% completers vs. 81% of noncompleters, $p<0.001$), more likely to have some college education (78% completers vs. 71% noncompleters, $p=0.006$), and more likely to be established patients at the clinic (87% vs.76%, $p<0.001$). Ninety-one percent ($n=1,696$) of survey completers granted permission to link their surveys to their EMR data; of these, 24% ($n=409$) indicated that they had been through menopause, were infertile, had been surgically sterilized, or had a sterilized partner; 29% ($n=486$) did not report receiving a prescription at their last visit. Thus, 801 surveys were available for this analysis.

In total, 23% ($n=188$) of survey respondents were prescribed potential teratogens by PCPs who received a CDS alert; an additional 26 women (3%) were prescribed potential teratogens by a PCP who was no longer receiving CDS. The potential teratogens most commonly prescribed included benzodiazepines (35%), antimicrobials (i.e., doxycycline and fluconazole, 20%), angiotensin-converting enzyme inhibitors and angiotensin-receptor blockers (18%), cardiovascular medications (e.g., beta-blockers, spironolactone, 10%), psychiatric medications (e.g., lithium and some antidepressants, 9%), and statins (7%). Women who received prescriptions that triggered the CDS were significantly older and less educated than women who received safer medications (Table 1).

Overall, 57% of women prescribed potential teratogens reported receiving some form of counseling about the risk of medication-induced birth defects or the benefits of contraception (data not shown in tables). Specifically, 29% reported that they were counseled to avoid pregnancy while using a medication, and 27% reported that they were told there was a chance that a medication they were using could cause birth defects; however, there was considerable overlap in these responses (data not shown in tables). Of sexually active women who were not trying to get pregnant, 37% reported receipt of counseling about contraception (data not shown in tables).

Women prescribed potential teratogens were more likely to report receipt of counseling about medication-induced birth defects than women prescribed safer medications (Table 2). However, women prescribed potential teratogens were not more likely than women prescribed safer medications to have discussed contraception during their clinic visit. PCPs

Table 1. Patient Characteristics by Prescription Type and Clinical Decision Support

	Prescribed safer medication N = *587* % (n)	*Prescribed potential teratogen* with CDS* N = *188* % (n)	*Prescribed potential teratogen* without CDS* N = *26* % (n)	p *value*†	p *value*‡
Age, mean years [SD]	31.0 [8.5]	33.2 [8.9]	32.0 [7.5]	<0.01	0.59
Over 30 years of age	52.5% (308)	61.2% (115)	57.7% (15)	0.04	0.74
White§	92.8% (538)	89.8% (167)	92.3% (24)	0.09	0.18
Married or living as married§	53.2% (309)	53.2% (99)	57.7% (15)	0.99	0.67
College degree or higher education§	58.7% (341)	45.5% (85)	76.9% (20)	<0.01	<0.01
Had sex in the last 3 months§	80.1% (467)	75.4% (141)	76.9% (20)	0.25	0.99
Had never had sex with a man§	5.9% (34)	2.7% (5)	4.0% (1)	0.08	0.67
Pregnant or trying	4.9% (29)	2.1% (4)	0.0% (0)	0.11	0.99
Seeing her usual PCP	74.1% (435)	85.6% (161)	84.6% (22)	<0.01	0.72
Seeing a female PCP	57.4% (337)	52.1% (98)	53.9% (14)	0.20	0.87
New patient to practice	9.9% (58)	11.7% (22)	11.5% (3)	0.40	0.78

*Potential teratogens defined as class D and X medications (as categorized by the U.S. Food and Drug Administration) as well as a subset of class C medications. Safer medications defined as class A, B, or C medications, which did not trigger a CDS alert. During the last 9 months of this intervention, CDS alerts were deactivated for half of the study physicians to allow for comparison of visits receiving no alerts to those continuing to receive alerts.

†Safer medication group versis potential teratogen group with CDS alerts; derived from generalized mixed effects models with a random effect for physician cluster and post-hoc tests for 2×2 comparisons.

‡Potential teratogen group with CDS alerts versus potential teratogen group without CDS; derived from generalized mixed effects models with a random effect for physician cluster and post-hoc tests for 2×2 comparisons.

§Survey data missing for race ($n=9$), marital status ($n=8$), education ($n=7$), sexual activity in the past 3 months ($n=5$), and history of being heterosexually active ($n=16$).

CDS, clinical decision support; PCP, primary care physician.

Table 2. Patient-Reported Receipt of Counseling by Prescription Type and Clinical Decision Support

Services received	*Prescribed safer medication* N=*587* % (n)	*Prescribed potential teratogen* with CDS* N=*188* % (n)	*Prescribed potential teratogen* without CDS* N=*26* % (n)	p *value*†	p *value*‡
Reported counseling about risk of birth defects or use of contraception	40.9% (240)	57.5% (108)	53.9% (14)	<0.01	0.92
Reported counseling about risk of birth defects	18.7% (110)	35.1% (66)	30.8% (8)	<0.01	0.78
Of those receiving counseling:					
Satisfied with counseling	95.2% (59)	88.4% (38)	80.0% (4)	0.20	0.83
Had all of their questions answered	93.1% (67)	90.9% (50)	100.0% (7)	0.66	1.00
Reported counseling about contraception§	34.4% (180)	37.6% (67)	32.0% (8)	0.14	0.21
Of those receiving counseling:					
Satisfied with counseling	92.3% (156)	95.0% (57)	87.5% (7)	0.48	0.41
Had all of their questions answered	77.7% (139)	70.2% (47)	87.5% (7)	0.76	0.48
EMR documentation of family planning services	42.6% (237)	38.8% (71)	53.6% (14)	0.53	0.16

*Potential teratogens defined as class D and X medications (as categorized by the U.S. Food and Drug Administration) as well as a subset of class C medications. Safer medications defined as class A, B, or C medications, which did not trigger a CDS alert. During the last 9 months of this intervention, CDS alerts were deactivated for half of the study physicians; this allowed comparison of visits receiving no alerts to those continuing to receive alerts.

†Safer medication group versus potential teratogen with CDS alert group; derived from generalized mixed effects models with a random effect for physician cluster and post-hoc tests for 2×2 comparisons.

‡Potential teratogen with CDS alert group versus potential teratogen without CDS group; derived from generalized mixed effects models with a random effect for physician cluster and post-hoc tests for 2×2 comparisons.

§Denominator excludes 73 women who reported that they were pregnant or trying to get pregnant, had a same sex partner, had not had sex within the past 3 months, or had never had sex with a man.

EMR, electronic medical record.

receiving CDS upon prescribing a potential teratogen were not more likely to have their patients report counseling about medication risks or contraception than women prescribed these medications by PCPs without CDS (58% with CDS vs. 54% without CDS, $p=0.92$).

Satisfaction with counseling, when it was provided, was high (Table 2). However, women prescribed potential teratogens tended to be less satisfied with their counseling than women receiving safer medications; women prescribed potential teratogens by PCPs receiving CDS were somewhat

Table 3. Factors Associated with Receipt of Counseling Regarding Risk of Medication-Induced Birth Defects or Use of Contraception

	Unadjusted OR (95% CI)	*Adjusted OR (95% CI)**
PCP/visit factors		
Visit with female physician	1.80 (1.20–2.70)	1.97 (1.26–3.09)
Visit with usual PCP	1.50 (1.05–2.15)	1.56 (1.05–2.30)
New patient visit	1.76 (1.09–2.84)	1.90 (1.13–3.19)
Patient factors		
Pregnant or trying to get pregnant	1.55 (0.76–3.19)	1.92 (0.90–4.09)
Sexually active in the past 3 months	1.71 (1.19–2.47)	1.95 (1.29–2.95)
Over 30 years of age	0.59 (0.44–0.79)	0.60 (0.43–0.84)
White	1.13 (0.65–1.96)	1.21 (0.68–2.15)
Married or living as married	0.84 (0.63–1.12)	0.77 (0.54–1.09)
College degree or higher	1.05 (0.77–1.42)	1.11 (0.81–1.54)
Medication type		
Safer medications†	—Referent—	—Referent—
ACE inhibiters/ARBs	1.06 (0.53–2.11)	1.27 (0.62–2.60)
Antimicrobials	2.17 (1.13–4.15)	2.29 (1.16–4.52)
Benzodiazepines	1.68 (1.02–2.76)	1.83 (1.08–3.10)
Cardiovascular medications	2.95 (1.15–7.53)	3.03 (1.16–7.91)
Psychiatric medications	4.57 (1.61–13.02)	4.76 (1.59–14.22)
Statins	2.40 (0.79–7.25)	3.27 (1.06–10.04)

*$N=787$, mixed-effects logistic regression model with physician as a random effect, adjusted for all of the variables in the table.

†Safer medications defined as class A, B or C medications, which did not trigger a CDS alert.

OR, odds ratio; CI, confidence interval; PCP, primary care provider; ACE, angiotensin-converting enzyme; ARB, angiotensin-receptor blockers.

more likely to be satisfied with the counseling they received than women prescribed potential teratogens by PCPs without CDS (88% with CDS vs. 80% without CDS, $p = 0.83$), although these findings did not reach statistical significance.

Mixed-effects logistic regression models found that those seeing their usual PCP, a female PCP, and visiting the study clinic for the first time all had greater odds of receiving teratogenic risk or contraceptive counseling (Table 3). Interestingly, women's pregnancy intentions had little effect on receipt of such counseling. Women over 30 years of age were less likely than younger women to receive such counseling. In addition, medication type was a significant predictor of counseling (Table 3). The ICC for PCP provision of counseling was 0.04.

When we cross-checked patient reports of counseling with EMR documentation, we found that most (80%) women with EMR documentation of provision of new family planning services at their clinic visit reported that they had received counseling about contraception or medication risks. However, only 55% of women who said they had received teratogenic risk counseling or contraceptive counseling had documented evidence of family planning services in their EMR for that visit.

After their visit, women who had been counseled about teratogenic risks or contraception when they were prescribed a potential teratogen were more likely to report using contraception than women who reported no such counseling (Table 4); women counseled by PCPs who received CDS were significantly more likely to report contraceptive use than women counseled by PCPs who did not receive CDS when prescribing potential teratogens, although sample sizes were small. This was primarily due to more prescriptions for hormonal contraception (Table 4). In addition, women who reported counseling about teratogenic risks tended to be more likely to state that they tried to find more information about their medication from internet sources than women who did not receive counseling; this was particularly true for women who received counseling from a PCP without CDS (Table 4). The most frequently consulted sources of information included the Internet, package inserts, and pharmacists.

Discussion

This study found that over 40% of women prescribed potential teratogens reported receiving no counseling about the risk of medication-induced birth defects or the importance of contraception, even when their PCPs were electronically notified when prescribing potential teratogens. Women seeing their usual PCP, a female PCP, or visiting the clinic for the first time were more likely to be counseled about teratogenic risks, but overall rates of patient-reported counseling remained low. Recently, a study of women Veterans similarly found that relatively few women prescribed potential teratogens remembered having been warned of teratogenic risks.[11] Although women in our study who were prescribed potential teratogens were more likely to report receipt of counseling about medication-induced birth defects than women prescribed safer medications, they were not more likely than women prescribed safer medications to have discussed contraception during their clinic visit. This is unfortunate as

Table 4. Patient-Reported Behavior After Receipt of a Potentially Teratogenic Prescription, by Counseling Received

Information seeking	*Not counseled* N = *92* % (n)	*Counseled with CDS** N = *108* % (n)	*Counseled without CDS** N = *14* % (n)	p-*value*[†]	p-*value*[‡]
Tried to find more information about their medication	35.9% (33)	41.7% (45)	71.4% (10)	0.40	0.06
Information source(s) consulted:					
Internet	36.4% (12)	62.2% (28)	60.0% (6)	0.02	0.06
OB/GYN	0.0% (0)	0.0% (0)	10.0% (1)	–	0.32
Pharmacist	36.4% (12)	33.3% (15)	20.0% (2)	0.79	0.65
Package insert	51.5% (17)	44.4% (20)	30.0% (3)	0.35	0.40
Drug safety call center/hotline	0.0% (0)	2.2% (1)	0.0% (0)	0.89	–
Use of contraception at last intercourse[§]	N = *82* % (n)	N = *99* % (n)	N = *11* % (n)		
No contraception	35.4% (29)	14.1% (14)	27.3% (3)	< 0.01	< 0.01
Behavior/barrier[‖]	30.5% (25)	34.3% (34)	18.2% (2)	0.58	0.53
Hormonal[¶]	28.1% (23)	44.4% (44)	45.5% (5)	0.02	0.05
Intrauterine or subdermal contraception	6.1% (5)	7.1% (7)	9.1% (1)	0.81	0.89

*During the last 9 months of this intervention, CDS alerts were deactivated for half of the study physicians; this allowed comparison of visits receiving no alerts to those continuing to receive alerts.

[†]No counseling group versus teratogen prescribed and counseled with CDS alert group; derived from generalized mixed effects models with a random effect for physician cluster and post-hoc tests for 2×2 comparisons.

[‡]Teratogen prescribed and counseled with CDS alert group versus teratogen prescribed and counseled without CDS group; derived from generalized mixed effects models with a random effect for physician cluster and post-hoc tests for 2×2 comparisons.

[§]Excludes women who reported that they were pregnant or trying to get pregnant, had a same sex partner, had not had sex within the past 3 months, or had never had sex with a man.

[‖]Barrier methods defined as rhythm, withdrawal, condoms, diaphragm, and/or spermicide.

[¶]Hormonal methods defined as pill, patch, ring, and/or injection.

effective contraception can help prevent pregnancies that may be adversely affected by medication use.[2]

Communication between clinicians and patients about contraception has been identified as a critical factor in effective contraceptive use.[12,13] In one study, women who had received contraceptive counseling in the past year were 80% less likely to report contraceptive nonuse.[14] Another study found that women who had ever discussed contraception with a healthcare worker were six times as likely to be currently using contraception.[15] The U.S. Centers for Disease Control and Prevention has issued guidance on the use of contraception by women with a variety of chronic conditions.[16] However, many PCPs remain unaware of these guidelines, have limited training in family planning, and may have inaccurate perceptions of the effectiveness of available contraceptives,[17,18] which preclude high quality counseling.

Pharmacists can also play an important role in ensuring that patients are informed about medication risks. Previously, an intervention designed to increase pharmacist provision of teratogenic risk counseling was found to have some effect on dispensing practices.[19] However, satisfaction with this intervention was limited by delays in transfer of pregnancy information.[19] In addition, women have indicated that, because of the limited privacy available in most pharmacy settings, they prefer to be notified of teratogenic risks by their prescribing clinician.[4]

Although underpowered to find many statistically significant differences, the results of this study suggest that CDS may affect teratogenic risk counseling. However, there are several limitations that must be considered when interpreting these findings. While most patients reported satisfaction with the counseling they received, we do not have an objective measure of how comprehensive or compelling the counseling provided was. Because we did not collect patient survey data before introducing this CDS intervention, we cannot be sure that this CDS improved the counseling women received; however, as women's reports of counseling began to trend downward when PCPs were no longer receiving CDS, we suspect that this CDS did boost rates of counseling. When considering the data collected during this post-intervention period, we recognize that PCPs who had recently received CDS may have been more likely to continue counseling after the CDS was deactivated than they were before ever receiving CDS. Also, we cannot be certain that women's last sexual intercourse occurred after her study visit. However, as premenopausal women are sexually active on a median of 8 days per month (range 2–28 days),[20] and participants completed surveys a median of 7 days after visiting the clinic, for most women the last episode of intercourse likely followed receipt of counseling. Finally, only 19% of eligible women completed a survey after visiting a study clinic, and those who did complete surveys were more likely to be white, have a college education, and be established clinic patients, which may limit the generalizability of our findings.

Conclusions

In conclusion, PCPs who counsel their patients about teratogenic risks appear to increase their patients' contraceptive use. Established PCP relationships may increase the likelihood that teratogenic risk counseling will be provided, especially by female PCPs; in addition, CDS may be helpful in increasing rates of such counseling. However, even with the CDS we developed, over 40% of women reported that they received no counseling from their PCP about the risk of medication-induced birth defects or the benefits of contraceptive. Therefore, other efforts are needed to ensure that women receive the information they need to optimize their health prior to pregnancy. Future research should examine ways to increase the effectiveness of CDS and explore other ways to inform women of teratogenic risks and their options for birth defect prevention. For example, as web-based personal health records become more widely available to patients, the internet may offer new ways to provide women information on their medications' teratogenic risks.

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Author Disclosure Statement

No competing financial interests exist.

References

1. Schwarz EB, Maselli J, Norton M, Gonzales R. Prescription of teratogenic medications in United States ambulatory practices. Am J Med 2005;11:1240–1249.
2. Schwarz EB, Postlethwaite DA, Hung YY, Armstrong MA. Documentation of contraception and pregnancy when prescribing potentially teratogenic medications for reproductive-age women. Ann Intern Med 2007; 6:370–376.
3. Finer LB, Henshaw SK. Disparities in rates of unintended pregnancy in the United States, 1994 and 2001. Perspect Sex Reprod Health 2006;2:90–96.
4. Santucci AK, Gold MA, Akers AY, Borrero S, Schwarz EB. Women's perspectives on counseling about risks for medication-induced birth defects. Birth Defects Res A Clin Mol Teratol 2010;1:64–69.
5. Nordeng H, Koren G, Einarson A. Pregnant women's beliefs about medications—a study among 866 Norwegian women. Ann Pharmacother 2010; 9:1478–1484.
6. D'Angelo D, Williams L, Morrow B, et al. Preconception and interconception health status of women who recently gave birth to a live-born infant—Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 26 reporting areas, 2004. MMWR Surveill Summ 2007;10:1–35.
7. Andrade SE, Gurwitz JH, Davis RL, et al. Prescription drug use in pregnancy. Am J Obstet Gynecol 2004; 2:398–407.
8. Lee E, Maneno MK, Smith L, et al. National patterns of medication use during pregnancy. Pharmacoepidemiol Drug Saf 2006;8:537545.
9. Felix RJ, Jones KL, Johnson KA, McCloskey CA, Chambers CD, Organization of Teratology Information Services Collaborative Research G. Postmarketing surveillance for drug safety in pregnancy: the Organization of Teratology Information Services project. Birth Defects Res A Clin Mol Teratol 2004;12:944–947.
10. Schwarz EB, Parisi SM, Handler SM, et al. Clinical decision support to promote safe prescribing to women of repro-

ductive age: A cluster-randomized trial. J Gen Intern Med 2012;7:831–838.
11. Schwarz EB, Mattocks K, Brandt C, et al. Counseling of female veterans about risks of medication-induced birth defects. J Gen Intern Med 2013;28 Suppl 2:598–603.
12. Isaacs JN, Creinin MD. Miscommunication between healthcare providers and patients may result in unplanned pregnancies small star, filled. Contraception 2003;5:373–376.
13. Lee JK, Parisi SM, Akers AY, Borrero S, Schwarz EB. The impact of contraceptive counseling in primary care on contraceptive use. J Gen Intern Med 2011;7:731–766.
14. Upson K, Reed SD, Prager SW, Schiff MA. Factors associated with contraceptive nonuse among U.S. women ages 35–44 years at risk of unwanted pregnancy. Contraception 2010;5:427–434.
15. Huber LR, Ersek JL. Contraceptive use among sexually active university students. J Womens Health (Larchmt). 2009;7:1063–1070.
16. Curtis KM, Jamieson DJ, Peterson HB, Marchbanks PA. Adaptation of the World Health Organization's medical eligibility criteria for contraceptive use for use in the United States. Contraception 2010;1:3–9.
17. Parisi SM, Zikovich S, Chuang CH, Sobota M, Nothnagle M, Schwarz EB. Primary care physicians' perceptions of rates of unintended pregnancy. Contraception 2012;1:48–54.
18. Eisenberg DL, Secura GM, Madden TE, Allsworth JE, Zhao Q, Peipert JF. Knowledge of contraceptive effectiveness. Am J Obstet Gynecol 2012;6:479 e1–9.
19. Raebel MA, Carroll NM, Kelleher JA, Chester EA, Berga S, Magid DJ. Randomized trial to improve prescribing safety during pregnancy. J Am Med Inform Assoc 2007;4:440–450.
20. Davison SL, Bell RJ, LaChina M, Holden SL, Davis SR. Sexual function in well women: stratification by sexual satisfaction, hormone use, and menopause status. J Sex Med 2008;5:1214–1222.

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Appendix

Appendix 1. Medications that Triggered Clinical Decision Support when Ordered for a Woman Aged 18–50 Years with No Electronic Medical Record Documentation of Sterilization

Acitretin
Alprazolam
Amiodarone hcl
Amitriptyline
Amphetamine
Anastrozole
Atenolol
Atorvastatin
Azathioprine
Belladonna alkaloids/phenobarbital
Benazepril hcl
Bexarotene
Bisoprolol fumarate
Bosentan
Candesartan
Capecitabine
Captopril
Carbamazepine
Carteolol hcl
Carvedilol
Carvedilol phosphate
Chlordiazepoxide
Clonazepam
Clorazepate
Colchicine
Cyclophosphamide
Cyclosporine
Danazol
Diazepam
Diclofenac-misoprostolDihydroergotamine
Divalproex sodium
Doxazosin mesylate
Doxycycline
Efavirenz
Enalapril
Eprosartan mesylate
Ergotamine tartrate/caffeine
Estazolam
Estrogen,ester/me-testosterone
Exemestane
Ezetimibe/simvastatinFinasteride
Fluconazole
Fluorouracil
Flurazepam hcl
Fluvastatin sodium
Fosinopril sodium
Gemcitabine hcl
Goserelin acetate
Griseofulvin, microsize
Hydrochlorothiazide triamterene
Hydroxyurea
Imatinib mesylate
Imipramine
Irbesartan
Isotretinoin
Labetalol
Leflunomide
Leuprolide acetate
Leuprorelin
Lisinopril
Lithium
Lorazepam
Losartan
Lovastatin
Meprobamate
Mercaptopurine
Methimazole
Methotrexate sodium
Methyltestosterone
Metoprolol succinate
Metoprolol tartrate
Midazolam
Minocycline hcl
Misoprostol
Mycophenolate mofetil
Mycophenolic acid
Nadolol
Nortriptyline
Olmesartan medoxomil
Oxazepam
Paroxetine
Paroxetine hcl
Penicillamine
Perindopril erbumine
Phenobarbital
Phenytoin
Pindolol
Pravastatin sodium
Primidone
Propranolol hcl
Propylthiouracil
Quinapril
Quinine
Raloxifene
Ramipril
Ribavirin
Rosuvastatin
Simvastatin
Sotacor
Sotalol
Spironolactone
Tamoxifen
Telmisartan
Temazepam
Tetracycline
Thalidomide
Timolol maleate
Topiramate
Trandolapril
Triamterene
Triazolam
Trimipramine maleate
Valproate sodium
Valproic acid
Valsartan
Warfarin sodium