Providing Contraception for Women Taking Potentially Teratogenic Medications: A Survey of Internal Medicine Physicians' Knowledge, Attitudes and Barriers

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BACKGROUND: The majority of women prescribed category D or X medications may not receive adequate contraceptive counseling or a reliable contraceptive method. Physicians who prescribe potentially teratogenic medications have a responsibility to provide women with contraceptive counseling, a method of highly-effective contraception, or both.

OBJECTIVE: Investigate the knowledge, beliefs and barriers of primary care physicians toward providing adequate contraception to women taking potential teratogens.

DESIGN & PARTICIPANTS: Self-administered confidential survey of primary care internal medicine physicians at an urban, academic medical center.

MEASUREMENTS: Knowledge of potential teratogenic medications and contraceptive failure rates was assessed. Participants' beliefs about adequacy of their medical education, practice limitations and attitudes toward improving provision of contraception to women on potential teratogens were assessed.

RESULTS: One hundred and ten physicians responded (57.3%). Nearly two-thirds (62.3%) of participants had cared for reproductive aged women taking category D or X medications in the past year. The mean percent of correctly identified category D or X medications was 58.4% (SD 22.1%). The mean percent correct for knowledge of published contraceptive failure rates was 64.6% (SD 23.1%). Most respondents (87.6%) felt it is the responsibility of primary care physicians to provide contraception. Time constraints were reported to be somewhat or very limiting by 61.3% and over half felt medical school (63.2%)

or residency (58.1%) inadequately prepared them to prescribe or counsel about contraceptives.

CONCLUSIONS: Primary care physicians commonly encounter reproductive age women taking category D or X medications, but may lack sufficient knowledge and time to counsel about potential teratogens and contraception to prevent fetal exposure to these drugs.

KEY WORDS: adult; contraception; counseling; female; humans; physician practice patterns; physician behavior; pregnancy; prescription drugs; primary care; survey; teratogens; women's health. J Gen Intern Med 25(4):291-7

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Birth defects are a major cause of infant mortality and childhood morbidity.^{1,2} Ten percent of congenital anomalies have been associated with exposure to a confirmed teratogen, a chemical that can cause structural and/or functional birth defects.³ This could increase the risk of birth defects as much as three-fold.³ With nearly half of pregnancies in the US unplanned,⁴ family planning efforts for women taking potentially teratogenic medications must be vigilant. Studies of large administrative healthcare databases indicate that women taking potentially teratogenic medications, classified D or X by the US Food and Drug administration (Table 1), are no more likely to be using a highly-effective method of contraception than those who are taking medications that are lower risk of teratogenicity, category A, B, or C medications.^{5,6} Approximately 11.7 million prescriptions for category D or X drugs are written for women of reproductive age each year.^{5,6} It is estimated that 5.8% of US pregnancies may be exposed to category D and X medications.^{7,8}

Pregnancy for women taking potentially teratogenic medication carries more risk from both fetal exposure to potential teratogens and the effect of pregnancy on the underlying medical condition requiring treatment with such medications. Physicians who prescribe potentially teratogenic medications have a responsibility to provide contraceptive counseling, a method of highly-effective contraception, or both to all women who will be receiving those medications.^{5-7,9} Authors of prior studies discuss the importance of physician behavior in

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Table 1. US FDA Pregnancy Risk Classification^{20,23–27}

METHODS

Category	Brief description	FDA pregnancy category definition
A	Proven no risk to humans	Adequate, well-controlled studies in pregnant women have not shown an increased risk of fetal abnormalities
B	No evidence of risk to humans	Animal studies have revealed no evidence of harm to the fetus, however, there are no adequate and well-controlled studies in pregnant women or Animal studies have shown an adverse effect, but adequate and well-controlled studies in pregnant women have failed to demonstrate a risk to the fetus
C	Risks cannot be ruled out in humans	Animal studies have shown an adverse effect and there are no adequate and well-controlled studies in pregnant women or No animal studies have been conducted and there are no adequate and well-controlled studies in pregnant women
D	Clear evidence of risk in humans	Adequate well-controlled or observational studies in pregnant women have demonstrated a risk to the fetus. However, the benefits of therapy may outweigh the potential risk
X	Contraindicated in human pregnancy	Adequate well-controlled or observational studies in animals or pregnant women have demonstrated positive evidence of fetal abnormalities. The use of the product is contraindicated in women who are or may become pregnant

When a medication was listed as category C or D depending on the reference source or timing of pregnancy exposure, it was considered to be category D

ensuring that women of childbearing age are adequately counseled about the teratogenic potential of medications and that women are provided highly-effective methods of contraception.^{5–7,9} To our knowledge, no published research has studied physician behavior.

To explore physicians' roles in ensuring adequate contraceptive protection among women for whom pregnancy represents the highest risk, we conducted a survey of the primary care physicians (PCPs) at a single, urban, academic medical center and its affiliated community practices. The goals of the survey were to investigate the barriers PCPs encounter in provision of contraception to women on category D or X medications and their knowledge of both contraceptive efficacies and classification of potential teratogens. We hoped to assess whether PCPs know which commonly prescribed medications are classified as D or X, measure PCPs knowledge of contraceptive effectiveness (failure rates), evaluate if PCPs believe their medical education regarding potential teratogens and contraception was adequate, and determine limitations to contraceptive counseling and prescribing within the practice of primary care medicine.

Survey Process

A confidential self-administered survey instrument (see appendix available online at www.jgim.org) was developed with experts in survey design and methodology. Specialists in the fields of contraception, pharmacology, teratology and primary care internal medicine assisted with the content and assessed the survey for face validity. It was then pretested among members of the internal medicine department at our institution, modified to reflect suggested changes from these reviewers, and then it was transferred to an electronic format using a web-based survey service (www.surveymonkey.com). The electronic and written versions of the survey, data collection and entry techniques were then pilot tested by having the authors and selected faculty of the gynecology department complete both written and web-based versions. Based on our pilot testing, the survey took less than ten minutes to complete, regardless of whether it was done on paper or via the web-based format.

To maximize response, the survey was provided in both written and electronic formats with matched unique identifiers to prevent duplication.¹⁰ An email invitation with an embedded html link to the web-based survey was sent to all potential participants with two subsequent reminder emails sent at two and five weeks to non-responders. The invitation included an endorsement from the chief of staff of the hospital and the chief of general internal medicine. A written version of the survey was mailed on the same day as the initial email notification inviting participants to use the web-based format. The paper mailing included a copy of the survey, a self-addressed stamped envelope and a \$5.00 Starbucks™ gift card as a thank you for the subject's participation. Corresponding with the email notifications, reminder postcards were sent via traditional mail two weeks later after the initial mailing. A second full copy of the survey was mailed to all non-responders five weeks after the first solicitation. The initial invitation to participate in the survey was sent in early November, 2008 with subsequent reminders through the middle of December, 2008. Any response received before the end of January, 2009 was included for analysis.

Survey Content

Information about the physician's medical school and residency training and practice setting were collected. Participants were asked to categorize medications as potentially teratogenic—classified as D or X—versus those that are lower risk of teratogenicity—category A, B, or C. The list included 33 of the most commonly prescribed medications in the US for 2007¹¹ with 42% (14/33) classified as D or X.¹² Medications listed as either category C or D depending on reference source or timing of exposure were considered potential teratogens. Contraceptive failure rates are published as either typical use or perfect use statistics.¹³ Though the survey asked participants to identify “typical failure rates” for birth control methods, an answer that was consistent with either typical or perfect use was accepted as correct. Questions rated on a four-point Likert-type scale assessed physicians' beliefs about their medical education regarding prescribing and counseling about contraceptives and teratogenic medications. Lastly, participants were asked to rate

limitations and potential interventions they felt would be most useful in improving their ability to regularly provide contraception to women taking potential teratogens. There were no instructions about whether respondents could use reference materials during completion of the survey.

Study Site & Participants

All 194 PCPs associated with a large, academic hospital in Chicago, Illinois, were identified by the medical staff office of the hospital which provided contact, demographic and educational information about the physicians. Inclusion criteria for potential participants were that the individual is a licensed MD or DO who participates in the hospital referral and admitting network specializing in primary care internal medicine. Of note, all PCPs associated with the study institution specialize in internal medicine. The subjects self-selected for inclusion by choosing to participate and complete the survey. This study was approved by the institutional review board of Northwestern University with a waiver of informed consent.

Measurements & Data Analysis

All data obtained from written surveys were manually entered into the web-based format by a single research assistant and checked for entry errors. The survey data were downloaded from the web-based application and combined with the demographic data obtained from the medical staff office. Data management and analysis were completed using SAS statistical software (SAS version 9.2, Cary, NC). Questions regarding attitudes and beliefs with four-point scale Likert-type scales were dichotomized (strongly disagree/disagree and agree/strongly agree) as were those questions regarding practice limitations (not at all limiting/not too limiting and, somewhat limiting/very limiting). Physician respondents and nonrespondents were compared using the Student's *t*-test for continuous data and chi-square test for categorical variables to determine potential response biases. Respondents who completed the survey by mail were compared with those who completed the web-based version. Descriptive statistics for all data are reported.

RESULTS

Study Participants

Of the 194 PCPs identified, two were excluded because they had participated extensively in the survey development and pretesting process leaving 192 eligible respondents. A total of 110 completed a survey (response rate of 57.3%). Characteristics of participants are listed in Table 2. Compared with nonresponders, physicians who responded were in practice for fewer years (10.9 vs. 13.5 years, $p=0.04$). The majority of respondents (66/110) chose paper over the web-based format, but younger respondents (41.5 vs. 45.6 years, $p=0.02$) and those who were in practice for less time (12.0 vs. 9.0 years, $p=0.04$) were significantly more likely to respond via the web.^{14,15} When asked to describe their current practice environments, 12% selected more than one practice setting. Of the remaining respondents who chose only one practice type, 26.3% reported they are part of a multi-specialty office, 22.1% work in an academic/university practice, 16.9% are in private practice,

11.6% in a single-specialty office, 9.5% work in a hospital owned practice, 9.5% are in solo practice, 3.2% work in a community clinic, and the final 1.1% in a hospital based clinic.

Practice Characteristics

Most participants (62.3%) cared for a reproductive aged woman who was taking a category D or X medication in the past year. The majority of respondents reported they have refrained from prescribing (70.4%), changed (68.5%) or discontinued (63.0%) category D or X medications because of concern for possible fetal exposures. Respondents were asked to identify what references they use when determining pregnancy risk classification for potential teratogens. A single respondent reported using only paper based references such as textbooks, whereas 46.3% use only electronic references such as websites or handheld computer reference software. The vast majority of respondents, 81.5%, report using at least two sources. Almost 64% of respondents agreed that handheld medication reference tools are important. Greater than half, 56.1% of respondents report they are using an electronic health record (EHR) for documenting patient visits. Most respondents (72.2%) report seeing three or four patients per hour. Only 4% of respondents have prescribed an isotretinoin medication, such as Accutane®, and thus participated in an FDA mandated contraceptive compliance program.

Knowledge of Teratogenic Medications

Of the 107 respondents who completed the teratogen knowledge exercise, the overall mean percent correctly identified was 58.4% (SD 22.1%). Table 3 shows that accuracy varied across all FDA pregnancy risk categories. The most common errors reflected respondents' beliefs that medications in category A, B

Table 2. Participant Characteristics (n=110)

Variable type	Variable	Proportion of all respondents
Demographics		
	Age in years (n=107) Mean (SD)	43.9 (8.6)
	Gender (n=109) (% female)	48.6%
	Years in practice (n=109) Mean (SD)	10.9 (7.9)
Practice info		
	Proportion of patients who are reproductive aged women Mean (SD)	37.5% (21.1)
	Cared for reproductive aged woman on D/X med in last 12 months (n=98)	62.3%
	Cares for women during pregnancy (e.g. on-going treatment for chronic condition) (n=106)	85.0%
	Provide gynecology services (i.e. pap smear, STD testing) (n=107)	89.7%
	Counsel about contraception (n=105)	90.7%
	Prescribe contraception (n=108)	86.8%
	Recommended emergency contraception (n=105)	71.0%
	Have billed for contraception counseling/mgmt (n=110)	69.1%
	Uses an electronic medical record (n=107)	56.1%

Table 3. Percent Medications Correctly Identified by FDA Pregnancy Classification (n=107)

FDA pregnancy risk category	Number of medications in exercise	Medications listed in knowledge exercise	Mean % correctly identified (SD)
Low risk of teratogenicity			
A	1	Levothyroxine	97.2%
B	7	Cetirizine, Clopidogrel, Esomeprazole, Pantoprazole, Montelukast, Pantoprazole, Sildenafil	53.5%
C	11	Amitriptyline, Amphetamine/ Dextroamphetamine, Ciprofloxacin, Escitalopram, Ezetimibe, Fluticasone/ Salmeterol, Levofloxacin, Metoprolol, Pioglitazone, Sertraline, Venlafaxine	46.4%
Mean % correct (SD) for all low risk medications		51.7 (24.1)	
Potentially teratogenic			
C/D	5	Candesartan, Enalapril, Losartan, Ramipril, Valsartan	86.4%
D	6	Alprazolam, Carbamazepine, Divalproex Sodium, Doxycycline, Lorazepam, Phenytoin	57.5%
X	3	Atorvastatin, Pravastatin, Warfarin	74.1%
Mean % correct (SD) for all potentially teratogenic medications		71.4 (24.2)	
Total	33		58.4% (22.1)

Percent correct was calculated as the mean percent correctly identified for all respondents within a drug category. The total for all low risk and potential teratogens reflects the mean percent correct within the larger class

or C carried greater risk and thus incorrectly rated them as D or X. Physicians were less likely to correctly identify medications designated category A, B or C (mean 51.7%, SD 24.1%) than category C/D, D or X medications (71.4%, SD 24.2%).

Knowledge of Contraceptive Failure Rates

The mean percent correct for responses about contraceptive failure rates was 64.6% (SD 23.1%). Overestimating the effectiveness of the specific contraceptive method was the most common error, regardless of type. Physicians were less likely to correctly identify failure rates for less reliable contraception, such as natural family planning and barrier methods (mean 41.4%, SD 25%) than for more reliable methods, such as hormonal contraception and sterilization (mean 87.1%, SD 27.4%). The mean percent correct for each contraceptive method is listed in Table 4.

Respondents' Beliefs and Perceptions Regarding Counseling and Prescribing

Most (87.6%) respondents reported they feel it is the responsibility of the PCP to provide family planning and contraceptive services. When asked to rank what they believed were the most important factors in counseling patients about possible adverse effects of potentially teratogenic medications, 98.1% felt physician counseling was most important followed by information provided by a pharmacist. When asked about their likelihood to prescribe various contraceptive methods to women on category D or X medications, most of the respon-

dents reported they were somewhat or very likely to prescribe hormonal contraception or refer to another provider for a subdermal implant, intrauterine contraception or sterilization. As detailed in Table 5, the majority of respondents felt their

Table 4. Percent Correct Responses to Questions about Contraceptive Failure Rates (n=110)

Contraceptive method	Proportion of respondents correct
Less effective methods (failure rate > 10%) ^{13,28}	
Timing/Rhythm methods	72.7%
Withdrawal	77.3%
Male condoms	52.7%
Female condoms	10.0%
Diaphragm/Cervical cap	59.1%
Spermicides (foam, jelly, lubricants)	27.3%
Mean % correct (SD) for all less effective methods	41.4 (25.0)
Moderately effective methods (failure rate 1–10%) ^{13,28}	
Hormonal contraception (combined or progestin only pills, NuvaRing®, Ortho Evra® patch)	92.7%
Injectable hormonal contraceptives (i.e. DepoProvera®)	88.2%
Mean % correct (SD) for all moderately effective methods	90.5% (27.5)
Most effective methods (failure rate <1%) ^{13,28}	
Implantable subdermal contraceptive (i.e. Implanon™)	79.1%
Intrauterine contraceptives (i.e. Mirena®, Paragard®)	84.6%
Sterilization (i.e. tubal ligation, vasectomy, Essure®)	90.9%
Mean % correct (SD) for all most effective methods	84.8% (29.5)
Overall mean percent correct	64.6% (23.1)

Percent correct was calculated as the mean percent correctly identified for all respondents for each contraceptive method. The total for reflects the mean percent correct within the whole category

Table 5. Participants Beliefs and Perceptions Regarding Counseling & Prescribing (n = 106)

Variable type	Variable	Proportion of all respondents
Beliefs about medical education		
	Felt medical school inadequately prepared them to provide contraception	63.2%
	Felt residency inadequately prepared them to provide contraception*	58.1%
	Felt medical school inadequately prepared them to deal with teratogenic medications	61.0%
	Felt residency inadequately prepared them to deal with teratogenic medications	42.5%
Perceptions of barriers		
	Felt limited by time constraints	61.3%
	Felt limited by inability to bill for counseling time	36.8%
	Felt limited by poor reimbursement for counseling time	44.3%
	Felt limited by insufficient knowledge of contraception	44.3%
	Felt limited by insufficient knowledge of teratogens*	45.7%
	Felt limited by poor communication between different physicians†	45.1%

*n = 105, †n = 71

medical school or residency training was inadequate in preparing them to counsel or prescribe contraception. However, more than half (57.5%) agreed that their internal medicine residency adequately prepared them to counsel about potential teratogens.

Identification of Barriers and Potential Interventions

When asked to identify how limited participants felt by a selection of potential barriers to providing adequate contraception to women on potentially teratogenic medications, time constraints was the only one the majority (61.3%) of respondents identified. Other items that the majority of participants did not feel limited by are listed in Table 5. Although 69.1% of respondents have billed for either contraceptive counseling or management, the majority did not feel that poor reimbursement was an issue. Most respondents (88.6%) agreed they are interested in obtaining more information. Specifically, the vast majority agreed they would benefit from continuing medical education on counseling patients about potential teratogens (88.6%) and contraception (80.0%). Nearly 85% of respondents agreed that a laminated pocket reference regarding teratogenic medications sorted by therapeutic category would be useful, whereas nearly all (99.1%) reported that an EHR alert would be worthwhile. Roughly 63% of participants felt all category D or X medications should have FDA mandated contraceptive compliance programs such as those that have been used for isotretinoin compounds (e.g. Accutane®). Approximately two-thirds of respondents agreed a referral or telephone consultation services for assistance in providing appropriate contraception for women on potential teratogens would be useful. Nearly all (97.1%) agreed there is a need for information about potential teratogens designed for patient understanding, and 98.1% agreed that an evidence-based pregnancy risk classification system would be useful.

DISCUSSION

Principal Findings

Nearly two-thirds of the respondents reported they encountered a reproductive-aged woman on a category D or X medication in the past year. PCPs who discuss a potential teratogenic therapy with patients should review the need to avoid pregnancy and methods of contraception. Schwarz et al, noted the importance of clinicians' knowledge of highly-effective contraceptive methods in the prevention of pregnancy when discussing the potential harm from teratogenic medications.⁶ The majority of respondents identified time constraints as a limitation in providing adequate counseling. Although the majority of respondents did not feel limited by their knowledge of potential teratogens or contraceptive methods to prevent fetal exposures, this study indicates physicians' actual knowledge may be lower than they believe it to be. If physicians are unaware of their limitations, they may not perceive them as barriers. Interventions aimed at reducing fetal exposures to potential teratogens should include a campaign to raise awareness of these issues. Such a campaign should aim to improve the knowledge of prescribers, pharmacists, women and their partners regarding the need for women taking potential teratogens to be on a highly-effective contraceptive. This could decrease exposures and potentially lower the rate of teratogenic induced congenital anomalies. PCPs frequently discuss preventive health initiatives with their patients. The prevention of teratogenic exposure by provision of highly-effective contraception decreases potential harm to both mother and fetus. Contraceptive counseling can significantly increase the odds of contraceptive use and unintended pregnancy decreases with provision of contraception.^{13,16}

Strengths & Limitations

To our knowledge, this was the first study to evaluate physicians' knowledge, beliefs and barriers to providing contraception for women taking potentially teratogenic medications. To effectively implement improvements, it is important to understand physician behavior and what barriers they perceive in their practice. Although our response rate of 57.3% is higher than the typical range from 20–47% for surveys of physicians, because this is a cross-sectional survey, the findings apply only to the current day practice of the physicians who participated.^{10,14,15} Other limitations in the generalizability of our findings are related to the relative homogeneity of the respondents and a bias toward younger physicians participating. However, previous studies indirectly agree with our results that prescribers of potential teratogens may face significant barriers to ensuring women taking potential teratogens are protected from unintended pregnancy. These studies demonstrated that women prescribed potential teratogens are no more likely to be using a highly-effective method of contraception than those who are taking medications that have a lower risk of teratogenicity.^{5,6} Published estimates report that 5.8% of US pregnancies may be exposed to category D and X medications.^{7,8} Another potential limitation is that it is unclear if participants made use of reference materials to answer knowledge questions. However, given the level of knowledge reported among PCPs, it is unlikely this was common. Though these findings may not be applicable to other

practice settings, we believe that because our participants are associated with an urban, academic medical center their self-reported behaviors and knowledge may be better than average community PCPs.

Intervention Strategies & Next Steps

PCPs were selected as the best cohort of physicians to study because they prescribe more contraception and the largest proportion of category D and X medication than any other single specialty.⁶ Given the breadth of patients that PCPs see, it is unrealistic to expect these physicians to have knowledge about teratogens and contraception always at hand. Furthermore, patients on category D or X medications have underlying medical issues to discuss leaving less time for the clinician to adequately counsel or provide contraception. Most respondents felt that handheld, bedside tools would be useful. Many of the respondents in this study felt their medical school and/or residency training in internal medicine was inadequate in preparing them to provide contraception or to deal with discussions of potential teratogenic medications. As such, medical school and residency curricula should be strengthened to include more information on such topics and to ensure exposure to clinical scenarios that would provide training in this area. A continuing medical education program could be created to emphasize the need to recognize opportunities to prevent teratogenic exposure. Conversely, those PCPs who have less familiarity with contraception should refer patients taking potentially teratogenic drugs to another clinician such as a gynecologist or other women's health specialist.

Many of the same principles being studied to reduce medical errors across healthcare settings and to incorporate electronic health record (EHR) based tools¹⁷⁻¹⁹ could be applied to preventing inadvertent exposure to potential teratogens. The EHR could be a powerful tool to alert physicians of potential teratogenic risk in reproductive aged women, prompting a discussion about contraception or an alternate therapy. With the current efforts to implement EHR programs^{18,19} and update the FDA pregnancy risk classification system,²⁰ this is an ideal time to develop standards of practice within the EHR that tie into the new FDA regulations. An EHR that is used in the exam room or at the bedside can be programmed to recognize a prescription being written for a potential teratogen to a reproductive aged female and prompt the physician to proceed with contraceptive counseling, prescribing or referral to another clinician if necessary. This will help to eliminate the need for physicians to recognize all medications which are considered potentially teratogenic. A similar alert could be used within the pharmacy software system. Implementation of such an EHR-based safeguard could be an effective tool, but will require significant upkeep as new medications are approved and new evidence for and against fetal risk is published. Given the public health burdens of teratogen exposure resulting in birth defects and the subsequent infant mortality and childhood morbidity, there is significant benefit to employing such an initiative.^{1,2,6,21,22}

Assessment of physician behaviors is complicated and a single institution survey is unlikely to adequately quantify all the factors that affect prescribing practices. These results could inform the design of a larger study of prescribers across geographic regions and medical specialties to better define the barriers to providing contraception to women on potentially

teratogenic medications. Future studies should also evaluate the impact of pharmacist and patient behaviors in reducing risk. Though the underlying issues associated with prevention of fetal exposure to potential teratogens are complex, it is imperative to make efforts to reduce such occurrences.

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REFERENCES

- Petrini J, Damus K, Russell R, Poschman K, Davidoff MJ, Mattison D. Contribution of birth defects to infant mortality in the United States. *Teratology*. 2002;66(Suppl 1):S3-6.
- Yoon PW, Olney RS, Khoury MJ, Sappenfield WM, Chavez GF, Taylor D. Contribution of birth defects and genetic diseases to pediatric hospitalizations. A population-based study. *Arch Pediatr Adolesc Med*. 1997;151(11):1096-103.
- Cunningham GF, Leveno KL, Bloom SL, Hauth JC, Gilstrap LC, Williams KD. *Obstetrics*, 22nd Edition. 22nd ed. New York: McGraw-Hill Professional; 2005:1600.
- Jones RK, Zolna MR, Henshaw SK, Finer LB. Abortion in the United States: incidence and access to services, 2005. *Perspect Sex Reprod Health*. 2008;40(1):6-16.
- Schwarz EB, Maselli J, Norton M, Gonzales R. Prescription of teratogenic medications in United States ambulatory practices. *Am J Med*. 2005;118(11):1240-9.
- 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;147(6):370-6.
- Andrade SE, Gurwitz JH, Davis RL, et al. Prescription drug use in pregnancy. *Am J Obstet Gynecol*. 2004;191(2):398-407.
- Lee E, Maneno MK, Smith L, et al. National patterns of medication use during pregnancy. *Pharmacoepidemiol Drug Saf*. 2006;15(8):537-45.
- Andrade SE, Raebel MA, Morse AN, et al. Use of prescription medications with a potential for fetal harm among pregnant women. *Pharmacoepidemiol Drug Saf*. 2006;15(8):546-54.
- VanGeest JB, Johnson TP, Welch VL. Methodologies for improving response rates in surveys of physicians: a systematic review. *Eval Health Prof*. 2007;30(4):303-21.
- Verispan V. Top prescriptions dispensed in 2007.
- Clinical Pharmacology. Gold Standard, Inc., Tampa, FL; 2009. www.jgim.org was developed with experts in survey design and methodology. Specialists in the fields of contraception, pharmacology, teratology and primary care internal medicine assisted with the content and assessed the survey for face validity. It was then pretested among members of the internal medicine department at our institution, modified to reflect suggested changes from these reviewers, and then it was transferred to an electronic format using a web-based survey service <http://www.clinicalpharmacology.com>. Accessed November 20, 2009.
- Russell J. Contraceptive failure in the United States. *Contraception*. 2004;70(2):89-96.

14. **Akl EA, Maroun N, Klocke RA, Montori V, Schunemann HJ.** Electronic mail was not better than postal mail for surveying residents and faculty. *J Clin Epidemiol.* 2005;58(4):425–9.
15. **Boyer KK, Olson JR, Calantone R, Jackson J.** Print versus electronic surveys: a comparison of two data collection methodologies. *J Oper Manag.* 2002;20(Issue 4):357–73.
16. **Weisman CS, Maccannon DS, Henderson JT, Shortridge E, Orso CL.** Contraceptive counseling in managed care: preventing unintended pregnancy in adults. *Womens Health Issues.* 2002;12(2):79–95.
17. **Bates DW.** Preventing medication errors: a summary. *Am J Health Syst Pharm.* 2007;64(14 Suppl 9):S3–9. quiz S24–26.
18. **Chaudhry B, Wang J, Wu S, et al.** Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Ann Intern Med.* 2006;144(10):742–52.
19. **El-Kareh R, Gandhi TK, Poon EG, et al.** Trends in primary care clinician perceptions of a new electronic health record. *J Gen Intern Med.* 2009;24(4):464–8.
20. **FDA.** Pregnant Women to Benefit from Better Information. *FDA Consumer Health Information* [2008; <http://www.fda.gov/downloads/ForConsumers/ConsumerUpdates/UCM143746.pdf> Accessed November 20, 2009.
21. **Honein MA, Lindstrom JA, Kweder SL.** Can we ensure the safe use of known human teratogens?: The iPLEDGE test case. *Drug Saf.* 2007;30(1):5–15.
22. **Lagoy CT, Joshi N, Cragan JD, Rasmussen SA.** Medication use during pregnancy and lactation: an urgent call for public health action. *J Womens Health (Larchmt).* 2005;14(2):104–9.
23. **Code of Federal Regulations, Title 21, Vol 4, 21 CFR201.57;** 2001.
24. **Physicians Desk Reference,** 57th edition. Montvale, NJ: Thomson PDR; 2004.
25. **Teratology public affairs committee position paper: pregnancy labeling for prescription drugs: ten years later.** *Birth Defects Res A Clin Mol Teratol.* 2007;79(9):627–30.
26. **Buhimschi CS, Weiner CP.** Medications in pregnancy and lactation: part 1. Teratology. *Obstet Gynecol.* 2009;113(1):166–88.
27. **Buhimschi CS, Weiner CP.** Medications in pregnancy and lactation: part 2. Drugs with minimal or unknown human teratogenic effect. *Obstet Gynecol.* 2009;113(2 Pt 1):417–32.
28. **Trussell J.** Contraceptive efficacy. In: **Hatcher RA, Trussell J, Stewart F, et al., eds.** *Contraceptive Technology* Eighteenth revised edition. New York: Ardent Media; 2004.