Maternal and newborn outcomes in planned home birth vs planned hospital births: a metaanalysis

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OBJECTIVE: We sought to systematically review the medical literature on the maternal and newborn safety of planned home vs planned hospital birth.

STUDY DESIGN: We included English-language peer-reviewed publications from developed Western nations reporting maternal and newborn outcomes by planned delivery location. Outcomes' summary odds ratios with 95% confidence intervals were calculated.

RESULTS: Planned home births were associated with fewer maternal interventions including epidural analgesia, electronic fetal heart rate monitoring, episiotomy, and operative delivery. These women were less likely to experience lacerations, hemorrhage, and infections. Neonatal outcomes of planned home births revealed less frequent prematurity, low birthweight, and assisted newborn ventilation. Although planned home and hospital births exhibited similar perinatal mortality rates, planned home births were associated with significantly elevated neonatal mortality rates.

CONCLUSION: Less medical intervention during planned home birth is associated with a tripling of the neonatal mortality rate.

Key words: neonatal mortality, patient safety, planned home childbirth

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Approximately 1 in 200 US women deliver at home, accounting for approximately 25,000 deliveries annually.[1] An estimated 75% of low-risk singleton home births appear to be planned home deliveries.[2] The American College of Obstetricians and Gynecologists does not support home birth, citing safety concerns and lack of rigorous scientific study.[3] Ideally, further investigation regarding the relative safety of planned home vs planned hospital delivery would occur via randomized trials, which are, however, impractical. Large cohort studies comparing outcomes of actual home with actual hospital births provide valuable data, particularly regarding rare but serious events.[2] However, such investigations likely underestimate the risks associated with planned home birth, as up to 9% of parous and 37% of nulliparous women intending home birth require intrapartum transfer to hospital.[4-7] Thus, adverse outcomes among the latter deliveries are attributed to hospital births. Therefore, cohort studies comparing planned home with planned hospital births provide the only sources of data by intended delivery location. Since individual reports of this design are limited by sample size, we employed metaanalysis according to proposed reporting methods to clarify the relative merits of planned home vs planned hospital birth.[8]

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For Editors' Commentary, see Table of Contents

★ EDITORS' CHOICE ★

Materials and Methods

Search strategy

Computerized literature searches of MEDLINE and EMBASE were performed by a physician and medical librarian.

MEDLINE search results

The search strategy for the query for "all studies, regardless of methods, comparing intended/planned home births to intended/planned hospital births for maternal and newborn outcomes" was run in the MEDLINE database from 1950 through November week 1 2009 (Figure 1). The following terms were used: explosion of the medical subject heading "Home Childbirth" (defined as childbirth taking place at home); explosion of the medical subject heading "Delivery, Obstetric" (defined as delivery of the fetus and placenta under the care of an obstetrician or a health worker; obstetric deliveries may involve physical, psychological, medical, or surgical interventions); explosion of the medical subject heading "Hospitalization" (defined as being in a hospital or being placed in a hospital; the confinement of a patient in a hospital); and explosion of the medical subject heading "Inpatients" (defined as persons admitted to health facilities that provide board and room, for the purpose of observation, care, diagnosis, or treatment). The terms "Hospitalization" or "Inpatients" or any mention of the word form "Hospital*" (designated with an asterisk as the wild card picking up any letters after the "l," eg, "hospitals," "hospitalized") was then combined with the term "Delivery, Obstetric" to limit to a hospital birth. These results were then "anded" with the term "Home Child-

FIGURE 1
MEDLINE search strategy

Database: Ovid MEDLINE(R) <1950 to November Week 1 2009>
Search Strategy:
---
1 exp Home Childbirth/ (1495)
2 exp Delivery, Obstetric/ (54357)
3 exp Hospitalization/ (122627)
4 exp Inpatients/ (8376)
5 2 and (3 or 4 or hospital*.mp) [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier] (7942)
6 1 and 5 (155)
7 6 (155)
8 limit 7 to (english language and humans) (132)
9 8 and (outcome* or compar* or intend* or plan*).mp. [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier] (83)
10 from 9 keep 1-83 (83)

Wax. Outcomes in planned home birth vs planned hospital births. Am J Obstet Gynecol 2010.

birth" and by doing so indicated that the citation must include indexing for both terms; thus the discussion in the article would include both concepts. Limits to English language and human studies were then included. The final line of strategy was to take the retrieval and limit to any citations that would include the word forms for "outcome*" or "compar*" or "intend*" or "plan*" as a way to narrow the results to include the concepts of outcomes, comparisons, comparing, intended, or planned by using the asterisk as a wild card.

EMBASE search results

This strategy was done using EMBASE classic (1947 through present). Using the all subject words feature the term "Home Delivery" was searched. The term "Childbirth" was also searched and combined with any form of the word "Hospital?" with the ? indicating a wild card to pick up any forms of the word, such as "hospitals" and "hospitalization."

The Cochrane Database of Systematic Reviews was also searched for relevant publications. Titles and abstracts of citations were reviewed for potential relevance and selected manuscripts were reviewed. References in these papers were manually reviewed and retrieved if potentially relevant.

Study selection criteria

Inclusion criteria were determined before the literature search was performed. Studies were included if performed in developed Western countries, published in English-language peer-reviewed literature, maternal and newborn outcomes were analyzed by planned delivery location, and data were presentable in a 2×2 table. Manuscripts were evaluated for quality using a published instrument.[9] Outcome data were extracted by 2 physicians, with differences resolved by consensus. Outcomes for maternal intervention included epidural analgesia, electronic fetal heart rate monitoring, episiotomy, operative vaginal delivery (forceps or vacuum), and cesarean delivery. Maternal outcomes included mortality, morbidity measures of lacerations (≥3 degrees, vaginal, and perineal), infections (chorioamnionitis, endometritis, wound, and urinary), postpartum hemorrhage, retained placenta, and umbilical cord prolapse. Neonatal outcomes included 5-minute Apgar score <7, prematurity (<37 weeks' gestation), low birthweight (<10% for gestational age or <2500 g), macrosomia (≥90% for gestational age or ≥4000 g), postdatism (≥42 weeks' gestation), assisted ventilation requirement, perinatal death (stillbirth of at least 20 weeks or 500 g or death of liveborn within 28 days of birth), and neonatal death (death of a liveborn within 28 days of delivery). Perinatal and neonatal deaths were evaluated overall and for nonanomalous offspring. The study did not require institutional review board approval.

Statistical methods

Studies were assessed for homogeneity using the Breslow-Day test. When present, a fixed effects model was used; when absent, a random effects model was employed. Summary odds ratios (ORS) with 95% confidence intervals (CIS) were calculated for maternal and newborn outcomes, comparing planned home to planned hospital deliveries. Sensitivity analyses were conducted for studies employing matched planned home and hospital births,[4,10-12] those primarily based upon pre-1990 data,[5,10,13] lesser quality reports,[5,13,14] and those not clearly specifying home birth attendants or in which home births were conducted by other than certified or certified nurse midwives.[10,15] We used software (SAS, version 9.2; SAS Institute Inc, Cary, NC) for most data analysis. Random effects results were analyzed using an online metaanalysis calculator from the University of Pittsburgh (http://www.pitt.edu/~super1/lecture/lec1171/meta5.doc).

Results

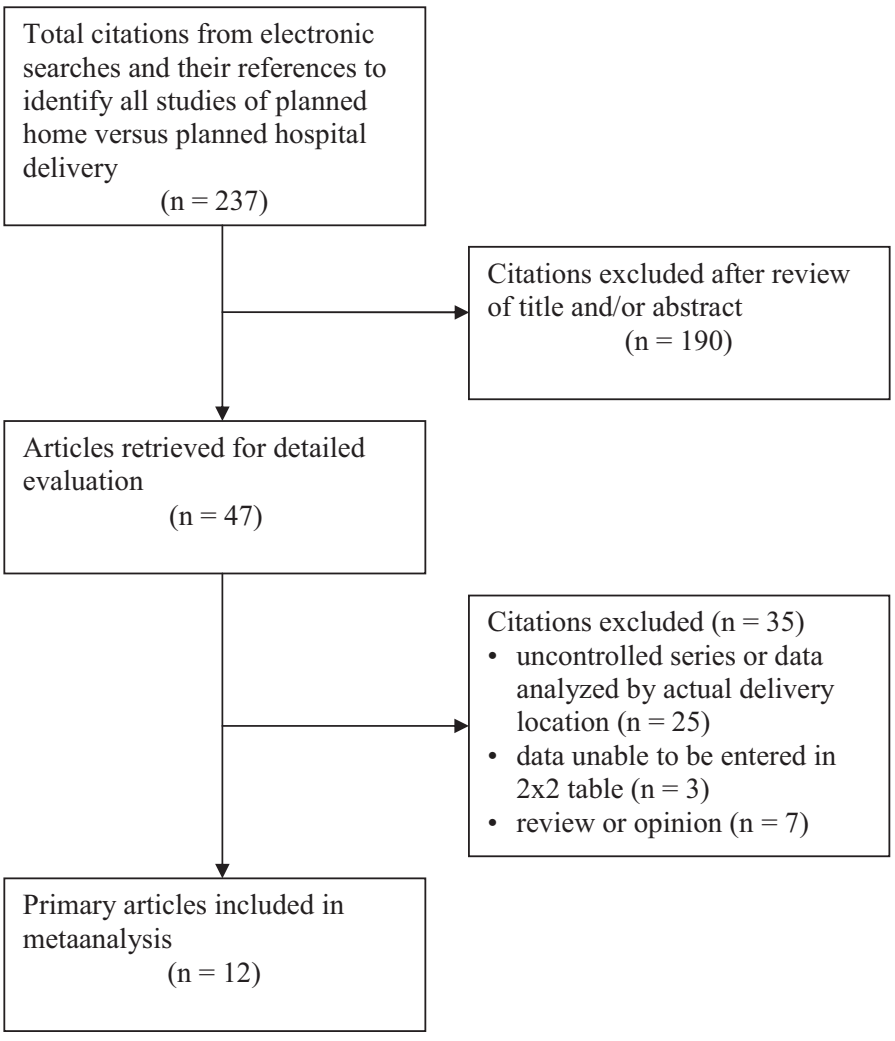
The results of the literature search are noted in Figure 2. Characteristics of the 12 included studies are described in Table 1.[4-7,10-17] A total of 342,056 planned home and 207,551 planned hospital deliveries were available for analysis. No maternal deaths were reported in 4 studies totaling 10,977 planned home and 28,501 planned hospital births, precluding metaanalysis. However, we calculated the upper 95% confidence limits for these rates, expressed per 100,000 births, as 27.3 and 10.5, respectively.[4,7,11,12] Table 2 presents the meta-analysis of maternal outcomes by intended delivery location. Planned home births experienced significantly fewer medical interventions including epidural analgesia, electronic fetal heart rate monitoring, episiotomy, and operative vaginal and cesarean deliveries. Likewise, women intending home deliveries had fewer infections, ≥3-degree lacerations, perineal and vaginal lacerations, hemorrhages, and retained placentas. There

was no significant difference in the rate of umbilical cord prolapse.

Table 3 describes the metaanalysis of neonatal outcomes. Low Apgar scores could not be evaluated as most studies considered thresholds other than a score of 7 (range, 4–8). Compared to offspring of women planning hospital births, those of mothers planning home births were less likely to be born preterm or be of low birthweight. However, planned home births more often progressed to ≥42 weeks. While there was no difference in the rate of assisted ventilation, 1 large study found more frequent ventilation among planned home births, while 2 smaller studies noted lower rates in this group.[11,15,17] Perinatal mortality was similar by intended delivery location, overall as well as just among nonanomalous offspring. In contrast, the overall neonatal death rate was almost twice as high in planned home vs planned hospital births, and almost tripled among nonanomalous neonates. Importantly, these latter observations were consistent across all studies examining neonatal mortality, regardless of the covered time period.[4,7,10,13,15,17] The anticipated population-based attributable risk of neonatal death overall and among nonanomalous offspring, employing a home birth prevalence of 0.6%, was 0.3% and 0.4%, respectively.

The results of the sensitivity analyses excluding older studies and poorer quality investigations revealed no significantly different findings from the original metaanalysis. In contrast, the sensitivity analysis excluding the 4 papers employing matching found no significant differences between planned home and planned hospital births regarding ≥3-degree lacerations (OR, 0.90; 95% CI, 0.62–1.31), retained placentas (OR, 0.66; 95% CI, 0.38–1.14), hemorrhage (OR, 0.80; 95% CI, 0.64–1.00), prematurity (OR, 0.52; 95% CI, 0.27–1.00), and neonatal death among nonanomalous offspring (OR, 2.22; 95% CI, 0.83–5.97). The analysis excluding studies that included home births attended by other than certified or certified nurse midwives had findings similar to the original study, except that the ORs for neonatal deaths among all (OR, 1.57; 95% CI, 0.62–3.98) and nonanomalous (OR, 3.00; 95% CI, 0.61–14.88) newborns were not statistically significant.

FIGURE 2
Study selection process



Wax. Outcomes in planned home birth vs planned hospital births. Am J Obstet Gynecol 2010.

Comment

Of concern, this investigation identified a doubling and tripling of the neonatal mortality rate overall and among nonanomalous offspring, respectively, in planned home compared to planned hospital births. This finding is particularly robust considering the homogeneity of the observation across studies. It is especially striking as women planning home births were of similar and often lower obstetric risk than those planning hospital births. The planned home delivery group commonly exhibited fewer obstetric risk factors such as excessive body mass index, nulliparity, prior cesarean, and previous pregnancy complications.[6,7,10,17] Moreover, our data show that planned home births are characterized by less frequent premature and low birthweight infants. The differential obstetric risk by planned delivery location was not unexpected since women self-select for home birth.

In developed nations, following congenital anomalies, most perinatal deaths are related to intrapartum anoxia.[18] Among the studies in our metaanalysis reporting causes of neonatal deaths in planned hospital births, this pattern was confirmed.[4,7,10,15] In contrast, 2 cohort studies implicated intra-

TABLE 1
Characteristics of studies included in metaanalysis

Setting	Study design	Time period studied	Publication year	Data source	Inclusions	Data analysis by parity	Planned deliveries, n		Intrapartum transfer to hospital rate		
							Home	Hospital	Nulliparous	Parous	Overall
California, United States[13]	Retrospective cohort	1976-1982	1984	ND	Single obstetrician and lay midwife practice, nulliparous and parous	Stratification	454	67	25/258 (9.7)	5/263 (1.9)	30/521 (5.8)
United Kingdom[5]	Prospective cohort	1978-1983	1985	Submitted data collection forms	Low risk, parous, no past obstetric complications, 26 practices	Parous only	202	185	ND	3.5%	3.5%
Western Australia[10]	Matched cohort	1981-1987	1994	Birth records, transfer forms, computer system	All Western Australian women booking for home birth and matched cohort of not planned home birth, nulliparous and parous	Matching	976	2928	ND	ND	14.0%
Switzerland[4]	Prospective cohort with matched pairs	1989-1992	1996	Special data collection forms	Women receiving care from 1 team of physicians and midwives, no formal policy for planned home delivery, nulliparous and parous	Matching	489	385	25%	ND	15.9%
Netherlands[6]	Prospective cohort	1990-1993	1996	Questionnaire, birth records	Low-risk pregnancies receiving midwifery care in 54 practices, nulliparous and parous	Stratification	1140	696	36.7%	8.7%	20.3%
Sweden[7]	Population-based cohort	1992-2004	2008	Swedish Medical Birth Register	All Swedish women planning home birth and control group of 37-42 wk low-risk singletons in ratio of 1:10, nulliparous and parous	No	897	11,341	ND	ND	ND
British Columbia, Canada[17]	Prospective cohort	1998-1999	2002	British Columbia Reproductive Care Program antenatal, birth, and newborn records	Low-risk women ≥36 wk planning home birth with midwife enrolled in Home Birth Demonstration Project and low-risk women 37-41 wk planning hospital birth, physician or midwife, nulliparous and parous	No	862	1314	ND	ND	16.5%
United Kingdom[14]	Randomized trial	1994	1996	ND	Low-risk parous women in 1 practice	Parous only	5	6	0	0	0

Wax. Outcomes in planned home birth vs planned hospital births. Am J Obstet Gynecol 2010. *(continued)*

TABLE 1
Characteristics of studies included in metaanalysis *(continued)*

Setting	Study design	Time period studied	Publication year	Data source	Inclusions	Data analysis by parity	Planned deliveries, n		Intrapartum transfer to hospital rate		
							Home	Hospital	Nulliparous	Parous	Overall
Washington State, United States[15]	Population-based cohort	1989-1996	2002	Birth certificates	Low-risk singletons ≥34 wk and ≥37 wk, nulliparous and parous	Adjustment	6133	10,593	ND	ND	ND
Netherlands[16]	Population-based cohort	2000-2006	2009	National perinatal registration data	Low-risk singletons 37-42 wk, nulliparous and parous	Stratification	321,307	163,261	ND	ND	ND
Ontario, Canada[11]	Population-based cohort with matched controls	2003-2006	2009	Ministry of Health midwifery database	Low-risk singletons 37-43 wk, nulliparous and parous	Matching	6692	6692	ND	ND	5.4%
British Columbia, Canada[12]	Population-based cohort with matched controls	2000-2004	2009	Provincial perinatal database	Low-risk singletons 36-41 wk, nulliparous and parous	Not performed	2899	10,083	ND	ND	ND

ND, not described.

Wax. Outcomes in planned home birth vs planned hospital births. Am J Obstet Gynecol 2010.

partum asphyxia in 31% and 52% of planned home delivery perinatal deaths.[19,20] The past 2 decades have seen a significant decrease in such deaths, with evidence suggesting fewer fetuses experiencing intrapartum anoxia.[18,21] Speculative explanations for the trend include more liberal use of ultrasound, electronic fetal heart rate monitoring, fetal acid-base assessment, labor induction, and cesarean delivery.[18,21] Our findings, considered in light of these observations, raise the question of a link between the increased neonatal mortality among planned home births and the decreased obstetric intervention in this group.

Additionally, while limited by the number of neonatal deaths described in sufficient detail, planned home births were characterized by a greater propor-

TABLE 2
Metaanalysis of maternal outcomes in planned home vs planned hospital births

Outcome	No. of studies	Planned home n/N (%)	Planned hospital n/N (%)	OR	95% CI
Intervention					
Epidural in labor[a]	3	945/10,453 (9.0)	4148/18,089 (22.9)	0.24	0.22–0.25
Electronic fetal heart rate monitoring	2	521/3761 (13.8)	7138/11,397 (62.6)	0.10	0.09–0.10
Episiotomy[a]	8	939/13,427 (7.0)	3075/29,677 (10.4)	0.26	0.24–0.28
Operative vaginal delivery[a]	8	497/14,157 (3.5)	3433/33,624 (10.2)	0.26	0.24–0.28
Cesarean delivery[a]	10	731/14,616 (5.0)	3140/33,697 (9.3)	0.42	0.39–0.45
Morbidity					
≥3-degree laceration[a]	5	150/12,604 (1.2)	794/31,740 (2.5)	0.38	0.33–0.45
Infection[b]	5	36/5341 (0.7)	319/12,347 (2.6)	0.27	0.19–0.39
Postpartum bleeding/hemorrhage[a]	7	933/18,720 (4.9)	1639/32,552 (5.0)	0.66	0.61–0.71
Perineal laceration[a]	6	2408/5632 (42.7)	8422/22,695 (37.1)	0.76	0.72–0.81
Vaginal laceration[b]	3	640/8078 (7.9)	4126/18,418 (22.4)	0.85	0.78–0.93
Cord prolapse[b]	3	3/4658 (0.06)	32/22,738 (0.14)	0.37	0.11–1.24
Retained placenta[a]	5	73/6079 (1.2)	248/15,208 (1.6)	0.65	0.51–0.83

CI, confidence interval; *OR*, odds ratio.

[a] Random effects model; [b] Fixed effects model.

Wax. Outcomes in planned home birth vs planned hospital births. Am J Obstet Gynecol 2010.

TABLE 3
Metaanalysis of neonatal outcomes in planned home vs planned hospital births

Outcome	No. of studies	Planned home n/N (%)	Planned hospital n/N (%)	OR	95% CI
Morbidity					
Prematurity <37 wk[a]	5	75/9751 (0.77)	191/4076 (4.7)	0.72	0.55–0.96
Postdates ≥42 wk[a]	4	193/9297 (2.1)	238/10,701 (2.2)	1.87	1.50–2.32
Low birthweight <10% or <2500 g[b]	5	209/15,411 (1.3)	468/21,290 (2.2)	0.60	0.50–0.71
Large for gestational age >90% or 4000 g[a]	4	1344/13,525 (9.9)	1340/17,411 (7.7)	1.07	0.99–1.16
Newborn ventilation[a]	3	497/13,525 (3.7)	502/10,701 (4.7)	1.12	0.99–1.28
Mortality					
Perinatal death					
All[b]	6	229/331,666 (0.07)	140/175,443 (0.08)	0.95	0.77–1.18
Nonanomalous[b]	4	225/330,324 (0.07)	134/173,266 (0.08)	0.95	0.76–1.18
Neonatal death					
All[b]	7	32/16,500 (0.20)	32/33,302 (0.09)	1.98	1.19–3.28
Nonanomalous[b]	6	23/15,633 (0.15)	14/31,999 (0.04)	2.87	1.32–6.25

CI, confidence interval; *OR*, odds ratio.

[a] Random effects model; [b] Fixed effects model.

Wax. Outcomes in planned home birth vs planned hospital births. Am J Obstet Gynecol 2010.

tion of deaths attributed to respiratory distress and failed resuscitation.[7,10,13,15] These findings echo concerns raised in a recent large US cohort study in which home births experienced significantly more 5-minute Apgar scores <7 as compared to low-risk term hospital births, suggesting an increased need for resuscitation among home births.[2] Therefore, the personnel, training, and equipment available for neonatal resuscitation represent other possible contributors to the excessive neonatal mortality rate among planned home births. Finally, we note that there may well be other unrecognized factors contributing to the higher neonatal death rate among planned home births.

Interestingly, our metaanalysis noted similar perinatal mortality rates by intended delivery site, both overall, as well as among nonanomalous offspring. This result is not surprising considering the low-risk nature of the antecedent pregnancies. However, it is an unexpected finding given the increased neonatal mortality rate observed with planned home delivery. The apparent discordance may result from the differences in obstetric risk among women planning home vs hospital births. A study published after our analysis found similar perinatal mortality rates in planned home and hospital deliveries. However, adjusting the perinatal mortality ratio for the later gestational ages at delivery and greater birthweights among home births demonstrated higher standardized perinatal mortality ratios among planned home deliveries, particularly among those requiring transfer to hospital.[22] Such an adjustment could not be performed in the current analysis without patient-level data. However, one may speculate that similar findings would be noted based on the later gestational age at birth and greater birthweights seen in our analysis among planned home vs planned hospital births. In contrast, we were able to estimate the population-based attributable risk of neonatal death due to home birth. The absolute risk was small, reflecting the low prevalence of home birth and rarity of the outcome, despite its significantly increased OR.

A paucity of data in the original studies precluded a more in-depth examination of contributors to the perinatal mortality rates described in this metaanalysis. Potentially valuable insights could result from evaluating antepartum vs intrapartum stillbirths, as well as potentially preventable deaths. Interestingly, 2 Dutch studies observed no relationship between potentially avoidable perinatal deaths and delivery setting (home vs hospital) or birth attendant (midwife vs physician).[23,24] However, a recent Australian study identified an increased rate of intrapartum perinatal deaths among planned home deliveries, one-third of which were attributed to asphyxia, contrasting only 3.6% of intrapartum perinatal deaths among planned hospital births.[22]

The maternal mortality rate arguably represents the ultimate measure of childbirth safety. The current study could not perform metaanalysis of maternal mortality by planned delivery location because no deaths were described among studies reporting this outcome. The absence of maternal deaths is not surprising considering the number of deliveries comprising the study populations. Thus, more data are necessary before drawing any conclusions regarding the maternal mortality rates of planned home and planned hospital delivery.

The current metaanalysis shows that planned home compared to planned hospital births are associated with signif-

icantly less maternal and newborn medical intervention and morbidity particularly among selected low-risk women cared for by highly trained and regulated midwives who are integrated into the health care system. These findings are notable in that our analysis by planned delivery site confirms many of the observations of a recent cohort study evaluating outcomes by actual delivery location.[2] At first glance, these results are not surprising for several reasons. Many women choose home birth, at least in part to avoid pharmacologic analgesia and medical technology.[4,25-30] Most women considered to be home birth candidates exhibit low obstetric risk and should therefore anticipate more favorable outcomes than women choosing or requiring a planned hospital delivery. Finally, most home births are attended by midwives, a group demonstrating distinctly different obstetric practice patterns from physicians performing most in-hospital deliveries.[31-34] A systematic review and metaanalysis of randomized trials of midwife-led vs other care models confirms less medical intervention and improved perinatal outcomes in the former group.[35] Importantly, these trials included hospital but not home births.

Women, particularly low-risk parous individuals, choosing home birth are in large part successful in achieving their goal of delivering with less morbidity and medical intervention than experienced during hospital-based childbirth. Of significant concern, these apparent benefits are associated with a near tripling of the neonatal mortality rate among nonanomalous infants. These results confirm and complement those of prior large cohort studies assessing outcomes by actual birth location, suggesting generalizability to and value in counseling low-risk women considering home birth particularly with highly trained, regulated midwives who are fully integrated into existing health care systems. Therefore, these data may be of limited applicability to women opting for home birth in the United States.[36] The large number of outcomes for which heterogeneity was present suggests that such results should be interpreted with caution. Finally, one must appreciate that the lower obstetric risk characterizing women self-selecting planned home birth likely underestimates the risk and overestimates the benefit of this delivery choice.

Future research needs to be directed at identifying contributors to and reducing the apparently excessive neonatal mortality among planned home births. Data regarding maternal mortality, maternal and newborn readmission rates and indications, and newborn neurologic injury are insufficient for evaluation and comparison. Comprehensive economic analyses by planned birth location are also lacking.[37] Ideally, the results of such work will contribute to an obstetric and newborn best practices model benefiting women and children regardless of chosen birth location. ■

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