OBSTETRICS

Apgar score of 0 at 5 minutes and neonatal seizures or serious neurologic dysfunction in relation to birth setting

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OBJECTIVE: To examine the occurrence of 5-minute Apgar scores of 0 and seizures or serious neurologic dysfunction for 4 groups by birth setting and birth attendant (hospital physician, hospital midwife, freestanding birth center midwife, and home midwife) in the United States from 2007-2010.

METHODS: Data from the United States Centers for Disease Control's National Center for Health Statistics birth certificate data files were used to assess deliveries by physicians and midwives in and out of the hospital for the 4-year period from 2007-2010 for singleton term births (≥37 weeks' gestation) and ≥2500 g. Five-minute Apgar scores of 0 and neonatal seizures or serious neurologic dysfunction were analyzed for 4 groups by birth setting and birth attendant (hospital physician, hospital midwife, freestanding birth center midwife, and home midwife).

RESULTS: Home births (relative risk [RR], 10.55) and births in freestanding birth centers (RR, 3.56) attended by midwives had a significantly higher risk of a 5-minute Apgar score of 0 ($P < .0001$) than hospital births attended by physicians or midwives. Home births (RR, 3.80) and births in freestanding birth centers attended by midwives (RR, 1.88) had a significantly higher risk of neonatal seizures or serious neurologic dysfunction ($P < .0001$) than hospital births attended by physicians or midwives.

CONCLUSION: The increased risk of 5-minute Apgar score of 0 and seizures or serious neurologic dysfunction of out-of-hospital births should be disclosed by obstetric practitioners to women who express an interest in out-of-hospital birth. Physicians should address patients' motivations for out-of-hospital delivery by continuously improving safe and compassionate care of pregnant, fetal, and neonatal patients in the hospital setting.

Key words: Apgar score, birth center, homebirth, hospital birth, neonatal seizures, patient safety

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Home births have increased in the United States in the last decade,[1] allthough home births in the Netherlands, the country with the greatest experience with home births, have decreased.[2] The 2011 American College of Obstetricians and Gynecologists' Committee Opinion, "Planned Home Birth," provides a useful review of the literature.[3] The Cochrane Collaboration has published 2 reviews, one of clinical trials comparing planned hospital birth with planned home birth[4] and another of trials comparing institutional and alternative birth settings.[5] The safety of out-of-hospital birth remains controversial. The purpose of this study was to examine the occurrence of 5-minute Apgar scores of zero and seizures or serious neurologic dysfunction for 4 groups by birth setting and birth attendant (hospital physician, hospital midwife, freestanding birth center midwife, and home midwife) in the United States from 2007-2010.

Materials and Methods

Data were obtained from the National Center for Health Statistics (NCHS) of the US Centers for Disease Control (CDC) birth certificate data for 2007-2010, the most recent data available. The CDC files contain detailed information on each of the approximately 4 million births in the United States each year. Data on patient characteristics include setting and method of delivery as well as birth attendant as reported on birth certificates filed each year with the states of the United States and compiled by NCHS. These data are publicly accessible on the internet (http://205.207.175.93/vitalstats/ReportFolders/ReportFolders.aspx), where detailed tables can be created and downloaded for further evaluation.

The data that we report in this study are for the 2007-2010 period. We excluded

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preterm births (<37 weeks), infants weighing under 2500 g, and multiple gestations. This study therefore includes only singleton term births (deliveries ≥37 weeks) and infants weighing ≥2500 g.

Data on patients' characteristics included parity, race and ethnicity, maternal age, and clinical factors including neonatal weight and weeks of gestation. We included patients in the 4 CDC categories that are described by birth setting and birth attendant: hospital-based physician; hospital-based midwife; freestanding birth center midwife; and home-based midwife.

Missing data were excluded for each parameter before percentages were computed. Differences noted as higher or lower were statistically significant at the $P < .05$ level.

Apgar scores[6,7] are well reported on birth certificates.[1,8-11] We included outcome data on 5-minute Apgar scores of 0, the clinical and prognostic utility of which is well established.[1,8-11] We also included outcome data on neonatal seizures or serious neurologic dysfunction, the category used by the CDC. Since the introduction of the 2003 revised US Standard Certificate of Live Birth, outcome data such as seizures or serious neurologic dysfunction have been documented in 21 states in 2007, 27 states in 2008 and 2009, and 35 states in 2010. We calculated the risk ratios for seizures or serious neurologic dysfunction only for those states that had these data on their birth certificates, which included about 56% of all US births. Five-minute Apgar scores of 0 and data on seizure or serious neurologic dysfunction were placed into the same 4 groups by birth place and attendant. Five-minute Apgar scores of 0 and seizures or serious neurologic dysfunction are reported, as well as by parity (0, ≥1).

Bivariable analyses were conducted to determine whether characteristics of mothers and infants differed by the 4 groups. Hospital births attended by physicians served as the reference group in this analysis. For characteristics that had multiple levels (eg, age and race), a reference group was selected (<25-years-old for age and non-Hispanic white for race). All levels of the characteristic were individually compared with the reference group. χ^2 statistics were calculated for each bivariable analysis. Risk ratios and 95% confidence intervals (CIs) were calculated for each outcome in the 4 groups. Risks of the other 3 groups were individually compared with risks for hospital births attended by physicians. To account for confounding by parity, stratified analyses were conducted for parity = 0 and parity >0 for 5-minute Apgar scores of zero and seizures or serious neurologic dysfunction. In addition, stratum-specific estimates were calculated for maternal age <35-years-old, maternal age ≥35-year-old, gestational age 37-40 weeks, and gestational age ≥41 weeks for 5-minute Apgar scores of zero. All statistical analyses were conducted in OpenEpi (Open Source Epidemiologic Statistics for Public Health, Atlanta, GA).[12]

Because nonidentifiable data from a publicly available dataset were used, our study was not considered human subjects research and did not require review by the institutional review board of Weill Medical College of Cornell University.

RESULTS

From 2007 to 2010, there were a total of 16,693,978 births in the United States. Our study population consisted of 13,891,274 singleton deliveries, ≥37 weeks, with a birthweight ≥2500 g who were delivered in the hospital, a birthing center, or at home by either a physician or a midwife. In our study population, 5-minute Apgar scores were available for 98.8% of all states and for neonatal seizures or serious neurologic dysfunction in 97.5% of those states that had collected presence or absence of neonatal seizures or serious neurologic dysfunction in their birth certificates.

Table 1 shows patient characteristics and the distribution of the 4 groups of settings and birth attendants of our study population. There were a total of 13,891,274 births by physicians or midwives in the hospital, a freestanding birthing center, or at home between 2007 and 2010. The majority of term singleton births (91.16%; n = 12,663,051) were physician hospital births; midwife hospital births constituted 8.05% of birth (n = 1,118,678), and 0.49% (n = 67,429) were midwife home deliveries. Patients delivering at home attended by midwives were significantly more likely to be multiparous, non-Hispanic white, ≥30 years of age, delivering beyond 41 and 42 weeks, and having macrosomic infants over 4000 and 4500 g ($P < .0001$).

Table 2 shows the outcomes and relative risks (RRs) by the 4 groups of settings and attendants for 5-minute Apgar scores of 0, by parity. The RR of a 5-minute Apgar score of 0 for midwife home deliveries was 10.55 (95% CI, 8.62–12.93). The RR of a 5-minute Apgar score of 0 for midwife home deliveries further increased to 14.24 (95% CI, 10.16–19.96) for nulliparous patients. The RR for freestanding birth center midwife deliveries was less than home deliveries (3.56 vs 10.55) but it was increased relative to hospital deliveries by physicians or midwives. Within the hospital, midwife-attended deliveries had a lower RR (0.55; 95% CI, 0.45–0.68) compared with physicians.

When we analyzed 5-minute Apgar scores of 0 for women <35 years of age, we found that the RR for midwife home deliveries was 8.76 (95% CI, 6.85–11.21) and for freestanding birth center midwife deliveries the RR was 4.28 (95% CI, 2.81–6.52). The RR for women ≥ 35 years of age for midwife home deliveries was 15.86 (95% CI, 10.97–22.92). When we analyzed 5-minute Apgar scores of 0 for women ≥41 weeks' gestation we found that the RR for midwife deliveries was 6.5 (96% CI, 4.09–10.33) and 11.7 (95% CI, 9.33–14.68) for deliveries between 37-40 weeks.

Table 3 shows the outcomes by the 4 groups of settings and attendants for seizures or serious neurologic dysfunction and by parity. The RR of seizures or serious neurologic dysfunction for midwife home deliveries was 3.80 (95% CI, 2.80–5.16), and the RR of seizures or serious neurologic dysfunction for midwife home deliveries further increased to 6.28 (95% CI, 4.08–9.67) for nulliparous patients. Freestanding birthing centers midwife deliveries showed an increased risk of 1.88 (95% CI, 1.11–3.17) for seizures or serious neurologic dysfunction and an increased risk of 2.77 (95% CI, 1.48–5.15) for

TABLE 1
Characteristics of study population

Characteristic	Hospital physician	Hospital midwife	Freestanding birth center midwife	Home midwife
TOTAL N = 13,891,274	12,663,051 (91.16)	1,118,578 (8.05)	42,216 (0.30)	67,429 (0.49)
Para = 0	n = 12,615,994	n = 1,115,794	n = 42,000	n = 60,296
Yes	5,155,779 (40.9)	44,0642 (39.5)	15,228 (36.3)	14,801 (24.5)
No	7,460,215 (59.1)	675,152 (60.5)	26,772 (63.7)	45,495 (75.4)
Ethnicity	n = 12,576,465	n = 1,111,003	n = 41,992	n = 66,314
Non-Hispanic white	6,894,312 (54.8)	585,553 (52.7)	34,270 (81.6)	60,017 (90.45)
Non-Hispanic black	1,719,347 (13.7)	145,442 (13.1)	1865 (4.4)	1314 (1.98)
Hispanic	3,100,313 (24.7)	301,223 (27.1)	4759 (11.3)	3533 (5.3)
Non-Hispanic other	862,493 (6.9)	78,785 (7.1)	1098 (2.6)	1490 (2.2)
Mother's age	n = 12,553,246	n = 1,118,578	n = 42,216	n = 67,429
<25 y	4,307,508 (34.3)	449,318 (40.2)	9338 (22.1)	10,336 (15.3)
25-29 y	3,505,877 (27.9)	325,607 (29.1)	14,432 (34.2)	20,899 (31.0)
30-34 y	2,957,460 (23.6)	228,962 (20.5)	12,119 (28.7)	21,331 (31.6)
≥35 y	1,782,401 (14.2)	114,691 (10.3)	6327 (15.0)	14,863 (22.0)
Post EDD	n = 12,701,519	n = 1,118,936	n = 42,229	n = 67,504
≥41 wk	1,982,383 (15.61)	227,607 (20.34)	11,184 (26.48)	19,286 (28.57)
≥42 wk	798,882 (6.29)	85,375 (7.63)	3711 (8.79)	6449 (9.55)
Macrosomia	n = 12,663,051	n = 1,118,578	n = 312,586	n = 61,684
≥4000 g	1,104,459 (8.72)	98,644 (8.82)	29,899 (9.57)	12,831 (20.80)
≥4500 g	148,509 (1.17)	11,114 (0.99)	3699 (1.18)	2538 (4.11)

EDD, estimated due date.

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seizures or serious neurologic dysfunction for nulliparous patients. Within the hospital, midwife-attended deliveries had a lower RR compared with physicians (0.74; 95% CI, 0.62–0.89).

COMMENT

Principal findings

There is an identifiable pattern in these data for the outcomes of singleton term births: home birth is associated with a significantly increased risk of 5-minute Apgar scores of 0 and neonatal seizures or serious neurologic dysfunction compared with hospital birth. When it comes to home births vs hospital births, home births are strongly associated with worse outcomes. The increased rate of adverse outcomes of home births exists despite the reported lower risk profile of home birth.[13] The pattern for freestanding birth centers is also identifiable: this setting is associated with increased risk compared with hospital delivery, though not as high risk as home birth. When it comes to births at a freestanding birth center vs a hospital, births at a freestanding birthing center are strongly associated with worse outcomes.

It is essential to note that these significantly increased risks of adverse outcomes from the setting of home and from the setting of freestanding birth centers reported here may be serious underestimations of clinical complications. A substantial number of the adverse outcomes attributed to hospital births result from transfers from home births.[14] In the Birthplace in Britain study, up to 45% of nulliparous patients were transferred to the hospital.[15] In the CDC dataset the outcomes for patients whose care began out of the hospital but were transferred to the hospital are counted as outcomes of care in the hospital. They are not reported as outcomes of the original out-of-hospital setting. Obviously, correction of this factor would further negatively impact the RR of all adverse outcomes for births out of the hospital.

We emphasize that the increased risks of poor outcomes from the setting of home birth, regardless of attendant, are virtually impossible to solve by transport. This is because total time for transport from home to hospital cannot realistically be reduced to clinically satisfactory times to optimize outcome

TABLE 2
5-minute Apgar scores = 0 by birth setting, birth attendant, and parity

Outcome/Birth setting	n/Total (per 1000)	RR (95% CI)
5-minute Apgar 0 (all)		
Hospital MD	1,943/12,615,994 (0.16)	1.00
Hospital midwife	95/1,115,794 (0.09)	0.55 (0.45–0.68)
Freestanding BC midwife	23/42,000 (0.55)	3.56 (2.36–5.36)
Home midwife	98/60,296 (1.63)	10.55 (8.62–12.93)
5-minute Apgar 0 ($P = 0$)		
Hospital MD	856/5,155,779 (0.17)	1.00
Hospital midwife	37/440,642 (0.84)	0.51 (0.36–0.70)
Freestanding BC midwife	11/15,226 (7.22)	4.35 (2.40–7.89)
Home midwife	35/14,801 (2.36)	14.25 (10.16–19.96)
5-minute Apgar 0 ($P > 0$)		
Hospital MD	1087/7,460,215 (0.15)	1.00
Hospital midwife	58/675,152 (0.09)	0.59 (0.45–0.77)
Freestanding BC midwife	12/26,772 (0.45)	3.08 (1.74–5.43)
Home midwife	63/45,495 (1.35)	9.5 (7.37–12.25)

Hospital MD is the reference group.

BC, birth center; *CI*, confidence interval; *MD*, doctor; *RR*, relative risk.

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when time is of the essence when unexpected deterioration of the condition of either the fetal patient or pregnant patient occurs.

Clinical implications

Our data have important implications for the informed consent process for planned out-of-hospital birth. In the ethics and law of informed consent, obstetricians have the professional responsibility to identify medically reasonable alternatives for the management of pregnancy and their benefits and risks.[16] The data reported here strongly support the clinical judgment that home delivery and birth in freestanding centers are not medically reasonable, given their preventable, clinically significant absolute and RRs of adverse perinatal outcomes. Physicians therefore should not offer and should recommend against birth settings outside the hospital.[17,18] We emphasize that this stance should be accompanied by effective efforts to reduce unnecessary interventions and to improve the institutional setting of hospital delivery to make it more home like,[17,18] as well as continuously improve its quality and safety.[19]

Implications for research

Initiation of clinical trials at any phase requires protection of human subjects from preventable adverse events in the study design. In our judgment, the principal findings of our study document increased, preventable harms of out-of-hospital settings that should rule out as ethically unacceptable randomized controlled clinical trials of hospital vs out-of-hospital birth settings.[17,18]

Findings in other studies

Some studies that reported on low-risk home births showed decreased perinatal and neonatal mortality rates,[20,21] although other studies reported increased mortality rates.[22-24] In a comparison of midwife-attended hospital vs midwife-attended home birth, Malloy reported an increased risk of neonatal mortality and 5-minute Apgar scores <4 for the home vs the hospital setting.[25] Our analysis is more comprehensive than Malloy's both by setting and by attendant.

There is a pattern related to the incidence of 5-minute Apgar scores of 0 in our analysis: nulliparous patients have a many-fold significantly higher risk of 5-minute Apgar scores of 0 in the home setting, when compared with multiparous women. Others have observed this pattern[26] and have called for discouraging women from having their first birth at home.[27] We emphasize that, despite these differences, lower risk conditions such as multiparity or term births below 41 weeks do not provide acceptable protection from adverse outcomes in the home setting.

Strengths and limitations

The major strength of our analysis is the large sample size for both hospital and home birth over a 4-year period from the most comprehensive and reliable dataset available in the United States. Our data are also consistent with those of others who found increased neonatal morbidity and mortality[25] in home births, especially in nulliparous women.[26]

Our study has several limitations. The quality of data reported in birth certificates can vary.[11,28] Although information on setting, birth attendant, and Apgar scores are reliable in the CDC dataset, data on seizures or serious neurologic dysfunction are less so.[1,8-11] Another limitation is that our data for seizures or serious neurologic dysfunction included about 60% of the US births between 2007 and 2010 for those states that have been using the 2003 US Standard Certificate of Live Birth. Because of this sample, results about neonatal seizures or serious neurologic dysfunction may not be generalizable for the whole country. Nevertheless, for the states reporting, there was a 97.5% compliance rate for indicating presence or absence of seizures or serious neurologic dysfunction. The CDC data on seizures or serious neurologic dysfunction include those of genetic, prenatal, intrapartum, and neonatal origin that might not be related to birth setting.

Another limitation is that it is not possible to know from the CDC data whether a 5-minute Apgar score of 0 was

TABLE 3
Neonatal seizures or serious neurologic dysfunction by birth setting, birth attendant, and parity

Variable	N/Total (per 1000)	RR (95% CI)
Seizures (All)		
Hospital MD	1823/8,102,337 (0.22)	1.00
Hospital midwife	121/727,395 (0.17)	0.74 (0.62–0.89)
Freestanding BC midwife	14/33,188 (0.42)	1.88 (1.11–3.17)
Home midwife	42/49,091 (0.86)	3.8 (2.80–5.16)
Seizures ($P = 0$)		
Hospital MD	981/3,297,301 (0.30)	1.00
Hospital midwife	77/286,920 (0.27)	0.90 (0.72–1.14)
Freestanding BC midwife	10/12,155 (0.83)	2.77 (1.48–5.15)
Home midwife	21/11,239 (1.87)	6.28 (4.08–9.67)
Seizures ($P > 0$)		
Hospital MD	842/4,805,036 (0.18)	1.00
Hospital midwife	44/440,475 (0.10)	0.57 (0.42–0.77)
Freestanding BC midwife	4/21,073 (0.19)	1.08 (0.41–2.89)
Home midwife	21/37,853 (0.55)	3.17 (2.05–4.88)

Hospital MD is the reference group.

BC, birth center; *CI*, confidence interval; *MD*, doctor; *RR*, relative risk.

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effectively a stillbirth that occurred antepartum or intrapartum. We do not believe that this limitation changes our major findings. This is because the vast majority of stillbirths delivered in the hospital are known to be antepartum and not intrapartum.[29-31] On the other hand, in out-of-hospital settings, most antepartum deaths in planned home births would be transferred to the hospital. Moreover, in out-of-hospital settings, there is likely less antepartum testing and no continuous electronic intrapartum fetal monitoring, both of which may have affected adverse outcomes.

Data on long-term follow-up of neonates would be optimal, but the CDC database does not include such information. An Apgar score of 0 indicates that there are no signs of life (no heartbeat, no breathing or movements). Infants with a 5-minute Apgar score of 0 have a significantly increased risk of mortality and if they survive an increased risk of significant morbidity.[32,33] Survival relates directly to the effectiveness of neonatal resuscitation that is severely limited in home births. Head cooling may improve outcomes but there is still significant mortality and morbidity.[34]

Most importantly, the CDC does not categorize as out-of-hospital births those hospital births that resulted from transfer from out-of-hospital settings where there was an intention for out-of-hospital birth. A midwife-attended delivery at home or at a birth center, however, is an appropriate proxy for intended or planned out-of-hospital delivery. There is no way to assess from these data when intended out-of-hospital deliveries are transferred to the hospital, making an intention-to-treat analysis impossible.

Conclusion

The increased risk of 5-minute Apgar score of 0 and increased rates of seizures or serious neurologic dysfunction of out-of-hospital birth must be acknowledged by all obstetric practitioners and should be disclosed to all pregnant women who express an interest in out-of-hospital birth. In addition, physicians have the professional responsibility to recommend against planned out-of-hospital births to women who express an interest in it and not to refer their patients to randomized controlled clinical trials of hospital vs out-of-hospital birth as ethically unacceptable.[17,18] Physicians also have the professional responsibility to address the root cause of patients' motivations for out-of-hospital delivery through continuous efforts to address patient concerns about interventions,[35] and to improve compassionate and safe care of pregnant, fetal, and neonatal patients in the hospital setting.[17-19] ■

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