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Trends and Outcomes for Donor Oocyte Cycles in the United States, 2000–2010

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Abstract

IMPORTANCE—The prevalence of oocyte donation for in vitro fertilization (IVF) has increased in the United States, but little information is available regarding maternal or infant outcomes to improve counseling and clinical decision making.

OBJECTIVES—To quantify trends in donor oocyte cycles in the United States and to determine predictors of a good perinatal outcome among IVF cycles using fresh (noncryopreserved) embryos derived from donor oocytes.

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DESIGN, SETTING, AND PARTICIPANTS—Analysis of data from the Centers for Disease Control and Prevention's National ART Surveillance System, to which fertility centers are mandated to report and which includes data on more than 95% of all IVF cycles performed in the United States. Data from 2000 to 2010 described trends. Data from 2010 determined predictors.

MAIN OUTCOMES AND MEASURES—Good perinatal outcome, defined as a singleton live-born infant delivered at 37 weeks or later and weighing 2500 g or more.

RESULTS—From 2000 to 2010, data from 443 clinics (93% of all US fertility centers) were included. The annual number of donor oocyte cycles significantly increased, from 10 801 to 18 306. Among all donor oocyte cycles, an increasing trend was observed from 2000 to 2010 in the proportion of cycles using frozen (vs fresh) embryos (26.7% [95% CI, 25.8%–27.5%] to 40.3% [95% CI, 39.6%–41.1%]) and elective single-embryo transfers (vs transfer of multiple embryos) (0.8% [95% CI, 0.7%–1.0%]to 14.5% [95% CI, 14.0%–15.1%]). Good perinatal outcomes increased from 18.5% (95% CI, 17.7%–19.3%) to 24.4% (95% CI, 23.8%–25.1%) ($P < .001$ for all listed trends). Mean donor and recipient ages remained stable at 28 (SD, 2.8) years and 41 (SD, 5.3) years, respectively. In 2010, 396 clinics contributed data. For donor oocyte cycles using fresh embryos (n = 9865), 27.5% (95% CI, 26.6%–28.4%) resulted in good perinatal outcome. Transfer of an embryo at day 5 (adjusted odds ratio [OR], 1.17 [95% CI, 1.04–1.32]) and elective single-embryo transfers (adjusted OR, 2.32 [95% CI, 1.92–2.80]) were positively associated with good perinatal outcome; tubal (adjusted OR, 0.72 [95% CI, 0.60–0.86]) or uterine (adjusted OR, 0.74 [95% CI, 0.58–0.94]) factor infertility and non-Hispanic black recipient race/ethnicity (adjusted OR, 0.48 [95% CI, 0.35–0.67]) were associated with decreased odds of good outcome. Recipient age was not associated with likelihood of good perinatal outcome.

CONCLUSIONS AND RELEVANCE—In the United States from 2000 to 2010, there was an increase in number of donor oocyte cycles, accompanied by an increase in good outcomes. Further studies are needed to understand the mechanisms underlying the factors associated with less successful outcomes.

During the past several decades, mean maternal age at delivery of a first infant has increased steadily to 25.2 years in the United States and 30 years in Germany and Britain in 2009.[1] The number of live births to women in their early 40s in the United States has also increased steadily, from 7.4 per 1000 women in 1999 to 10.3 per 1000 in 2011.[2]

Delay of childbearing may result from multiple factors, including technological advances in reproductive science, evolution of women's societal roles, increased availability of effective contraception, and increased acceptance of divorce and delayed marriage.[3] Reproductive potential declines with advancing female age, and current technology using autologous oocytes remains limited by the ovarian "biological clock."

Oocyte donation initially gained acceptance as treatment for premature ovarian insufficiency but has become more common for treatment of age-related diminished reserve. Among women of advanced age who conceive spontaneously, evidence demonstrates increased maternal and neonatal risk.[4–6] Small retrospective studies have attempted to quantify perinatal risk among older women undergoing donor oocyte in vitro fertilization (IVF) and have found that rates of pregnancy and miscarriage reflect donor rather than recipient age. However, these studies obtained conflicting results when comparing obstetric complications

of donor oocyte IVF with spontaneously conceived, autologous oocyte IVF, or other-donor IVF pregnancies.[7–13] Evidence suggests increased risk of preterm delivery and low birth weight among singleton pregnancies conceived using autologous oocyte IVF,[14] and race/ethnicity, infertility diagnosis, and embryo culture duration may decrease the likelihood of a good perinatal outcome.[15] However, such predictors have not been affirmed in donor oocyte IVF. We investigated donor oocyte use from 2000 to 2010 using the United States' National ART Surveillance System (NASS) and determined predictors of good perinatal outcome (singleton live-born infant delivered at 37 weeks or later and weighing 2500 g or more) among donor oocyte IVF cycles performed in 2010 using fresh (noncryopreserved) embryos.

Methods

Data used in this study were obtained from NASS, a federally mandated reporting system that collects information about assisted reproductive technology (ART) cycles performed in the United States.[16,17] The study was approved by the institutional review board of the Centers for Disease Control and Prevention; a waiver of informed consent was obtained.

Assisted reproductive technology procedures include those involving the laboratory handling of gametes, namely, IVF with transcervical embryo transfer, gamete intrafallopian transfer, and zygote intrafallopian transfer. The NASS data are ART cycle–based and include patient demographics, medical and obstetric history, infertility diagnoses, detailed parameters of each ART treatment cycle, and, if applicable, the resultant pregnancy outcome. Although 6% to 12% of ART clinics did not report data in any given year between 2000 and 2010, we estimate that NASS includes data from more than 95% of all ART cycles performed in the United States.[18] Additionally, for each of the study years, approximately 7% to 10% of reporting clinics were randomly selected for data validation, with slightly greater selection chances for larger clinics and clinics with a low cycle cancellation rate. During validation, a randomly selected sample of ART data reported by the clinics is compared with information recorded in medical records and discrepancy rates are calculated. Overall, discrepancy rates for the variables evaluated in the present study were less than 5%, except for the diagnosis of infertility, which had higher rates (up to 18%), mostly attributable to report of "other" or "unexplained" infertility instead of a specific cause.

To explore trends in oocyte donation, we included all donor oocyte cycles using fresh and frozen embryos performed in the United States between 2000 and 2010 that did not use a gestational carrier (a third party who agreed to carry a pregnancy on behalf of the intended parents). In the trend analysis, we report the absolute number and percentage of all ART cycles using donor oocytes. We then eliminated all canceled cycles for which a retrieval or transfer was not performed and calculated the annual percentage of donor oocyte cycles that used fresh or frozen embryos, involved an elective single-embryo transfer, and resulted in a good perinatal outcome. Elective single-embryo transfer was defined as the transfer of a single embryo when additional embryos were available and subsequently cryopreserved. We also calculated the mean age of donors and recipients for each year for which data were available (2000 through 2010 for recipients, 2007 through 2010 for donors). A linear

regression was used to assess all trends over time. Last, trend analyses were performed for first donor cycles and repeat donor cycles from 2004 to 2010 (cycles within a given clinic were linked beginning in 2004).

To minimize misclassification and confounding and to capture the most recent practice patterns, for all subsequent analyses cycles were limited to donor oocyte IVF cycles with fresh embryos performed in 2010. Our analysis included donor embryos and donor oocytes but was primarily composed of donor oocyte cycles (99.3%) rather than donor embryo cycles. Cycles using autologous oocytes and fresh embryos were chosen as the comparison group for characterization of donor and recipient traits. The NASS definition of a clinical intrauterine gestation is ultrasound confirmation of at least 1 gestational sac within the uterus, regardless of whether a heartbeat is observed or fetal pole established. Without ultrasound data, confirmation is achieved through documented birth, spontaneous miscarriage, or induced abortion. For the calculation of number of fetal heartbeats, only cycles that resulted in pregnancy (had an outcome of clinical intrauterine gestation or heterotopic pregnancy) were included; cycles that had no indication of pregnancy from either β–human chorionic gonadotropin testing or ultrasound or that resulted in biochemical or ectopic pregnancies were excluded. We calculated plurality in cycles resulting in a live birth. Number of fetal heartbeats and plurality were included in descriptive analysis but were not used in the bivariable or multivariable analyses because they are in the causal pathway to the final outcome.

The primary outcome of interest was good perinatal outcome, defined as a singleton live birth at 37 weeks or later and birth weight of 2500 g or more.[19,20] The American Society of Reproductive Medicine and recent literature support the consideration of a singleton but not twin term infant to be a good perinatal outcome, because higher-order gestations are at increased risk of complications.[19,20]

Bivariable analyses were conducted to explore the relationship between good perinatal outcome and donor and recipient characteristics including age of donor and recipient, race/ethnicity, infertility diagnosis, obstetric history, ART history, and characteristics of the IVF cycle. Unadjusted odds ratios (ORs), adjusted ORs, 95% CIs, and *P* values were generated using logistic regression. The Pearson χ^2 test was used to assess differences between donor and autologous oocyte cycles.

A multivariable logistic model with clinic as a random effect was used to explore the relationship between good perinatal outcome and recipient and donor characteristics. Race/ethnicity was excluded because of a high percentage of missing values (35% for oocyte recipients). Stepwise regression was used to assess significant characteristics and interactions, using a significance level of .05. No interactions were found to be significant. A patient-level random effect (with patients nested within clinics) was also considered but found to be not significant. Colinearity and overfitting were also assessed. Characteristics determined to be significant (tubal and uterine factor infertility, embryo stage at transfer, and elective single-embryo transfer) were included as covariates in the primary model. Last, race/ethnicity was added to the final logistic model in addition to the above-mentioned variables, because race/ethnicity is thought to have an association with perinatal outcome.

Missing race/ethnicity was treated as a single "missing" category. Individual clinics classified individuals' race/ethnicity based on information provided by the patient to the clinician at the time of initial encounter. Of note, the majority of variables had less than 2% missing data; the exceptions include race/ethnicity as mentioned above, donor age (38% missing), and number of fetal heartbeats at first ultrasound (6% missing). Donors are purposefully selected for their young age; 98% of the reported donor ages were younger than 35 years, suggesting that the majority of the missing values were also likely younger than 35 years. Number of fetal heartbeats is listed in the descriptive analysis but was not included in the bivariable or multivariable models because it is part of the causal pathway.

Additionally, a stepwise regression analysis was performed on the data limited to the first donation cycle in 2010. The data set for this analysis included 1 cycle for each patient. A logistic model with clinic as a random effect was fit to these data. The primary model included the same covariates.

All statistical tests were 2-sided, and statistical significance was determined using an α level of .05. All analyses were conducted using either SAS version 9.3 (SAS Institute Inc) or SUDAAN version 11.0 (RTI International).

Results

From 2000 to 2010, data from 443 clinics (93% of all US fertility centers) were included. The annual number of donor oocyte cycles performed in the United States significantly increased from 10 801 in 2000 to 18 306 in 2010, as did the percentage of such cycles that involved frozen oocytes or embryos (vs fresh) (26.7% [95% CI, 25.8%–27.5%] to 40.3% [95% CI, 39.6%–41.1%]) and involved elective single-embryo transfer (vs transfer of multiple embryos) (0.8% [95% CI, 0.7%–1.0%] to 14.5% [95% CI, 14.0%–15.1%]). Good perinatal outcome increased from 18.5% (95% CI, 17.7%–19.3%) to 24.4% (95% CI, 23.8%–25.1%) ($P < .001$ for all listed trends) (Figure). The mean age of donors and recipients remained stable at 28 (SD, 2.8) years and 41 (SD, 5.3) years, respectively. The average number of oocytes retrieved increased from 17.2 in 2000 to 19.6 in 2010 ($P < .001$). From 2004 to 2010, the absolute number of first donor cycles increased (13 319 to 15 988; $P = .002$ for trend), as did the number of repeat donor cycles (1856 to 2318; $P = .004$ for trend).

In 2010, of 11 144 donor oocyte cycles using fresh embryos performed in the United States, 1279 (11.5%) were canceled prior to embryo retrieval or transfer. Because of missing values for some independent variables, only 8946 of the 9865 cycles that progressed to retrieval were included in the final model. The mean donor and recipient ages were 28 (SD, 2.6) years and 41 (SD, 5.2) years, respectively; for patients using autologous oocytes, the mean age was 35 (SD, 4.7) years (Table 1).

Among participants with reported race/ethnicity, the majority of donor oocyte recipients and patients using autologous oocytes were non-Hispanic white and had no prior miscarriages or live births. The majority of donor oocyte recipients had an infertility diagnosis of diminished ovarian reserve, whereas male factor infertility accounted for the majority of infertility

diagnoses among autologous oocyte cycles in 2010. Among the majority of donor oocyte cycles and autologous oocyte cycles, agonist suppression protocols and intracytoplasmic sperm injection were used, elective single-embryo transfer was not performed, and the cycle resulted in a singleton pregnancy. The majority of donor oocyte cycles did not involve sharing of donor oocytes among multiple recipients. More oocytes were retrieved and more embryos were available for cryopreservation among donor oocyte cycles than among autologous oocyte cycles. Assisted hatching (the purposeful disruption of an embryo's zona pellucida by laser, mechanical, or chemical means to improve implantation) was also used more frequently in autologous oocyte cycles than in donor oocyte cycles. Two or more embryos were transferred in the majority of donor and autologous oocyte cycles, and the majority of donor oocyte cycles transferred embryos on day 5, whereas the majority of autologous oocyte cycles transferred embryos on day 3. Thirty-seven percent of donor oocyte cycles resulted in twins, compared with 29% of autologous oocyte cycles ($P < .001$). Triplet pregnancies, however, were less common (0.8% compared with 1.5%) among donor oocyte cycles compared with autologous oocyte cycles resulting in pregnancy ($P < .001$). Of the 2019 twin pregnancies (4038 births), 1015 infants (25%) were born at 37 weeks or later and weighed 2500 g or more. Of the 44 triplet pregnancies (132 births), 1 infant (0.8%) was born at 37 weeks or later and weighed 2500 g or more.

For donor oocyte cycles performed in 2010 using fresh embryos, 2713 (27.5% [95% CI, 26.6%–28.4%]) resulted in a good perinatal outcome (Table 2). For several variables, bivariable analyses revealed negative associations with good perinatal outcome that were no longer significant in the multivariable analysis; these factors and the unadjusted estimates included Hispanic race/ethnicity (OR, 0.78 [95% CI, 0.64–0.95]) and having had 2 or more prior preterm births (OR, 0.38 [95% CI, 0.15–0.97]), 2 or more prior full-term births (OR, 0.79 [95% CI, 0.67–0.94]), or 2 or more prior ART cycles (OR, 0.82 [95% CI, 0.74–0.90]). Having 2 or more prior preterm births was reported for only 5 donor oocyte cycles, and this was likely at least in part responsible for wide CIs overlapping the null value in the multivariable analysis. Additionally, increasing the number of embryos transferred had a negative association with likelihood of good perinatal outcome; however, this variable was not included in the multivariable model because it has a co-linear relationship with elective single-embryo transfer.

Multivariable analysis suggested a significantly increased likelihood of a good perinatal outcome for embryo transfer on day 5 rather than day 3 (29.6% vs 23.3%; adjusted OR, 1.17 [95% CI, 1.04–1.32]) and for elective single-embryo transfer as compared with no elective single-embryo transfer (44.7% vs 24.9%; adjusted OR, 2.32 [95% CI, 1.92–2.80]). Infertility diagnoses of a tubal factor (20.9% vs 28.0%; adjusted OR, 0.72 [95% CI, 0.60–0.86]) or uterine factor (21.9% vs 27.8%; adjusted OR, 0.74 [95% CI, 0.58– 0.94]) were associated with a decreased likelihood of good perinatal outcome. Donor age, recipient age, prior obstetric or ART history, sharing of donor oocytes, number of oocytes retrieved, number of cryopreserved embryos, and diagnosis of endometriosis, ovulatory disorder, diminished ovarian reserve, or male factor infertility were not associated with good perinatal outcome in the multivariable analysis.

All of the significant associations detected in the multi-variable model remained significant, with minimal changes in magnitude when race/ethnicity was included in the final model. Compared with non-Hispanic white participants, non-Hispanic black participants were less likely to have a good perinatal outcome (16.3% vs 28.6%; adjusted OR, 0.48 [95% CI, 0.35–0.67]). Additionally, a secondary analysis of only first oocyte donation cycles (total number of cycles, 9442) revealed similar results (eTable in the Supplement).

Discussion

During the past 11 years in the United States, use of donor oocytes with ART increased, as did the percentage of such cycles that involved frozen oocytes or embryos, involved elective single-embryo transfer, and resulted in good perinatal outcome, regardless of recipient age. The mean age of recipients remained relatively constant at 41 years, consistent with the American Society of Reproductive Medicine Ethics Committee recommendation for use of oocyte donation in healthy recipients younger than 55 years.[21] Although the positive trend of good perinatal outcomes mirrored an increased tendency toward elective single-embryo transfer, room for improvement exists because the rate of twin delivery among donor recipients remains high at 37%. The high percentage of multiple births among donor oocyte recipients, possibly resulting from the transfer of multiple embryos on day 5, suggests potential for further improvement in perinatal outcomes if elective single-embryo transfer is used more frequently among donor oocyte cycles. In a subsequent analysis of cycle data for which donor age was reported, we found that 85.5% of the cycles with donors younger than 35 years did not involve elective single-embryo transfer, despite the committee's recommendation of that approach for donor oocyte cycles in which the donor is younger than 35 years.[20,22]

Good perinatal outcome appears to be independent of recipient age in our data set. The effect of recipient age on perinatal outcome has been inconsistent in previous smaller studies.[7–13] In our data, recipient age had no significant association with good perinatal outcome. Our primary outcome reflects gestational age and birth weight, which may indirectly capture complications of pre-eclampsia, pregnancy-induced hypertension, or intrauterine growth restriction. However, it may not incorporate other pregnancy complications that have been shown to increase in frequency with maternal age. Not surprisingly, we did not find donor age to have a significant association with perinatal outcome; this likely reflects the homogeneity of the donor group, in which more than 98% of those for whom age was reported were younger than 35 years. Predictors of good perinatal outcome among donor oocyte IVF cycles with fresh embryos performed in 2010 are similar to predictions previously identified in autologous oocyte cycles with fresh embryos. Transfer of fewer embryos and transfer of embryos on day 5 positively predicted increased likelihood of good perinatal outcome,[15,23] whereas infertility diagnoses of tubal or uterine factors and non-Hispanic black race/ethnicity were associated with a decreased likelihood.[15,24] These negative predictors are similar to those noted in autologous oocyte cycles, suggesting a predisposing risk in women with uterine or tubal factor infertility or of non-Hispanic black race/ethnicity who have access to medical resources.[15,24]

As with any study using a national surveillance system, our study was limited by the accuracy of input from individual clinics and by the amount of missing data for some covariates. Additionally, because data collection is cycle-based and is not linked overtime, women who under went more than 1 donor oocyte IVF cycle would likely have been included more than once in the outcome data. As a result, the increase in absolute number of donor cycles from 2000 to 2010 reflects either an increase in the number of women using oocyte donation, an increase in the number of cycles oocyte recipients under went, or more likely a combination of the two. However, a significant increase was seen in both the number of first donation cycles and the number of repeat cycles. A secondary analysis of only first oocyte donation cycles performed in 2010 also revealed no significant changes in our findings. The restriction of the predictive modeling analysis to a single year may be a limitation in that it reflects a more limited amount of data; however, such restriction allowed us to capture most recent practices as success rates and procedures have evolved over the 11-year period and also to reduce the likelihood that a single donor was included more than once in the analysis. Ideally, we also would have controlled for additional medical and social history characteristics such as presence or absence of hypertensive disorder or diabetes, patient body mass index, or tobacco-use status. In 2007, the NASS began collecting some of these additional data. Future studies incorporating more detailed patient information may allow additional exploration of potential confounding. Additionally, the current surveillance system did not allow us to evaluate donor complications, although this is important to examine given the increase in the number of oocytes retrieved from donors over time and the risk of ovarian hyperstimulation syndrome. The data collection questionnaire is now being revised to allow collection of such data.

The study is strengthened by the large sample size and by the high compliance of clinics with nationally mandated reporting by fertility clinics. To our knowledge, this study is the first to report recent national donor oocyte trends and the largest to investigate predictors of good perinatal outcome among donor oocyte ART cycles.

Use of donor oocytes is an increasingly common treatment for infertile women with diminished ovarian reserve for whom the likelihood of good perinatal outcome appears to be independent of recipient age. To maximize the likelihood of a good perinatal outcome, the American Society of Reproductive Medicine recommendations suggesting transfer of a single embryo in women younger than 35 years should be considered. Additional studies evaluating the mechanisms by which race/ethnicity, infertility diagnosis, and day of embryo culture affect perinatal outcomes in both autologous and donor IVF pregnancies are warranted to develop preventive measures to increase the likelihood of obtaining a good perinatal outcome among ART users. Given the increasing trend of oocyte donations, the inclusion of more detailed information about donor risks, such as ovarian hyperstimulation syndrome, in the NASS will be useful for monitoring the safety of donor cycles.

Conclusion

There was an increase in the number of donor oocyte cycles in the United States between 2000 and 2010, as well as an increase in good perinatal outcomes. Further studies are needed

to understand the mechanisms underlying the factors associated with less successful outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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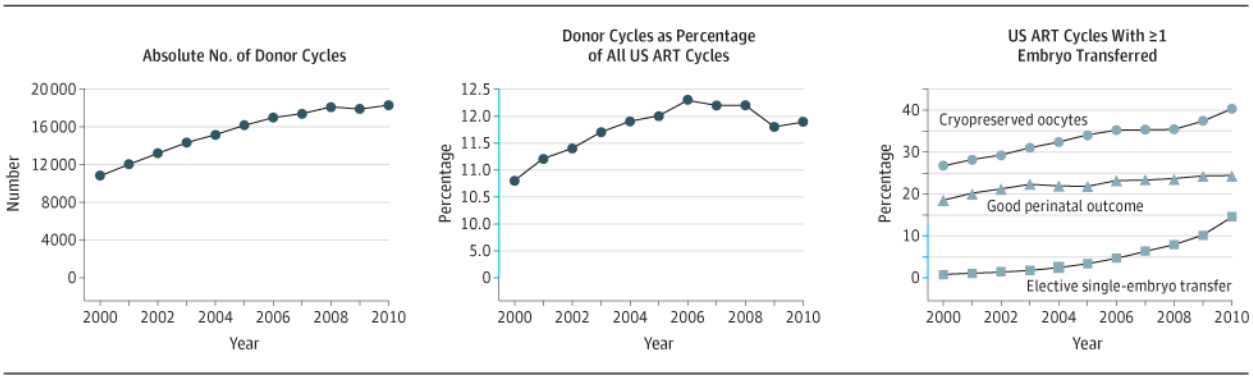

Figure. Donor Oocyte Trends in the United States From 2000–2010

Good perinatal outcome defined as a singleton live birth at 37 weeks or later and birth weight of 2500 g or more. Y-axes shown in blue indicate the interval 0% to 12.5%. ART indicates assisted reproductive technology.

Table 1

Population Characteristics: Oocyte Donors, Donor Oocyte Recipients, and Patients Using Nondonor (Autologous) Oocytes, Reported per Fresh In Vitro Fertilization Cycle, 2010

Characteristic	No. (%)[a]		
	Oocyte Donor (n = 9865)	**Donor Oocyte Recipient (n = 9865)**	**Autologous Oocyte Patient (n = 82 563)**
Age, mean (SD), y[a]	28.0 (2.6)	41.0 (5.2)	35.0 (4.7)
<35	6006 (60.9)	1083 (11)	36 372 (44.1)
35–37	62 (0.6)	957 (9.7)	17 779 (21.5)
38–40	5 (0.05)	1791 (18.2)	17 103 (20.7)
41–42	<5 (<0.05)[b]	1844 (18.7)	7494 (9.1)
43–44	<5 (<0.05)[b]	1751 (17.7)	348 (3.7)
≥45	<5 (<0.05)[b]	2439 (24.7)	767 (0.9)
Race/ethnicity[a]			
Non-Hispanic white	Not collected	4672 (47.4)	36 093 (43.7)
Non-Hispanic black		399 (4.0)	3538 (4.3)
Asian/Pacific Islander		774 (7.8)	6558 (7.9)
Hispanic		588 (6.0)	5099 (6.2)
Other		12 (0.1)	103 (.1)
Missing		3420 (34.7)	31 172 (37.8)
Infertility diagnosis			
Tubal factor	NA	679 (6.9)	13 204 (16.0)
Endometriosis		622 (6.3)	8867 (10.7)
Uterine factor		530 (5.4)	4128 (5.0)
Ovulatory disorder		355 (3.6)	12 312 (14.9)
Diminished ovarian reserve		7372 (74.7)	17 580 (21.3)
Male factor		1835 (18.6)	31 546 (38.2)
Protocol			
Agonist suppression	5398 (54.7)	NA	35 611 (43.1)
Agonist flare	139 (1.4)		9634 (11.7)
Antagonist suppression	3319 (33.6)		32 856 (39.8)
No. of oocytes retrieved			
Mean (SD)	19.6 (9.6)	NA	12.3 (7.5)
0–10	1521 (15.4)		38 950 (47.2)
11–20	4369 (44.3)		32 785 (39.7)
≥21	3972 (40.3)		10 828 (13.1)
Oocytes shared with multiple patients			
Yes	1594 (16.2)	NA	NA
No	8271 (83.8)		

Characteristic	No. (%)[a]		
	Oocyte Donor (n = 9865)	Donor Oocyte Recipient (n = 9865)	Autologous Oocyte Patient (n = 82 563)
Embryo stage at transfer			
Day 3	NA	2852 (28.9)	43 245 (52.4)
Day 5		6343 (64.3)	31 026 (37.6)
No. of embryos transferred			
1	NA	1581 (16.0)	12 759 (15.5)
2		7308 (74.1)	43 623 (52.8)
3		847 (8.6)	17 621 (21.3)
≥4		129 (1.3)	8560 (10.4)
No. of supernumerary embryos cryopreserved			
0	NA	2746 (27.8)	52 004 (63.0)
1–2		1889 (19.2)	12 390 (15.0)
3–4		1849 (18.8)	8590 (10.4)
≥5		3358 (34.0)	9339 (11.3)
Elective single-embryo transfer			
Yes	NA	1287 (13.4)	4634 (6.2)
No		8284 (86.6)	69 804 (93.8)
No. of prior pregnancies			
0	Not collected	3850 (39.0)	36 472 (44.2)
1		2287 (23.2)	21 927 (26.6)
≥2		3623 (36.7)	23 811 (28.8)
No. of prior spontaneous miscarriages			
0	Not collected	5967 (60.5)	56 656 (68.6)
1		2076 (21.0)	16 341 (19.8)
≥2		1684 (17.1)	8947 (10.8)
No. of prior preterm births			
0	Not collected	9404 (95.3)	79 139 (95.9)
1		238 (2.4)	2265 (2.7)
≥2		40 (0.4)	289 (0.4)
No. of prior full-term births			
0	Not collected	7171 (72.7)	59 937 (72.6)
1		1723 (17.5)	16 623 (20.1)
≥2		829 (8.4)	5422 (6.6)
No. of prior ART cycles			
0	Not collected	4081 (41.4)	46 002 (55.7)
1		1647 (16.7)	16 723 (20.3)
≥2		4124 (41.8)	19 804 (24.0)
Use of intracytoplasmic sperm injection			
Yes	NA	7572 (76.8)	61 754 (74.8)

Characteristic	No. (%)[a]		
	Oocyte Donor (n = 9865)	Donor Oocyte Recipient (n = 9865)	Autologous Oocyte Patient (n = 82 563)
No		2279 (23.1)	20 637 (25.0)
Use of assisted hatching			
Yes	NA	1942 (19.7)	35 592 (43.1)
No		7923 (80.3)	46 971 (56.9)
No. of fetal heartbeats at first ultrasound[a]			
1		3549 (54.9)	23 313 (62.7)
2	NA	2400 (37.2)	10 544 (28.3)
3		130 (2.0)	1067 (2.9)
Plurality			
1		3438 (62.5)	21 215 (69.7)
2	NA	2019 (36.7)	8754 (28.8)
≥3		44 (0.8)	455 (1.5)

Abbreviations: ART, assisted reproductive technology; NA, not applicable.

[a] Missing data: 38% of donor age, 35% of oocyte recipient race/ethnicity, 38% of race/ethnicity for patients using autologous oocytes, 6% of number of fetal heartbeats at first ultrasound. All other variables had les than 2% missing data.

[b] Actual counts suppressed to protect confidentiality because of small cell size.

Table 2

Good Perinatal Outcome Among Completed In Vitro Fertilization Cycles in 2010 Using Fresh (Noncryopreserved) Donor Oocytes (N=9865 Cycles)

Exposure	Donor Oocyte Cycles With Good Perinatal Outcome, No. (%) [95% CI][a]	Odds Ratio (95% CI)	
		Unadjusted	Adjusted[b]
Total	2713 (27.5) [26.6–28.4]		
Donor age, y[c]			
<35	1644 (27.4) [26.3–28.5]	1 [Reference]	
35–37	21 (33.9) [23.2–46.4]	1.37 (0.78–2.42)	
38–44	NA[d]	NA[d]	
Recipient age, y			
<35	289 (26.7) [24.1–29.4]	1 [Reference]	
35–37	273 (28.5) [25.8–31.5]	1.10 (0.90–1.34)	
38–40	511 (28.5) [26.5–30.7]	1.10 (0.91–1.33)	
41–42	498 (27.0) [25.0–29.1]	1.02 (0.84–1.23)	
43–44	496 (28.3) [26.3–30.5]	1.09 (0.90–1.31)	
≥45	646 (26.5) [24.8–28.3]	0.99 (0.82–1.19)	
Race/lEthnicity[c]			
Non-Hispanic white	1338 (28.6) [27.4–30.0]	1 [Reference]	
Non-Hispanic black	65 (16.3) [13.0–20.2]	0.48 (0.33–0.71)	
Asian/Pacific Islander	213 (27.5) [24.5–30.8]	0.95 (0.80–1.12)	
Hispanic	140 (23.8) [20.5–27.4]	0.78 (0.62–0.97)	
Other	2 (16.7) [4.2–47.7]	0.50 (0.11–2.35)	
Missing	955 (27.9) [26.4–29.5]	0.97 (0.86–1.09)	
Infertility diagnosis			
No tubal factor	2571 (28.0) [27.1–28.9]	1 [Reference]	1 [Reference]
Tubal factor	142 (20.9) [18.0–24.1]	0.68 (0.57–0.82)	0.72 (0.60–0.86)
No endometriosis	2560 (27.7) [26.8–28.6]	1 [Reference]	
Endometriosis	153 (24.6) [21.4–28.1]	0.85 (0.70–1.04)	
No uterine factor	2597 (27.8) [26.9–28.7]	1 [Reference]	1 [Reference]
Uterine factor	116 (21.9) [18.6–25.6]	0.73 (0.58–0.91)	0.74 (0.58–0.94)
No ovulatory disorder	2606 (27.4) [26.5–28.3]	1 [Reference]	
Ovulatory disorder	107 (30.1) [25.6–35.1]	1.14 (0.91–1.44)	
No diminished ovarian reserve	671 (26.9) [25.2–28.7]	1 [Reference]	
Diminished ovarian reserve	2042 (27.7) [26.7–28.7]	1.04 (0.90–1.21)	
No male factor	2218 (27.6) [26.7–28.6]	1 [Reference]	
Male factor	495 (27.0) [25.0–29.1]	0.97 (0.84–1.12)	
No. of prior pregnancies			
0	1097 (27.7) [26.3–29.2]	1 [Reference]	

Exposure	Donor Oocyte Cycles With Good Perinatal Outcome, No. (%) [95% CI][a]	Odds Ratio (95% CI)	
		Unadjusted	Adjusted[b]
1	636 (27.8) [26.0–29.7]	1.00 (0.90–1.12)	
≥2	977 (27.0) [25.5–28.4]	0.96 (0.87–1.07)	
No. of prior spontaneous abortions			
0	1672 (28.0) [26.9–29.2]	1 [Reference]	
1	553 (26.6) [24.8–28.6]	0.93 (0.84–1.04)	
≥2	442 (26.3) [24.2–28.4]	0.91 (0.80–1.04)	
No. of prior preterm births			
0	2576 (27.4) [26.5–28.3]	1 [Reference]	
1	73 (30.7) [25.1–36.8]	1.17 (0.87–1.58)	
≥2	5 (12.5) [5.3–26.7]	0.38 (0.15–0.96)	
No. of prior full term births			
0	1964 (27.4) [26.4–28.4]	1 [Reference]	
1	510 (29.6) [27.5–31.8]	1.11 (0.98–1.27)	
≥2	191 (23.0) [20.3–26.0]	0.79 (0.65–0.96)	
No. of prior ART cycles			
0	1202 (29.5) [28.1–30.9]	1 [Reference]	
1	457 (27.8) [25.6–30.0]	0.92 (0.78–1.08)	
≥2	1049 (25.4) [24.1–26.8]	0.82 (0.72–0.92)	
Use of intracytoplasmic sperm injection			
No	635 (27.9) [26.1–29.7]	1 [Reference]	
Yes	2072 (27.4) [26.4–28.4]	0.98 (0.85–1.12)	
Use of assisted hatching			
No	2243 (28.3) [27.3–29.3]	1 [Reference]	
Yes	470 (24.2) [22.3–26.2]	0.81 (0.69–0.95)	
Embryo stage at transfer			
Day 3	663 (23.3) [21.7–24.8]	1 [Reference]	1 [Reference]
Day 5	1879 (29.6) [28.5–30.8]	1.39 (1.21–1.59)	1.17 (1.04–1.32)
No. of embryos transferred			
1	648 (41.0) [38.6–43.4]	1 [Reference]	
2	1876 (25.7) [24.7–26.7]	0.50 (0.42–0.59)	
3	168 (19.8) [17.3–22.7]	0.36 (0.28–0.45)	
≥4	21 (16.3) [10.9–23.7]	0.28 (0.17–0.47)	
Elective single-embryo transfer[e]			
No	2065 (24.9) [24.0–25.9]	1 [Reference]	1 [Reference]
Yes	575 (44.7) [42.0–47.4]	2.43 (2.04–2.91)	2.32 (1.92–2.80)
No. of supernumerary embryos cryopreserved			
0	643 (23.4) [21.9–25.0]	1 [Reference]	
1–2	523 (27.7) [25.7–29.7]	1.25 (1.09–1.43)	

Exposure	Donor Oocyte Cycles With Good Perinatal Outcome, No. (%) [95% CI][a]	Odds Ratio (95% CI)	
		Unadjusted	Adjusted[b]
3–4	562 (30.4) [28.3–32.5]	1.43 (1.20–1.71)	
≥5	979 (29.2) [27.6–30.7]	1.35 (1.17–1.54)	
No. of oocytes retrieved			
0–10	385 (25.3) [23.2–27.6]	1 [Reference]	
11–20	1202 (27.5) [26.2–28.9]	1.12 (0.98–1.29)	
≥21	1124 (28.3) [26.9–29.7]	1.16 (1.01–1.34)	
Donor shared			
No	2250 (27.2) [26.3–28.2]	1 [Reference]	
Yes	463 (29.1) [26.9–31.3]	1.10 (0.94–1.28)	

Abbreviations: ART, assisted reproductive technology; NA, not available; OR, odds ratio.

[a] Good perinatal outcome defined as a singleton live birth at 37 weeks or later and with birth weight of 2500 g or more. Numbers shown are for logistic regression model excluding race/ethnicity.

[b] Multivariable analysis reflects primary model not including race/ethnicity; magnitude and direction of effect did not change significantly when race/ethnicity was included in the final model.

[c] Missing data: 38% of donor age, 35% of oocyte recipient race/ethnicity. All other variables had less than 2% missing data.

[d] Values not reported to protect confidentiality because of small cell size and small denominators (see Table 1).

[e] Defined as 1 embryo transferred and 1 or more cryopreserved. Not included in multivariable analysis as linear relationship with elective single-embryo transfer.