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Association of state insurance coverage mandates with assisted reproductive technology care discontinuation

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Abstract

BACKGROUND: Insurance coverage for fertility services may reduce the financial burden of high-cost fertility care such as assisted reproductive technology and improve its utilization. Patients who exit care after failing to reach their reproductive goals report higher rates of mental health problems and a lower sense of well-being. It is important to understand the relationship between state-mandated insurance coverage for fertility services and assisted reproductive technology care discontinuation.

OBJECTIVE: This study aimed to assess whether state-mandated insurance coverage for fertility services is associated with lower rates of care discontinuation after an initial assisted reproductive technology cycle that did not result in a live birth.

STUDY DESIGN: This is a retrospective, population-based cohort study using data from United States fertility clinics reporting to the National Assisted Reproductive Technology Surveillance System during 2016 and 2018. Patients who began their first autologous assisted reproductive technology cycle during 2016 and 2017 and did not have a live birth were included. We describe the rate of assisted reproductive technology care discontinuation (no additional cycle within 12 months of the previous cycle's date of failure). Multivariable analyses were conducted to evaluate factors independently associated with care discontinuation, including the scope of fertility services included in state coverage mandate at assisted reproductive technology cycle initiation that were as follows: comprehensive (≥3 assisted reproductive technology cycles), limited (1, 2, or an

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unspecified number of assisted reproductive technology cycles), mandate not including assisted reproductive technology, and no mandate.

RESULTS: Among 91,324 patients who underwent their first autologous assisted reproductive technology cycle that did not result in live birth, 24,072 (26.4%) discontinued care. Compared with patients who lived in states with mandates for comprehensive assisted reproductive technology coverage, those in states with mandates for fertility services coverage that did not include assisted reproductive technology or states with no mandate were 46% (adjusted relative risk, 1.46; 95% confidence interval, 1.31–1.63) and 26% (adjusted relative risk, 1.26; 95% confidence interval, 1.15–1.39) more likely to discontinue care, respectively, after controlling for patient and cycle characteristics. Increasing patient age, distance from clinic ≥50 miles, previous live birth, fewer oocytes retrieved, and not having embryos cryopreserved were also associated with higher rates of discontinuation. Non-Hispanic Black, non-Hispanic Asian, and Hispanic patients had higher rates of care discontinuation than non-Hispanic White patients regardless of the existence or scope of state-mandated assisted reproductive technology coverage.

CONCLUSION: Comprehensive state-mandated insurance coverage for assisted reproductive technology is associated with lower rates of assisted reproductive technology care discontinuation.

Keywords

access to care; discontinuation of care; health policy; infertility; insurance; insurance mandates; in vitro fertilization

Introduction

According to the World Health Organization, the American Medical Association, and the American Society for Reproductive Medicine, infertility is a disease.[1–3] Since the first infant was delivered after in vitro fertilization (IVF) in the United States in 1981, there has been a consistent increase in the availability and utilization of assisted reproductive technology (ART) such that in 2019, 2.1% of all infants born in the United States were the result of ART.[4]

Given that the cumulative likelihood of live birth increases with subsequent ART cycles, successive use of ART after an initial failed cycle can improve cumulative success rates for patients with infertility.[5–8] Despite this, 10% to 37% of patients pursuing ART discontinue care after their first unsuccessful cycle.[9–14]

Involuntary childlessness is associated with symptoms of anxiety, depression, and complicated grief; patients who have unmet parenthood goals after seeking fertility evaluation or treatment have been shown to have negative long-term health consequences.[15–17] Existing data describing ART care discontinuation report that emotional distress, perception of poor prognosis, increasing female age, and lower oocyte or embryo yield are associated with early care discontinuation.[9–12,18–20] These studies primarily involved patients in countries where national health plans or other public funding systems cover costs associated with ART cycles for eligible patients, limiting generalizability to countries where widespread financial coverage is not available and many patients pay out-of-pocket.[9–11,18,20] In the United States, where insurance coverage for ART is not required, a single IVF cycle has been estimated to cost between $12,400 and $24,000, and evidence suggests that cost may be a treatment barrier.[21–25]

Since the 1980s, 19 states have passed laws to improve access to fertility treatment that vary greatly in scope.[26–28] More specifically, some states have enacted “mandates” that require certain categories of employers to include coverage for fertility-related services.[26–28] Studies show that these insurance mandates are associated with increased ARTutilization, fewer embryos per transfer, and lower rates of multiple gestations.[29–33] In 1 retrospective study, patients with insurance coverage for IVF (both mandated and nonmandated) were more likely to attempt IVF again if the first cycle was unsuccessful and had a higher cumulative probability of live birth than those who self-paid for IVF.[34] A secondary analysis of the same data looking at factors associated with discontinuation showed that women without IVF insurance coverage were more likely to discontinue treatment than women with insurance coverage,[13] Both studies used data obtained from a single center. Despite these reported benefits of insurance coverage for ART, racial, ethnic, and socioeconomic disparities in utilization have been found to persist even in states with mandates.[35,36] Therefore, it is important to better understand how insurance coverage for infertility services impacts the patterns of ART care in states with mandates to further understand factors that contribute to disparities in fertility care utilization nationally.

This population-based retrospective cohort study aims to quantify the rate of discontinuation in ART care after an initial failed cycle in the United States, determine if patients living in states without comprehensive mandated insurance coverage for fertility services are more likely to discontinue ART after an initial failed cycle, and evaluate which patient and cycle outcomes are associated with care discontinuation.

Methods

The data used for this study were derived from the US National ART Surveillance System (NASS)—a congressionallymandated reporting system that collects information on nearly all (98%) ART cycles performed in the United States.[4] In NASS, ART cycles, defined as fertility treatments in which oocytes or embryos are handled in the laboratory, include cycle-level information on patient characteristics, clinical characteristics of the ART procedure, and pregnancy outcomes.

We selected all patients who began their first autologous ART cycle from January 1, 2016–December 31, 2017 and did not have a live birth as a result of this cycle (N=127,090). Patients were excluded if the cycle intention was long-term banking (N=27,916), the intended transfer was to a gestational carrier (N=768), the cycle outcome was unknown (N=365), or patient death occurred (N=9). Patients were also excluded if their primary residence was outside the United States, including US territories, or if state of residence was unknown (N=6708). These exclusion criteria applied to each patient’s initial cycle only.

Subsequent patient cycles recorded in NASS during 2016 to 2017 were linked to each patient’s first cycle to identify those who continued care by undergoing an additional cycle —an oocyte retrieval or embryo transfer—within 12 months of the previous cycle’s date of failure and those who discontinued care (ie, did not undergo an additional cycle within 12 months). For patients who intended to undergo fresh transfer during their initial cycle, care discontinuation was determined within 1 year after the date of the initial cycle's outcome or date of transfer when no pregnancy occurred or when the outcome was an ectopic or heterotopic pregnancy. For patients who cryopreserved all embryos made during their initial cycle, care discontinuation was determined 1 year after the date of cycle outcome (or date of transfer when no pregnancy occurred or for ectopic or heterotopic pregnancies) of the first intended frozen embryo transfer with embryo(s) derived from the initial cycle.

Given the variability in state-mandated insurance coverage for fertility services in the United States and the lack of an established classification standard,[26] we stratified states into 4 groups based on the scope of covered fertility benefits required by the state mandate in effect during 2016 to 2017 (Figure). All laws considered in this stratification were in effect during the entire study period. The first group included states with a comprehensive mandate, defined as covering at least 3 ART cycles. The second group included states with a limited mandate, defined as covering 1, 2, or an unspecified number of required ART cycles. The third group included states with mandates for fertility care not including ART. This group includes states with mandates for insurance coverage for fertility services not specifically including or excluding ART coverage or mandates that insurers offer policies covering infertility treatments. The remainder of states were categorized as having no mandate.[26–28] Stratification of states was performed by the authors' review of the existing fertility coverage laws in place during the years studied and were developed with guidance from previously published work on insurance mandates for ART in the United States.[37] Patients were separated into these 4 groups based on their provided state of residence.

Patient demographic characteristics, medical history, and ART cycle information were extracted from NASS. Information on race or ethnicity was missing for 38% of included patients. Procedures used to address missing patient race or ethnicity, calculate a patient's distance from their ART clinic, and determine median household income by zip code can be found in supplementary materials. We used Pearson chi-squared tests to evaluate associations between patient demographics, reproductive history, cycle characteristics and outcomes, and treatment discontinuation. Multivariable analyses were conducted to evaluate factors independently associated with care discontinuation. Variables included in the final multivariable model were chosen a priori based on clinical expertise (Supplemental Materials). We used multilevel logistic regression models (PROC RLOGIST in SUDAAN) to analyze the multiply imputed data and account for clustering by clinic. Predicted marginal proportions were calculated to estimate unadjusted and adjusted relative risks (aRR) and accompanying 95% confidence intervals (CIs) for each covariate.

To further evaluate factors associated with care discontinuation in states with mandated insurance coverage for any ART compared with those without mandated insurance coverage for ART, we stratified analyses into the following 2 categories: patients residing in states with a comprehensive or limited ART insurance mandate and those residing in states with no mandate or a mandate that did not include ART. Multivariate analyses were conducted controlling for the same variables listed above. Statistical analyses were conducted using SAS version 9.4 (SAS Institute) and SUDAAN 11.0.3 (RTI International). All *P* values

<.05 were considered statistically significant. Epidemiologic research using NASS data was reviewed and approved by the institutional review board at the Centers for Disease Control and Prevention.

Results

In the United States, during 2016 and 2017, 91,324 patients underwent their first autologous ART cycle and did not have a live birth. Of these individuals, 41.6% had their first cycle cancelled before oocyte retrieval or embryo transfer, and the remaining 58.4% did not achieve live birth after embryo transfer. Of this cohort, 26.4% did not pursue additional treatment within 1 year of their first unsuccessful cycle outcome. More than half (56.7%) of the patients in this cohort lived in a state where there was no mandated insurance coverage for fertility services (Table 1). The remaining patients lived in a state that was classified as comprehensive mandate (15.1%), limited mandate (2.9%), or a state with mandated insurance coverage for fertility services not including ART (25.3%).

The mean age of this cohort was 35.3 years. Overall, 65.0% of patients identified as non-Hispanic White with non-Hispanic Asian, Hispanic, and non-Hispanic Black patients representing 15.9%, 9.1%, and 8.8%, respectively. The most common infertility diagnoses were male factor (31.3%) and diminished ovarian reserve (29.1%) (Table 1).

In this cohort of patients who did not have a live birth after their first ART cycle, patients who lived in states categorized as having comprehensive mandates discontinued care at the lowest rate (21.1%) than those in states with limited mandates (25.4%), mandates for fertility coverage not including ART (29.4%), and no mandated insurance coverage for fertility benefits (26.4%) (Table 2). Patients living in states with insurance mandates not including ART or states with no mandates were 46% (aRR, 1.46; 95% CI, 1.31–1.63) and 26% (aRR, 1.26; 95% CI, 1.15–1.39) more likely to discontinue care, respectively, than patients who lived in states with comprehensive ART insurance mandates after controlling for patient and cycle characteristics (Table 2).

Other demographic characteristics were also associated with ART care discontinuation in this population after adjusting for potential confounding factors (Table 2). Increasing female age, distance from clinic ≥50 miles, median zip code household income <$100,000 per year, and previous live births were all associated with increased risk of care discontinuation. Patients who identified as non-Hispanic Black, non-Hispanic Asian, or Hispanic were 1.13–1.29 times more likely to discontinue care than those identified as non-Hispanic White. Patients with “other” included as a reason for ART were significantly more likely to discontinue care (aRR, 1.12; 95% CI, 1.08–1.16), whereas those with polycystic ovary syndrome (aRR, 0.91; 95% CI, 0.87–0.95) and unexplained infertility (aRR, 0.89; 95% CI, 0.84–0.94) diagnoses were less likely to discontinue care than those without those diagnoses.

Cycle outcomes associated with discontinuation of care included having fewer oocytes retrieved (none, 1–10, and 11–20 oocytes compared with ≥21 oocytes) and not having embryos cryopreserved (aRR, 2.24; 95% CI, 2.12–2.37). Patients whose first cycle resulted in spontaneous abortion (aRR, 1.13; 95% CI, 1.09–1.17), stillbirth (aRR, 1.64; 95% CI, 1.46–1.84), or induced abortion (aRR, 1.32; 95% CI, 1.18–1.48) were more likely to discontinue care than those who did not achieve pregnancy after embryo transfer. In contrast, cancellation before retrieval (aRR, 0.53; 95% CI, 0.45–0.62) or before transfer (aRR, 0.69; 95% CI, 0.65–0.74) were both associated with a lower risk of care discontinuation than patients with no pregnancy after embryo transfer.

When our cohort was stratified into 2 groups based on presence (comprehensive or limited mandate) or absence (fertility mandate not including ART or no mandate) of mandated insurance coverage for any ART, patients residing in zip codes with median household income <$50,000 per year remained at an increased risk of care discontinuation in states without mandated insurance coverage for ART (aRR, 1.17; 95% CI, 1.01e1.36) but the association was no longer significant in states with mandated insurance coverage for ART (aRR, 1.23; 95% CI, 1.00–1.50) (Table 3). The risk of care discontinuation remained elevated among non-Hispanic Black, Hispanic, and Asian patients than in non-Hispanic White patients regardless of whether they resided in a state with or without mandated insurance coverage for any ART (Table 3).

Comment

Principal findings

Using a large national surveillance system, this study quantifies the rate of ART care discontinuation in the United States after an initial failed autologous ART cycle and demonstrates that individuals residing in states without mandated insurance coverage for ART were more likely to discontinue treatment after an initial unsuccessful cycle than those living in states with comprehensive mandated ART insurance coverage. This association remained after controlling for patient and cycle characteristics, including median zip code household income. Further, non-Hispanic Black, non-Hispanic Asian, and Hispanic patients had higher rates of care discontinuation than non-Hispanic White patients in states with and without mandated insurance coverage for any ART.

Results in the context of what is known

In a retrospective cohort study by Miller et al[14] of 974 good-prognosis couples in New Zealand who qualified for a subsequent publicly funded ART cycle, authors found only a 10% discontinuation rate after the first unsuccessful cycle. Conversely, in our study including all patients regardless of prognosis, 1 in every 4 US ART patients did not have a repeat ART cycle 1 year after an initial failed cycle. When patients were divided by fertility coverage scope mandated in their state of residence, the highest rates of care discontinuation were noted in those living in states with fertility mandates not including ART and states with no mandate.

Clinical implications

Given the high cost of an ART cycle in the United States, economic barriers may be a factor that limits utilization of continued ART treatment cycles, despite the potential for success after an initial failed cycle.[22,38] A study of patients recruited from 8 US fertility clinics reported that the median cost for ARTover 18 months of treatment was $24,373 (based on 2006 dollars), with median out-of-pocket cost estimated at $19,234 for 1 cycle.[23,24] Furthermore, Chambers et al showed that 1 fresh ART cycle accounted for 52% of an individual's average disposable income in states without mandated insurance coverage for ART compared with 13% for states with such coverage.[22] Although many factors contribute to care discontinuation, addressing financial barriers with ART insurance coverage has been shown to increase the proportion of individuals and couples that continue care after an unsuccessful initial ART cycle.[13]

Notably, when comparing ART care discontinuation rates across mandate levels, the percentage of patients who discontinued care was highest among individuals living in states with mandated insurance coverage for fertility services not including ART. This group also had the highest relative effect size in the adjusted analysis than patients living in states with no mandated insurance coverage. We hypothesize that state-mandated insurance benefits for fertility testing and treatment excluding ART may increase the initiation of fertility services, including ART. However, following an initial failed cycle, these patients may discontinue care at higher rates owing to the financial burden of additional cycles. Conversely, in states with no mandated insurance coverage for fertility services, patients may not ever pursue infertility care or proceed to ART owing to the financial burden.

It is important to recognize that mandated insurance coverage for fertility services does not result in coverage for all state residents, as coverage is limited to individuals who have employer-based insurance plans that fall under the state insurance mandates. Moreover, in states with mandated insurance coverage for fertility services, the eligibility criteria for coverage can be limited to specific populations, for example, heterosexual couples using autologous gametes who meet specific diagnostic criteria; this would exclude single individuals, same-sex couples, and patients who require donor gametes.[26,27] These mandates do not always include treatment for men with male factor infertility.[39] Many state laws do not require religious organizations, smaller employers, employers that self-insure, and public insurers such as Medicare and Medicaid to provide insurance coverage for fertility treatment.[26,27] Therefore, this analysis may underestimate the potential benefit of mandated insurance coverage for ART that included all patients, insurance types, and employer categories.

Research implications

Previous studies have shown that individuals who identify as African American or Hispanic are less likely to utilize infertility care, even in states where comprehensive mandates are in place,[35] and are more likely to discontinue care after an initial failed cycle regardless of insurance coverage level.[13] Similarly, in our study, non-Hispanic Black, non-Hispanic Asian, and Hispanic patients were more likely to discontinue care than non-Hispanic White patients in both states with and without mandated insurance coverage for ART, even after controlling for median household income in patient zip code, suggesting the influence of other structural or social determinants of care continuation.[13]

Black and Hispanic women are more likely to have public insurance or no insurance than the non-Hispanic White population, and state mandates for ART coverage examined in this study do not apply to uninsured women or those covered by public plans.[40] Lower median household income ($41,361 and $51,450 for Black and Hispanic households, respectively vs $70,642 for non-Hispanic White households in 2018)[41,42] may also limit the ability to continue care after a failed cycle even with insurance coverage for ART, owing to the burden of uncovered costs including copays, missed work, travel, and transportation. In a survey of women accessing fertility treatment in Illinois, African American and Hispanic women reported having more difficulty taking time off work and paying for treatment than White respondents.[43] Thus, it is important to identify other factors associated with equitable utilization and continuation of ART care beyond state insurance coverage mandates.

Strengths and limitations

The study limitations include an inability to identify patients who switch fertility clinics to continue care and identify those with previous cycles completed at other clinics. In addition, this study does not account for individual-level insurance information that is not available in NASS. Thus, this study evaluated the effect of state-level laws mandating insurance coverage for fertility services and not the effect of insurance coverage itself. The availability of actual insurance coverage may be impacted by the employer mix within a state and the number of employers that are subject to existing mandates. Furthermore, the range of benefits covered by an employer’s plan could also be beyond what is required by insurance mandates for ART, if present. We had limited ability to account for differences in income and wealth in this study. The estimation of average household income was done using residential zip code, which may underestimate the true income of patients in this cohort seeking ART. In addition, the “distance to clinic” variable was calculated from the main clinic address provided by the reporting clinic and did account for potential clinic satellite locations used by patients in this cohort. Finally, the large amount of missing data for race or ethnicity is a limitation of this analysis despite the use of multiple imputation.

This study demonstrates an association between categories of state-mandated insurance coverage for ART and ART care discontinuation after an initial unsuccessful cycle but does not imply that mandated ART insurance coverage is the cause for this relationship. State-mandated insurance coverage for ART has been correlated with increased rates of utilization; however, it is unclear if these mandates increase population demand and utilization or if increased utilization and therefore demand drives the development and implementation of mandates in these states.[44] Finally, this observational, retrospective cohort study may be subject to bias because of uncontrolled confounding. Specifically, if the rate of ART discontinuation was influenced by factors that are also associated with state of residence but not controlled for in our analysis, it may confound the correlation between mandated insurance coverage and care discontinuation.

Conclusions

Economic barriers contribute to disparities in the utilization of effective infertility treatment, including ART, in the United States.[45] In this study, comprehensive mandated insurance coverage for ART at the state level was associated with lower rates of ART care discontinuation than states with no mandates for ART. Although state-mandated insurance coverage for ART was associated with a reduction in disparities in care discontinuation seen in the lowest category of median household income by zip code, racial and ethnic disparities persisted. Future collection of additional patient-level information in NASS may enhance research addressing the economic, geographic, social, cultural, and structural barriers that limit access to and utilization of this health service.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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AJOG at a Glance

Why was this study conducted?

This study aimed to determine if patients discontinue care at higher rates after an unsuccessful initial assisted reproductive technology (ART) cycle in states where insurance coverage for ART is not mandated by law.

Key findings

With regard to patients in the United States who did not achieve a live birth after their first autologous ART cycle during 2016 to 2017, those living in states with mandated insurance coverage for fertility services that did not include ART or states with no mandated insurance coverage for fertility services had a higher rate of care discontinuation than those living in states with comprehensive mandated insurance coverage for ART (≥ 3 ART cycles).

What does this add to what is known?

Patients living in states without mandated insurance coverage for ART are more likely to discontinue care after an initial failed ART cycle than those living in states with comprehensive mandated insurance coverage for ART.

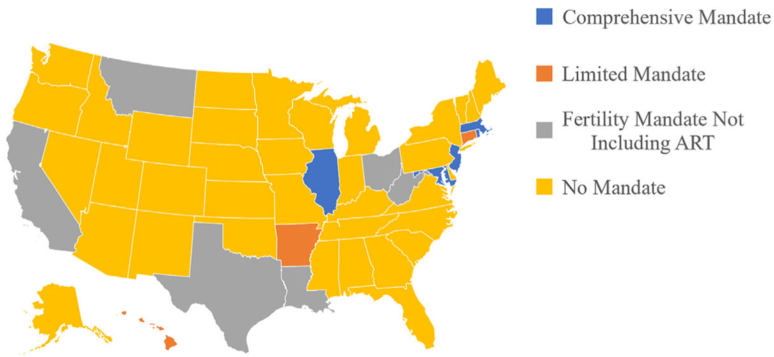

FIGURE. State variation in mandated insurance coverage for infertility care, 2016–2017[29]

Comprehensive mandate states defined as those covering at least 3 ART cycles; limited mandate states defined as those covering 1, 2, or an unspecified number of ART cycles; states with fertility mandate not including ART include states with laws regarding fertility care but not including ART coverage; states with no mandate have no required coverage for ART.

ART, assisted reproductive technology.

TABLE 1

Patient and cycle characteristics at the initial, autologous ART cycles that did not result in live birth (2016–2017)

	Overall	Discontinued treatment	Continued treatment
	N (%)[b]	N (%)[b]	N (%)[b]
Female characteristics[a]	**91,324 (100)**	**24,072 (26.4)**	**67,252 (73.6)**
State ART insurance mandate level			
Comprehensive mandate[c]	13,751 (15.1)	2905 (12.1)	10,846 (16.1)
Limited mandate[d]	2620 (2.9)	665 (2.8)	1955 (2.9)
Fertility mandate not including ART[e]	23,145 (25.3)	6805 (28.3)	16,340 (24.3)
No fertility insurance mandate[f]	51,808 (56.7)	13,697 (56.9)	38,111 (56.7)
Patient age (y)			
<35	40,881 (44.8)	8149 (33.9)	32,732 (48.7)
35–37	19,490 (21.3)	4947 (20.6)	14,543 (21.6)
38–40	16,831 (18.4)	5502 (22.9)	11,329 (16.8)
41–42	7604 (8.3)	2838 (11.8)	4766 (7.1)
>42	6518 (7.1)	2636 (11.0)	3882 (5.8)
BMI at cycle start (kg/m^2)			
<18.5	1841 (2.0)	462 (1.9)	1379 (2.1)
18.5–24.9	37,956 (41.6)	9181 (38.1)	28,775 (42.8)
25–29.9	19,440 (21.3)	5162 (21.4)	14,278 (21.2)
≥30.0	18,128 (19.9)	5181 (21.5)	12,947 (19.3)
Missing	13,959 (15.3)	4086 (17.0)	9873 (14.7)
Race and ethnicity[g]			
Hispanic	8308 (9.1)	2754 (11.4)	5554 (8.3)
Non-Hispanic American Indian, Alaska Native	286 (0.3)	86 (0.4)	200 (0.3)
Non-Hispanic Asian	14,481 (15.9)	4063 (16.9)	10,418 (15.5)
Non-Hispanic Black	8013 (8.8)	2757 (11.5)	5256 (7.8)
Non-Hispanic Native Hawaiian, Pacific Islander	358 (0.4)	95 (0.4)	263 (0.4)

	Overall	Discontinued treatment	Continued treatment
	N (%)[b]	N (%)[b]	N (%)[b]
Female characteristics[a]	**91,324 (100)**	**24,072 (26.4)**	**67,252 (73.6)**
Non-Hispanic White	59,319 (65.0)	14,161 (58.8)	45,158 (67.1)
Two or more races	559 (0.6)	156 (0.6)	403 (0.6)
Number of previous pregnancies			
0	50,867 (55.7)	11,948 (49.6)	38,919 (57.9)
1	19,156 (21.0)	5071 (21.1)	14,085 (20.9)
≥2	21,301 (23.3)	7053 (29.3)	14,248 (21.2)
Number of previous live births			
0	71,049 (77.8)	17,392 (72.3)	53,657 (79.8)
1	13,795 (15.1)	4199 (17.4)	9596 (14.3)
≥2	6480 (7.1)	2481 (10.3)	3999 (5.9)
Infertility diagnosis (selections are not mutually exclusive)			
Diminished ovarian reserve	26,592 (29.1)	9258 (38.5)	17,334 (25.8)
Endometriosis	6694 (7.3)	1794 (7.5)	4900 (7.3)
Male factor	28,621 (31.3)	6994 (29.1)	21,627 (32.2)
PCOS	12,145 (13.3)	2167 (9.0)	9978 (14.8)
Infertility diagnosis (selections are not mutually exclusive)			
Other ovulation disorders (not PCOS)	14,083 (15.4)	4665 (19.4)	9418 (14.0)
Tubal factor	12,271 (13.4)	3542 (14.7)	8729 (13.0)
Uterine factor	5032 (5.5)	1451 (6.0)	3581 (5.3)
Unexplained	12,292 (13.5)	2598 (10.8)	9694 (14.4)
Other	15,679 (17.2)	4439 (18.4)	11,240 (16.7)
History of pregnancy loss (spontaneous abortion, ectopic pregnancy, or stillbirth)			
Yes	23,263 (25.5)	7010 (29.1)	16,253 (24.2)
No	68,061 (74.5)	17,062 (70.9)	50,999 (75.8)
Distance from clinic (miles)			
0–9	30,895 (34.0)	7987 (33.4)	22,908 (34.2)
10–24	31,233 (34.3)	8116 (33.9)	23,117 (34.5)

	Overall	Discontinued treatment	Continued treatment
	N (%)[b]	**N (%)[b]**	**N (%)[b]**
Female characteristics[a]	**91,324 (100)**	**24,072 (26.4)**	**67,252 (73.6)**
25–49	14,033 (15.4)	3581 (15.0)	10,452 (15.6)
≥50	14,808 (16.3)	4245 (17.7)	10,563 (15.8)
Median household income (thousands of dollars)			
<50	10,006 (11.1)	3045 (12.8)	6961 (10.4)
50–99	54,477 (60.3)	14,510 (61.1)	39,967 (60.0)
100–150	22,200 (24.6)	5293 (22.3)	16,907 (25.4)
>150	3683 (4.1)	891 (3.8)	2792 (4.2)
Number of oocytes retrieved[h]			
0	11,764 (12.9)	4106 (17.1)	7658 (11.4)
No attempt at retrieval	10,920 (12.0)	3711 (15.4)	7209 (10.7)
No oocytes retrieved at retrieval	844 (0.9)	395 (1.6)	449 (0.7)
1–10	33,355 (36.5)	11,781 (48.9)	21,574 (32.1)
11–20	27,575 (30.2)	5534 (23.0)	22,041 (32.8)
≥21	15,624 (17.1)	2016 (8.4)	13,608 (20.2)
Missing	3006 (3.3)	635 (2.6)	2371 (3.5)
Intracytoplasmic sperm injection[h]			
Yes	64,286 (71.5)	16,271 (69.3)	48,015 (72.3)
No	15,157 (16.9)	3630 (15.5)	11,527 (17.4)
NA	10,416 (11.6)	3578 (15.2)	6838 (10.3)
Preimplantation genetic testing[h]			
Yes	20,935 (23.3)	4882 (20.8)	16,053 (24.2)
No	58,548 (65.1)	15,040 (64.0)	43,508 (65.5)
NA	10,412 (11.6)	3576 (15.2)	6836 (10.3)
Number of embryos transferred[i]			
None	37,982 (41.6)	9069 (37.7)	28,913 (43.0)
Number of embryos transferred[i]			

Female characteristics[a]	Overall N (%)[b]	Discontinued treatment N (%)[b]	Continued treatment N (%)[b]
	91,324 (100)	**24,072 (26.4)**	**67,252 (73.6)**
1	32,859 (36.0)	7684 (31.9)	25,175 (37.4)
2	17,453 (19.1)	5910 (24.6)	11,543 (17.2)
3	2373 (2.6)	1098 (4.6)	1275 (1.9)
≥4	657 (0.7)	311 (1.3)	346 (0.5)
Number of embryos cryopreserved[h]			
None	35,130 (38.5)	14,618 (60.7)	20,512 (30.5)
Indicated yes, but number unknown	23,353 (25.6)	3315 (13.8)	20,038 (29.8)
1	5951 (6.5)	1554 (6.5)	4397 (6.5)
2	6021 (6.6)	1375 (5.7)	4646 (6.9)
3	4637 (5.1)	894 (3.7)	3743 (5.6)
4	3792 (4.2)	636 (2.6)	3156 (4.7)
≥5	12,440 (13.6)	1680 (7.0)	10,760 (16.0)
Ovarian hyperstimulation syndrome			
Yes	657 (0.7)	59 (0.2)	598 (0.9)
No	90,667 (99.3)	24,013 (99.8)	66,654 (99.1)
First ART cycle outcome[i]			
Cancellation before retrieval	10,920 (12.0)	3711 (15.4)	7209 (10.7)
Cancellation before transfer	27,062 (29.6)	5358 (22.3)	21704 (32.3)
No pregnancy after transfer	44,063 (48.2)	12,392 (51.5)	31,671 (47.1)
Spontaneous abortion	7883 (8.6)	2190 (9.1)	5693 (8.5)
Ectopic or heterotopic pregnancy	694 (0.8)	160 (0.7)	534 (0.8)
Stillbirth	294 (0.3)	126 (0.5)	168 (0.2)
Induced abortion	408 (0.4)	135 (0.6)	273 (0.4)

ART, assisted reproductive technology; *BMI*, body mass index; *NA*, not applicable; *PCOS*, polycystic ovary syndrome.

[a]Missing category included when percentage missing exceeds 3%;

[b]When there is no missing category, percentage is based on those with known values;

[c] Comprehensive mandate states defined as those covering at least 3 ART cycles and include Illinois, Massachusetts, New Jersey, Rhode Island, and Maryland during the study period;

[d] Limited mandate states defined as those covering 1, 2, or an unspecified number of ART cycles and include Arkansas, Connecticut, and Hawaii during the study period;

[e] States with fertility mandate not including ART include states with laws regarding fertility care but not including ART coverage and include California, Louisiana, Montana, Ohio, Texas, and West Virginia;

[f] States with no mandated coverage for ART include all other states;

[g] Patient race/ethnicity are derived from multiple imputed analyses;

[h] Based on initial cycle;

[i] Based on first intent to transfer cycle (also includes unsuccessful intended short-term banking)

TABLE 2

Patient and cycle characteristics associated with ART care discontinuation (2016–2017)

		Unadjusted analysis		Adjusted analysis[a]	
Variable	**Discontinuation rate**	**RR**	**95% CI**	**Adjusted RR**	**95% CI**
State ART insurance mandate level					
Comprehensive mandate	21.1%	Ref.		Ref.	
Limited mandate	25.4%	1.20	(0.95–1.51)	1.18	(0.95–1.48)
Fertility mandate not including ART	29.4%	1.39	(1.19–1.62)	1.46	(1.31–1.63)
No mandate	26.4%	1.25	(1.10–1.43)	1.26	(1.15–1.39)
Patient age (y)					
<35	19.9%	Ref.		Ref.	
35–37	25.4%	1.27	(1.22–1.33)	1.07	(1.03–1.11)
38–40	32.7%	1.64	(1.57–1.71)	1.21	(1.16–1.25)
41–42	37.3%	1.87	(1.77–1.98)	1.27	(1.20–1.33)
>42	40.4%	2.03	(1.91–2.16)	1.39	(1.32–1.48)
Race and ethnicity					
Hispanic	33.1%	1.39	(1.32–1.46)	1.19	(1.13–1.25)
Non-Hispanic American Indian, Alaska Native	30.1%	1.26	(1.02–1.56)	1.19	(0.98–1.46)
Non-Hispanic Asian	28.1%	1.18	(1.12–1.23)	1.13	(1.08–1.18)
Non-Hispanic Black	34.4%	1.44	(1.37–1.52)	1.29	(1.23–1.36)
Non-Hispanic Native Hawaiian, Pacific Islander	26.5%	1.11	(0.92–1.33)	1.22	(0.97–1.53)
Non-Hispanic White	23.9%	Ref.		Ref.	
Two or more races	27.9%	1.17	(1.01–1.35)	1.13	(0.98–1.31)
Number of previous live births					
None	24.5%	Ref.		Ref.	
1	30.4%	1.24	(1.21–1.28)	1.16	(1.13–1.20)
≥2	38.3%	1.56	(1.49–1.64)	1.32	(1.26–1.38)
Infertility diagnosis[b]					
Diminished ovarian reserve	34.8%	1.52	(1.46–1.59)	1.05	(1.00–1.11)

		Unadjusted analysis		Adjusted analysis[a]	
Variable	Discontinuation rate	RR	95% CI	Adjusted RR	95% CI
Endometriosis	26.8%	1.02	(0.97–1.07)	1.04	(0.99–1.08)
Male factor	24.4%	0.90	(0.85–0.95)	0.96	(0.93–1.00)
PCOS	17.8%	0.64	(0.61–0.68)	0.91	(0.87–0.95)
Other ovulation disorders (not PCOS)	33.1%	1.32	(1.26–1.37)	0.96	(0.92–1.00)
Tubal factor	28.9%	1.11	(1.07–1.16)	0.98	(0.95–1.02)
Uterine factor	28.8%	1.10	(1.01–1.20)	1.03	(0.97–1.10)
Unexplained	21.1%	0.78	(0.73–0.83)	0.89	(0.84–0.94)
Other	28.3%	1.09	(1.05–1.14)	1.12	(1.08–1.16)
Distance from clinic (miles)					
0–9	25.9%	Ref.		Ref.	
10–24	26.0%	1.01	(0.96–1.06)	1.03	(0.99–1.16)
25–49	25.5%	0.99	(0.92–1.06)	1.04	(0.99–1.09)
≥50	28.7%	1.11	(1.03–1.20)	1.13	(1.06–1.22)
Median household income (thousands of dollars)					
<50	30.4%	1.26	(1.10–1.44)	1.21	(1.07–1.38)
50–99	26.6%	1.10	(0.98–1.24)	1.15	(1.02–1.29)
100–150	23.8%	0.99	(0.89–1.09)	1.03	(0.94–1.14)
>150	24.2%	Ref.		Ref.	
Number of oocytes retrieved					
None (includes no retrieval)	34.9%	2.70	(2.47–2.96)	1.71	(1.47–2.00)
1–10	35.3%	2.74	(2.58–2.91)	1.48	(1.40–1.57)
11–20	20.1%	1.56	(1.47–1.64)	1.21	(1.16–1.27)
≥21	12.9%	Ref.		Ref.	
Embryos cryopreserved					
Yes	16.8%	Ref.		Ref.	
None	41.6%	2.47	(2.34–2.62)	2.24	(2.12–2.37)
First ART cycle outcome					
Cancellation before retrieval	34.0%	1.21	(1.13–1.29)	0.53	(0.45–0.62)

Variable	Discontinuation rate	Unadjusted analysis		Adjusted analysis[a]	
		RR	95% CI	Adjusted RR	95% CI
Cancellation before transfer	19.8%	0.70	(0.65–0.77)	0.69	(0.65–0.74)
No pregnancy after transfer	28.1%	Ref.		Ref.	
Spontaneous abortion	27.8%	0.99	(0.94–1.04)	1.13	(1.09–1.17)
Ectopic or heterotopic pregnancy	23.1%	0.82	(0.72–0.94)	0.96	(0.86–1.07)
Stillbirth	42.9%	1.52	(1.32–1.76)	1.64	(1.46–1.84)
Induced abortion	33.1%	1.18	(1.02–1.36)	1.32	(1.18–1.48)

ART, assisted reproductive technology; *CI*, confidence interval; *PCOS*, polycystic ovary syndrome; *Ref.*, reference; *RR*, relative risk.

[a] Model adjusted for state fertility mandate status, age, race and ethnicity, parity, infertility diagnosis, distance from clinic, household income, number of oocytes retrieved, whether embryos were cryopreserved, and first cycle outcome and accounts for clustering by clinic;

[b] Reference group for each diagnosis is not having diagnosis.

TABLE 3

Factors associated with ART care discontinuation across state fertility insurance mandate groups (2016–2017)

Variable	Comprehensive or limited ART insurance mandate (N=16,371)			Fertility insurance mandate not including ART or no mandate (N=74,953)		
	Discontinuation rate	aRR[a]	95% CI	Discontinuation rate	aRR[a]	95% CI
Patient age (y)						
<35	15.7%	Ref.		20.8%	Ref.	
35–37	20.1%	1.06	(0.97–1.16)	26.6%	1.07	(1.03–1.11)
38–40	24.8%	1.12	(1.01–1.24)	34.6%	1.22	(1.17–1.27)
41–42	31.8%	1.32	(1.19–1.46)	38.7%	1.26	(1.19–1.33)
>42	40.1%	1.65	(1.44–1.89)	40.5%	1.34	(1.26–1.42)
Race and ethnicity						
Hispanic	27.3%	1.24	(1.09–1.41)	34.0%	1.21	(1.15–1.27)
Non-Hispanic American Indian, Alaska Native	27.8%	1.13	(0.64–2.01)	30.9%	1.21	(0.97–1.51)
Non-Hispanic Asian	24.4%	1.29	(1.16–1.44)	28.9%	1.14	(1.08–1.19)
Non-Hispanic Black	29.7%	1.34	(1.18–1.52)	35.9%	1.28	(1.22–1.34)
Non-Hispanic Native Hawaiian, Pacific Islander	24.4%	1.63	(1.22–2.18)	26.9%	1.02	(0.79–1.33)
Non-Hispanic White	19.0%	Ref.		24.9%	Ref.	
Two or more races	26.5%	1.35	(1.00–1.82)	28.2%	1.12	(0.95–1.32)
Number of previous live births						
None	19.9%	Ref.		25.5%	Ref.	
1	25.7%	1.18	(1.12–1.24)	31.5%	1.16	(1.13–1.20)
≥2	37.0%	1.53	(1.37–1.70)	38.5%	1.30	(1.24–1.36)
Infertility diagnosis[b]						
Diminished ovarian reserve	29.1%	1.00	(0.89–1.13)	36.0%	1.07	(1.01–1.13)
Endometriosis	22.0%	1.04	(0.91–1.18)	27.7%	1.04	(0.99–1.09)
Male factor	19.7%	0.97	(0.91–1.02)	25.6%	0.97	(0.93–1.01)
PCOS	13.2%	0.80	(0.71–0.91)	18.7%	0.93	(0.89–0.97)
Other ovulation disorders (not PCOS)	27.9%	0.99	(0.88–1.12)	34.3%	0.96	(0.91–1.00)
Tubal factor	23.0%	0.92	(0.85–1.00)	30.2%	0.99	(0.95–1.03)

Variable	Comprehensive or limited ART insurance mandate (N=16,371)			Fertility insurance mandate not including ART or no mandate (N=74,953)		
	Discontinuation rate	aRR[a]	95% CI	Discontinuation rate	aRR[a]	95% CI
Uterine factor	26.0%	1.09	(0.97–1.23)	29.4%	1.04	(0.98–1.10)
Unexplained	18.6%	0.88	(0.77–0.99)	21.8%	0.89	(0.84–0.95)
Other	23.0%	1.12	(1.03–1.21)	29.6%	1.13	(1.09–1.17)
Distance from clinic (miles)						
0–9	21.9%	Ref.		26.7%	Ref.	
10–24	21.1%	1.01	(0.93–1.11)	27.2%	1.04	(0.98–1.10)
25–49	20.8%	1.03	(0.93–1.13)	27.0%	1.05	(0.99–1.11)
≥50	28.3%	1.29	(1.12–1.48)	28.7%	1.12	(1.04–1.21)
Median household income (thousands of dollars)						
<50	26.5%	1.23	(1.00–1.50)	30.9%	1.17	(1.01–1.36)
50–100	22.8%	1.13	(0.94–1.34)	27.4%	1.11	(0.96–1.27)
100–150	19.5%	0.99	(0.85–1.15)	25.3%	1.01	(0.90–1.13)
>150	20.1%	Ref.		25.7%	Ref.	
Number of oocytes retrieved						
None (includes no retrieval)	33.6%	1.38	(0.90–2.12)	35.2%	1.78	(1.53–2.05)
1–10	27.3%	1.34	(1.15–1.56)	37.3%	1.50	(1.42–1.60)
11–20	15.1%	1.06	(0.93–1.21)	21.1%	1.24	(1.18–1.30)
≥21	11.5%	Ref.		13.2%	Ref.	
Embryos cryopreserved						
Yes	13.6%	Ref.		17.5%	Ref.	
None	33.4%	1.98	(1.76–2.22)	43.6%	2.28	(2.15–2.42)
First ART cycle outcome						
Cancellation before retrieval	33.5%	0.87	(0.58–1.31)	34.1%	0.49	(0.42–0.56)
Cancellation before transfer	16.6%	0.76	(0.65–0.88)	20.5%	0.68	(0.64–0.73)
No pregnancy after transfer	21.4%	Ref.		29.6%	Ref.	
Spontaneous abortion	25.9%	1.36	(1.20–1.54)	28.2%	1.10	(1.06–1.14)
Ectopic or heterotopic pregnancy	22.5%	1.25	(0.93–1.67)	23.2%	0.92	(0.82–1.02)
Stillbirth	42.3%	2.11	(1.60–2.79)	43.0%	1.57	(1.38–1.78)

	Comprehensive or limited ART insurance mandate (N=16,371)			Fertility insurance mandate not including ART or no mandate (N=74,953)		
Variable	**Discontinuation rate**	**aRR[a]**	**95% CI**	**Discontinuation rate**	**aRR[a]**	**95% CI**
Induced abortion	32.8%	1.78	(1.32–2.40)	33.1%	1.27	(1.12–1.43)

aRR, adjusted relative risk; *ART*, assisted reproductive technology; *CI*, confidence interval; *PCOS*, polycystic ovary syndrome; *Ref.*, reference.

[a]Model adjusted for age, race and ethnicity, parity, infertility diagnosis, distance from clinic, household income, number of oocytes retrieved, whether embryos were cryopreserved, and first cycle outcome and accounts for clustering by clinic;

[b]Reference group for each diagnosis is not having diagnosis.