

A comparison of live birth rates and cumulative ongoing pregnancy rates between Europe and North America after ovarian stimulation with corifollitropin alfa or recombinant follicle-stimulating hormone

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Objective: To compare live birth rates after fresh embryo transfer (ET) and cumulative ongoing pregnancy rates after fresh ET and frozen-thawed (ET) between continents and overall after one treatment cycle with corifollitropin alfa or recombinant FSH.

Design: Double-blind, multicenter, randomized controlled trial.

Setting: Fourteen centers in North America (NA); 20 in Europe (EU).

Patient(s): 804 NA patients and 702 EU patients.

Intervention(s): Patients >60 kg received a single dose of corifollitropin alfa or daily rFSH for the first 7 days of controlled ovarian stimulation.

Main Outcome Measure(s): Live birth rates.

Result(s): Within each continent no differences were noted between the two treatment groups; however, between continents, the cumulative ongoing pregnancy rate and live birth rate were considerably higher in NA than in EU. The live birth rate in NA was 39.2% in both treatment groups compared with 31.5% and 28.8% in EU after corifollitropin alfa and rFSH treatment, respectively. Considering the number of embryos transferred, the live birth rate per ET was still higher in NA than in EU (42.7% v.s 36.8% with corifollitropin alfa and 41.6% vs. 30.9% with rFSH). Overall live birth rates after fresh ET were 35.6% and 34.4% (estimated difference 1.1% [95% confidence interval -3.7-5.8]), and the estimated cumulative live birth rates were 43.4% and 41.3% with corifollitropin alfa and rFSH, respectively.

Conclusion(s): Live birth rates and cumulative pregnancy rates were higher in NA than in EU after treatment with either corifollitropin alfa or daily rFSH; both treatment protocols provided equal success rates.

ClinicalTrials.gov Identifiers: NCT00703014 and NCT00702273. (Fertil Steril® 2012;97:1351-8. ©2012 by American Society for Reproductive Medicine.)

Key Words: Live birth rates, cumulative pregnancy rates, corifollitropin alfa, GnRH antagonist, North America, Europe

There is no uniform definition of success after in vitro fertilization (IVF), but preferred clinical outcome is often indicated as “delivery with at least one live born child” or

“birth of a singleton healthy child at term” (1). The effectiveness of IVF treatment regimens is frequently presented as the ongoing pregnancy rate per started cycle, which is the number

of pregnancies as a percentage of all treatment cycles, including cycles without embryo transfer (ET) (2). However, it is the live birth rate per started cycle that really matters in the end, which is the percentage of all treatment cycles that lead to live born infants adjusted for miscarriage and stillbirth (3). Alternatively, ongoing pregnancy rates may be presented as cumulative figures, including the number of pregnancies obtained from embryos cryopreserved during the treatment cycle. Both percentages provide a better estimate of the patient's chance of becoming

Received September 30, 2011; revised and accepted February 27, 2012; published online March 28, 2012.

R.B. has nothing to disclose. B.M. is an employee of Merck Sharp & Dohme Corp. S.P. has nothing to disclose. M.F.-S. has nothing to disclose. H.W. is an employee of Merck Sharp & Dohme Corp. P.D. has nothing to disclose.

Supported by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Whitehouse Station, New Jersey.

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Fertility and Sterility® Vol. 97, No. 6, June 2012 0015-0282/\$36.00

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doi:10.1016/j.fertnstert.2012.02.038

pregnant and of taking home a live born infant after a single treatment cycle. Apart from the stimulation protocols, many other factors determine the success rates of IVF units, including the patient population treated, the quality of the IVF laboratory, and the number of embryos transferred. In multicenter randomized controlled trials, the same stimulation protocol is applied to a cohort of similar patients in a large number of IVF units, often in different geographic locations. Comparison of the success rates indicate that ongoing pregnancy rates per started cycle may vary between continents and between IVF units within one continent, which complicates trial designs and analyses to demonstrate or exclude a potential difference in pregnancy rates between two treatment regimens (4). Such variability should be taken into account at trial design (randomization) by achieving a close balance of the two treatment groups per IVF unit in terms of number of patients treated.

The novel sustained follicle stimulant corifollitropin alfa (5) was compared with daily recombinant FSH (rFSH) in inducing multifollicular development in women undergoing controlled ovarian stimulation (COS) in a very large, multinational, double-blind, randomized, comparative trial (Engage trial) including 1,506 patients aged ≤ 36 years undergoing ovarian stimulation before IVF/intracytoplasmic sperm injection (ICSI). The global study was unique because it concerned a fixed treatment protocol among a cohort of similar patients cycling in 14 IVF units in North America (NA) and 20 IVF units in Europe (EU) and resulted in highly similar ongoing pregnancy rates between the two treatment groups (2, 6).

Patients who became pregnant in the Engage trial were followed to delivery to compare the live birth rates after COS with corifollitropin alfa and daily rFSH. Patients who did not become pregnant after fresh ET but who had cryopreserved embryos were followed when they underwent frozen-thawed embryo transfer (FTET) cycles, which offered the opportunity to assess whether the final success rates resulting from a single treatment cycle of corifollitropin alfa is at least similar to that of a single treatment cycle of daily rFSH.

This report presents the live birth rates as well as the cumulative ongoing pregnancy rates from a single treatment cycle with corifollitropin alfa or daily rFSH. These success rates are evaluated per continent and overall per treatment group.

MATERIALS AND METHODS

Intervention Trial

Details of the design of the Engage trial have been described previously (2, 6). This intervention trial was a multicenter, randomized, double-blind double dummy, noninferiority clinical trial ($n = 1,506$), involving 14 centers in NA (13 centers in USA and one in Canada) and 20 centers in EU (three in Spain, three in UK, two in Belgium, two in Czech Republic, two in Finland, two in France, two in Norway, two in Sweden, one in Denmark, and one in The Netherlands). The trial included women with an indication for COS before IVF or ICSI; aged 18–36 years with a body weight of 60–90 kg, a body mass index of 18–32 kg/m², a regular menstrual cycle of 24–35 days, and partners having ejaculatory sperm. The

primary efficacy outcome of this trial was ongoing pregnancy rate defined as presence of at least one fetus with heart activity ≥ 10 weeks after ET. All patients who received at least one dose of corifollitropin alfa (Elonva; N.V. Organon) or rFSH (Puregon/Follistim AQ Cartridge; N.V. Organon) in the intervention trial and who became pregnant were eligible for entry into the pregnancy follow-up trial. Patients from whom embryos were cryopreserved during the intervention trial and for which at least one embryo was thawed for use in a subsequent FTET cycle were eligible for the follow-up to collect the outcome of FTET cycles. Both follow-up trials were conducted in accordance with principles of Good Clinical Practice and were approved by the appropriate Institutional Review Boards and regulatory agencies. Written informed consent was provided by each subject.

Pregnancy Follow-up After Fresh ET

This prospective trial (NCT 00703014) began once the first patient signed informed consent as part of consent for the Engage trial, but actual enrollment started when the first ongoing pregnancy was established. In total, 275 of 294 pregnant patients in the corifollitropin alfa group and 266 of 286 pregnant patients in the rFSH group were enrolled in the pregnancy follow-up trial. The study was completed in March 2009. The primary efficacy outcome was the live birth rate after fresh ET after a single treatment cycle. The live birth rate was calculated as the number of patients with at least one live born infant relative to the total number of patients who started treatment (per started cycle) or who had ET (per ET). The health of infants born after corifollitropin alfa treatment and after rFSH treatment, including any major or minor malformation, was also collected but will be reported separately.

Follow-up After FTET Cycles

Patients who consented to participate in the follow-up with embryos cryopreserved in the Engage trial, of which at least one embryo was thawed for use in a subsequent FTET cycle, were included in this prospective study (NCT 00702273). Each study site was allowed to follow its routine procedure for FTET cycles, and thawed embryos could be replaced in natural cycles or in supplemented cycles. The study was completed in May 2009. The primary efficacy outcome was the cumulative ongoing pregnancy rate, defined as the percentage of patients who had an ongoing pregnancy ≥ 10 weeks after either fresh ET or one or more FTET cycles.

Other efficacy assessments were the number and quality of embryos transferred after thawing, and FTET cycle outcomes including miscarriage, ectopic pregnancy, intrauterine pregnancy (including vital pregnancy at 5–6 weeks after ET), and ongoing pregnancy ≥ 10 weeks after ET.

Statistical Methods

Treatment differences for ongoing pregnancy rate, live birth rate, and cumulative ongoing pregnancy rate were estimated with the use of a generalized linear model with identity link. Treatment group (corifollitropin alfa vs. rFSH), continent (NA vs. EU), age group (<32 y vs ≥ 32 y), and previous IVF cycle

(yes/no) were the independent factors in this model. The two treatment groups in the Engage trial were balanced by continent and age group: randomization of the patients in this trial was done per center and was stratified for age group. Previous IVF cycle appeared to be a predictive factor of pregnancy achievement. The effect of previous IVF cycle was significant ($P < .05$) in univariate logistic regression analysis of ongoing pregnancy. Two-sided 95% confidence intervals (CIs) of the estimates based on the likelihood ratio method were calculated. Cumulative live birth rates were estimated by extrapolation of the cumulative pregnancy rates with the rate of pregnancy loss observed after fresh ET in the Engage pregnancy and neonatal follow-up trial.

Treatment and continent effects on pregnancy and live birth rates were estimated based on the same model with the use of the logit link. P values of the odds ratio estimates were based on the likelihood ratio method. The number of embryos transferred (single vs. double) was added as an independent factor to the model to estimate treatment and continent effects on ongoing pregnancy rate and live birth rate per ET.

Analysis of variance was applied to estimate treatment and continent effects on the duration of stimulation, total rFSH dose from stimulation day 8 onward, number of follicles ≥ 11 mm on day of hCG, number of oocytes retrieved, and

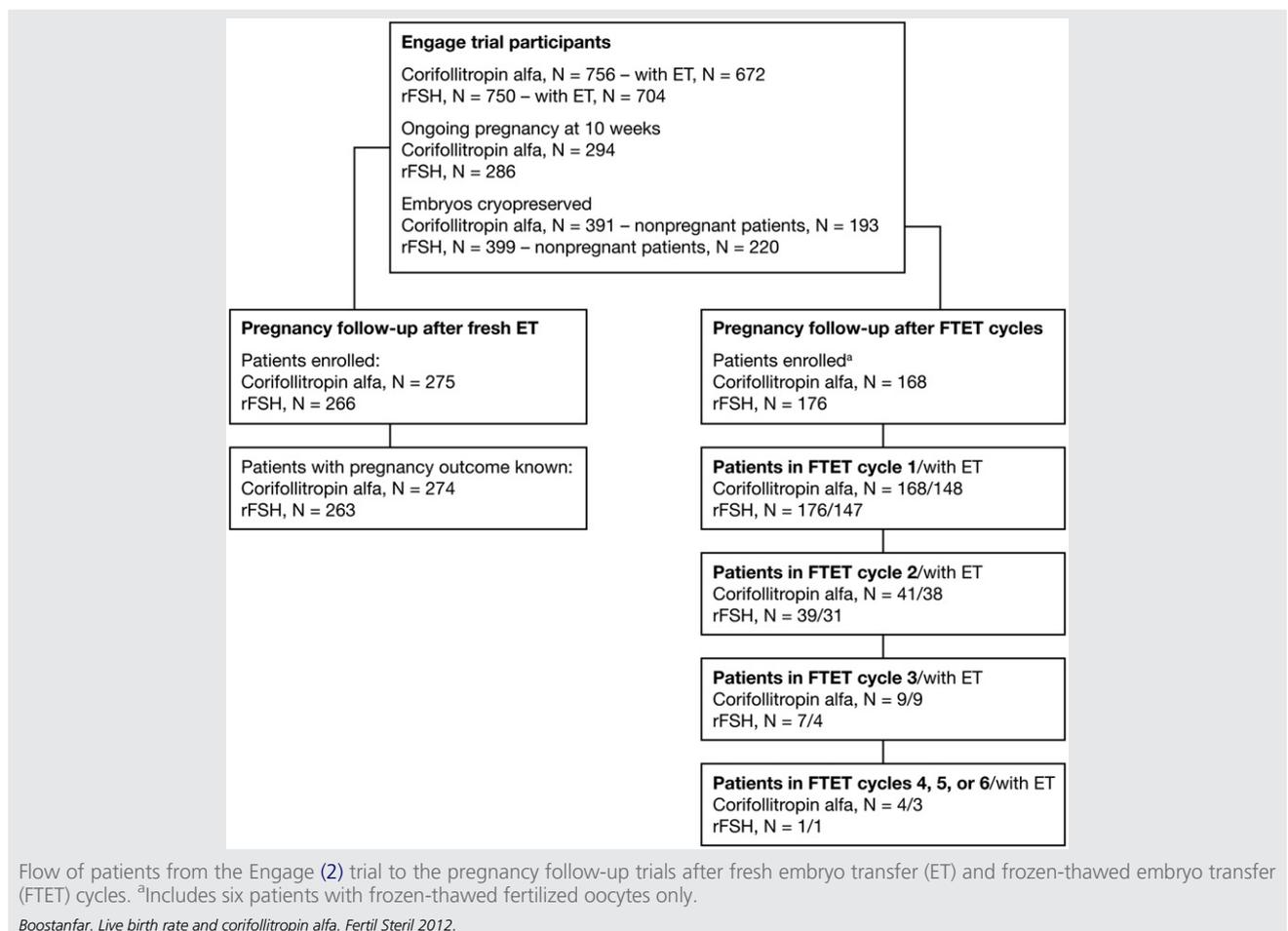
number of good quality embryos obtained. A proportional odds model was applied to estimate treatment and continent effects on the implantation rate (0, 50%, 100%) and the number of frozen-thawed embryos (1, 2, 3, or more) transferred, whereas a logistic regression model was applied to estimate these effects on the multiple pregnancy rate (singleton vs. multiple) and the number of fresh embryos (1 vs. 2 or 3) transferred. In these models, treatment group, continent, and age group were included as independent factors.

Treatment by continent interaction was investigated in all applied models and appeared not to be significant ($P \geq .10$). All calculations were performed in SAS software.

RESULTS

A total of 1,506 patients (mean age 31.5 years) were treated in the intervention trial in which 756 subjects received a single dose of 150 μg corifollitropin alfa and 750 subjects received 200 IU/d rFSH for the first 7 days of COS (intent-to-treat [ITT] group). In total, 391 subjects (51.7%) in the corifollitropin alfa group and 399 (53.2%) in the rFSH group had embryos cryopreserved. The flow of subjects from the intervention trial to the pregnancy follow-up trial and the follow-up of FTET cycles are summarized in Figure 1.

FIGURE 1



Comparison of Clinical Outcome in NA and EU

Table 1 presents the patient characteristics per treatment group and continent (14 IVF units in NA and 20 IVF units in EU). There was no difference between the groups within one continent, but comparison between continents indicated that patients in NA had a slightly higher antral follicle count, lower FSH, lower incidence of primary infertility, longer duration of infertility, and fewer previous IVF cycles, although none of these small differences was statistically significant. Of these patient characteristics, only age ($P=.04$) and previous IVF cycle ($P<.01$) had a significant effect on ongoing pregnancy rate. Table 2 presents the clinical outcome per treatment group in each continent, which includes, among others, implantation rates, ongoing pregnancy rates, and live birth rates after fresh ET as well as cumulative ongoing pregnancy rates after FTET.

Regardless of the continent, patients treated with corifollitropin alfa required less rFSH from stimulation day 8 onward ($P<.01$), had more follicles ≥ 11 mm on the day of hCG ($P<.01$), and had more oocytes ($P<.01$). An apparent difference in implantation rate did not reach statistical significance ($P=.07$).

Regardless of treatment, patients in NA had significantly more follicles ≥ 11 mm on the day of hCG ($P<.01$), had more oocytes ($P<.01$), required less rFSH from stimulation day 8 onward, and had a shorter duration of stimulation than patients treated in EU. The mean (SD) number of good-quality embryos obtained in NA was 5.3 (4.6) and 5.1 (4.4) for corifollitropin alfa and rFSH, respectively, and was significantly higher compared with 3.4 (3.7) and 3.5 (3.0), respectively, in EU. Also the recovery of good-quality embryos as a percentage of the total number of oocytes was higher in NA than in EU (37.3% and 38.2% in NA and 26.5% and 30.2% in EU for the corifollitropin alfa and rFSH groups, respectively).

The mean (SD) number of fresh embryos transferred for both treatment groups was 1.9 (0.3) in NA and 1.5 (0.5) in EU. The implantation rates in both treatment groups were significantly higher in NA than in EU. The ongoing pregnancy rate, multiple pregnancy rate, live birth rate, and cumulative pregnancy rate were significantly higher in NA than in EU, whereas there was no difference between the treatment groups. When taking into account the number of embryos transferred, the ongoing pregnancy rate per ET was significantly higher in NA and an apparent difference in the live birth rate per ET did not reach significance ($P=.55$).

Cumulative Ongoing Pregnancy Rates

The total number of patients with cryopreserved embryos and a subsequent FTET cycle is presented in Figure 1.

Table 3 presents a total of 225 FTET cycles for the corifollitropin alfa group and 224 FTET cycles for the rFSH group, the number of embryos thawed, the number and quality of transferred embryos, and the clinical outcome. The number of FTET cycles in each treatment group was very similar, but the number of FTET cycles in EU was much higher than in NA (Table 3). In the corifollitropin alfa group, 19.2% had transfer in a natural cycle and 80.8% in a hormone-supplemented cycle, whereas these figures were 18.0% and 82.0%, respectively, in the rFSH group. As with fresh ET, in both treatment groups an average 1.7 (0.7) embryos were transferred in the FTET cycles, of which 1.3 (0.8) embryos were of good quality (grades 1 and 2). The clinical pregnancy rates were 43.5% and 38.6% and the miscarriage rates per clinical pregnancy 8.2% and 17.6%, respectively. The ongoing pregnancy rates were 38.7% and 30.7% with multiple pregnancy rates of 28.2% and 23.1%, respectively. The majority of the ongoing pregnancies after FTET were singletons: 47 (72.3%) in the corifollitropin alfa group and 42 (77.8%) in the

TABLE 1

Patient characteristics per treatment group and continent (intent-to-treat group).

	Corifollitropin alfa		rFSH	
	NA	EU	NA	EU
Age (y)				
n	401	355	403	347
Mean (SD)	31.7 (3.3)	31.4 (3.3)	31.7 (3.3)	31.3 (3.2)
Primary/secondary infertility, n (%)				
Primary infertility	196 (48.9)	207 (58.3)	200 (49.6)	193 (55.6)
Secondary infertility	205 (51.1)	148 (41.7)	203 (50.4)	154 (44.4)
Duration of infertility (y)				
n	401	355	403	346
Mean (SD)	3.6 (2.7)	3.1 (2.1)	3.5 (2.5)	2.9 (1.7)
Previous IVF cycle, n (%)				
No	343 (85.5)	226 (63.7)	342 (84.9)	210 (60.5)
Yes	58 (14.5)	129 (36.3)	61 (15.1)	137 (39.5)
AFC stimulation day 1				
n	401	343	403	335
Mean (SD)	12.4 (4.7)	12.2 (4.4)	12.8 (4.7)	11.9 (4.1)
FSH stimulation day 1 (IU/L)				
n	358	353	350	346
Median (P5, P95)	6.2 (4.2, 9.8)	6.5 (4.1, 10.8)	6.3 (4.1, 10.0)	6.5 (4.2, 10.3)

Note: AFC = antral follicle count; P5, P95 = 5th and 95th percentiles; EU = Europe; NA = North America.

Boastanfar. Live birth rate and corifollitropin alfa. Fertil Steril 2012.

TABLE 2

Main clinical outcome including ongoing pregnancy rate and live birth rate after transfer of fresh embryos and cumulative pregnancy rate after transfer of fresh and frozen-thawed embryos per treatment group and continent.

	Corifollitropin alfa		rFSH		P value ^a	
	NA	EU	NA	EU	Treatment effect	Continent effect
Mean (SD) duration of stimulation (d)	9.4 (1.4)	9.8 (1.5)	9.0 (1.2)	9.4 (1.3)	< .01	< .01
Mean (SD) of total rFSH dose (IU) from day 8 onward	372.9 (279.6)	443.8 (320.6)	322.6 (236.5)	379.4 (277.8)	< .01	< .01
Mean (SD) no. of follicles \geq 11 mm on day of hCG	16.4 (7.3)	15.5 (6.6)	14.5 (6.6)	13.2 (5.3)	< .01	< .01
Mean (SD) no. of oocytes	14.4 (8.7)	12.9 (7.6)	13.3 (7.5)	11.6 (5.6)	< .01	< .01
Mean (SD) no. of good-quality embryos	5.3 (4.6)	3.4 (3.7)	5.1 (4.4)	3.5 (3.0)	.62	< .01
Mean (SD) no. of fresh embryos transferred	1.9 (0.3)	1.5 (0.5)	1.9 (0.3)	1.5 (0.5)	.67	< .01
Single ET, %, n/N	7.6%, 28/368	47.7%, 145/304	11.1%, 42/380	45.7%, 148/324		
Mean (SD) no. of frozen embryos transferred	2.2 (0.8)	1.5 (0.5)	2.1 (0.6)	1.5 (0.6)	.61	< .01
Single ET, %, n/N	12.1%, 8/66	50.0%, 67/134	11.7%, 7/60	51.6%, 64/124		
Implantation rate of fresh embryos, n, mean (SD)	368, 39.6% (41.0%)	304, 32.1% (42.0%)	380, 36.8% (39.8%)	324, 26.7% (39.8%)	.07	< .01
Ongoing pregnancy rate after transfer of fresh embryos, %, n/N	45.4%, 182/401	31.5%, 112/355	45.7%, 184/403	29.4%, 102/347	.75 ^b	< .01 ^b
Ongoing pregnancy rate after transfer of fresh embryos, per ET, %, n/N	49.4%, 182/368	36.8%, 112/304	48.4%, 184/380	31.5%, 102/324	.28 ^c	< .01 ^c
Multiple pregnancies, %, n/N	34.6%, 63/182	17.9%, 20/112	28.8%, 53/184	12.7%, 13/102	.13 ^b	< .01 ^b
Live birth rate after transfer of fresh embryos, %, n/N	39.2%, 157/401	31.5%, 112/355	39.2%, 158/403	28.8%, 100/347	.63 ^b	< .01 ^b
Live birth rate after transfer of fresh embryos, per ET, %, n/N	42.7%, 157/368	36.8%, 112/304	41.6%, 158/380	30.9%, 100/324	.23 ^c	.55 ^c
Cumulative pregnancy rate after transfer of fresh and frozen embryos, %, n/N	53.1%, 213/401	40.6%, 144/355	51.9%, 209/403	36.9%, 128/347	.37 ^b	< .01 ^b

Note: ET = embryo transfer; other abbreviations as in Table 1.

^a P values of estimated odds ratios (ORs) based on model including treatment group, continent, and age group (<32 y vs. \geq 32 y) as factors.

^b P values of estimated ORs based on model including treatment group, continent, age group, and previous IVF cycle (yes/no) as factors.

^c P values of estimated ORs based on model including treatment group, continent, age group, previous IVF cycle, and number of embryos transferred (single vs. double) as factors.

Boostanfar. Live birth rate and corifollitropin alfa. Fertil Steril 2012.

TABLE 3

Frozen-thawed embryo transfer (FTET) cycles performed and the number and quality of embryos transferred across all FTET cycles.

	Corifollitropin alfa (n = 168)	rFSH (n = 176)
Total no. of FTET cycles performed	225	224
In NA, n (%)	68 (30.2)	63 (28.1)
In EU, n (%)	157 (69.8)	161 (71.9)
No. (SD) of embryos cryopreserved ^a	4.7 (3.6)	4.0 (2.6)
No. (SD) of embryos thawed across all FTET cycles ^{a,b}	3.4 (2.5)	3.0 (1.8)
No. (SD) of embryos transferred per FTET cycle	1.7 (0.7)	1.7 (0.6)
Good-quality embryos	1.3 (0.8)	1.3 (0.8)
Grade 1	0.7 (0.8)	0.7 (0.8)
Grade 2	0.6 (0.7)	0.6 (0.7)
Grade 3	0.4 (0.7)	0.3 (0.7)
Other	0.1 (0.3)	0.0 (0.2)
Clinical pregnancy rate per started cycle	43.5% (73/168)	38.6% (68/176)
Miscarriage rate per clinical pregnancy	8.2% (6/73) ^c	17.6% (12/68)
Ongoing pregnancy rate per started cycle	38.7% (65/168) ^d	30.7% (54/176) ^d
Multiple pregnancy per ongoing pregnancy	27.7% (18/65)	22.2% (12/54)

^a Restricted to 164 patients in the corifollitropin alfa group and 174 patients in the rFSH group with embryos cryopreserved (excludes fertilized oocytes).^b Includes thawed fertilized oocytes.^c Including one subject with miscarriage in FTET cycles 1 and 2 who was counted once.^d Excluding two subjects with a vital pregnancy at 5–6 weeks who were lost to follow-up.Boostanfar. Live birth rate and corifollitropin alfa. *Fertil Steril* 2012.

rFSH group. There were 18 (27.7%) multiple pregnancies in the corifollitropin alfa group and 12 (22.2%) in the rFSH group. Two subjects (1.2%) in the corifollitropin alfa group and one subject (0.6%) in the rFSH group that started an FTET cycle had an ectopic pregnancy. In total, 18 subjects with a clinical pregnancy had a miscarriage: 6 subjects (8.2%) in the corifollitropin alfa group and 12 subjects (17.6%) in the rFSH group.

The cumulative ongoing pregnancy rate after a single cycle of COS for IVF/ICSI, including pregnancies from fresh ET and FTET, was 47.2% per started cycle with corifollitropin alfa and 44.9% per started cycle after stimulation with rFSH. The estimated treatment difference was 2.3% (95% CI –2.7%–7.2%) in favor of corifollitropin alfa and was not significant.

Live Birth Rates

There were 346 live births from women in the corifollitropin alfa group (196 from singleton and 150 from multiple pregnancies) and 313 live births from women in the rFSH group (202 from singleton and 111 from multiple pregnancies). The live birth rate in the ITT group was 35.6% (269/756) in the corifollitropin alfa group and 34.4% (258/750) in the rFSH group (estimated treatment difference 1.1% [95% CI –3.7–5.8]). Restricted to patients with ET, the live birth rates were 40.0% (269/672) and 36.6% (258/704) in the corifollitropin alfa group and the rFSH group, respectively.

Extrapolation of cumulative ongoing pregnancy rates with the rate of pregnancy loss observed after fresh ET provided cumulative live birth rate estimates of 43.4% in the corifollitropin alfa group and 41.3% in the rFSH group.

DISCUSSION

To our knowledge, this is the first very large multicenter trial including two fixed treatment regimens recruiting one-half of the IVF patients in NA (13 sites in USA and one in Canada) and

one-half of the patients in EU (20 sites), thus allowing the comparison of pregnancy rates between these two continents. Moreover, randomization in this trial was performed by stratifying for age (<32 y vs. ≥32 y) and center, thus minimizing imbalance between the treatment groups due to age or center differences. Clearly, the estimated (cumulative) ongoing pregnancy rates and the live birth rates after corifollitropin alfa and after daily rFSH treatment were very similar within each continent and confirm the overall success rates of this trial. However, using exactly the same stimulation protocol, the implantation rates and pregnancy rates were considerably higher in NA than in EU. Potential explanations for the apparent difference in pregnancy rates between the United States and Europe have been described previously (7–9). These factors include the patient's ovarian reserve, the longer waiting lists in EU, the number of embryos replaced, the quality of the IVF laboratory, and the skills of the treating physician and embryology staff. Our data indicate that the patients recruited in NA had a slightly higher ovarian reserve and had fewer previous IVF attempts, which may partly explain why IVF units in NA recover more oocytes and require less FSH in a study population that was otherwise similar. More good-quality embryos for transfer and freezing were recovered in NA, which may be related to better or different oocyte pick-up procedures and embryo culture conditions. In addition, the higher implantation rate indicates that the NA sites may have a better embryo selection procedure, resulting in higher pregnancy rates. Better embryo transfer techniques could also contribute to the higher implantation rates. On the other hand, the rate of multiple pregnancies was twice as high in NA than in EU, owing to more frequent double ET than single ET in NA, whereas elective single ET would be indicated for the majority of this relatively young IVF population (≤36 y) (10, 11). Health economics and outcomes research should confirm whether the (in)direct costs related to required additional treatment to reach the same success

rates in EU would outweigh those related to the cost and social burden of multiple pregnancies in NA (12).

This large, randomized, multicenter trial also demonstrates that corifollitropin alfa and daily rFSH for the first 7 days of COS in a GnRH antagonist protocol provide similar cumulative ongoing pregnancy rates and live birth rates. The extrapolated cumulative live birth rates were also found to be similar between the treatment groups, although it is recognized that the assumption of equal incidence of miscarriage and stillbirth in fresh and frozen cycles may not be fully correct. Following transfer of the same number of cryopreserved embryos, the multiple pregnancy rate was 5% higher after corifollitropin alfa treatment than after rFSH treatment, and this 5% higher incidence was also observed after fresh transfer of equal numbers of embryos (2).

This additional information on the effectiveness of corifollitropin alfa is intriguing, because FSH activity declines from high to normal during the first week of stimulation with corifollitropin alfa (6, 13, 14) whereas in the reference group with rFSH the reverse occurs, in that FSH activity increases daily up to stimulation day 5 when steady-state levels of FSH are reached (15). Apparently, at least when applying a GnRH antagonist protocol, these fluctuations of FSH concentrations have no significant impact on embryo quality or on endometrial development, as long as the FSH activity is sufficiently high to support multiple follicular development (16). These data demonstrate the broad therapeutic window for FSH during COS, although this window may be related to the amount of endogenous or exogenous LH activity available during treatment (17). For this reason the need for LH activity may deviate with age and may differ between a GnRH antagonist protocol and a long GnRH agonist protocol (18). A very recent prospective randomized trial comparing hMG and rFSH in 749 IVF patients (≤ 34 years old) using a GnRH antagonist and single-blastocyst transfer did not reveal any difference in the ongoing pregnancy rates (19), indicating that the amount of endogenous LH is not critical in young IVF patients using GnRH antagonists. This finding is in agreement with a recent retrospective analysis indicating no association between serum LH levels during follicular stimulation and the chance of pregnancy in patients up to 39 years old using a GnRH antagonist protocol (20, 21). Whether the LH levels are more critical in patients of advanced reproductive age, who usually have higher LH levels than younger patients, remains to be determined (18).

The development of the corifollitropin alfa–GnRH antagonist regimen reduces the number of injections compared with daily rFSH protocols, and early responders may proceed to triggering of final oocyte maturation without the need for additional rFSH injections (2, 22). Moreover, a single injection of corifollitropin alfa can safely and effectively be applied in normal-responder patients undergoing up to three treatment cycles without concerns of immunogenicity (23). However, repeated treatment may not be required, because a single injection of corifollitropin alfa has been shown to result in a substantial number of good-quality embryos, and, as demonstrated in the present trial, sufficient numbers of cryopreserved embryos can be retained for se-

quential ETs without any further treatment intervention. Elective single ET and/or vitrification of all good-quality embryos would further reduce the treatment burden for patients by increasing the overall success rates while minimizing multiple gestations (10, 24) and the risk of ovarian hyperstimulation syndrome (25).

In conclusion, using the same study population and fixed treatment protocol, success rates were higher in 14 IVF units in NA than in 20 IVF units in EU. Corifollitropin alfa has been proven to be a highly effective treatment option and similar to rFSH in terms of the live birth outcome from patients who became pregnant following fresh ET and in terms of the cumulative pregnancy rate from cryopreserved embryos. Per COS treatment cycle with a single injection of corifollitropin alfa in a GnRH antagonist protocol, a cumulative ongoing pregnancy rate of 47.2% was achieved.

Acknowledgments: Medical writing and editorial assistance was provided by P. Milner, Ph.D., of PAREXEL. This assistance was funded by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Whitehouse Station, New Jersey.

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