Public health implications of a North American publicly funded in vitro fertilization program; lessons to learn

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Abstract

Purpose A retrospective study was conducted to determine trends in practice and outcomes that occurred since the implementation of the publicly funded in vitro fertilization (IVF) and single embryo transfer (SET) program in Quebec, in August, 2010.

Methods Data presented was extracted from an advisory report by the Health and Welfare Commissioner, and from a report by the Ministry of Health and Social Services published in June 2014 and October 2013, respectively. This data is publicly available, and was collected from all six private and three public-assisted reproduction centers in Quebec providing IVF services. Data pertains to all IVF cycles performed from the 2009–2010 to 2012–2013 fiscal years.

Results SET was performed in 71 % of cycles in 2012. The number of children born from IVF was 1057 in 2009–2010 and 1723 in 2012–2013 ($p<0.0001$). Multiple birth rates from IVF were 24 % in 2009–2010 (before the program began) and 9.45 % in 2012–2013 ($p<0.0001$). The proportions of IVF babies that were premature, that were the result of multiple births, or that required neonatal intensive care unit admission (NICU) all decreased by 35.5 % ($p<0.0001$), 55 % ($p<0.0001$), and

37 % ($p<0.0001$), respectively, from 2009–2010 to 2012–2013. The cost per NICU admission for an IVF baby increased from \$19,990 to \$28,418 from 2009–2010 to 2011–2012.

Conclusion This first North American publicly funded IVF program with a SET policy shows that such a program contributes substantially to number of births. It has also succeeded in increasing access to treatment and decreasing perinatal morbidity by decreasing multiple birth rates from IVF. A substantial increase in global public health care costs occurred as well.

Keywords In vitro fertilization · Public funding · Single embryo transfer · Neonatal outcomes

Introduction

Public coverage of assisted reproductive technologies (ART) including in vitro fertilization (IVF) in the province of Quebec was implemented on August 5, 2010. To ensure a decrease in multiple birth rates, a single embryo transfer (SET) policy was established, as several studies have shown it to be successful in this respect [1–7]. Multiple births are associated with complications to both mother and fetuses, as well as with long-term health issues and so it is of public health interest to lower these rates [8–11]. Birth rates from single embryo transfer are lower than from double embryo transfer. However, several studies suggest that the cumulative live birth rate from a single fresh embryo transfer followed by a frozen embryo transfer from the same cycle is not significantly lower than the live birth rate after a double embryo transfer [12, 13].

Quebec is not the first jurisdiction to offer public funding for assisted reproduction; several countries from Western and Northern Europe, as well as Israel and Australia, have been doing so for years [14]. However, it is the first North American jurisdiction to do so. The pregnancy rates of IVF

Capsule This first North American publicly funded IVF program with a SET policy has contributed substantially to number of births, has increased access to treatment, and has decreased multiple birth rates from IVF.

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in North America and Europe differ significantly for reasons that are not well understood [15]. However, due to these differences, the public health outcomes of this program have a unique lesson to deliver.

The three main goals of the Quebec program were to reduce the multiple birth rates from IVF from approximately 30 % to under 10 %, to increase Quebec's births by 1000–1500 live babies per year, and to facilitate conception for infertile couples in a safe manner. The minister predicted that the savings from neonatal intensive care unit (NICU) admissions based on the reduced multiple birth rates would fund the public program. This was theorized to occur because twins and higher order multiples have significant chances of preterm delivery and NICU admission [9].

A recent study published after the first full year (2011) of public coverage in Quebec showed this new practice to be cost effective as the total of all treatment and medical cost per baby up to 1 year after birth has decreased, even though the absolute total costs have increased [16]. However, this latter article was written before most public health impacts of the program were assessable. This article was written to present these implications for the first government-covered IVF program in North America.

Material and methods/details on the data presented

The data in this article was extracted from the Health and Welfare Commissioner advisory report on assisted reproduction in Quebec that was published in June 2014 [17]. This advisory report is publicly available on the Health and Welfare Commissioner website. Some data was also taken from a report by the Ministry of Health and Social Services on Assisted Reproduction Acts published in October 2013 [18]. The sources of data in these reports concerning IVF cycle details and clinical outcomes was gathered from several sources, which are not linked: the Ministry of Health and Social Services database as well as the Canadian IVF Register (CARTR) for cycle number details and outcomes; the ministry's hospital admission database (MED-ÉCHO) for hospital admission data; as well the fee-for-service medical services and pharmaceutical services database for medical acts billed and medications purchased. The CIVFR database is based on voluntary participation of clinics; however, there was complete reporting from all Quebec clinics for the time period pertaining to this study.

The data presented was collected from all assisted reproduction centers in Quebec providing IVF services: three university hospital-based public centers in Montreal (Sainte-Justine University Hospital Centre, McGill University Health Centre, and University of Montreal Hospital Centre) as well as six private centers (Montreal Fertility Centre (Montreal, QC), OriginElle Fertility Clinic (Montreal, Qc),

Clinique Procrea (Montreal and Quebec City, QC), Clinique OVO (Montreal, QC), and Fertylis (Laval, QC)).

Data in the text and tables is presented mainly by financial year (April 1 to March 31). Since data from birth outcomes from IVF reflect treatments performed approximately 9 months prior, the year 2012–2013 pertains to outcomes after implementation of the program. The years 2009–2010 and (2010–2011, 2011–2012) pertain to outcomes wholly and partially before the implementation of the program, respectively.

Data pertains to babies born in hospitals and to babies transferred to hospital centers. It does not account for babies delivered at home and at birthing centers who stayed in these locations; however, this represents less than 5 % of births (Unpublished data, confirmed with Statistics Quebec). It should be noted that out-of-hospital-deliveries do not represent any antepartum admissions, premature deliveries, or NICU admissions.

Prior to August, 2010, IVF was private, funded by patients seeking the treatment; however, they received a 50 % tax credit. Since its implementation, the Quebec program has been fully government funded. It is accessible to all women of any reproductive age with a valid public health insurance card. All legal residents in Quebec hold such a card. Women are covered for egg donor cycles up to their 51st birthday. This is an age limit introduced by IVF centers and not the government. It covers the cost of de-identified donor sperm, but not frozen donor oocytes. It covers the costs of a fresh donor IVF cycle, without compensated donors, which are illegal in Canada. All medical services related to IVF are covered by the public insurance plan for up to three stimulated cycles, or six modified natural cycles, per live birth. If a cycle does not culminate in an embryo transfer, the cycle is not counted by the government tally. In most cases, embryos must be transferred individually and excess embryos cryopreserved. Except in specific situations that the clinician deems appropriate to transfer a maximum of two blastocysts or three embryos [19]. Examples of these situations include recurrent implantation failures, patients >40 years old with a failed transfer, or poor responders with a failed transfer or poor quality embryos. There is no maximum amount of embryo transfer procedures that can be performed from one cycle; however, all frozen embryos must be used before proceeding to a subsequent cycle. After a live birth, three stimulated cycles, or six modified natural cycles, can be repeated. Patients who are not covered by public health insurance or patients who have exhausted all covered attempts may pay for care. Drugs used by patients are covered either by public or private insurance companies depending on which of these provides the patient's medications. Private insurers are required by law to cover these drugs for each covered cycle. All residents must be covered for medication, under either the public or public program.

Statistical analysis was performed using Graph Pad for Chi-squared with Yates correction. Pearson's correlation

coefficients were performed using Wessa, P. (2014), Free Statistics Software, Office for Research Development and Education, version 1.1.23-r7. *T* tests could not be performed because standard deviations were unknown. Data was presented as odds ratio (OR) with 95 % confidence intervals (CI) where appropriate. Two-sided *p* values ≤ 0.05 were accepted as significant.

Results

Cost and cycle numbers Table 1 presents the IVF cycle numbers preceding and during the program. Cycle numbers have increased every year, as a significant correlation with time ($r=1.0$, $p=0.007$). These cycle numbers are consistent with extrapolated percentages of populations performing IVF in other publically funded European countries [20].

The number of initial consultations in infertility clinics saw a rise of 91 % over 3 years since the implementation of the program. In absolute numbers, there were 5058 initial consultations billed in 2010–2011, and 9652 in 2012–2013; however, 2010–2011 was not a full year as the program only began in early August 2010. When looking at the two full years of data, a 35 % increase in oocyte collections was noted over the 2011–2012 to 2012–2013 period (from 6989 to 9442); as well as an 18.5 % increase in fresh and frozen embryo transfers (from 7202 to 8526). It should be noted that embryo transfers differ from cycle numbers, and this is due to canceled cycles. Over the 3 years, 25 % of embryo transfers took place in patients 40 year or older.

The costs for the main services billed related to IVF (ovarian stimulation, oocyte retrieval, embryo transfer) over the years 2010–2011, 2011–2012, and 2012–2013 were \$16,413,628, \$33,677,900, and \$30,806,162, respectively ($r=0.78$, $p=0.43$). The decrease in costs between 2011–2012 and 2012–2013 is explained by a decrease in payment for IVF as of January 1, 2012, after the government reassessed the profits made from IVF. This was done by auditing the books of an IVF center, which was owned by a publicly traded company (PROCREA). The payments went from \$7100 per completed cycle to \$4750 per completed cycle. The total cost of medication prescribed in IVF cycles saw a steady increase:

from \$85,376 in 2009–2010, to \$2,618,805 in 2010–2011, to \$6,319,455 in 2011–2012, to \$7,942,762 in 2012–2013 ($r=0.99$, $p=0.01$). These costs do not include indirect services and medications linked to non-IVF-related treatments, surgical sperm extraction, or physician consultations. It should be noted that in most cases, prior to August 2010, medication costs were not covered. This explains the drastic change between 2009–2010 and 2010–2011. It should also be noted that part of the 2010–2011 year includes a period of several months during which medications were not covered as well. In few cases, private medication insurance covered the cost of medications prior to August 2010, which is where the costs of \$85,376 were accrued.

Effect on pregnancy and live birth rates The number of pregnancies and live births through IVF has increased over the 4 years as presented in Table 2. The most substantial increases took place between 2011–2012 and 2012–2013. The discordance between the number of live births and number of deliveries can be attributed to stillbirths and multiple pregnancies. The proportion of live births that are a result of IVF has increased since 2009–2010, from 1.23 to 2.02 % ($p<0.0001$). This represents an absolute increase of 0.79 % in the provincial birth rate, than would not have occurred without such a program. The OR of a baby being born post-program as compared to pre-program was 1.95 (95 % CI 1.80 to 2.11, $p=0.0001$).

Effect on multiple pregnancies When looking at the data on multiple pregnancies and children born from multiple births that are the result of IVF (Table 3), there was a consistent decrease over the 4 years, in both of these categories. The multiple pregnancy rates decreased from about 25 % prior to the program to under 10 % in the first full year of the program ($p<0.0001$). The number of multiple births went from 218 in 2009–2010 to 165 in 2012–2013. This represents a decrease of 60.7 % in the proportion of all IVF births that are multiple ($p=0.003$). In regards to spontaneous conceptions, the proportion of multiple births has remained steady, at around 1.3 % ($p=0.07$) (range 1.27 to 1.33 %). The OR of a baby being born as the result of an IVF multiple pregnancy comparing the years 2012–2013 to the 2009–2010 decreased significantly (OR 0.78, 95 % CI 0.66–0.91, $p=0.003$).

Table 1 Realizations of the publicly funded program in Quebec

	2010–2011	2011–2012	2012–2013	2013–2014 (projections)
Number of cycles in public centers	1700 (49 %)	2070 (28 %)	2515 (31 %)	3130 (35 %)
Number of cycles in private clinics	1800 (51 %)	5249 (72 %)	5530 (69 %)	5670 (65 %)
Total of IVF cycles	3500	7319	8045	8800
Grand total of costs (\$) (including medications)	26,281,713	51,686,146	51,822,889	Not yet determined

Government data for 2009–2010 was not collected prior to the initiation of the program and therefore is unavailable

Table 2 Number of deliveries and babies born from IVF and spontaneous conception, by financial year

	IVF babies (number)	Women delivering after IVF (number)	Spontaneous conception babies (number)	Women delivering after spontaneous conception (number)	Proportion of total live new-borns that are the result of IVF (%)
2009/2010 Pre-program	1057	906	84,553	83,469	1.23
2010/2011 Pre-program	1021	889	84,283	83,247	1.20
2011/2012 Incomplete year of program	1243	1,160	84,248	83,228	1.45
2012/2013 First full year of program	1723	1746	83,646	82,531	2.02

The proportion of IVF babies that were the result of a multiple birth also dropped substantially, from 38.5 to 17.2 %, ($p<0.0001$). The percentage of babies from multiple pregnancies out of the total number of babies born has decreased from 3.1 % prior to the program to 2.8 % ($p=0.0003$), even when the multiple birth rates among spontaneous conceptions remained stable ($p=0.25$).

Effect on pregnancy outcomes The percentage of babies resulting from IVF that were born prematurely (<37 weeks) went from 29.61 to 19.09 % over the 4 years (Table 4) ($p<0.0001$). The absolute numbers, however, have seen a slight increase, from 313 to 329 babies from IVF that were born prematurely. The proportion of all babies that were born prematurely has remained stable at a little over 7 % ($p=0.82$). The OR of a premature delivery did not change when comparing IVF and spontaneous conceptions from 2009–2010 to 2012–2013 (OR 1.07, 95 % CI 0.91 to 1.25, $p=0.42$) in spite of the substantial decrease in the multiple pregnancy rate during this time period. However, the OR of an IVF conceived baby being born prematurely did decrease in this time span (OR 0.64, 95 % CI 0.54–0.77, $p<0.0001$). It should be noted that during this time period, a similar decrease occurred among spontaneous pregnancies, without the drop in multiple pregnancy rates, for a reason that is unknown.

The proportion of all IVF babies that were hospitalized in the neonatal intensive care unit (NICU) decreased from 18.83 to 11.84 % ($p<0.0001$) (OR 0.62, 95 % CI 0.51–0.78, $p<0.0001$). However, the absolute number of IVF babies admitted to the NICU increased slightly, due to increased IVF usage. The average time spent in the NICU for a baby resulting from assisted reproduction went from 14.65 days in 2009–2010 to 16.87 days in 2012–2013. The average number of days spent in the NICU for a spontaneously conceived baby remained stable at about 10 days. Table 4 also shows the average cost spent on each NICU hospitalization for babies conceived through IVF as well for babies conceived spontaneously. The average cost for a baby conceived through IVF was \$19,990 in 2009–2010, and increased to \$28,418 in 2011–2012. This translates into total costs for NICU stays for babies conceived through IVF of \$3,977,958 and \$4,802,614, respectively. Data for the 2012–2013 year is missing;

however in the 2011–2012 year, the average cost was 11,263\$ more for a baby conceived through IVF than through a spontaneous conception. To account for yearly increases in cost related to inflation, the difference was standardized based on the costs of a spontaneous conception NICU admission for that year. This percent difference increased for the IVF conceived NICU admission yearly, during the period of study.

The mean age of women pregnant through assisted reproduction ranged between 33.5 and 34.3 years old, over the 4 years of data collection. This compares to a mean age range of 29.3 to 29.7 years old, over the 4 years, for women pregnant through spontaneous conception. Of all the women pregnant through assisted reproduction, the percentage of women that were at least 40 years of age went from 11.47 to 14.20 % over the 4 years ($p=0.04$). This compares to a stable rate around 2.5 % for women pregnant through spontaneous conceptions.

Prematurity rates varied by maternal age. In women under 40 years old who conceived through IVF, 22.32 % delivered prematurely in 2009–2010, and this rate dropped to 15.42 % by 2012–2013. In women 40 years and older, this rate of premature births <37 weeks stayed constant at about 19 % throughout the 4 years.

Figure 1 shows the number of women hospitalized antenatally by type of pregnancy. Over the 4 years, there was a consistently higher percentage of women hospitalized in the group of women who conceived through IVF compared to women who conceived spontaneously ($p<0.0001$ for each of the four periods studied), and this number increased throughout the 4 years ($p=0.05$). It should also be noted that for the women who conceived spontaneously, the percentage of those hospitalized also increased in a similar manner during this time period ($p<0.0001$). The rate of hospital admission went from 32.2 % in 2009–2010 to 37.4 % in 2012–2013 in IVF pregnancies, and from 20.9 to 23.7 % in spontaneous pregnancies in the same years.

Discussion

Quebec is currently the only province in Canada with such a widely available public program. Ontario currently offers reimbursement for IVF only in cases of bilateral tubal blockage

Table 3 Multiple births and babies from multiple births from IVF and from spontaneous conception, by financial year

	IVF		Spontaneous conception		Proportion of multiple births that is the result of IVF (%)	Proportion of babies from multiple births that were conceived through IVF (%)	Proportion of total babies born that are from multiple births (%)
	Multiple births (number, % rate)	Babies born from multiple births (number, % rate)	Multiple births (number, % rate)	Babies born from multiple births (number, % rate)			
2009/2010 Pre-program	218 (24.06)	407 (38.5)	1112 (1.33)	2273 (2.69)	16.39	15.2	3.1
2010/2011 Pre-program	226 (25.42)	393 (38.5)	1070 (1.29)	2206 (2.62)	17.44	15.1	3.0
2011/2012 Incomplete year of program	152 (13.10)	287 (23.1)	1061 (1.27)	2138 (2.54)	12.53	11.8	2.8
2012/2013 First full year of program	165 (9.45)	297 (17.2)	1046 (1.27)	2125 (2.54)	13.63	12.3	2.8

Table 4 Premature babies, babies requiring NICU admission, and average cost of each NICU admission, by financial year

	IVF		Spontaneous conception		Difference in average NICU cost (\$)	Difference in average NICU costs (%)
	Premature babies <37 weeks (number, %)	Babies in NICU (number, %)	Premature babies <37 weeks (number, %)	Babies in NICU (number, %)		
2009/2010 Pre-program	313 (29.61)	199 (18.83)	6041 (7.14)	4554 (5.39)	5427	37.3
2010/2011 Pre-program	241 (23.60)	157 (15.38)	5979 (7.06)	4640 (5.51)	7438	48.3
2011/2012 Incomplete year of program	257 (20.68)	169 (13.60)	5810 (6.89)	4436 (5.27)	11,263	65.7
2012/2013 First full year of program	329 (19.09)	204 (11.84)	5945 (7.11)	4426 (5.29)	N/A	N/A

NICU neonatal intensive care unit, N/A not available

Fig. 1 Women hospitalized in ART and spontaneous pregnancies

infertility, although a program to fund one IVF cycle for each patient in that province is being considered. It should be noted that due to increased demand, initially the wait time for care was 1 year. However, as physician number increased and changes were made in clinics to accommodate demand, there was no longer a wait for care.

Importantly, the program permitted a decrease in the multiple pregnancy rate, below 10 %. This was achieved in 2012–2013, the first year to fully reflect no pre-program embryo transfers. In 2012–2013, 9.45 % of all IVF births were multiple births. This represents a 60 % drop from 2009 to 2010 pre-program levels. The reduction in absolute numbers of multiple births from 218 to 165 between 2009–2010 and 2012–2013 is less drastic (24 %), as the total number of births from IVF approximately doubled. This drop is the result of the single embryo transfer (SET) mandate that was implemented at the start of the program. The rate of single embryo transfer was 61 % in 2011, and 71 % in 2012, which meets the government objective of a 70 % single embryo transfer rate. The pre-program SET rate was less than 5 %. It is possible that embryo screening using time-lapse imaging and genetic screening which have proved to be superior to standard morphology could decrease this rate further [21, 22]. However, currently in Quebec, no centers have a time-lapse imaging system and pre-implantation genetic screening is difficult to obtain [23].

The Quebec multiple pregnancy rates compare favorably to rates in other countries who have adopted a single embryo transfer policy: Sweden reported a 5.8 % twin delivery rate and a 73.3 % SET rate in 2010; Finland reported a 10.6 % twin delivery rate and a 67.5 % SET rate in 2010 [24]; and Australia and New Zealand reported a 7.9 % twin delivery rate and a 70.2 % SET rate in 2010 [25]. Countries that

performed mostly higher order embryo transfers reported higher rates of multiple deliveries, resembling the situation in Quebec prior to public funding [24]. Only a single higher order multiple birth has been recorded as a result of IVF since the program began.

The public funding of IVF in Quebec has also had a positive impact on the likelihood of a child born from IVF being a result of a multiple pregnancy. In 2012–2013, 297 babies were born as a result of multiple pregnancies. This represented 1 in 5.8 IVF conceived babies. This seems high when compared to 1 in 39 babies that were conceived spontaneously. However, this represents a significant drop from 2009 to 2010, when 1 in 2.6 IVF babies was the result of a multiple birth.

The increase in live births was slightly lower than the 1000–1500 anticipated. In 2012–2013, there were 1743 babies born from IVF, which represents 666 more than in 2009–2010 and 480 more than in 2011–2012. This program increased the provincial birth rate by just under 1 %, which was a statistically significant amount. The proportion of all babies that were born through IVF was 2.02 % in 2012–2013. This represents a 63 % increase since 2009–2010. It is important to note that in societies with low birth rates, like Quebec, with a reported fertility rate of 1.65 children per woman in 2014 [26], increasing the birth rate is imperative. If the birth rate is not increased, the society will contract and social programs based on a pyramid platform will collapse.

The Quebec government planned to fund the program by savings generated from lower costs related to NICU admissions by lower multiple pregnancy rates. Although the rate of multiple births and the number of babies born from multiple pregnancies through IVF has dropped drastically since the program was initiated, these savings did not materialize.

When considering babies conceived as a result of IVF, the absolute numbers of preemies and those requiring NICU admissions have remained relatively stable. However, decreases in rates of prematurity and NICU admissions from 29.6 to 19.1 % and from 18.8 to 11.8 %, respectively, were noted. The rate of antepartum admissions has increased for both spontaneous conceptions and IVF pregnancies yearly during the period of study in a parallel and almost similar manner, for reasons that are not understood. It will be an important public health issue to determine why prematurity seems to be on the rise. Further data should be collected to determine if this trend continues.

The NICU admission rate for IVF conceived children including singletons was substantially higher than those of spontaneous conceptions. This is likely the result of a complex interplay of factors making for higher rates of pregnancy complications in couples with fertility problems [27–33]. Clearly, a predominantly SET practice as well as increased use of frozen embryo transfer has not completely eliminated the perinatal risks associated with fertility care. Singleton pregnancies from IVF are at higher risk for prematurity due to a combination of factors that are difficult to isolate such as the infertility itself, the IVF treatment itself, and maternal factors [30, 34]. The average age of women pregnant through IVF in Quebec is higher than that of women pregnant through spontaneous conception, and the percentage of IVF pregnancies occurring in women 40 years or older has increased and is higher than that for spontaneous pregnancies. Pregnancies in women at least 40 years of age has been linked to worse obstetric and perinatal outcomes [35–41], and could therefore contribute to rising NICU admission costs, since these women represent a greater percent of IVF than spontaneous conceptions. It should also be noted that the number of women in this age group who underwent treatment increased with public funding of IVF.

NICU admissions incur high costs to a single payer health care system. Table 4 shows that the average cost of each NICU admission is much higher for a baby conceived through IVF than a baby conceived spontaneously. This cost has been increasing consistently in both categories over the three presented years. However, the increase has been more important for an IVF baby, despite a significant drop in the rate of multiple births. This difference in cost reached \$11,263 in 2011–2012. This difference is partially explained by the longer average NICU stay for an IVF baby; however, this is unlikely the sole explanation. Clearly, singletons derived from IVF who require NICU admission are sicker and require more interventions than twins derived from IVF requiring admission to the NICU. No new procedures were induced during this time period to account for the increased costs.

It should be noted that prematurity rates dropped among younger women. This is the group in which most multiple pregnancies occur, when SET is not used. However, there are relatively low multiple pregnancy rates among women at

least 40 years of age. Therefore, the switch to a SET policy had little impact on prematurity in this older age group, where multiples were rare.

Another cost that has been increasing is from antenatal admissions. Despite the lower number and rate of multiple pregnancies, the proportion of women pregnant through IVF who were hospitalized antenatally went from 32 to 37 % in 4 years. This proportion increased from 20 to 25 % in pregnant women who conceived spontaneously. Clearly, these findings confirm that IVF pregnancies are generally associated with higher rates of complications than spontaneous pregnancies. These complications include antepartum hemorrhage, hypertensive disorders of pregnancy, congenital anomalies, gestational diabetes, placenta previa, cesarean section, preterm birth <37 and <32 weeks, low birth weight, admission to NICU, and perinatal mortality [42–45]. However, the reason why both groups saw an increase in admission during the time period of the study is an area requiring further investigation.

Unfortunately, donor cycles could not be accounted for in this database. It is a minor drawback that we cannot compare how this affects NICU and antepartum admissions. In our center, donor cycles account for about 4 % of all cycles, and we expect this rate to be about similar in the other centers throughout the province.

An economic analysis of Quebec's public program comparing the costs from cycles performed in 2009 to costs of those performed in 2011 was published recently [16]. These costs were estimates based on projections of live births from clinical pregnancy rates. Vélez et al. [16] showed that although the total cost (including treatment, antenatal, birth, and neonatal costs) increased from approximately \$7 million to \$26 million in those years, the cost per child decreased from \$49,517 to \$43,362, as did the cost per cycle from \$16,747 to \$8960. This difference may be an underestimate as it does not take into account long-term health costs after 1 year, and this difference could be expected to be even wider after 2012, when the pricing of IVF went down, which was not included in their analysis. Our study pertains to IVF cycles performed over a longer period of time, and to the actual birth outcomes. A crucial finding in our study is the increase in NICU costs per admission for IVF conceived offspring when the rate of multiple pregnancy induced prematurity was decreased. This suggests a singleton delivered after IVF by an infertile couple and requiring NICU admission has more substantial complications than prematurity induced by multiples. However, since the proportion of healthy babies born from IVF cycles with a SET policy is greater than the proportion of babies requiring intensive care, the cost per cycle and baby will likely continue to decrease.

Several differences exist between the data as collected from government medical admission sources and the data projected in the Vélez et al. [16] study. It is possible that the latter study underestimated the clinical pregnancy rate for IVF in the first

year of the program, listed as 24.8 % per fresh embryo transfer, as the actual live birth rate in 2012–2013 was 23.8 %. The number of twin deliveries (69 estimated) was underestimated as compared to the actual number which was greater than 150 in 2011–2012 (Table 3). Also, the source of their data on NICU admissions and estimated costs related to them is not specified. These differences may have significant impact on cost estimates, which could therefore be underestimated in the Vélez et al. [16] article.

Publicly funded programs are based on the premise that all couples should have equal access to services and treatments related to infertility, a condition recognized as a disease [46]. As shown, such a program can lead to a significant increase in the birth rate of a state. From a patient's perspective, the numbers presented are quite promising as access is easily available, and expenses have decreased substantially. From a public health perspective, the program has succeeded in decreasing the multiple birth rates in this population, and therefore the health of children born through IVF, by decreasing the percent of children requiring NICU admissions. However, there are still substantial numbers of NICU admissions and large costs associated with them. From a financial standpoint, this program increased the costs related to assisted reproduction.

Compliance with ethical standards

Conflicts of interests None to declare, on behalf of all authors.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. As the sources of data used in study are available online on government sites (listed in the reference section), this study did not require Ethic Committee approval. For this type of study format, consent is not required.

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