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Assisted reproductive technologies in Thailand: 2001–2007 results generated from the ART Registry, Royal Thai College of Obstetricians and Gynaecologists

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Abstract

Aim: To present the results of assisted reproductive technology (ART) performed in Thailand during 2001–2007.

Methods: All licensed ART centers are obliged to submit annual reports on the number of patients, cycles, ART techniques and treatment outcomes to the Reproductive Medicine Subcommittee of the Royal Thai College of Obstetricians and Gynaecologists. Data from all centers were aggregated and analyzed retrospectively.

Results: Cycles were categorized into fresh and frozen/thawed embryo transfer (FET) cycles. Initiated cycles in the first category for 2001 to 2007 were 2183, 2112, 2780, 2717, 3458, 3579 and 4288, respectively. FET cycles during the same period were 467, 558, 733, 768, 1136, 1210 and 1473, respectively. The average pregnancy rate for *in vitro* fertilization (IVF) was 28.9% per retrieval (range, 26–32.3%) or 33.8% per transfer (range, 30.7–38.6%). Multiple pregnancies (of which 89.3% were twins) from all treatment procedures during this period were 11.4% (range, 9.2–14.5%). A congenital abnormality was reported in 0.56% of live births. The number of embryos per transfer in IVF decreased from 4.1 to 2.9, with no drop in pregnancy rates. Oocyte insemination by intracytoplasmic sperm injection (ICSI) was utilized more often than standard IVF, while gamete intrafallopian transfer and zygote intrafallopian transfer were almost completely replaced by IVF/ICSI. There was a significant difference in pregnancy rates ($P < 0.01$) when clinics were classified by cycle volumes (<100, 100–400 and >400 cycles/year).

Conclusions: Despite many limitations, the data provided in this report will help patients, clinicians and policy makers understand the current situation of ART practice in Thailand.

Key words: assisted reproductive technology, frozen embryo transfer, intracytoplasmic sperm injection, *in vitro* fertilization, multiple births, pregnancy rate.

Introduction

The Thai Assisted Reproductive Technology (ART) Registry was established in 1997. The Registry collects treatment-cycle data from all licensed Thai fertility centers that employ any assisted reproductive technologies, including gamete intrafallopian transfer (GIFT), zygote intrafallopian transfer (ZIFT), *in vitro* fertilization and embryo transfer (IVF and ET), intracytoplasmic sperm injection (ICSI), surgical sperm recovery (SSR) and frozen embryo transfer (FET).

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The Reproductive Medicine Subcommittee (RMS), under the Royal Thai College of Obstetricians and Gynaecologists (RTCOG), directs the ART registry. In turn, the RTCOG submits a yearly report on ART practice to the Medical Council of Thailand. The RMS is also responsible for the accreditation and licensing of all ART centers nationwide.

Licensing of ART centers in Thailand is now compulsory. Centers without a license risk a court verdict if consumers file legal complaints. The practice of ART is regulated by medical practice guidelines that are issued by the Medical Council of Thailand. Accreditation and licensing of ART centers requires submission of an application form that contains detailed information about the center, from its facility down to the IVF team. The RMS will make a site visit to inspect the center. A license, which is valid for two years, will be issued to centers meeting the requirements set forth by the Medical Council of Thailand. Once accredited, the centers are obliged to submit annual reports to the RMS. The RMS will send an audit team to investigate centers that do not submit reports or that send in suspicious reports.

This is the first international report on the current status of ART practice in Thailand from 2001–2007. The national Thai ART data will serve as a public reference and help in the future improvement in ART data collection and the quality of ART practice in this country and abroad. It will be useful to patients, clinicians and policy-makers in understanding the role of ART in managing infertility in Thailand.

Materials and Methods

Data collection

In March of each year, the RMS sends a request letter and data form to all licensed ART centers nationwide for annual data collection. Most ART centers record data by hand, while some centers use simple computer programs such as Microsoft Excel (Microsoft, Bangkok, Thailand). Very few centers have access to a dedicated ART data collection program.

Each center submitted the information regarding the number of patients, cycles and types of ART, and the details of treatment, pregnancy and birth outcomes for all cycles. The director of each ART center validated and approved the completed form before its submission to the RMS. Corrections or clarifications were requested from participating centers when necessary; however, no on-site data validation from the source documents was conducted.

The records from all ART centers were aggregated for data analysis. Records from individual ART centers were treated as classified documents and were kept anonymous. Only the summarized data were made available to the public. As centers were requested to submit data in March, some of the pregnancy outcomes were not yet known and were reported as ongoing pregnancies.

It is not necessary to obtain institutional review board approval for this study because data collection is one of the requirements for accreditation of centers providing ART services, under the regulation of the Medical Council of Thailand. ART centers are obliged to inform patients that such data will be collected in a manner that is anonymous. Before submission for publication, this report was read and approved by members of the RMS, and the Secretary and the President of the RTCOG.

Definitions of outcomes

A treatment cycle is considered to have started when a woman undergoing ovarian stimulation receives the first dose of gonadotropin. A FET cycle is considered to have started when a decision is made to attempt to replace frozen/thawed embryos in that cycle. A cancelled cycle is one that is stopped before the oocyte retrieval procedure in a stimulated cycle or the thawing of embryos in a FET cycle.

In the analysis, only cycles with clinical pregnancies, and not those with chemical pregnancies, were reported. A clinical pregnancy is defined as the presence of a gestational sac with a fetal heartbeat in the uterine cavity on ultrasonography. Ectopic pregnancy data were reported separately.

Pregnancy loss includes miscarriage and therapeutic abortion of a clinical intrauterine pregnancy, occurring at <20 weeks' gestation. Any pregnancy termination, either spontaneous or therapeutic, that occurs after 20 weeks' gestation is considered a stillbirth. A delivery is the birth of one or more infants, either living or not, after 20 weeks' gestation. A live birth is a delivery that results in at least one living infant. A multiple birth is the delivery of >1 infant, either live or stillborn.

Statistical analysis

Statistical analysis was performed using the STATA program version 8.2 (StataCorp, College Station, TX, USA). Descriptive statistics were used to report the mean, standard deviation (SD), range and percentage. χ^2-tests were used occasionally to compare proportions.

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Table 1 Reported cycles from 2001 to 2007

	2001	2002	2003	2004	2005	2006	2007
Centers	26	26	29	28	27	25	30
Initiated cycles	2183	2112	2780	2717	3458	3579	4288
GIFT (%)	135 (6.2)	72 (3.4)	68 (2.4)	52 (1.9)	39 (1.1)	27 (0.8)	29 (0.7)
ZIFT (%)	97 (4.4)	66 (3.1)	13 (0.5)	9 (0.3)	12 (0.3)	48 (1.3)	11 (0.3)
IVF (%)	832 (38.1)	882 (41.8)	1338 (48.1)	1400 (51.5)	1558 (45.1)	1598 (44.6)	1574 (36.7)
ICSI (%)	1100 (50.4)	1092 (51.7)	1361 (48.9)	1256 (46.3)	1849 (53.5)	1906 (53.3)	2674 (62.4)
FET cycles	467	558	733	768	1136	1210	1473

FET, frozen/thawed embryo transfer; GIFT, gamete intrafallopian transfer; ICSI, intracytoplasmic sperm injection; IVF, *in vitro* fertilization; ZIFT, zygote intrafallopian transfer.

A two-tailed $P < 0.05$ was considered statistically significant.

Because of missing data on cancelled cycles, the number of initiated cycles might not be as accurate as the number of retrieval and embryo transfer cycles. Therefore, the clinical pregnancy rate was reported as per initiated cycle, as well as per cycle of oocyte retrieval and per cycle of embryo transfer.

Results

The names of the ART centers operating in 2001 to 2007 that contributed data to the RMS are included in Appendix I.

The total initiated cycles from 2001 to 2007 are shown in Table 1. They were categorized into fresh and frozen/thawed (FET) cycles. The average multiple pregnancy rate from all ART treatment during this period was 11.4% (range, 9.2–14.5%). Twins contributed to 89.3% of all multiple pregnancies (range, 85.7–94.2%). Gross congenital abnormality at birth was reported in 11 out of 1973 live births (0.56%). The various procedures and their success rates are described in the following sections.

GIFT and ZIFT

The proportion of cycles employing GIFT and ZIFT steadily declined over this period, from 6.2% and 4.4% of fresh cycles in 2001 to 0.7% and 0.3% in 2007, respectively. By the year 2007, GIFT and ZIFT cycles together contributed to only about 1.0% of all ART cycles. The results from GIFT and ZIFT procedures are shown in Table 2.

The number of licensed centers performing GIFT decreased from 13 centers in 2001 to four centers in 2007. There was no significant change in the pregnancy rate per initiated cycle (average = 36.3%; $P = 0.928$), per retrieval (average 38.2%; $P = 0.933$) or per transfer cycle (average = 43.9%; $P = 0.645$) throughout these years. There was no ectopic pregnancy or congenital abnormality reported. Abortion occurred in 37 of 150 clinical pregnancies (24.7%). Multiple pregnancies accounted for 31 of 100 live births (31%) during this seven-year period.

Compared to GIFT, there were even fewer centers that performed ZIFT. One private center in Northeastern Thailand performed nearly 75% of all ZIFT cycles in the country. There has been a large variation in ZIFT pregnancy rates over the years; however, the small numbers of ZIFT cycles in some years (only 9–13 cycles/year) make it difficult to make a valid statistical comparison. With all cycles combined, the average pregnancy rate of ZIFT was 27.3% per initiated cycles, 29.2% per retrieval cycle and 30.4% per transferred cycle. There were only two cases of ectopic pregnancy and no cases of congenital abnormality during this seven-year period. Abortion occurred in 10 out of 70 clinical pregnancies (14.3%) and multiple pregnancies accounted for 13 out of 49 live births (26.5%).

In vitro fertilization

A total of 9182 IVF cycles were initiated in this seven-year period (Table 3). Of these, 8613 cycles (93.8%) resulted in oocyte retrieval (range, 89.3–96.9%). Overall, the fertilization rate for IVF was 66.4% (range, 59.3–70.5%). The average pregnancy rate for IVF was 28.9% per retrieval (range, 26–32.3%) or 33.8% per transfer (range, 30.7–38.6%). With little fluctuation, the abortion rate did not exceed 16.0% from 2001–2006. Multiple births reported at the time of delivery ranged from 13.6–33.3% (mean ± SD, 20.2 ± 6.9%). Congenital anomaly was reported in 10 out of 1805 births (0.6%).

Intra-cytoplasmic sperm injection

Only 19 of the 26 licensed centers (73.1%) performed ICSI in 2001 (Table 4). The number increased over the years, until ICSI was performed in all 30 centers (100%) in 2007. The proportion of ICSI to IVF/ICSI retrieval

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Table 2 Assisted reproductive technology (ART) cycles employing gamete intrafallopian transfer (GIFT) and zygote intrafallopian transfer (ZIFT) techniques in 2001–2007

	2001	2002	2003	2004	2005	2006	2007
GIFT							
No. of ART centers	13	10	9	5	8	5	4
Initiated cycles	135	72	68	52	39	27	29
Retrieved cycles	130	67	64	49	35	27	28
Transferred oocytes	477	225	253	188	195	102	99
Transfer cycles	113	62	52	43	32	21	27
Oocytes/transfer	4.2	3.6	4.9	4.4	6.1	4.9	3.7
Cycles with pregnancy	45	25	28	17	13	11	11
Pregnancies/initiated cycle (%)	33.3	34.7	41.2	32.7	33.3	40.7	37.9
Pregnancies/retrieved cycle (%)	34.6	37.3	43.8	34.7	37.1	40.7	39.3
Pregnancies/transfer cycle (%)	39.8	40.3	53.8	39.5	40.6	52.4	40.7
ZIFT							
No. of ART centers	7	5	5	3	4	4	5
Initiated cycles	97	66	13	9	12	48	11
Retrieved cycles	96	59	13	8	11	44	9
Transferred zygotes	305	170	46	26	34	160	28
Transfer cycles	83	56	13	8	12†	48†	10†
Zygotes/transfer	3.7	3.0	3.5	3.3	2.8	3.3	2.8
Cycles with pregnancy	23	14	5	1	2	23	2
Pregnancies/initiated cycle (%)	23.7	21.2	38.5	11.1	16.7	47.9	18.2
Pregnancies/retrieved cycle (%)	24.0	23.7	38.5	12.5	18.2	52.3	22.2
Pregnancies/transfer cycle (%)	27.7	25.0	38.5	12.5	16.7	47.9	20.0

†ZIFT of frozen/thawed zygotes (2PN-stage) were performed.

Table 3 All *in vitro* fertilization (IVF) cycles performed from 2001–2007

IVF	2001	2002	2003	2004	2005	2006	2007
No. of ART centers	23	26	29	28	27	28	29
Initiated cycles	832	882	1338	1 400	1 558	1 598	1 574
Retrieved cycles	775	835	1288	1 349	1 510	1 451	1 405
Oocytes inseminated	3997	6762	9019	13 266	15 543	13 753	13 973
Oocytes fertilized	2816	4616	6084	8 718	10 274	9 261	8 287
Fertilization rate	70.5	68.3	67.5	65.7	66.1	67.3	59.3
Transferred embryos	2885	2020	2612	3 078	3 512	3 084	3 442
Transfer cycles	697	707	1079	1 163	1 345	1 189	1 187
Embryos/transfer	4.1	2.9	2.4	2.6	2.6	2.6	2.9
Pregnancies	218	217	416	412	469	400	382
Pregnancies/initiated cycle (%)	26.2	24.6	31.1	29.4	30.1	25.0	24.3
Pregnancies/retrieved cycle (%)	28.1	26.0	32.3	30.5	31.1	27.6	27.2
Pregnancies/transfer cycle (%)	31.3	30.7	38.6	35.4	34.9	33.6	32.2
Ectopic pregnancies	5	4	5	6	8	9	7

ART, assisted reproductive technology.

cycles increased from 22.5% in 2001 to an average of 52.5% (range, 47.8–55.3%) during 2002–2006. The proportion of ICSI cycles clearly predominated over IVF cycles in 2007 (63.5%). The fertilization rates of ICSI employing ejaculated spermatozoa (mean ± SD, 69.3 ± 2.3%; range, 66.8–72.5%) or surgically retrieved spermatozoa (mean ± SD, 64.5 ± 5.7%; range, 58.1–69.7%) were not significantly different ($P = 0.06$). Pregnancy rates per initiated cycle (mean ± SD, 20.0 ± 0.8%), per retrieval cycle (mean ± SD, 20.8 ± 0.9%) and per transfer cycle (mean ± SD, 26.9 ± 2.0%) for ICSI using ejaculated spermatozoa were not statistically different during 2002–2007 ($P = 0.759$, 0.989 and 0.422, respectively). Abortion occurred in 19.3 ± 1.9% of pregnancies and was not significantly different over this period ($P = 0.531$). Ectopic pregnancies were reported in 66 cases (3.6%). Multiple pregnancies at the time of delivery ranged from 16% to 25.4%

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Table 4 All intra-cytoplasmic sperm injection (ICSI) cycles performed in 2001–2007

	2001	2002	2003	2004	2005	2006	2007
ICSI (fresh sperm)							
No. of ART centers	19	17	22	24	25	26	30
Initiated cycles	n/a†	1012	1218	1102	1 675	1 729	2 481
Retrieval cycles	225	955	1177	1084	1 577	1 604	2 260
Injected oocytes	1964	7208	8883	8660	13 655	13 564	19 675
Fertilized oocytes	1405	5228	6387	5783	9 221	9 598	13 403
Fertilization (%)	71.5	72.5	71.9	66.8	67.5	70.8	68.1
Transferred embryos	n/a	1981	2626	2487	3 472	3 085	4 422
Transfer cycles	n/a	712	934	869	1 257	1 177	1 643
Embryos per transfer	n/a	2.8	2.8	2.9	2.8	2.6	2.7
Cycles with pregnancy	n/a	200	256	229	325	335	478
Pregnancies/initiated cycle (%)	n/a	19.8	21.0	20.8	19.4	19.4	19.3
Pregnancies/retrieval cycle (%)	n/a	20.9	21.8	21.1	20.6	20.9	21.2
Pregnancies/transfer cycle (%)	n/a	28.1	27.4	26.4	25.9	28.5	29.1
ICSI (SSR sperm)							
No. of ART centers	n/a	13	15	18	17	21	19
Initiated cycles	n/a	80	143	154	174	177	193
Retrieval cycles	n/a	78	143	152	169	168	186
Injected oocytes	n/a	739	1303	1561	1 762	1 812	1 864
Fertilized oocytes	n/a	509	806	1088	1 192	1 053	1 187
Fertilization (%)	n/a	68.9	61.9	69.7	67.7	58.1	63.7
Transferred embryos	n/a	207	382	462	462	337	389
Transfer cycles	n/a	67	121	138	150	130	150
Embryos per transfer	n/a	3.1	3.2	3.3	3.1	2.6	2.6
Cycles with pregnancy	n/a	19	25	40	53	41	41
Pregnancies/initiated cycle (%)	n/a	23.8	17.5	26.0	30.5	23.2	21.2
Pregnancies/retrieval cycle (%)	n/a	24.4	17.5	26.3	31.4	24.4	22.0
Pregnancies/transfer cycle (%)	n/a	28.4	20.7	29.0	35.3	31.5	27.3

†n/a: data not available; data for SSR/ICSI were not recorded separately prior to 2002. ART, assisted reproductive technology; SSR, surgical sperm recovery.

(mean ± SD, 21.9 ± 3.4%). Congenital anomaly was reported in 0–2% of the newborn infants.

From 2002 to 2007, a total of 921 cycles were initiated for ICSI using spermatozoa from SSR, which resulted in 896 cycles of oocyte retrieval. Approximately 70% of all centers performing ICSI using ejaculated spermatozoa also offered services for ICSI using surgically retrieved spermatozoa. The pregnancy rates per initiated cycle (mean ± SD, 23.7 ± 4.4%), per retrieval cycle (mean ± SD, 24.3 ± 4.6%) and per transfer cycle (mean ± SD, 28.7 ± 4.8%) were not statistically different over the years 2002–2007 ($P = 0.129$, 0.129 and 0.177, respectively). Abortion occurred in 19.8 ± 6.7% of pregnancies and were not significantly different over this period ($P = 0.270$). There were no significant differences in the abortion rates among pregnancies employing ejaculated or SSR spermatozoa ($P = 0.849$). Five cases of pregnancy were ectopic in nature (2.3%). Multiple pregnancies at the time of deliveries ranged from 0–35.7% (mean, 15.3 ± 11.9%). Congenital anomaly was not detected in any of the 104 newborn infants during this 7-year period.

Frozen-thawed embryo transfer cycle

A total of 5699 transferred cycles were performed from 2001–2007 (Table 5), with the number of cycles increased steadily during this period. From 2002–2007 (the data for 2001 was not available), the survival rates of frozen/thawed embryos remained stable at 83.2 ± 1.7% (range, 81–85%). There were no significant differences in the pregnancy rates per initiated or per transfer cycle, despite a decrease in the average number of embryos per transfer in 2006 and 2007 when compared to 2001 and 2002. Multiple pregnancies at the time of delivery ranged from 7.9–26.4% (mean ± SD, 21.3 ± 6.2%). Ectopic pregnancies accounted for 1.5 ± 0.9% (range, 0–2.5%) of all pregnancies reported and the abortion rate was 17.8 ± 3.9% (range, 13.8–26.3%). Over this seven-year period, the incidence of congenital abnormality at birth was 0.55%.

ART volume of clinics and pregnancy rates

When clinics were grouped by their numbers of initiated cycles, there was a significant difference in pregnancy rates per transferred cycle, as shown in Table 6.

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Table 5 Frozen-thawed cycles from 2001–2007

FET	2001	2002	2003	2004	2005	2006	2007
No. of ART centers	10	19	22	17	24	23	26
Cycles initiated	n/a	558	733	768	1136	1210	1473
No. embryo thawed	n/a	2394	2911	3197	4544	5157	5985
No. embryo survived	n/a	1943	2450	2595	3758	4379	5081
Survival rate (%)	n/a	81.2	84.2	81.2	82.7	84.9	84.9
No. transferred embryos	1084	1502	1848	2060	2937	3033	3385
Transfer cycles	300	518	673	730	1031	1154	1293
No. embryo per transfer	3.6	2.9	2.7	2.8	2.8	2.6	2.6
Cycles with pregnancy	80	155	197	174	280	357	411
Pregnancies/initiated cycle (%)	n/a	27.8	26.9	22.7	24.6	29.5	27.9
Pregnancies/transfer cycle (%)	26.7	29.9	29.3	23.8	27.2	30.9	31.8

ART, assisted reproductive technology; n/a, not available.

Table 6 Cycle volume and pregnancy rates/transfer over the seven-year period

Year	Cycles	No. of centers	Total cycles	Pregnancies/ transfer cycle (%)	*P*-value
2001	<100	20	673	21.8	<0.001
	100–400	4	961	32.5	
	>400	2	976	29.5	
2002	<100	15	416	25.9	0.242
	100–400	9	1300	30.6	
	>400	2	954	30.3	
2003	<100	19	680	23.3	<0.001
	100–400	6	761	29.5	
	>400	4	2072	36.1	
2004	<100	20	725	26.2	<0.001
	100–400	4	652	20.8	
	>400	4	2128	34.0	
2005	<100	14	536	26.3	<0.001
	100–400	10	1677	25.3	
	>400	4	2381	34.2	
2006	<100	16	682	22.5	<0.001
	100–400	10	1919	32.4	
	>400	3	2184	33.7	
2007	<100	15	568	23.2	<0.001
	100–400	10	1851	26.7	
	>400	5	3345	34.6	

Discussion

The CIA World Factbook listed the total fertility rate of Thailand as 1.64 and the population in 2007 as 65.07 million.[1] Given this population and the estimation by Collins[2] that the global need for IVF was 1500 cycles per million of population per year, one would expect the total IVF cycles to be 97 605 cycles annually. In reality, fewer than 4500 cycles (or <5% optimal IVF utilization) were undertaken in Thailand in 2007.

This underutilization of IVF was probably due to the interplay of multiple factors, notably public health policy and economic forces. Infertility is not recognized as a medical condition, so Thai national health policy and private health insurance make no provisions to cover its treatment. The cost of IVF ranges from US$2900 per cycle in government hospitals up to US$5800 or more in private centers. By comparison, the average income per capita of Thais has been estimated to be only US$240/month.[3] Cost is therefore a major factor.

Another barrier was the limited availability of IVF treatment. Three-fourths of IVF centers are clustered in the capital city of Bangkok, with a population of 9 million.[4] In other regions of the country, with a population of 56 million, there are a few centers scattered in one or

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two big cities in the North, Northeast, East and South. Nevertheless, the utilization of ART steadily increased over the seven-year period and the number of cycles in 2007 nearly doubled that in 2001.

As annual reporting of data is mandatory, the Thai ART registry achieved 100% participation from all licensed centers. The varying number of contributing centers from 2001 to 2007 simply reflected the fact that some centers had no cases in a certain year, while others had closed down or just started their operation in that year.

Over this seven-year period, GIFT and ZIFT utilization decreased dramatically from 10.6% of all fresh cycles in 2001 to only 1% in 2007. This is in line with the experience in North America, where GIFT and ZIFT contributed to 0.4% and 0.8% of all initiated cycles in the USA in 2001[5] and <0.04% and 0% of all cycles in Canada in 2004.[6] Compared with IVF/ICSI, GIFT and ZIFT are more invasive and require the use of a laparoscope and general anesthesia, with significant additional risks. Advancements in embryo culture techniques have markedly improved the current success of IVF/ICSI, to the extent that it has now almost completely replaced GIFT and ZIFT.[7] However in developing countries like Thailand, GIFT may still be an attractive alternative to IVF in some centers where resources and expertise in embryo laboratories are limited.

ICSI has become increasingly more popular. Of IVF/ICSI cycles performed in 2001–2006, 44% were inseminated by standard IVF and 56% by ICSI. By 2007, ICSI accounted for 63% of all IVF/ICSI cycles in Thailand. This trend has also been observed elsewhere. In Canada in 2004, 42.1% of IVF/ICSI cycles were inseminated by standard IVF, 50.2% by ICSI and 7.7% by IVF/ICSI split.[6] In the USA, fertilization with ICSI was used in 37 552 (58.8%) of 63 847 IVF transfer in 2001.[5]

The use of IVF/ICSI split was uncommon in Thailand. Most centers would switch to ICSI in doubtful cases, while some routinely performed ICSI regardless of sperm quality. Whether ICSI should be preferred to IVF for non-male factor infertility remains an open question. ICSI is more costly and involves a larger workload and longer laboratory time than IVF. ICSI has not been shown to increase the chance of pregnancy over IVF in couples with non-male infertility. In addition, 33 more cases of ICSI would be required to avoid one failed fertilization after IVF.[8]

From 2002 onward, the RMS asked all centers to distinguish between the use of ejaculated or surgically retrieved spermatozoa for ICSI, on the basis that they might have different outcomes. When the results of ICSI from 2002 to 2007 were aggregated by category and compared, there were no significant differences in fertilization rates (69.3% vs 64.5%; $P = 0.06$), pregnancy rates per transfer (26.9% vs 28.7%; $P = 0.445$), or abortion rates (19.3% vs 19.8%; $P = 0.849$) between ICSI using ejaculated or SSR spermatozoa. This finding was in agreement with many recent studies,[9,10] including a meta-analysis by Nicopoullos *et al*.[11] As categorization of ICSI procedures proved noncontributory, the RMS should reconsider its position regarding the collection of such data in the future.

The number of frozen-thawed cycles nearly tripled over the period of seven years. Like fresh IVF cycles, the decrease in the average number of embryos per transfer did not significantly affect pregnancy rates. By 2007, the pregnancy rate per transfer of FET cycles (31.8%) approached that of fresh cycles (32.2%; $P > 0.05$), while the abortion rate was significantly lower (16.8% vs 34.6%; $P < 0.001$). In fresh and frozen/thawed cycles, the number of embryos per transfer (2.87 ± 0.57 and 2.86 ± 0.35, respectively) and the rate of multiple pregnancies ($21.9\% \pm 3.4\%$ and $21.3\% \pm 6.2\%$, respectively) were similar. Slow programmable freezing was the standard method for embryo cryopreservation in most centers in Thailand. Few employed rapid freezing and they also reported comparable results using slow freezing.[12]

Triplet or higher-order multiple pregnancies accounted for approximately 10% of multiple pregnancies or <3% of all deliveries. This was, however, underestimated as some multiple pregnancies might be lost through spontaneous miscarriage before 20 weeks' gestation. Moreover, fetal reduction was employed in some centers to reduce higher-order multiples to twins, and very occasionally to a singleton.

Elective single embryo transfer was not practiced in Thailand. As the cost of treatment was borne by infertile couples, there was a driving force in favor of multiple embryo transfer to increase the chance of pregnancy. Once a pregnancy (single or multiple) was established, patients would be fully covered by the national health policy. Social attitudes also prevail that twins were 'cute' and a blessing to parents. Our multiple pregnancy rate of around 20% was high, but still lower than those reported from the Canadian (27.8%) and the American IVF registries (32%).[5,6]

Our analysis confirmed the notion of the American Society of Reproductive Medicine[5] that clinics with larger cycle volumes achieved significantly higher pregnancy rates than smaller ones. Although the exact reason behind this remains unknown, we believe it

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could largely be due to differences in clinical and/or laboratory expertise of staff across clinics.

The present data collection did not include preimplantation genetic diagnosis (PGD) and preimplantation genetic screening (PGS). Currently, four centers perform PGD by single-cell polymerase chain reaction (PCR) to select embryos free of α- and β-thalassemia. To date, only three centers have reported live births from PGD.[13] We estimate that altogether they performed fewer than 15–20 cycles of PGD annually. The number of PGS cycles is not known. Information from the sole distributor of fluorescent probes in Thailand, and informal contact with IVF directors, indicated that 10 centers performed approximately 307 cycles of PGS in 2006. This prompted the RMS to start data collection on all PGS and PGD cycles from the year 2008 onward.

The present IVF registry had many limitations. Data were collected retrospectively. The registry did not include the age of the couples and indications for IVF treatment. It did not distinguish between the use of own and donor oocytes. The annual data collection was done in March, when some IVF pregnancies were still ongoing and the outcomes of pregnancy were not yet known. In response to these challenges, the RMS, in joint collaboration with the Siriraj ART unit and a pharmaceutical company, is developing a computer program that allows prospective data collection. The RMS also postponed its annual data collection until October of subsequent years, beginning from 2008 onward. In addition, the RMS asked centers to categorize patients by female ages as: ≤34, 35–39 and ≥40 years. The definition of clinical pregnancy was changed from 'the presence of a fetal heartbeat' to 'the detection of a gestational sac by ultrasound'. Ectopic pregnancy is now included under the category of clinical pregnancy. Other changes will be made in the near future to conform to international standards, as set forth by the International Committer on the Monitoring of Assisted Reproductive Technology (ICMART).[14]

In conclusion, this report can serve several purposes, despite some of its limitations. For example, it will help improve subsequent national data collection and reporting. With caution, data can be compared among countries and regions and serve as a benchmark for improving the quality of ART services at a national and international level.

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References

1. Barrientos M. Thailand population. IndexMundi; 2009. [Cited 23 Nov 2009.] Available from URL: http://www.indexmundi.com/thailand/population.html.
2. Collins J. An international survey of the health economics of IVF and ICSI. *Hum Reprod Update* 2002; **8**: 265–277.
3. Office of the National Economic and Social Development Board. National income of Thailand. 2008. [Cited 23 Nov 2009.] Available from URL: http://www.nesdb.go.th/Default.aspx?tabid=394.
4. Lee M. Bangkok: City profile. 2009. [Cited 23 Nov 2009.] Available from URL: http://www.asianinfo.org/asianinfo/bangkok/bangkok.htm.
5. Society for Assisted Reproductive Technology and the American Society for Reproductive Medicine. Assisted reproductive technology in the United States: 2001 results generated from the American Society for Reproductive Medicine/Society for Assisted Reproductive Technology registry. *Fertil Steril* 2007; **87**: 1253–1266.
6. Gunby J, Bissonnette F, Librach C, Cowan L. Assisted reproductive technologies (ART) in Canada: 2004 results from the Canadian ART register. *Fertil Steril* 2008; **89**: 1123–1132.
7. Seibel MM, Weissman A. Gamete intrafallopian transfer (GIFT) and zygote intrafallopian transfer (ZIFT). In: Gardner DK, Weissman A, Howles CM, Shoham Z (eds). *Textbook of Assisted Reproductive Technologies: Laboratory and Clinical Perspectives*, 3rd edn. London: Informa Uk, 2009; 673–691.
8. van Rumste MME, Evers JLH, Farquhar CM. ICSI versus conventional techniques for oocyte insemination during IVF in patients with non-male factor subfertility: A Cochrane review. *Hum Reprod* 2004; **19**: 223–227.
9. Naru T, Sulaiman MN, Kidwai A *et al*. Intracytoplasmic sperm injection outcome using ejaculated sperm and retrieved sperm in azoospermic men. *Urol J* 2008; **5**: 106–110.
10. Pasqualotto FF, Rossi-Ferragut LM, Rocha CC, Iaconelli A Jr, Borges E Jr. Outcome of in vitro fertilization and intracytoplasmic injection of epididymal and testicular sperm obtained from patients with obstructive and nonobstructive azoospermia. *J Urol* 2002; **167**: 1753–1756.
11. Nicopoullos JD, Gilling-Smith C, Almeida PA, Norman-Taylor J, Grace I, Ramsay JW. Use of surgical sperm retrieval in azoospermic men: A meta-analysis. *Fertil Steril* 2004; **82**: 691–701.
12. Vutyavanich T, Sreshthaputra O, Mongkolchaipak S, Wongrangan S, Piromlertamorn W. Slow programmable and ultrarapid freezing of human embryos. *J Obstet Gyneaecol Res* 2008; **34**: 457–463.
13. Piyamongkol W, Vutyavanich T, Piyamongkol S *et al*. A successful strategy for preimplantation genetic diagnosis for preimplantation genetic diagnosis of beta-thalassemia and simultaneous detection of Down's syndrome using multiplex fluorescent PCR. *J Med Assoc Thai* 2006; **89**: 918–927.
14. Zegers-Hochschild F, Nygren KG, Adamson GD *et al*. The ICMART glossary on ART terminology. *Hum Reprod* 2006; **21**: 1968–1970.

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Appendix I

Thai ART Centers that reported data to the RMS for 2001–2007

Bangkok

King Chulalongkorn Memorial Hospital, Chulalongkorn University
Thamasart University Hospital
Phramongkutklao Hospital
Bhumipol Hospital
Rajavithi Hospital
Ramathibodi Hospital, Mahidol University
Siriraj Hospital, Mahidol University
Jetanin Hospital
Blastocyst Center, Phra Ram 9 Hospital
Samitivej Hospital
Nawabutr Center for Assisted Reproduction & Embryology
Wichaiyut-Sydney IVF Center, Wichaiyut Hospital
Sukumvit Maternity Clinic
Family Health Clinic
Chintabutr Clinic
Smart Center, Sinpat Hospital
Bumrungrad International Hospital
Nonthavej Hospital
BNH Hospital
Phyathai 3 Hospital
Vipavadi Hospital
Vajira Hospital

Northern Thailand

Chiang Mai Ram Hospital
Maharaj Nakorn Chiang Mai Hospital, Chiang Mai University
Kullapat Clinic

Northeastern Thailand

Srinagarin Hospital
Jetabutr Clinic
Korat Memorial Hospital
Aekudorn Hospital

Eastern Thailand

Phyathai Sriracha Hospital

Southern Thailand

Songklanakarin Hospital
Hatyai Hospital
Sikarin Hospital
Rajyindi Hospital

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