SPANDIDOS PUBLICATIONS

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Impact of reorganized interfacility transfer on emergency obstetric care in Nara prefecture, Japan

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Abstract. The aim of this study was to assess the impact of interfacility transfers (IFTs) and medical coverage of complicated obstetric cases at emergency obstetric and neonatal care (EONC) centers. This is a retrospective time series study using a longitudinal design between January, 2006 and December, 2017 in Nara Prefecture, Japan. The Council for Perinatal Care (CPC) Committee set up and reorganized two EONC centers in Nara Medical University (NMU) Hospital in 2008 and Nara Prefecture General Medical Center (NPGMC) Hospital in 2010, coupled with an efficient coordination using telephone-based services by a transfer coordinator. The timespan was divided into three periods according to the reorganization date, 2006-2007 (before reorganization, Period 1), 2008-2010 (one reorganization, Period 2) and 2011-2017 (two reorganization and established coordinated protocols, Period 3). There were 3,020 IFTs during the study period. The IFT rate significantly increased from 1.6% (Period 1) to 2.7% (Period 3) (P<0.05). A significant decrease in the Out-of-Nara transfer rate was observed, ranging from 22.8% (95% CI 21.5-24.2) in Period 1 to 13.5% (95% CI 9.6-36.5) in Period 2 and 6.6% (95% CI 4.2-8.9) in Period 3 (P<0.05). The most common reason for IFTs to the EONC centers was preterm labor (36.7%). Maternal death and perinatal mortality rate are rare events and exhibited no significant differences between the time periods. The combination of the reorganization of two EONC centers and the implementation of an efficient coordination by a transfer operator is imperative for the successful management of IFTs.

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Key words: interfacility transfer, emergency obstetric care, transfer coordinator, Council for Perinatal Care Committee

Introduction

Perinatal care remains a major health concern among mothers and children worldwide. In Japan, 99% of women plan to give birth in obstetrics facilities, clinics and hospitals, under the care of obstetricians. When obstetric complications arise, a considerable proportion of pregnant and parturient women are sent from referring facilities (primary maternity clinics, midwifery homes, or district and general hospitals) to Emergency Obstetric and Neonatal Care (EONC) centers by the ambulance or doctor-helicopter service (1). In line with the government policy in Japan, the ambulance functions as an emergency transfer team and works 24 h a day, every day. Preterm birth is one of the most important complications of pregnancy and plays a major role in neonatal mortality and morbidity (2-4). Furthermore, major causes of direct maternal deaths from pregnancy complications include peripartum hemorrhage, amniotic fluid embolism, pulmonary embolism and preeclampsia (5,6). The current maternal mortality rate in Japan, which is estimated to be approximately 4 in 100,000 deliveries, is similar to that observed in other developed countries (6). Previous researchers have identified that inappropriate referral is an important factor associated with maternal mortality and morbidity (5).

A shortage of obstetrician resources and excessive workloads have been encountered in Japan, which may limit the provision of comprehensive EONC and affect the quality of care (7). In 2006, a serious incident related to interfacility transfer (IFT) occurred in Nara Prefecture, Japan. The patient suffered from a severe headache and loss of consciousness following the onset of labor. Finally, 18 hospitals refused care and treatment due to the lack of availability of both a maternal bed and a neonatal bed, as well as due to the obstetricians' increased workload. The patient was thus transferred outside of Nara Prefecture (Out-of-Nara transfer) and died of intracranial hemorrhage after the patient was transferred and following the attempted transfers to other hospitals which did not accept the patient. Realizing the above situation, the Governmental Organization in Nara prefecture has established the Council for Perinatal Care (CPC) Committee, with responsibility for reorganizing the IFT system and initiating a population-based perinatal and neonatal registry. At the time, the EONC centers often lacked human resources to safely manage women with

severe maternal and fetal complications. Since 2007, in order to improve the obstetric and neonatal care, the CPC Committee put forward a number of recommendations regarding the effective communication between referring facilities and referred facilities.

The aim of this study was to assess the impact of a newly established IFT system and medical coverage of IFT cases from 2006 to 2017.

Data collection and methods

A newly established IFT system. We used nationwide data in the vital statistics in Japan on the estimated population of 1,356,950 and 9,626 expected deliveries per year in Nara Prefecture in 2017 (the vital statistics published by Ministry of Health, Labor and Welfare in Japan, 2018; https://www.mhlw.go.jp/toukei/saikin/hw/jinkou/kakutei16/index.html and http://www.stat.go.jp/data/ssds/). Nara prefecture is an inland prefecture located in Kinki region. The geographical features in Nara Prefecture are basically a basin and mountainous region. The northern part is low and flat, and there are no barriers in accessing medical services. By contrast, the southern part is mostly mountainous landscape. The habitants live in hard-to-reach mountainous areas and have difficulties in accessing medical services. Women plan to give birth in one of four settings: Freestanding obstetrician-led clinics (approximately 54.2% of all births), freestanding midwife-led units (2.2%), the prefectural-level district and general hospitals (28.9%), and a tertiary hospital (14.7%). In 2006, at the beginning of this study, there were four prefectural-level hospitals [Nara Medical University (NMU), Nara Prefecture General Medical Center (NPGMC), Tenri Hospital and Kindai University Nara Hospital] which have specialist obstetric, pediatric, anesthetic and emergency services onsite, seven district and general hospitals with the functioning operation theater for obstetric and gynecological care, 17 primary clinics staffed by obstetricians and nine midwifery homes (primary level maternity units staffed by trained midwives). The majority of the hospitals and clinics were located in the northern part of the prefecture. The locations of the primary clinics, midwifery homes, district and general hospitals, NMU and NPGMC are illustrated in Fig. 1.

Obstetricians in obstetrics-gynecology clinics and professional midwives contribute to an uncomplicated physiological birth. They sometimes confront unmet needs for emergency obstetric care unavailable at their clinics, midwifery homes, or district and general hospitals. When women are diagnosed as having maternal and fetal complications, they are referred to EONC centers for appropriate care. EONC was available in only two of 11 hospitals; one is a tertiary care facility hospital of NMU (located in the central part of the prefecture) and the other is a prefectural-level hospital of NPGMC (located in the northern district of the prefecture). Multiple barriers at the time, including workforce shortage (shortage of obstetricians and nursing staffs), reduced service capability after standard working hours, excessive workloads of obstetricians, EONC center crowding and hospital bed shortage and poor collaboration between NMU and NPGMC, led the lack of availability and access to timely and appropriate emergency obstetric care. The emergency ambulance was available; however, an

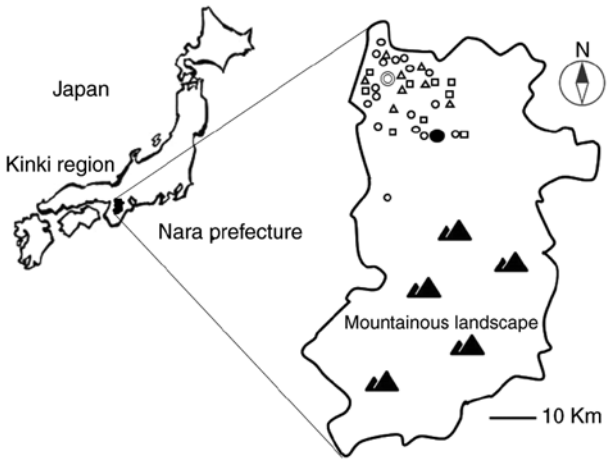

Figure 1. Map of Nara Prefecture showing the location of primary maternity clinics (n=16), midwifery homes (n=8), or district and general hospitals (n=9), and the EONC centers in 2017. In the map, the symbols indicate the following: ○, Primary maternity clinics (n-16); Δ, midwifery homes (n-8); □, district and general hospitals (n=9); ●, NMU; ◎, NPGMC (EONC centers). EONC centers, emergency obstetric and neonatal care centers; NMU, Nara Medical University; NPGMC, Nara Prefecture General Medical Center.

obstetrician of referring facilities or the land ambulance crew in charge of IFT had to often identify a transfer destination by oneself. A majority of specialists, including obstetricians, neonatologists and gynecologists, had unresolved problems with respect to job stress and had the negative impact of job-related satisfaction, work-family conflict and working in a rural area. Before 2006, there was a major public health concern in perinatal care due to an inadequate IFT program and the low referral coverage of complicated deliveries. The conflicts emerged between government and obstetricians at the point of the process of and policy recommendations for improving perinatal care management systems.

First, under the leadership of the government, the CPC Committee was set up to combat the various problems that obstruct perinatal care. To combat the issue of IFTs, the CPC Committee set up and reorganized the EONC centers in the tertiary NMU Hospital as Comprehensive Centers for Perinatal Medicine in 2008 and then NPGMC hospital as Regional Centers for Perinatal Medicine in 2010, respectively. Two EONC centers were reorganized through the selection, integrated arrangements and concentration of obstetric facilities, and requested to build a 24-h communication network system for the transfer of women with obstetric complications from referring facilities to the EONC centers. To ensure sufficient medical coverage at all times, the traditional overnight on-call and standby duties were assigned to obstetricians in NMU and NPGMC. Specialized maternal and neonatal care services were offered in a separate maternal-fetal intensive care unit (MFICU) and neonatology unit (NICU). We proposed a team composed of specialists from multiple disciplines (maternal-fetal medicine, perinatology, neonatology, gynecology with surgical skills, obstetric anesthesiology, interventional radiology, cardiology, pulmonology, advanced midwives and nurse specialists etc.). With this team-based approach, they strongly cooperated with each other to establish a support system. Further attempts were approached with careful triage protocol development. The CPC Committee has

Table I. Criteria for ambulance referrals to EONC centers of women at risk of or with an obstetric complication.

Maternal complication with or without organ dysfunction:
Cardiovascular or renal pathologies, severe hypertension or stroke, diabetes, asthma, appendicitis, enterocolitis, and infections.
Specified critical interventions:
Need massive blood transfusion, ventilation and hysterectomy
Obstetric complications:
Prematurity <36 weeks gestation
Premature rupture of membranes <36 weeks gestation
Hypertensive disorders of pregnancy/Preeclampsia/eclampsia
Placental abruption
Placenta previa
Multiple pregnancy
Pregnant women without antenatal health care
Non-reassuring fetal status
Fetal growth restriction
Intrauterine fetal death
Malpresentation of the fetus/umbilical cord
Abdominal pain during pregnancy
Bleeding during pregnancy
Postpartum hemorrhage
Postpartum sepsis

EONC centers, emergency obstetric and neonatal care centers.

achieved a consensus that preterm labor/birth and premature rupture of membranes between 22+0 and 27+6 weeks of gestation requires an intensive care in the NMU Hospital, while preterm labor with a gestational age of >28 weeks with an estimated fetal body weight >1,000 g is managed by prolonged tocolytic regimens in the NPGMC Hospital. Since it is very difficult to save the lives of newborns, pregnant women with a gestational age of <22+0 weeks do not require an intensive care in EONCs. If women fulfilled the specific referral criteria (Table I), they have to be properly transferred from referring facilities to either of the two EONC centers by an ambulance, with the distance between 1 and 20 km (up to 0.7 h drive one way to the furthest clinics). At the start of the IFT program, full or optimal coverage of complicated deliveries had not yet been achieved.

Second, there is growing interest in the effectiveness of task shifting that is an important government policy option to improve workforce shortages of an obstetrician (8). Professional midwives have provided obstetric care and reproductive healthcare for normal deliveries under the guidance of obstetricians. Since 2011, midwives in NMU Hospitals were responsible for labor and delivery care in a low-risk midwifery-led unit. The intense, hands-on training has been provided in order to improve their skills in the study meetings of the Japan Association of Obstetricians and Gynecologists and Japan Academy of Midwifery of Nara prefecture.

Third, the government programs employed an obstetrician as a transfer coordinator. Telephone-based services by a transfer coordinator can provide valuable informational and practical support for IFTs. A five-point demand was proposed based on the agreement by the CPC Committee as follows: i) An obstetrician, midwife, or nurse in referring facilities rides in the ambulance for the care in principle. The ambulances are well equipped with a means of communication, EONC treatment protocols, a patient stretcher, oxygen, drugs, ECG monitor and pulse oximeter that could be administered in the ambulance by the accompanying medical staffs en route to emergency obstetric hospitals. ii) In 2015, full-scale 24-h communication network began using telephone-based services by a transfer coordinator. The implementation of an emergency referral network includes an efficient coordination by a transfer coordinator and an effective communication. Without taking a labor in the referring facilities, the transfer coordinator can understand an obstetrician's need, taking each facility's limitations and acceptance into consideration and can objectively identify a destination. An optimal combination of the definitive destination avoiding delay and any necessary support to manage the patient can be provided over the cell phone to the ambulance medical staffs by the transfer coordinator. iii) If all beds are filled with patients in EONC centers, the IFT patient will be transferred from the referring facilities to emergency obstetric hospitals outside of the prefecture limits (the Out-of-Nara transfer). iv) If the ambulance arrives at the referring facilities following vaginal delivery, the woman and neonate will be transferred to emergency hospitals, even though she does not require emergency postpartum care. v) Our effective emergency medical services system includes a timely dispatch of one ambulance car with special equipment such as a portable incubator for neonatal transport stationed at the NPGMC hospital. Ambulance use is free of charge.

Finally, perinatal health registries were developed in Nara prefecture in 1997. In 2006, the government established a standing committee to focus on emergency perinatal care. The Board of the CPC Committee was authorized to design, approve and finance observational studies in relevant scientific fields to ensure the quality of community perinatal care services. A hospital-based perinatal registry was collected, validated, managed, analyzed and published, which was conducted by an underlying organization of the CPC Committee at an annual meeting. The publication of the 'Annual Report of the Epidemiology and Management regarding Emergency Obstetric and Neonatal Care' is a project initiated by the Committee (http://www.pref.nara.jp/46607.htm). Recent summary data published through releasing an annual report would be helpful to strengthen collaboration among critical care staffs and physicians.

Study design and population. This is a retrospective time series study using a longitudinal design between January, 2006 and December, 2017. All facilities were invited to participate in the registry. There are 35 hospitals with deliveries in Nara Prefecture and only 4 hospitals (NMU, NPGMC, Tenri Hospital and Kindai University Nara Hospital) accept patients with obstetric and neonatal complications. Transferred patients were defined as either patients that transported from the primary facilities to EONC centers or those with the Out-of-Nara transfer. The annual number of and reasons for IFTs was registered in the CPC Committee during the study period.

The patients were divided into three periods according to the reorganization date as follows: Between 2006-2007 (before reorganization, Period 1), 2008-2010 (one reorganization, Period 2) and between 2011-2017 (two reorganization and an efficient coordination, Period 3). During Period 2, the NMU EONC center officially commenced in order to improve the maternal and neonatal care system. During Period 3, the NPGMC EONC center was also officially commenced and IFTs were then timely coordinated by a transfer operator who can identify a transfer destination. Transfer coordinators would be required to keep the entire management smooth and safe and facilitate prompt transfer to the definitive destination avoiding delay at the emergency.

Data collection. All reporting data forms were completed by obstetricians and midwives and mailed to the Board of the CPC Committee on a yearly basis. The Committee members transferred the data to an electronic database for future statistical evaluation. The database was subsequently double checked to confirm whether patients had been reported by both sending and receiving hospitals. Any disagreements were resolved by confirming the ambulance call log books and the electronic patient database at NMU and NPGMC hospitals. Furthermore, data were independently extracted from the paramedic and coordinator's reports for all IFTs. The IFT data and reason for transfer were collected from the administrative database operated by the CPC Committee. To assess the quality of medical practice in Nara Prefecture, maternal and perinatal mortality was confirmed from data provided by National Statistics Center (https://www.e-stat.go.jp/).

Statistical analysis. To assess the impact of the newly established IFT system, the number and rate of IFTs and Out-of-Nara transportation were compared among the three periods. Analyses were performed using commercially available software packages (SPSS Statistics for Windows version 17.0; IBM Corp. and Medcalc for Windows version 11.4.2.0; Medcalc) (Stata version 16.0, StataCorp LLC, TX). Values of $P<0.05$ were deemed to indicate statistically significant differences. Linear regression analysis was used for the comparison of differences in each data between each year and the three periods.

Results

Information regarding the annual number of obstetric units, obstetrician-gynecologists and NICU and GCU beds. During the study period, 129,482 deliveries were recorded in our database. There were approximately 10,000 deliveries per year (a maximum of 11,659 in 2006 and a minimum of 9,626 in 2017). The number of deliveries significantly decreased by 17.4% between 2006 and 2017 ($P<0.0001$). The annual numbers of obstetric units, obstetrician-gynecologists and NICU and GCU beds are presented in Table II. The number of obstetric units in Nara Prefecture did not change between 2006 and 2017. The number of obstetrician-gynecologists increased annually ($P=0.0132$) and between the three periods ($P<0.0001$). The number of NICU and GCU beds increased annually ($P=0.0149$).

The annual number of IFTs from the referring facilities to EONC centers. The CPC Committee databases (2006-2017) were used to identify an annual trend analysis of the IFTs and Out-of-Nara transfer. The number of deliveries significantly decreased by 17.4% between 2006 and 2017 ($P<0.0001$). The number of the patient transfers to the EONC centers is presented in Table II and Fig. 2. Among a total of 129,482 deliveries, 3,020 were transferred to the EONC centers (2.33%). Of the 3,020 IFTs, 1,472 (48.7%) and 1,185 (39.2%) patients were transferred to NMU and NPGMC, respectively. The annual IFT number and rate increased from 192 (1.6%) per 11,659 deliveries in 2006 to 290 (3.0%) per 9,626 deliveries in 2017 ($P<0.0001$), resulting in a 82.4% increase in the number of cases. The patients were divided into three periods to assess the effects of these organizational changes on IFTs. The number of IFTs significantly increased from 188.5 cases (95% CI, 144.0-233.0) per year in Period 1 to 217.7 cases (188.2-247.1) in Period 2 and 284.3 cases (273.4-295.2) in Period 3 ($P<0.0001$).

Out-of-Nara transfer rates. There was a marked decrease in the incidence of the Out-of-Nara transfer, ranging from 22.9% in 2006 to 2.4% in 2017 (10.0% per year on average, $P=0.0057$). The annual IFT rate of the Out-of-Nara transfer decreased by 89.6% between 2006 (22.9%) and 2017 (2.4%, $P=0.0011$). The medical coverage of complicated obstetric cases at the EONC centers was estimated to be 77.1% (148/192) in 2006 and 97.6% (283/290) in 2017. A significant decrease in the Out-of-Nara transfer rate was shown from 22.8% (95% CI, 21.5-24.2) in Period 1 to 13.5% (9.6-36.5) in Period 2 and 6.6% (4.2-8.9) in Period 3 ($P=0.0065$).

Table II. The number of the patient transfers to the EONC centers.

	Period 1		Period 2			Period 3								
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	Significance
Population of Nara Prefecture	1,416,323	1,410,825	1,405,074	1,400,951	1,400,738	1,395,687	1,389,690	1,383,549	1,376,466	1,364,950	1,356,950	1,348,257	16,648,826	P<0.05[a,b]
Number of deliveries	11,659	11,456	11,224	10,898	11,164	10,995	11,021	10,752	10,257	10,414	10,016	9,626	129,482	P<0.05[a,b]
Number of IFTs	192	185	204	224	225	275	283	284	265	292	301	290	3,020	P<0.05[a,b]
Average on Period (95% CI)	188.5 (144.0-233.0)		217.7 (188.2-247.1)					284.3 (273.4-295.2)						
Number of patients transferred to facilities within Nara Prefecture	148	143	158	193	216	254	25	263	251	278	272	283	2,717	P<0.05[a,b]
The number of patients transferred to NMU	114	67	83	130	153	146	157	156	107	125	106	128	1,472	n.s.
Number of patients transferred to NPGMC	20	84	65	60	63	106	100	105	141	147	148	146	1,185	P<0.05[a,b]
Number of patients transferred to other facilities in Nara	14	15	10	3	0	2	1	2	3	6	18	9	83	n.s.
Number of Out-of-Nara transfers	44	42	46	31	9	21	25	21	14	14	29	7	155.4	P<0.05[a]
Average on Period (95% CI)	43.0 (30.3-55.7)		28.7 (-17.6-74.9)					18.7 (11.8-25.6)						
Out-of-Nara rate (%)	22.9	22.7	22.5	13.8	4.0	7.6	8.8	7.4	5.3	4.8	9.6	2.4	5.1	P<0.05[a,b]
Average on Period (95% CI)	22.8 (21.5-24.2)		13.5 (9.6-36.5)					6.6 (4.2-8.9)						
Number of obstetric units (total)	36	36	36	36	36	36	36	37	36	36	35	35		n.s.
Prefectural-level hospitals	4	4	4	4	4	4	4	4	4	4	4	4		
General hospitals	7	7	5	5	5	5	5	5	5	7	7	7		
Primary clinics	17	17	18	18	18	18	18	19	19	17	16	16		
Midwifery homes	8	8	9	9	9	9	9	9	8	8	8	8		
Number of obstetrician-gynecologists of four prefectural-level hospitals (total)	31	35	40	39	40	43	43	44	44	43	46	49		P<0.05[a,b]
Nara Medical University (NMU)	12	15	20	19	21	22	22	24	22	22	25	25		
Nara Prefecture General Medical Center (NPGMC)	6	7	7	7	7	9	9	9	10	10	10	12		
Tenri Hospital	8	8	8	8	4	4	4	3	4	5	5	5		
Kindai University Nara Hospital	5	5	5	5	8	8	8	8	8	6	6	7		
Number of NICU and GCU beds (total)	34	40	40	40	40	40	40	40	40	39	63	78		P<0.05[a]
Nara Medical University (NMU)	15	21	21	21	21	21	21	21	21	21	45	45		
Nara Prefecture General Medical Center (NPGMC)	9	9	9	9	9	9	9	9	9	9	9	24		
Kindai University Nara Hospital	10	10	10	10	10	10	10	10	10	9	9	9		
Number of maternal deaths	2	0	0	0	0	0	2	0	0	2	0	0	6	n.s.
Perinatal mortality rate (per 1,000 births)	6.2	4.2	5.5	5.2	3.3	5.1	3.3	4.4	3.8	5.2	3.7	4.7		
Average on Period (95% CI)	5.2 (-7.5-17.9)		4.7 (1.7-7.6)					4.3 (3.6-5.0)						
Incidence of prolonged mechanical ventilation (%)	ND	38.2	44.8	47.1	49.5	44.3	48.7	43	54.1	56.9	37.5	23		n.s.
Average on Period (95% CI)	38.2		47.1 (41.3-53.0)					43.9 (33.4-54.4)						

EONC centers, emergency obstetric and neonatal care centers; NMU, Nara Medical University; NPGMC, Nara Prefecture General Medical Center. ND, no data. Linear regression analysis was used for the comparison of differences in each data between each year and the three periods; [a]in association with year; [b]between 3 periods; n.s., not significant.

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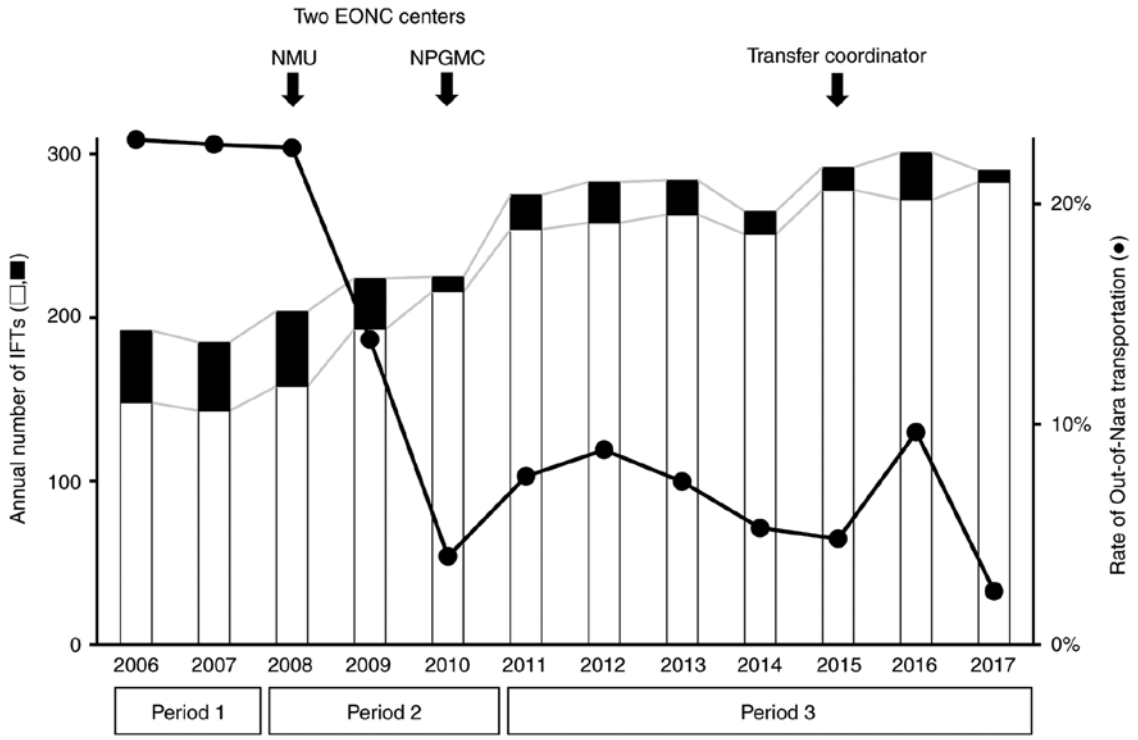

Figure 2. Trends in the number of the patient transfers to the EONC centers and the Out-of-Nara transfer rates. In the figure, the symbols indicate the following: □, The number of patients transferred to facilities within Nara Prefecture; ■, the number of Out-of-Nara transfers; ●, the rate of Out-of-Nara transportation. EONC centers, emergency obstetric and neonatal care centers; NMU, Nara Medical University; NPGMC, Nara Prefecture General Medical Center.

Top reasons for IFTs. The most common reasons for IFTs to the EONC centers were preterm labor (36.7%), followed by premature rupture of membranes (PROM) (20.0%), hypertensive disorders of pregnancy (HDP) (8.7%), postpartum hemorrhage (PPH) (8.3%), placental abruption (4.0%) (Table III).

Maternal and perinatal mortality. In addition, we estimated the annual change in incidence of maternal and perinatal outcomes before and after the reorganization of the EONCs. We queried the CPC Committee registry for the medical records of maternal death, perinatal mortality, and adverse clinical outcomes, including NICU length of stay, the need for inotropes and prolonged mechanical ventilation. It was found that maternal death (P=0.926), perinatal mortality rate (P=0.947) and adverse clinical outcomes (P=0.518) between 2006-2017 did not change prior to and after the reorganization (Table II). Six maternal deaths were registered in 2006 (n=2, postpartum hemorrhage and dilated cardiomyopathy), 2012 (n=2, Group A streptococcal infection and malignant lymphoma), and 2015 (n=2, brain stroke and aortic dissection), respectively. Since maternal mortality was rare throughout the period studied, no association was observed between maternal mortality and vehicle-dispatch data. Furthermore, the perinatal mortality rate exhibited no significant difference between the periods studied [Period 1, 5.2 (95% CI, -7.5-17.9); Period 2, 4.7 (1.7-7.6); and Period 3, 4.3 (3.6-5.0)]. We finally investigated adverse clinical outcomes of the deliveries prior to and after the reorganization. Both NICU length of stay and duration of mechanical ventilation may be associated with a trend towards neonatal mortality and morbidity. The duration of mechanical ventilation, but not the NICU length of stay, was recorded in the CPC committee database. The incidence of prolonged mechanical ventilation was unchanged before and after the reorganization.

Discussion

In this study, a prefecture-based observational study was conducted for a period of 12 years. This study assessed the impact of the newly established IFT system and medical coverage of complicated obstetric cases at two EONC centers. The timespan was divided into three periods (before reorganization, one reorganization and two reorganizations). The IFT rate significantly increased from 1.7% (Period 1) to 2.4% (Period 2) and finally to 2.9% (Period 3) (P<0.0001). In contrast to these changes, the Out-of-Nara transfer rate significantly declined from 22.7% (Period 1) to 7.8% (Period 2) and finally to 5.7% (Period 3) (P=0.0065). The key findings of this study were as follows: i) The IFT rates significantly increased over the study period; and ii) the Out-of-Nara transfer rate markedly declined after the reorganization of the EONC centers. The combination of the reorganization of the EONC centers and the implementation of an emergency referral network, including an efficient coordination using telephone-based services by a transfer coordinator and an effective communication, can facilitate the IFTs of women who urgently require emergency obstetric care.

First, we highlight serious social and medical issues related to emergency obstetric care and some of the important factors to significantly reduce the number of the Out-of-Nara transfer. Japan now faces serious medical issues, including a shortage of physicians, an increase in the number of females

Table III. Main reasons for patient transfer to the EONC centers, Nara prefecture, Japan.

Reasons for patient transfer	n 3,043	(%) (100)
Preterm labor	1,118	(36.7)
PROM	609	(20.0)
HDP	265	(8.7)
PPH	254	(8.3)
Placental abruption	123	(4.0)
Placenta previa	89	(2.9)
Non-reassuring fetal status	69	(2.3)
FGR	58	(1.9)
HELLP syndrome	51	(1.7)
Pregnant women without antenatal health care	35	(1.2)
Threatened abortion	23	(0.8)
Others	349	(11.5)

EONC centers, emergency obstetric and neonatal care centers; PROM, premature rupture of membranes; HDP, hypertensive disorders of pregnancy; PPH, postpartum hemorrhage; FGR, fetal growth restriction; HELLP, hemolysis, elevated liver enzyme levels and low platelet levels.

entering medicine and physician maldistribution between medical departments (9). The number of OB/GYN physicians, obstetricians and gynecologists, is specifically decreasing. Furthermore, emerging evidence indicates an increase in the incidence of obstetric complications in recent years (2). The recent trend of delayed parenthood and the associated use of assisted reproductive technologies (ARTs) have led to the increased risk of obstetric complications (4). There has been an increase in the number of high-risk pregnant women who have their first baby at an age >35 years. Other risk factors include not only *in vitro* fertilization and embryo transfer (IVF-ET), but also a pre-pregnancy BMI ≥30 kg/m^2 or <18 kg/m^2, or a family history of hypertension or diabetes (2).

The government has accelerated the selection and concentration of obstetric facilities to cope with workforce shortages and excessive workloads, including transfer or relocation of services from one health care sector to EONC centers. Policy-makers are facing acute shortages of obstetricians needed to provide improved EONC services. Since 2007, the Japan Society of Obstetrics and Gynecology (JSOG) created actionable recommendations to implement the innovative and community relevant interventions called the 'selection and concentration' of obstetric facilities (8-10). This was a political issue, in which the reorganization of the EONC center should be considered to reduce the increased workload of obstetricians, increase job satisfaction and improve maternal and neonatal outcomes. Considering the fact that health workforce shortage and increasing complicated delivery in Japan, the reorganization of EONC facilities could be a possible policy option. Two EONC centers (NMU in 2008 and NPGMC in 2010) were newly reorganized in Nara Prefecture and staffed by specialists. In almost one decade, larger and multispecialty groups have been reorganized through the selection, integrated arrangements and concentration of obstetric facilities. The reorganization has overcome accessibility of complicated obstetric cases and emergency care for women with obstetric and neonatal disabilities in the referring facilities. Therefore, both a resolution of a shortage of obstetricians with increased workload and the increased number of EONC beds may have a positive impact on the decreased Out-of-Nara transfer rate.

Second, perinatal emergencies remain a challenging burden on emergency department staff (11-14). IFTs may be a useful option to ensure a higher level of care than that which is available at the referring clinic or hospital. The CPC Committee held a series of meetings to implement a plan for coordinating the care of high-risk pregnancies with emergency obstetric conditions. An obstetric emergency care coordinator can quickly assess the limitations of each facility and acceptance, and can properly determine ENOC center suitable for a patient's condition, allowing information to be shared among obstetricians and neonatologists. Our policy is that ensuring an uneventful IFT will prepare prompt arrangement of transport for the patient and reduce delays in access to the EONC centers. Neither pregnant women nor their families denied to be transferred to the EONC centers. During Period 3, IFTs were carried out by a transfer coordinator through an agreement between the NMU hospital and the CPC Committee under a relational contract with the government. A modest investment in the transfer coordination may reduce the obstetrician's burden. Task shifting by a transfer coordinator is a potential strategy to improve access to the EONC centers and actualize the smooth management of the IFT system. This clinical innovation may involve a sustainable change in the clinical practice of emergency medicine, particularly in countries now facing serious medical issues, such as a shortage of obstetricians.

Third, the most common cause for IFTs was preterm labor (37.0%), followed by premature rupture of membranes (PROM) (20.2%), hypertensive disorders of pregnancy (HDP) (8.8%), postpartum hemorrhage (PPH) (8.4%), placental abruption (4.0%). Preterm delivery is considered to be the leading cause of neonatal mortality and morbidity worldwide (3). Its prevention is an important healthcare priority, but has been long-standing challenges. Since neonatal outcomes are better for expectant mother transferred *in utero* than those transferred *ex utero* (neonates), women with pregnancy complications, including preterm birth, should be transferred to the EONC centers as an *in utero* transfer (15). In addition, we estimated the annual change in incidence of the maternal death, perinatal mortality rate and adverse clinical outcomes, including prolonged mechanical ventilation, before and after the reorganization of the EONCs. However, the timely response for emergency IFTs was not associated with improved maternal-fetal outcomes. Due to the increase in preterm delivery for maternal or fetal indications, including preeclampsia or eclampsia, and intrauterine growth restriction, premature infants may require longer positive pressure ventilation.

Finally, we sought to identify other factors that may have influenced the results of this study: For example, the establishment of new hospitals inside Nara Prefecture, transportation system changes (the spatiotemporal changes

of new expressway network), and changes in the criteria for transportation. Nationwide, the number of obstetrics facilities decreased during the study period. It is commonly believed that the improvement of the expressway network exerts more widespread influences on the emergency transportation. However, there were no expressway infrastructure development plans in Nara Prefecture throughout the study period. Furthermore, the IFT rate varies according to the criteria for ambulance referrals to EONC centers of women at risk of or with an obstetric complication. All of the women who met these criteria in this study are shown in Table I. Therefore, it can be concluded that the reorganization may be a primary factor of this change.

In conclusion, the findings of this study demonstrate that i) progression of the selection, concentration and intensification of obstetrics facilities may reduce the Out-of-Nara transfer and acceptable referral coverage of complicated obstetric cases; and that ii) transfer coordination by an IFT operator who can quickly identify a transfer destination may provide an effective doctor-to-doctor communication between referring facilities and referred facilities.

In this study, we only analyzed the time trend data based on the CPC Committee database and did not assess whether the availability of the EONC centers is associated with an improved outcome of severe obstetric complications, which may be a main limitation of this study. Furthermore, this study did not evaluate the quality of life and job satisfaction in obstetricians of referring facilities and referred facilities. Koike *et al* reported that the selection, concentration and intensification of obstetrics facilities in fewer hospitals impairs patient access, but EONC centers had a greater annual caseload and better staffing than did those at non-specialized centers, which has the potential advantages of better clinical outcomes (16). Further studies are required to synthesize evidence regarding maternal and neonatal deaths, as well as comprehensive outcome measurements, including an improvement of quality of life of medical professionals.

In conclusion, the combination of reorganization of two emergency obstetric and neonatal care (EONC) centers and implementation of an efficient coordination by a transfer operator is imperative for the successful management of interfacility transfers (IFTs) in Nara Prefecture, Japan.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Authors' contributions

TT, JA and KN collected data regarding the recent trend of obstetric complications using the PubMed database. TS and KN collected data regarding the number of the patient transfers to the EONC centers and the Out-of-Nara transfer using the CPC committee database and nation data in the vital statistics in Japan. HK and MA contributed to the conception, design and interpretation of this study. HK wrote the first draft of the manuscript. The final version of the manuscript has been read and approved by all authors.

Ethics approval and consent to participate

This study was approved by the CPC Committee.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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