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Epidemiological analysis of neonatal CHD near Petrochemical Complex

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Abstract

Objective: To study the incidence, types, and characteristics of CHD in all live births delivered in Jinshan Hospital from 1 January, 2016 to 31 December, 2017, and to analyse the correlation between CHD and the distance between maternal residence and Shanghai Petrochemical Complex. *Methods:* All live births, delivered in Jinshan Hospital in 2016 and 2017, have received CHD screening and neonatal follow-up after delivery. For those both positive for CHD screening and negative for CHD screening but with heart murmur found during physical examination on neonatal follow-up after delivery, echocardiography was performed to confirm CHD diagnosis. All maternal residential addresses have been grouped for analysis according to the distance between maternal residence and Shanghai Petrochemical Complex. *Results:* There were 5544 live births in total, and a total of 79 children with CHD were confirmed by CHD screening and echocardiography, of which the types of diseases with high incidence, in descending order of incidence, are atrial septal defect (48/79), ventricular septal defect (25/79), patent ductus arteriosus (21/79), and pulmonary artery stenosis (9/79). There was no statistically significant difference in the incidence of CHD among the groups divided by the distance between maternal residence and Shanghai Petrochemical Complex. The incidence of neonatal CHD near Shanghai Petrochemical Complex is 1.42%. *Conclusions:* Most of the children with CHD can be screened out through CHD screening and physical examination in neonatal period and early infancy stage. The distance between maternal residence and Shanghai Petrochemical Complex has no significant direct effect on the incidence of CHD in neonates near Shanghai Petrochemical Complex.

CHD refers to abnormal cardiovascular structure and function at birth resulted from abnormal development of heart and vascular tissues during embryonic development,[1] it is an important cause of disability and death in infancy of newborns.[2,3] At present, CHD ranks the first among birth defects in China and has become a major public health problem affecting children's physical and mental health and the quality of life.[4] In order to study and reduce the incidence of CHD and improve the quality of birth population, it is imperative to understand the epidemiological characteristics and related factors of CHD. In this study, CHD screening and physical examination on neonatal follow-up after delivery were conducted for newborns born in Jinshan Hospital from 2016 to 2017, and analysis was made on the incidence and types of CHD in these newborns. With the continuous improvement of quality of life, people are paying more and more attention to the living environment, especially the pregnant women residing near Shanghai Petrochemical Complex because Shanghai Petrochemical Complex, covering an area of 9.4 sq km, is one of the largest comprehensive petrochemical enterprises in China. They may be worried about whether the rapid development of chemical industry could lead to environmental pollution and increase the incidence of congenital malformation. Everyone keep a watchful eye on such problems because the relevant reports are less, this study is to explore the correlation between the incidence of neonatal CHD and the distance between maternal residence and Shanghai Petrochemical Complex, and to provide the corresponding basis for taking related preventive measures.

Materials and methods

General data

Data were collected from all newborns in Jinshan Hospital from 1 January, 2016 to 31 December, 2017 for comparison and analysis.

Diagnostic method

According to neonatal CHD screening program, all newborns received the comprehensive physical examinations, including detailed cardiac auscultation and percutaneous oxygen saturation determination, that is, the determination of oxygen saturation on the right upper limb

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and any lower limb of the newborns. It is considered positive for screening if the measured oxygen saturation occurs in one of the following three conditions. If measured oxygen saturation on any part of the body was less than 90%, the difference in percutaneous oxygen saturation between on the right upper limb (before catheter) and on any lower limbs (after catheter) was more than 3%; percutaneous oxygen saturation on any part between 91 and 95% before was still less than 95% after reassessment before newborns were discharged from hospital. Patients with heart murmur II level or above were also considered positive for screening. Those positive for screening were all examined by echocardiography. In addition, newborns were followed up and detailed physical examination was performed on each newborn again 42 days after birth, those found heart murmur II level or above in the precordial region were also examined by echocardiography to confirm the diagnosis of CHD. The remaining newborns were followed up by telephone at one year of age. In this way, we knew whether they had symptoms of CHD and how to be diagnosed and treated subsequently.

Grouping

According to the linear distance between maternal residence and Shanghai Petrochemical Complex, the pregnant women were grouped by the distance of 5 and 10 km, respectively, and the incidence of CHD in different groups was calculated for comparison.

Statistical method

GraphPad Prism® (version 5.01) statistical software was used for analysis. Comparison of various counting data was conducted by χ^2 test, with $p < 0.05$ considered as statistically significant difference.

Results

Findings

From 2016 to 2017, a total of 5544 live births were delivered in Jinshan Hospital, including 2812 male, 2731 female, and 1 hermaphrodite, with 79 cases of CHD confirmed and the incidence of CHD 1.42%.

Composition of CHD type

Among the newborns from 2016 to 2017, there were a total of 79 cases of neonatal CHD confirmed by echocardiography, of which there were 46 cases of single CHD, including 25 cases of atrial septal defect,11 cases of ventricular septal defect, 7 cases of patent ductus arteriosus, 1 case of pulmonary artery stenosis, 1 case of pulmonary vein ectopic drainage, 1 case of coarctation of the aorta, and 33 cases of complex CHD, including 9 cases of patent ductus arteriosus with atrial septal defects, 8 cases of atrioventricular septal defect, 3 cases of tetralogy of Fallot, 3 cases of atrial septal defect with pulmonary artery stenosis, 2 cases of patent ductus arteriosus with pulmonary stenosis, 3 cases of atrioventricular septal defect with patent ductus arteriosus, 1 case of ventricular septal defect with abnormal tricuspid valve development, 1 case of ventricular septal defect with abnormal mitral valve development, 1 case of abnormal tricuspid valve development, and 2 cases of transposition of the great arteries (see Table 1). Combination of both single and complex CHD, the top five incidence rates were atrial septal defect in 48 cases, ventricular septal defect in 25 cases, patent ductus arteriosus in 21 cases, pulmonary artery stenosis in 9 cases, and tetralogy of Fallot in 3 cases (see Table 2).

Table 1. CHD types and composition ratios

Diagnostic type	Cases (n = 79)	Constituent ratio (%)	Morbidity (%)
Single CHD types (n = 46)			
Atrial septal defect	25	31.65	0.45
Ventricular septal defect	11	13.92	0.20
Patent ductus arteriosus	7	8.86	0.13
Pulmonary artery stenosis	1	1.27	0.02
Partial anomalous pulmonary venous drainage	1	1.27	0.02
Coarctation of aorta	1	1.27	0.02
Complex CHD types (n = 33)			
Patent ductus arteriosus with atrial septal defect	9	11.39	0.16
Atrioventricular septal defect	8	10.12	0.14
Tetralogy of Fallot	3	3.80	0.05
Atrioventricular septal defect with patent ductus arteriosus	3	3.80	0.05
Atrial septal defect with pulmonary artery stenosis	3	3.80	0.05
Patent ductus arteriosus with pulmonary stenosis	2	2.53	0.04
Ventricular septal defect with abnormal tricuspid valve development	1	1.27	0.02
Ventricular septal defect with abnormal mitral valve development	1	1.27	0.02
Transposition of the great arteries	2	2.53	0.04
Abnormal tricuspid valve development	1	1.27	0.02

Table 2. Top five CHD types and composition ratios

Diagnostic type	Cases (n)	Constituent ratio (%)	Morbidity (%)
Atrial septal defect	48	60.76	0.87
Ventricular septal defect	25	31.65	0.45
Patent ductus arteriosus	21	26.58	0.38
Pulmonary artery stenosis	9	11.39	0.16
Tetralogy of Fallot	3	3.80	0.05

Residential address

New Jinshan town where most pregnant women reside, on the northeast of Shanghai Petrochemical Complex, has a relatively concentrated population. The pregnant women were grouped by the linear distance of 5 and 10 km, respectively. According to the linear distance between maternal residence and Shanghai Petrochemical Complex (measured on Baidu map), 942 cases were within 5 km (18 cases of CHD) and 4602 cases beyond 5 km (61 cases of

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Table 3. Comparison of maternal residence

Distance* (km)	Total n	Case'number (%)	Normal group (%)	χ^2	p
⩽5	942	18 (1.91)	924 (98.09)	1.907	0.167
>5	4602	61 (1.33)	4541 (98.67)		
⩽10	2903	43 (1.48)	2860 (98.52)	0.066	0.797
>10	2641	36 (1.36)	2605 (98.64)		
⩽5	942	18 (1.91)	924 (98.09)	1.970	0.374
5–10	1961	25 (1.27)	1936 (98.73)		
>10	2641	36 (1.36)	2605 (98.64)		

*The linear distance between maternal residence and the Headquarters building located in the area of Shanghai Petrochemical Complex (hereby referred to as the distance between maternal residence and Shanghai Petrochemical Complex).

CHD). Statistical analysis was carried out on these two groups, which revealed that there was no significant difference with p value of 0.1673 more than 0.05. Grouped by the distance of 10 km, 2903 cases were within 10 km (43 cases of CHD) and 2641 cases beyond 10 km (36 cases of CHD). Statistical analysis was made on these two groups. The p value was 0.797, which is more than 0.05, showing no statistical significance. Meanwhile, through the comparison of the incidence among the three groups (one within 5 km, one with 5–10 km, and one beyond 10 km), the conclusion was that the difference was not statistically significant as shown in Table 3.

Discussion

According to World Health Organization data, there are about 1.5–2 million children born with CHD every year in the world,[5] and the incidence of CHD increases year by year.[6] There are 120,000–150,000 new CHD cases appearing in China every year. The average prevalence rate of CHD among Chinese newly-born population is 0.82%[7] with the detection rate of CHD varying from 0.5 to 1.3%[4,8–10] while the relevant foreign data are slightly different, the detection rate of CHD ranging from 0.8 to 1.33%.[11–13] The object of this study is the neonates born in Jinshan Hospital located in New Jinshan Town during the period of time from 2016 to 2017. The result is 79 neonates diagnosed clearly with CHD, and it shows that the incidence of CHD in this region is 1.42%, which is slightly higher than the average level in China. On the one hand, it may be related to the initiation of CHD screening[14,15] and standardised examination. Compared with the past, CHD screening is more detailed and effective[16] in detecting out more CHD children with no early clinical manifestations. In this way, the missed diagnosis is reduced. On the other hand, it may be related to the fact that all data collected in this study were from neonates and infants because it has been reported[9] that the incidence of CHD may decrease with the increase of age.

Previous study showed that[2,9,12,17,18] the types of diseases with high morbidity of congenital heart malformation were, in descending order of incidence, ventricular septal defect, atrial septal defect, patent ductus arteriosus, pulmonary artery stenosis, and tetralogy of Fallot. It is identical to high-incidence disease types found in this study, but the incidence of atrial septal defect and ventricular septal defect is slightly different. This study shows that atrial septal defect (0.87%) is the most common type of CHD in this region, followed by ventricular septal defect (0.45%) and patent ductus arteriosus (0.38%).In addition, the top three disease types with high incidence of complex CHD are patent ductus arteriosus with atrial septal defect, atrioventricular septal defect, and tetralogy of Fallot, respectively.

In recent years, the incidence of CHD has gradually increased,[19] but its aetiology is not completely clear.[4,10] The current general consensus is that the occurrence of CHD is mostly due to the interaction of environmental factors,[20] maternal factors,[21] and genetic factors.[22–26] With the continuous development of urban industrialisation, air pollution,[27] water pollution, exposure to dyes, paints, printing coatings, and other chemicals are all risk factors for increased heart malformation cases. Studies have shown[7,28] that exposure to environmental pollution in early pregnancy[29] can increase the risk of CHD. Shanghai Petrochemical Complex was established in 1972, and it is an important producer of oil products, intermediate petrochemical products, synthetic resin, and synthetic fibre in China. Its production capacity of crude oil is 16 million tons/year, ethylene 700,000 tons/year, organic chemical raw materials 4.28 million tons/year, and plastic resin 1 million tons/year. Has these chemical products caused air and water pollution?[30] Have they affected people who lived nearby? Have they been a threat to the development of the newborn's heart?

In this article, the pregnant women residing near Shanghai Petrochemical Complex were grouped according to the distance between maternal residence and Shanghai Petrochemical Complex, those women residing within 5 km away from the Shanghai Petrochemical Complex as $\text{Group}_{\leqslant 5\,\text{km}}$, including 29 residential quarters and administrative villages, such as Shi** residential quarter, Fei* residential quarter, and Yu* residential quarter, those women residing beyond 5 km away from Shanghai Petrochemical Complex as $\text{Group}_{>5\,\text{km}}$, including Wan** residential, Hong** residential, W** residential, and other administrative villages (5.1–41.9 km), analysis was made on CHD incidence in these two groups. In addition, the pregnant women were also divided into two groups by the distance of 10 km between maternal residence and Shanghai Petrochemical Complex, $\text{Group}_{\leqslant 10\,\text{km}}$ within 10 km and $\text{Group}_{>10\,\text{km}}$ beyond 10 km away from Shanghai Petrochemical Complex. The statistical analysis was carried out on CHD incidence in these two groups, and the results show that there is no statistically significant difference to support the idea that the distance between maternal residence and Shanghai Petrochemical Complex significantly affects incidence of CHD, the reasons for it may be linked to strict control of the emission of toxic and harmful substances and the effective implementation of environmental protection measures in Shanghai Petrochemical Complex, and may be related to the limitation of the sample size of this study. This is just the result of only one region, and we expect more samples from more regions for verification.

To sum up, the purpose of this study is to clearly understand the prevalence and types of CHD and to know the present situation and dynamic development trend of CHD in this region, master its epidemiological characteristics to take targeted preventive measures. Early detection of CHD is beneficial to early treatment, which improves the life quality of children patients, and is of great significance to improve the health of children. Meanwhile, the local data show that the distance between maternal residence and Shanghai Petrochemical Complex has no obvious effect on the incidence of CHD.

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Conflicts of Interest. None.

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Ethical Standards. The authors assert that all procedures contributing to this work comply with China's ethical standards on human experimentation, and with the Helsinki Declaration of 1975, as revised in 2008, and have been approved by Ethics Committee of Jinshan Hospital, Fudan University.

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