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CLINICAL ARTICLE

Risk factors for heart failure during pregnancy among Chinese women with cardiac disease

Qin Fu^{a,b}, Jianhua Lin^{a,b,*}^a Department of Obstetrics and Gynecology, Renji Hospital, School of Medicine, Shanghai Jiaotong University, Shanghai, China^b Shanghai Obstetrical Cardiology Intensive Care Center, Shanghai, China

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ABSTRACT

Objective: To identify risk factors for heart failure (HF) during pregnancy among women with pre-existing cardiac disease. **Methods:** A retrospective review was conducted of pregnant women with cardiac disease who attended Shanghai Obstetrical Cardiology Intensive Care Center, China, for delivery between January 1, 1993, and December 31, 2013. Independent predictors of HF were identified by logistic regression analysis. **Results:** Among 1086 pregnant women with cardiac disease, 116 (10.7%) developed HF. In multivariate analysis, HF was associated with left ventricular systolic dysfunction (odds ratio [OR] 13.16, 95% confidence interval [CI] 3.62–47.80; $P < 0.001$), history of HF before pregnancy (OR 11.66, 95% CI 5.83–23.33; $P < 0.001$), twin pregnancy (OR 11.63, 95% CI 4.10–32.99; $P < 0.001$), sinus tachycardia (OR 4.60, 95% CI 2.77–7.62; $P < 0.001$), New York Heart Association functional class higher than II (OR 3.36, 95% CI 1.11–10.25; $P = 0.033$), and severe pulmonary arterial hypertension (OR 1.40, 95% CI 1.10–1.78; $P = 0.007$). **Conclusion:** Women with cardiac disease who wish to become pregnant should be guided by risk factors for HF. Those who do conceive should be closely monitored during pregnancy to improve outcomes and reduce maternal mortality and morbidity.

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1. Introduction

Cardiac disease is one of the leading causes of non-obstetric maternal mortality in China [1]. Heart failure (HF) is a complex clinical syndrome that can present as a severe complication among pregnant women with cardiac disease. The underlying cause of HF is structural or functional impairment of ventricular filling or ejection. Symptoms include shortness of breath, fatigue, and fluid retention [2,3].

Heart compensation mechanisms during pregnancy do not generally cause issues for healthy women, but women with cardiac disease can develop HF during pregnancy due to the hemodynamic changes. One study [4] identified independent predictive risk factors for cardiac complications (including HF) as a baseline New York Heart Association (NYHA) functional class greater than II, cyanosis, reduced left ventricular systolic function, left heart outflow tract obstruction, and a cardiac event before pregnancy. Another study [5] identified cardiomyopathy, a NYHA functional class of at least III, WHO category of at least 3, signs of HF before pregnancy, and pulmonary arterial hypertension (PAH) as predictors of HF.

The aim of the present study was to identify risk factors for HF during pregnancy among Chinese women with pre-existing cardiac disease.

2. Materials and methods

A retrospective analysis was conducted of pregnant women who delivered at Shanghai Obstetrical Cardiology Intensive Care Center, Shanghai, China, between January 1, 1993, and December 31, 2013. All pregnant women with cardiac disease were eligible for inclusion in the present analysis. Cardiac conditions included congenital heart disease (CHD), rheumatic heart disease, cardiomyopathy, cardiopathy induced by severe pre-eclampsia, cardiac disease associated with systemic lupus erythematosus, cardiac disease associated with hyperthyroidism, and mixed connective tissue disease accompanied by PAH. Cardiopathy induced by severe pre-eclampsia is a pregnancy-specific condition that is associated with the acute onset of HF with left ventricular dysfunction among previously healthy women. A diagnosis of severe pre-eclampsia was made when the systolic blood pressure was at least 160 mm Hg, the diastolic blood pressure was at least 110 mm Hg, proteinuria (≥ 2 g/24 hours) was noted, or there was end-organ dysfunction [6]. Women within the first 20 weeks of pregnancy were excluded from the analysis, as were those who voluntarily underwent induced abortion. Owing to the retrospective design, neither ethical approval nor informed consent was required.

Shanghai Obstetrical Cardiology Intensive Care Center was opened in 1993 with the approval of the Shanghai Health Bureau. Based at Renji Hospital (affiliated with Shanghai Jiao Tong University School of Medicine), this center serves pregnant women with cardiac disease. Most patients are from Shanghai and Eastern China.

* Corresponding author at: Department of Obstetrics and Gynecology, Renji Hospital, School of Medicine of Shanghai Jiaotong University, No.1630, Dongfang Road, Shanghai, 200127, China. Tel.: +86 13816109700; fax: +86 2168383073.

E-mail address: linjhuarj@126.com (J. Lin).

Information for the present analysis was obtained through review of the institutional database, into which data had been entered on discharge of each patient. Baseline data had been collected before pregnancy or at the first prenatal visit. Subsequent data collection occurred during follow-up until delivery. Baseline data included age, parity, weeks of pregnancy, previous cardiac events (i.e. HF or sustained symptomatic arrhythmia before pregnancy), type of cardiac disease, NYHA functional classification [7], previous cardiac surgery, cardiac medications, results of physical examinations, oxygen saturation level of the blood, and results from standard electrocardiography, dynamic (Holter) electrocardiography, and echocardiography.

Neonatal events were classified as premature delivery (<37 weeks), low weight for gestational age (<10th percentile), neonatal asphyxia (5-minute Apgar score <7), fetal death (≥ 20 weeks), or neonatal death (within 28 days of delivery).

The data were analyzed using SPSS version 17.0 (SPSS Inc, Chicago, IL, USA). Baseline data are expressed as means with standard deviations; categorical data are expressed as percentages. Comparison of enumeration data was performed using the χ^2 test. Independent predictors of HF were analyzed in a logistic regression model. Univariate predictors were history of HF before pregnancy, NYHA functional class greater than II, any form of sustained symptomatic tachyarrhythmia or bradyarrhythmia requiring treatment, uncorrected shunt (atrial septal defect, ventricular septal defect, or patent ductus arteriosus), corrected or uncorrected cyanotic heart disease, moderate-to-severe pulmonary stenosis, moderate-to-severe pulmonary regurgitation, moderate-to-severe aortic stenosis, moderate-to-severe aortic insufficiency, moderate-to-severe mitral stenosis, moderate-to-severe mitral insufficiency, moderate-to-severe tricuspid insufficiency, oxygen saturation levels less than 90%, PAH (systolic pressure >50 mm Hg [moderate] or >80 mm Hg [severe]), cardiomyopathy (hypertrophic, dilated, or peripartum), mechanical valve replacement, and twin pregnancy. Potential risk factors identified in the univariate analysis were then tested in a multivariate logistic regression model. For both models, an odds ratio (OR) greater than 1.00 was indicative of a risk factor for HF. $P < 0.05$ was considered statistically significant.

3. Results

Overall, 1086 pregnant women with cardiac disease were identified. The main types of cardiac disease were CHD, rheumatic heart disease, cardiomyopathy, and cardiopathy induced by pre-eclampsia (Table 1). Cardiac surgery had been performed before pregnancy among 324 (29.8%) of the 1086 patients; 8 (0.7%) had undergone two operations on two different occasions and 11 (1.0%) had undergone two operations on one occasion. Surgical interventions included closure of shunts repair (204 [18.8%] patients), mitral valve replacement (40 [3.7%]) or repair (19 [1.7%]), tricuspid valve replacement (1 [0.1%]) or repair (6 [0.6%]), combined valve replacement (5 [0.5%]), relief of pulmonary stenosis (10 [0.9%]), provision of a pacemaker (3 [0.3%]), aortic balloon dilation (1 [0.1%]), aortic valve replacement (8 [0.7%]), radical correction of tetralogy of Fallot (35 [3.2%]), relief for right ventricular outflow tract obstruction (1 [0.1%]), excision of left atrial myxoma (1 [0.1%]), and correction of large blood vessel anomaly (1 [0.1%]). The operative procedures were not detailed in the medical record for 8 [0.7%] patients. In all, 318 (29.3%) patients received more than one cardiac medication (Table 1).

Among the 1086 women, 116 (10.7%) developed HF. The mean age of these 116 women was 28.00 ± 4.69 years (range 16–44). Most of the women with HF were primiparas and had a NYHA functional class of I–II (Table 1).

Despite active treatment, maternal deaths from HF were recorded among 12 patients (Table 2); six of these women had CHD. Patients were transferred to Shanghai Obstetrical Cardiology Intensive Care Center in a critical condition, with the exception of two patients with severe PAH and one with hypertrophic cardiomyopathy who had declined an

Table 1
Baseline characteristics of the study population.^a

Characteristic	Total cohort (n = 1086)	With heart failure (n = 116)	Without heart failure (n = 970)
Age, y			
18–35	1004 (92.4)	101 (87.1)	903 (93.1)
<18 or >35	82 (7.6)	15 (12.9)	67 (6.9)
Parity			
Primipara	842 (77.5)	80 (69.0)	762 (78.6)
Multipara	244 (22.5)	36 (31.0)	208 (21.4)
New York Heart Association functional class			
I–II	1065 (98.1)	106 (91.4)	959 (98.9)
III	21 (1.9)	10 (8.6)	11 (1.1)
Length of pregnancy at delivery, wk			
20–27	51 (4.7)	23 (19.8)	28 (2.9)
28–36	215 (19.8)	65 (56.0)	150 (15.5)
≥ 37	820 (75.5)	28 (24.1)	792 (81.4)
History of heart failure before pregnancy	48 (4.4)	28 (24.1)	20 (2.1)
Previous surgical interventions	324 (29.8)	6 (5.2)	318 (32.8)
Type of heart disease			
Congenital heart disease	789 (72.7)	31 (26.7)	758 (78.1)
Rheumatic heart disease	164 (15.1)	27 (23.3)	137 (14.1)
Cardiomyopathy	57 (5.2)	11 (9.5)	46 (4.7)
Cardiopathy induced by pre-eclampsia	56 (5.2)	44 (37.9)	12 (1.2)
Cardiac disease associated with	15 (1.4)	1 (0.9)	14 (1.4)
hyperthyroidism			
Cardiopathy induced by systemic lupus erythematosus	4 (0.4)	1 (0.9)	3 (0.3)
Mixed connective tissue disease accompanied by pulmonary arterial hypertension	1 (0.1)	1 (0.9)	0
Cardiac medication			
None	768 (70.7)	0	768 (79.2)
Digoxin	160 (14.7)	98 (84.5)	62 (6.4)
Diuretic	228 (21.0)	116 (100.0)	112 (11.5)
Vasodilation	134 (12.3)	87 (75.0)	47 (4.8)
Antiarrhythmic	93 (8.6)	19 (16.4)	74 (7.6)
Anticoagulant	46 (4.2)	4 (3.4)	42 (4.3)
Comorbidities			
Anemia	159 (14.6)	38 (32.8)	121 (12.5)
Diabetes mellitus, hypertension, or nephritis	19 (1.7)	0	19 (2.0)

^a Values are given as number (percentage).

induced abortion (suggested on the basis of a cardiac function evaluation during early pregnancy) and continued with a high-risk pregnancy.

A total of 123 neonatal complications were recorded among the 116 patients with HF. The most frequent neonatal complication in this group

Table 2
Maternal deaths among patients with heart disease.

Patient	Age, y	Length of pregnancy at delivery, wk ^a	Primary event
1	27	35 ⁺⁴	Severe pre-eclampsia with scoliosis
2	33	32 ⁺³	Patent ductus arteriosus with severe chest deformity
3	20	37 ⁺³	Peripartum cardiomyopathy
4	26	34 ⁺³	CHD, PAH, Eisenmenger syndrome
5	32	23 ⁺³	Peripartum cardiomyopathy
6	24	34 ⁺³	Cyanotic CHD
7	36	27 ⁺⁰	Mixed connective tissue disease accompanied by PAH
8	23	26 ⁺⁶	Ventricular septal defect with severe PAH
9	31	20 ⁺³	Arterial septal defect with severe PAH
10	24	30 ⁺⁵	Hypertrophic cardiomyopathy
11	23	24 ⁺³	CHD, repair of ventricular septal defect and mitral valve replacement, severe PAH
12	29	30 ⁺³	Rheumatic heart disease, mitral valve replacement, severe PAH

Abbreviations: CHD, congenital heart disease; PAH, pulmonary arterial hypertension.

^a Superscript numbers indicate number of days past previous whole week.

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