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Arrhythmias in Pregnancy. Experience of the Multidisciplinary Team

Abstract

Background. Arrhythmia is the main cause of pregnancy-related hospitalizations. Potential risk of arrhythmias during pregnancy is associated with hypercoagulation and increased risk of thromboembolism.

The aim. To increase patients' safety and to improve maternal and perinatal outcomes by choosing the optimal medical strategy.

Methods. We present the experience of multidisciplinary care for 54 pregnant and parturient women (32 with tachy-, 20 with bradyarrhythmia and 2 with ventricular asynchrony) who were admitted to the cardiac surgery facility from December 2013 to February 2022. Pacemakers were implanted in 15 cases of complete atrioventricular block, radiofrequency ablation was performed in 12 cases.

Results. There were no near misses and maternal losses in our group of patients. Two programmed perinatal losses were provided in patients with rhythm disorders and complex congenital heart defects. Type and place of delivery were chosen by the multidisciplinary team. There were nine childbirths at a specialized cardiac surgery clinic. There were no perinatal losses among patients who underwent rhythm interventions. In our group of patients, electrical cardioversion was performed in three cases, the pregnancies ended successfully with the birth of healthy newborns.

Conclusions. Arrhythmias in all trimesters of pregnancy and the postpartum period are a common reason for seeking medical attention and hospitalization during pregnancy. Most of the arrhythmias are hemodynamically insignificant and don't require hospitalization. Maternal risk stratification of major cardiac events during pregnancy, childbirth and the postpartum period is the cornerstone for choosing a strategy of medical care for pregnant women with arrhythmias. Patients with hemodynamic manifestations of tachy- and bradyarrhythmias, as well as patients with life-threatening types of rhythm disturbances are in the focus of attention of pregnancy heart team. Preconceptional management of patients with life threatening arrhythmias is the best type of care in these patients. Pregnancy and delivery in high-risk class patients should be managed in an experienced center with on-site interventional electrophysiology techniques. Rhythm interventions have extremely limited indications and can be conducted when less invasive treatment strategy is unsuccessful.

Keywords: *rhythm disturbances, gravidity, strategy of care, pregnancy heart team, maternal and perinatal outcomes.*

Introduction. Approximately 50% of women experience heart palpitations over the course of pregnancy. However, sustained tachycardias, which require specific treatment, occur approximately in 2-3 per 1,000 pregnancies, while pathologic bradycardia is quite rare at around 1/20,000 [1]. Any type of arrhythmia is the main reason of pregnancy-related hospitalizations in the US and occurs in 50-90 per 100,000 pregnant women. Patients with atrial fibrillation (AF) and supraventricular tachycardia (SVT) are hospitalized more often, while patients with paroxysmal ventricular tachycardia (VT) are admitted less often, even though VT is the most common cause of maternal and perinatal complications [7].

During pregnancy blood volume increases by 30-40%, and at the end of the second trimester it is 1,200-1,600 ml more than before pregnancy. Blood volume increase can cause atrial overload, which could be significantly arrhythmogenic [2]. Arrhythmias lead to dysfunction in myocardial contraction synchronization, thus decrease cardiac output. This can decrease oxygenation of tissues and organs. Decreased placenta perfusion can lead to intrauterine growth restriction and/or intrauterine fetal death [8].

Changes in the levels of sex steroid hormones that take place during pregnancy can also have antiarrhythmic effect on myocardium. Progesterone has protective effect against drug-induced arrhythmias, whilst estrogen potentiates medications that prolong QT interval [4]. Moreover, it is proven that estrogen induces growth of the number of adrenergic receptors in myocardium [9]. Increased catecholamine concentration in plasma and sensitivity of adrenoceptors, as well as hormonal and emotional changes are observed during pregnancy. Inheritance can also play an important role in the occurrence of arrhythmias. Catecholaminergic polymorphic ventricular tachycardia, inherited arrhythmia syndrome caused by autosomal dominant mutations can lead to fatal tachyarrhythmias (bidirectional VT, polymorphic ventricular extrasystoles or VT caused by catecholamine excretion, for instance, during physical exercise) [3]. Such patients can suffer from sudden cardiac arrest or loss of consciousness.

Preconditions for arrhythmias occurrence during pregnancy could be congenital or acquired, structural or non-structural. Structural are congenital heart defects (CHD) which cause re-entry or acquired valve diseases (resulting from infective endocarditis and rheumatic fever), cardiomyopathies. Non-structural factors of arrhythmias in pregnancy include congenital rhythm disorders (dual additional atrioventricular pathways, Wolff-Parkinson-White (WPW) syndrome, channelopathies) or acquired pathological states (degenerative changes of heart conduction system, acquired prolonged QT syndrome, metabolic disorders, drug overdose, etc.).

The number of fertile women with congenital structural heart defects increases annually due to improvements in the methods of surgical and medical care.

Such pathology as hypertrophic or dilated cardiomyopathy (including periportal), episodes of venous thromboembolism,

thyroid gland diseases, and anemia can also trigger arrhythmias in pregnancy. Pregnancy increases the risk of onset and aggravate the flow of SVT as well. This risk is higher in patients with congenital conditions like WPW syndrome.

Potential risk of arrhythmias during pregnancy is associated with hypercoagulation and increased risk of thromboembolism. Pregnant women with paroxysmal SVT have worse obstetric and perinatal outcomes compared to healthy pregnant women. Maternal mortality in patients with CHD is higher than in healthy pregnant women, while arrhythmia is the most common cardiac event [5].

The aim. To increase patients' safety and to improve maternal and perinatal outcomes by choosing the optimal medical strategy for pregnant patients with different types of arrhythmias.

Materials. National pregnancy heart team provided outpatient care to 4,471 pregnant women with cardiac pathology from December 2014 to February 2022. Women with arrhythmias were one of the largest groups in this study and accounted for 6.1% (n=274). Most of these patients belonged to the groups of low cardiovascular risk and did not require hospitalization.

Fifty-one pregnant and three parturient women with different types of arrhythmias were admitted for multidisciplinary care to the National Amosov Institute of Cardiovascular Surgery of the National Academy of Medical Sciences of Ukraine from December 2013 to February 2022. Mean patient's age was 28.7±7 years, mean pregnancy term was 24.5±8 weeks of gestation (from 5 to 36 weeks). The pregnancy was first (primigravida) in 20 women (37%), second in 23 women (8 had a history of successful delivery, 2 had miscarriages at early term), third in 6 women (only 4 had a history of successful delivery and 1 had stillbirth), 5 patients had more than four pregnancies in the history with successful deliveries and spontaneous abortions.

Most patients had symptomatic tachyarrhythmias (n=32), while cases of bradycardia due to complete atrioventricular block or sinus node dysfunction were also observed (n=20). Two patients had ventricular asynchrony with severe left ventricular failure (Fig. 1).

We studied trigger factors of arrhythmias. Data is shown in Table 1.

Table 1
Etiological factors of arrhythmias during pregnancy

Congenital factors		Acquired factors		Comorbidity	Idiopathic arrhythmias
Structural	Non-structural	Structural	Non-structural		
5	22	9	2	2	14

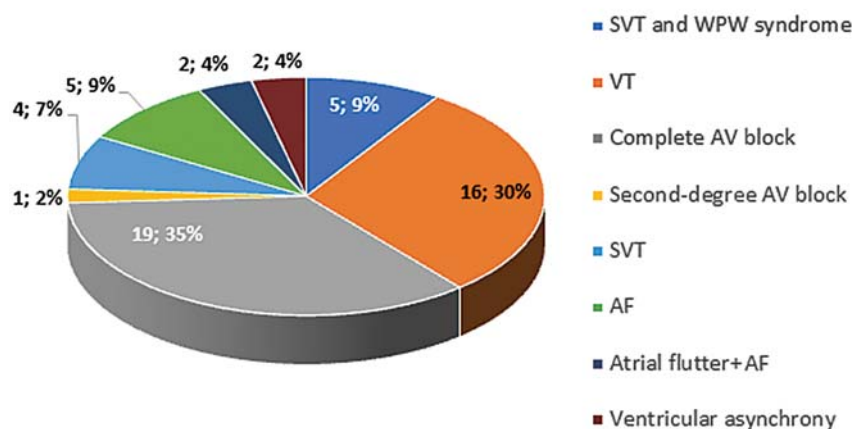


Fig. 1. Types of cardiac arrhythmias in the group of pregnant patients AV block, atrioventricular block.

Pregnant women with **structural** CHD that probably induced the onset of arrhythmias included 5 patients with corrected and uncorrected CHD, such as double outlet right ventricle, bicuspid aortic valve (complete atrioventricular block), patent ductus arteriosus (PDA) with severe pulmonary hypertension (persistent arterial flutter), pulmonary atresia (paroxysmal VT) and mitral valve prolapse with mitral insufficiency (paroxysmal VT). **Non-structural** congenital malformations of conducting system included congenital complete AV block (n=12), WPW syndrome (n=5), monomorphic VT (n=1), paroxysmal SVT with additional conduction pathway (n=4). Patients with **structural** acquired heart defects included women with heart tumor (recurrent VT) (n=1), dilated cardiomyopathy (paroxysmal VT) (n=5), iatrogenic complete AV block after CHD and acquired heart defect corrections (n=3). **Non-structural** heart pathology included two cases with history of myocarditis (complete AV block and AF). Comorbidity was observed in two patients with thyroid gland diseases (permanent AF and paroxysmal VT).

Nine patients had history of previous interventions: pacemaker implantation (n=5), implantable cardioverter-defibrillator (ICD) placement (n=1) and catheter ablation (n=3).

All the patients admitted to the cardiac surgery facility received multidisciplinary care with mandatory team involvement of electrophysiologist, obstetrician-gynecologist, cardiologist, cardiac surgeon, neonatologist. Management strategy was personalized in all cases in accordance with current recommendations for treatment of pregnant women with heart arrhythmias. Twelve women received conservative antiarrhythmic therapy followed by childbirth at highly specialized obstetrician center, 9 patients underwent caesarean section (CS) with arrhythmological support in cardiac surgery facility, 33 patients underwent rhythm interventions followed by multidisciplinary care and delivery in highly specialized obstetrician center, two underwent rhythm surgery followed by CS at cardiac surgery facility (Fig. 2).

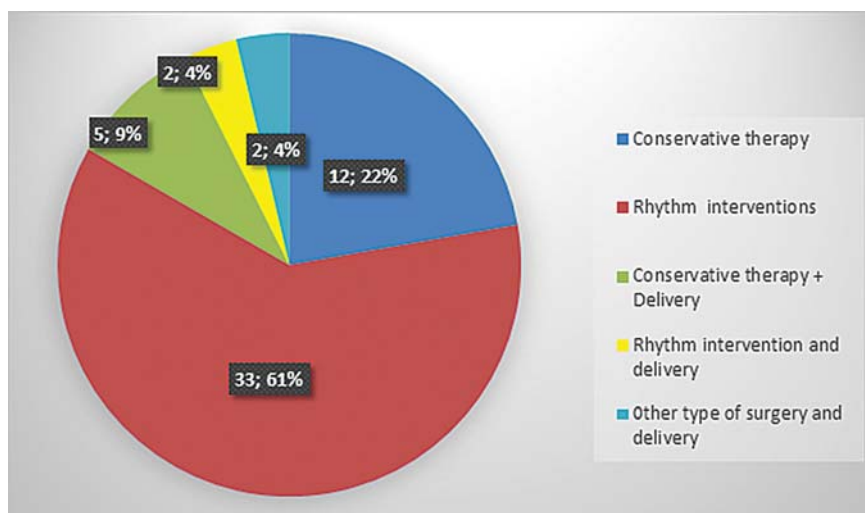


Fig. 2. Types of medical care of pregnant/parturient women with arrhythmias

Table 2*Types of multidisciplinary care for pregnant women with tachyarrhythmias*

Risk level	Type of tachycardia	No. of patients	Type of support
Low n=17	Paroxysmal SVT	2	Conservative
	AF	3	ECV at 8, 13, 30 weeks + conservative
		2	Conservative
	Atrial flutter	1	Conservative
	Idiopathic VT	2	Conservative
		1	EP study at 30 weeks
		2	Conservative + CS at a cardiac surgery institution
	SVT+VT	1	Conservative
WPW syndrome + SVT	2	Conservative	
Medium n=9	HUn SVT	6	RFA at 19, 21, 24, 25, 29, 30 weeks
	Cardiac tumor with the history of VT after ICD implantation	1	ICD generator change at 18 weeks of gestation + CS at a cardiac surgery institution followed by heart transplantation
	VT with structural heart defects	1	Conservative
		1	RFA postpartum
High n=6	HUn VT with structural heart defects	2	ICD implantation in postpartum
		1	RFA at 27 week
	HUn VT / Torsade de pointes	3	RFA at 19, 29, 31 weeks

ECV, electrical cardioversion; EP study, electrophysiological study; HUn, hemodynamically unstable; RFA, radiofrequency ablation.

In the group of patients with bradyarrhythmias (n=20), the choice of multidisciplinary care was as follows. In all the patients with complete AV block who had a slow wide QRS complex or severe symptoms, pacemaker was implanted. In our series of pacemaker implantations, 14 were permanent and 1 was temporary with subsequent removal. All the interventions were performed in the II-III trimesters of gestation (15-35 weeks). Five patients received conservative therapy due to the absence of life threatening features and indications for surgery during pregnancy.

Patients with tachyarrhythmias were stratified according to guidelines of the European Society of Cardiology to choose the optimal type of medical care. According to the identified risk our multidisciplinary team determined a certain type of patient's care (Table 2).

Radiofrequency ablation was performed in 12 cases: in 10 pregnant and 2 parturient patients. Indications for RFA in pregnancy were hemodynamically unstable SVT refractory to drug therapy (n=6), poorly tolerated SVT with severe symptoms (n=1), hemodynamically unstable VT with structural heart defects (n=2), hemodynamically unstable ventricular pirouette-type tachycardia (n=3). ICD implantation (n=3) was performed in

patients with VT: in two cases in the postpartum period, and in one case the ICD was replaced at 18 weeks of gestation.

All arrhythmological procedures were performed in II-III trimesters or in early postpartum period. In 32 cases interventions were performed with fetus in utero and mandatory fetal monitoring before and after intervention by cardiotocography and/or fetal echocardiography. Parturient women underwent interventions in cases of paroxysmal VT, in one case of peripartum cardiomyopathy and severe left ventricular dysfunction (left ventricular ejection fraction 12%), and in a case with WPW syndrome and paroxysmal SVT.

Local combined anesthesia with low dose of intravenous tranquilizers was applied. Antibiotics were not used for preventive care. Following traditional methods for minimizing irradiation were used during the interventions:

- The use of X-ray protection for fetus
- Low dose irradiation
- The use of anterior-posterior projections
- Minimizing of procedure exposure time
- Experienced staff
- Maximum possible collimation in the area of interest

Results*Short-term results*

Maternal and perinatal outcomes of pregnancy in patients are shown in Table 3.

Table 3

Maternal and perinatal outcomes of pregnancy in patients with rhythm disorders

		n=54
Maternal outcomes	Good	54
	Near miss	-
	Maternal mortality	-
Perinatal outcomes	Good	52
	PPL	2
	Spontaneous abortion / fetal death	-

PPL, programmed perinatal loss.

There were no near misses and maternal losses in our group of patients. Two programmed perinatal losses (abortions) were provided in a patient with PDA, severe pulmonary hypertension, permanent atrial flutter, and moderate myocardial dysfunction after endovascular closure of PDA at the 9th week of gestation as well as in a patient at the 12 week of gestation with single ventricle after hemodynamic correction (Fontan procedure) and a history of pacemaker implantation. In all other patients, according to the chosen medical strategy, delivery was taken either at high-specialized obstetrician institute, local perinatal centers or cardiac surgery facility under arrhythmological supervision. Type and place of delivery were chosen by the multidisciplinary team after considering the clinical situation and existing guidelines.

There were 9 cases of childbirths at a specialized cardiac surgery clinic: in patients with the history of three cardiopulmonary surgeries, mechanical aortic valve prosthesis and iatrogenic complete AV block with pacemaker implantation; patient with mitral valve prolapses, episodes of VT, frequent ventricular extrasystoles with moderate heart failure; woman with an intracardiac tumor, episodes of VT after ICD implantation; patient with single ventricle after the Fontan procedure and pacemaker implantation with mild dysfunction of a single ventricle; woman with congenital complete AV block, bicuspid aortic valve with moderate stenosis, post-stenotic dilation of the ascending aorta.

There were no perinatal losses among patients who underwent rhythm interventions. The patient with WPW syndrome and paroxysmal SVT after RFA performed at 19 weeks underwent emergency CS at 29 weeks of gestation due to threatening miscarriage. She gave birth to two extremely premature neonates (weight 1000 g each, 34 cm, Apgar score of 4). Both babies were discharged in good con-

dition from the center. Four years follow-up showed good results for the children and the mother.

In our group of patients, electrical cardioversion was performed in three cases: in patients with tachysystolic AF at 8, 13, and 30 weeks of gestation. In all cases, the pregnancy ended successfully with the birth of healthy newborns. In the other three cases, we used drug-induced cardioversion (1% ATP solution) to rapidly arrest the SVT attack.

Discussion. Risk stratification of pregnant women with arrhythmias and the choice of the optimal personalized strategy for their multidisciplinary care are the cornerstone in achieving safe ending of pregnancy for both a mother and a baby.

Most arrhythmias belong to the II class maternal cardiovascular risk (the risk of major cardiac event during pregnancy is about 5.7-10.5%), VT is classified as the III class risk (the risk of major cardiac event during pregnancy is 19-27%) [5]. However, it is important to consider the presence of structural heart pathology or myocardial dysfunction during risk stratification, which are also accompanied by life-threatening arrhythmias.

Thus, pregnancy and childbirth in patients with medium and high risk of tachyarrhythmias should be supervised by a multidisciplinary team with the participation of high-experienced invasive electrophysiologist. High-risk patients should be managed in an experienced center with on-site cardiac surgery and invasive electrophysiology techniques. Delivery should be taken in an operating room with availability of transfer to cardiac intensive care unit.

The European Society of Cardiology recommendations define the basic principles of medical supervision of pregnancy and childbirth with certain types of arrhythmias. Of course, the optimal prevention of major cardiac events during pregnancy is careful pregravid preparation. Thus, catheter ablation was performed before pregnancy in 3 women with recurrent SVT. One of them required a redo procedure at 29 weeks of gestation due to hemodynamically unstable arrhythmia refractory to drug therapy.

The emergency care for any type of hemodynamically unstable tachyarrhythmia suggests immediate electrical cardioversion, which is quite safe for the fetus. The risks of fetal arrhythmia or premature birth are low. Immediate electrical cardioversion is also recommended for sustained, both stable and unstable VT, AF with preexcitation [6]. In our group of patients, electrical cardioversion was performed in two cases: for patients with tachysystolic AF at 8 and 13 weeks of gestation. In both cases, the pregnancy ended successfully with the birth of healthy newborns. In other three cases, we used medical cardioversion (1% ATP solution) to quickly relieve the SVT attack.

In the case of conservative management of pregnant women with tachyarrhythmia we followed the principles of existing guidelines:

- We avoided any antiarrhythmic drug therapy during the first trimester of pregnancy.

- Beta-1-selective blockers (excluding atenolol) or verapamil were used to prevent SVT episodes. For patients with WPW syndrome we used propafenone or flecainide.
- Beta-1-selective blockers (excluding atenolol) were used to control the heart rate in SVT and AF.
- Patients with AF underwent therapeutic anticoagulation with heparin or vitamin K antagonists, depending on gestational age.

There are strict limitations for catheter ablation during pregnancy according to the modern international guidelines [5] due to potentially negative effects of irradiation on the fetus. In our study, we performed RFA for pregnant women only in cases of drug-refractory SVT and SVT poorly tolerated by the patient, and in cases of unstable (monomorphic) VT combined with structural heart defects or pirouette-type tachycardia. All such interventions were performed using electro-anatomical mapping systems and "traditional" methods of minimizing the impact of ionizing radiation on the fetus.

According to current guidelines [5], isolated congenital third-degree AV block is associated with favorable outcome during pregnancy, especially with a narrow QRS complex. Temporary ventricular pacing during delivery is not required for stable patients with complete AV block, however, it is recommended for some women with symptoms due to the risk of severe bradycardia and syncope [5]. At the same time, women with complete AV block who have a slow, wide QRS complex should have pacemaker implanted during pregnancy. Pacemaker can be implanted at any stage of pregnancy using echocardiography or electro-anatomical navigation, avoiding fluoroscopy to relieve the symptoms of bradycardia [10]. In our cases, 12 pacemakers were implanted during pregnancy for permanent and 1 for temporary rhythm management. We used electro-anatomical navigation and techniques to protect the fetus from ionizing irradiation. All the pregnancies in this group ended successfully with the birth of healthy babies. Long-term results are also good. Given that spinal anesthesia at CS might be accompanied by bradycardia of varying degrees (up to 13%) [1], the delivery in patients with complete AV block without implanted pacemaker was taken under general anesthesia.

Conclusions. Arrhythmias in all trimesters of pregnancy and the postpartum period are a common reason for seeking medical attention and hospitalization during pregnancy. Most of the arrhythmias are hemodynamically insignificant and don't require hospitalization.

Stratification of maternal risk of major cardiac events in pregnancy, childbirth and the postpartum period is the basis for choosing a strategy of medical care of such pregnant women. Patients with hemodynamic manifestations of tachy- and bradyarrhythmias, as well as patients with life-threatening types of rhythm disturbances are in the focus of attention of pregnancy heart team. High-risk arrhythmias

include hemodynamically unstable ventricular tachycardia and pirouette-type tachycardia.

Multidisciplinary supervision of high-risk patients throughout pregnancy is an important element of the patients' safety. Such patients should be managed at an experienced center with on-site cardiac surgery. Delivery should be taken in an operating room with availability of transfer to cardiac intensive care unit.

Rhythm interventions have extremely limited indications and can be conducted when the less invasive treatments are found ineffective. Interventions during pregnancy are performed using electro-anatomical mapping systems and techniques to protect the fetus from ionizing radiation.

Clear implementation of modern guidelines for the management of pregnant women with cardiac pathology and a personalized approach make it possible to achieve successful ending of pregnancy in most cases.

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Порушення ритму серця є основною причиною госпіталізації у період вагітності

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Резюме

Мета дослідження – підвищити безпеку пацієнтки й покращити материнські та перинатальні результати шляхом вибору оптимальної медичної стратегії.

Методи. Представлено досвід мультидисциплінарного лікування 54 вагітних і породіль (32 з тахі-, 20 з брадиаритмією і 2 з асинхронією шлуночків), яких було госпіталізовано до кардіохірургічного стаціонару з 12.2013 по 02.2022 р. У 15 випадках повної AV-блокади ми виконували встановлення штучного водія ритму серця, у 12 випадках – радіочастотну абляцію.

Результати. У нашій групі пацієнток не було жодних near-miss та випадків материнської смертності. Проведено дві програмовані перинатальні втрати у пацієнток із порушеннями ритму та складною вродженою вадою серця. Тип і місце пологів обирала мультидисциплінарна команда. У спеціалізованій кардіохірургічній клініці було проведено 9 пологів. Перинатальних втрат серед пацієнток, які перенесли корекцію порушень ритму не відзначено. У нашій групі пацієнток електрична кардіоверсія виконана у 3 випадках, вагітність завершилася благополучно народженням здорових новонароджених.

Висновки. Аритмії у всіх триместрах вагітності та післяпологовому періоді є частою причиною звернення до лікаря та госпіталізації під час вагітності. Більшість аритмій гемодинамічно незначущі і не потребують госпіталізації. Стратифікація материнського ризику основних серцевих подій під час вагітності, пологів і післяпологового періоду є наріжним каменем для вибору стратегії надання медичної допомоги вагітним з аритміями. У центрі уваги команди акушерської кардіології – пацієнтки з гемодинамічними проявами тахі- та брадиаритмій, пацієнтки із загрозливими для життя типами порушень ритму. Корекція життєзагрозливих аритмій до настання вагітності є найкращим видом догляду за такими пацієнтками. Спостерігати вагітність і проводити пологи у пацієнток групи високого ризику слід у спеціалізованому центрі з інтервенційною електрофізіологією на місці. Показання до аритмологічних втручань під час вагітності надзвичайно обмежені і можуть проводитися, коли менш інвазивна стратегія лікування є неефективною.

Ключові слова: порушення ритму, вагітність, стратегія лікування, команда акушерської кардіології, материнські та перинатальні результати.

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