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Fetal Outcome in Pregnancy-Induced Hypertension and Gestational Diabetes Mellitus: A Comparative Study

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ABSTRACT

Background: Pregnancy-induced hypertension (PIH) and Gestational Diabetes Mellitus (GDM) are among the most common medical complications of pregnancy and are significant contributors to adverse perinatal outcomes. Stillbirth remains a major public health concern, particularly in pregnancies complicated by hypertensive disorders. Comparative evaluation of fetal outcomes in PIH and GDM is essential for improving antenatal risk stratification and management.

Methods: This hospital-based observational comparative study was conducted at Rama Medical College and Hospital, Kanpur, from April 2016 to December 2017. A total of 370 pregnant women who delivered either vaginally or by caesarean section were included. The study population comprised 170 cases of PIH, 50 cases of GDM, and 150 controls. PIH cases were further classified into mild pre-eclampsia, severe pre-eclampsia, and eclampsia. Fetal outcome was recorded as stillbirth or live birth. Statistical analysis was performed using the Chi-square test, and p-values <0.05 were considered statistically significant.

Results: Stillbirth was observed in 19.4% of PIH cases, 2.0% of GDM cases, and 7.3% of controls. The differences in fetal outcomes between the PIH and control groups, as well as between the GDM and control groups, were statistically significant (p=0.0001). Within the PIH group, stillbirth rates increased with disease severity, being highest in severe pre-eclampsia (30.0%) and eclampsia (29.5%), compared to mild pre-eclampsia (9.3%). This association was statistically significant (p=0.003).

Conclusion: Pregnancy-induced hypertension, particularly in its severe forms, is strongly associated with an increased risk of stillbirth. Gestational Diabetes Mellitus was associated with comparatively favorable fetal outcomes, underscoring the importance of early diagnosis and effective management. Enhanced antenatal surveillance and severity-based risk stratification are crucial for reducing perinatal mortality.

Key-words: Pregnancy-Induced Hypertension, Gestational Diabetes Mellitus, Stillbirth, Fetal Outcome, Pre-eclampsia, Eclampsia

INTRODUCTION

Pregnancy is a complex physiological state that requires extensive maternal cardiovascular, metabolic, and endocrine adaptations to support fetal growth and development.

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Despite these adaptations, medical disorders complicating pregnancy remain a major cause of maternal and perinatal morbidity and mortality worldwide. Among these, Pregnancy Induced Hypertension (PIH) and Gestational Diabetes Mellitus (GDM) are the most frequently encountered complications and together account for a significant proportion of adverse pregnancy outcomes, particularly in low- and middle-income countries [1,2].

Pregnancy-induced hypertension refers to a spectrum of hypertensive disorders that develop after 20 weeks of gestation in previously normotensive women and

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includes gestational hypertension, pre-eclampsia, and eclampsia. The fundamental pathophysiology of PIH is rooted in abnormal placentation, characterized by defective trophoblastic invasion and inadequate remodeling of the spiral arteries [3]. These abnormalities result in high-resistance uteroplacental circulation, leading to placental ischemia, oxidative stress, endothelial dysfunction, and reduced uteroplacental blood flow. Such changes compromise fetal oxygen and nutrient delivery and are strongly associated with adverse fetal outcomes, including intrauterine growth restriction, preterm birth, placental abruption, and stillbirth [4-7].

Gestational Diabetes Mellitus is defined as glucose intolerance of variable severity with onset or first recognition during pregnancy. Maternal hyperglycemia results in increased transplacental glucose transfer, leading to fetal hyperinsulinemia and altered fetal metabolism [8]. These metabolic disturbances predispose the fetus to complications such as macrosomia, birth trauma, neonatal hypoglycemia, and long-term metabolic disorders [9]. Unlike PIH, the adverse fetal effects of GDM can be significantly reduced through early diagnosis, appropriate dietary modification, glucose monitoring, and pharmacological intervention when required [10].

Stillbirth remains one of the most devastating pregnancy outcomes and is widely regarded as a sensitive indicator of the quality of antenatal and intrapartum care. Globally, hypertensive disorders and diabetes in pregnancy are among the leading preventable causes of stillbirth [11]. The mechanisms of fetal demise differ between PIH and GDM. In PIH, placental hypoperfusion, infarction, endothelial injury, and abruptio placentae play a central role [7,12], whereas in GDM, fetal death is more commonly related to poor metabolic control, placental dysfunction, and fetal hypoxia rather than primary placental insufficiency [8].

Several studies have independently evaluated fetal outcomes in pregnancies complicated by PIH or GDM. Previous literature has consistently reported higher perinatal mortality in women with hypertensive disorders of pregnancy, particularly in cases of severe pre-eclampsia and eclampsia [6,12]. Large multicentric studies such as the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study have demonstrated a clear association between maternal hyperglycemia and adverse perinatal outcomes [8]. However, comparative studies evaluating fetal outcomes among PIH, GDM, and normotensive non-diabetic pregnancies within the same population remain limited.

Furthermore, the relationship between the severity of PIH and fetal outcome has not been adequately explored in many hospital-based studies, especially in the Indian context. Stratification of PIH into mild pre-eclampsia, severe pre-eclampsia, and eclampsia is clinically relevant, as disease severity directly influences maternal and fetal risk and guides management decisions [3]. Understanding this association is essential for improving antenatal surveillance and timely intervention.

In developing countries like India, late antenatal registration, inadequate monitoring, and delayed referral continue to contribute to the high burden of PIH-related perinatal mortality [11,13]. Although screening for GDM has improved in recent years, disparities in antenatal care persist, and fetal outcomes remain variable depending on the quality of management provided.

The present study was therefore undertaken to compare fetal outcomes, particularly stillbirth and live birth rates, among pregnancies complicated by Pregnancy Induced Hypertension, Gestational Diabetes Mellitus, and normal pregnancies, and to evaluate the association between the severity of PIH and fetal outcome.

MATERIALS AND METHODS

Research Design- The present study was a hospital-based observational comparative study conducted in the Department of Obstetrics and Gynecology in collaboration with the Department of Pathology at Rama Medical College and Hospital, Kanpur, Uttar Pradesh, India. The study was conducted over 21 months**,** from April 2016 to December 2017**.** The institution is a tertiary care teaching hospital catering to both urban and rural populations, with a high volume of antenatal and intrapartum cases, thereby providing an adequate and diverse study population.

Classification of PIH- Pregnancy-induced hypertension cases were subclassified based on clinical severity into:

- Mild pre-eclampsia
- Severe pre-eclampsia
- Eclampsia

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This subclassification was done to evaluate the association between the severity of hypertensive disorder and fetal outcome.

Control Group- The control group comprised pregnant women who were normotensive, non-diabetic, and had no significant medical or obstetric complications. These women were matched as closely as possible with the study groups in terms of gestational age and mode of delivery. Controls were selected from the same hospital during the same study period to minimize selection bias.

Methodology- All pregnant women admitted to the labor ward or obstetric units of Rama Medical College and Hospital during the study period who fulfilled the inclusion criteria and subsequently delivered either by vaginal route or caesarean section were considered eligible for inclusion. A total of 370 pregnant women were enrolled in the study after applying the inclusion and exclusion criteria. The study population was divided into three groups:

- Pregnancy-Induced Hypertension (PIH) group
- Gestational Diabetes Mellitus (GDM) group
- Control group**,** comprising normotensive, non-diabetic pregnant women

The grouping was done based on clinical diagnosis established during antenatal care and confirmed at the time of admission for delivery.

Inclusion Criteria- The following categories of pregnant women were included in the study:

1. **Gestational Diabetes Mellitus (GDM):** Pregnant women diagnosed with glucose intolerance of variable severity with onset or first recognition during pregnancy, as per standard diagnostic criteria followed by the hospital during the study period.
2. **Gestational Hypertension:** Pregnant women who develop hypertension after 20 weeks of gestation without associated proteinuria or pathological edema.
3. **Pre-eclampsia:** Pregnant women with hypertension after 20 weeks of gestation, accompanied by proteinuria, with or without pathological edema.
4. **Eclampsia:** Pregnant women with pre-eclampsia complicated by convulsions and/or coma not attributable to other neurological causes.
5. **Pre-eclampsia or eclampsia superimposed on chronic hypertension:** Pregnant women with previously undiagnosed chronic hypertension who developed features of pre-eclampsia or eclampsia during pregnancy.
6. **Mode of Delivery:** Only those patients who delivered either vaginally or by caesarean section within the institution were included to ensure complete and reliable outcome data.

Exclusion Criteria- Pregnant women with the following conditions were excluded from the study to eliminate confounding factors that could independently influence fetal outcome:

1. **Pre-existing Diabetes Mellitus**
   - Insulin Dependent Diabetes Mellitus (Type 1)
   - Non-Insulin Dependent Diabetes Mellitus (Type 2)
2. **Pre-existing or Chronic Hypertension**
   - Chronic hypertension
   - Essential hypertension
3. **Renal and Cardiovascular Disorders**
   - Chronic renal disease (including renovascular causes)
   - Coarctation of the aorta
   - Pheochromocytoma
4. **Endocrine Disorders**
   - Thyrotoxicosis
5. **Autoimmune and Connective Tissue Disorders**
   - Systemic lupus erythematosus and other connective tissue diseases
6. **Multiple Gestation**
   - Twin pregnancy or higher-order multiple pregnancies

These exclusion criteria were strictly applied to ensure homogeneity of the study groups and to avoid bias from conditions known to affect placental function and fetal outcome independently.

Data Collection- After obtaining informed consent, detailed clinical information was recorded for each patient using a structured proforma. Data collected included maternal age, parity, gestational age at delivery, clinical diagnosis, and mode of delivery. Relevant antenatal records were reviewed to confirm the diagnosis of PIH or GDM. Blood pressure recordings, urine protein estimation, and blood glucose measurements were documented from hospital records.

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All patients were followed until delivery, and fetal outcomes were recorded immediately after birth. Pregnancy outcome was categorized as stillbirth or live birth. Stillbirth was defined as intrauterine fetal death occurring after the age of viability, as per institutional protocol. Live birth was defined as the complete expulsion or extraction of a fetus showing any evidence of life after delivery.

Outcome Measures- The primary outcome measure was **fetal outcome**, categorized as:

- Stillbirth
- Live birth

Secondary analysis included assessing fetal outcome in relation to PIH severity.

Statistical Analysis- Data were entered into a Microsoft Excel spreadsheet and analyzed using appropriate statistical software. Descriptive statistics were used to summarize the data. Categorical variables were expressed as numbers and percentages. Comparisons of fetal outcome between the PIH, GDM, and control groups were performed using the Chi-square test. The association between PIH severity and fetal outcome was also analyzed using the Chi-square test. A p-value less than 0.05 was considered statistically significant.

Ethical Considerations- The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Institutional ethical clearance was obtained from the Institutional Ethics Committee of Rama Medical College and Hospital, Kanpur, on 12.03.20216**,** before commencement of the study. Written informed consent was obtained from all participants before inclusion in the study. Confidentiality of patient information was strictly maintained throughout the study.

RESULTS

A total of 370 pregnant women fulfilling the inclusion and exclusion criteria were included in the present study. The study population was divided into three groups: PIH group (n=170), Gestational Diabetes Mellitus (GDM) group (n=50), and a Control group comprising normotensive, non-diabetic pregnant women (n=150). All cases were followed up until delivery, and fetal outcomes were recorded. Fetal outcome was categorized as stillbirth or live birth**.** The distribution of pregnancy outcomes among the three study groups is summarized in Table 1.

Table 1: Comparison of the outcome of pregnancy among the groups

Outcome of pregnancy	PIH (n=170)		GDM (n=50)		Controls (n=150)		p-value[1]	
	No.	%	No.	%	No.	%	PIH vs Controls	GDM vs Controls
Still births	33	19.4	1	2.0	11	7.3	0.0001*	0.0001*
Live births	137	80.6	49	98.0	139	92.7		

**Statistically significant (Chi-square test)*

The highest stillbirth rate was observed in the PIH group (19.4%), followed by the control group (7.3%), while the lowest was observed in the GDM group (2.0%). A statistically significant difference in pregnancy outcomes was observed between the PIH and control groups (p=0.0001). Similarly, a significant difference was also found between the GDM and control groups (p=0.0001). Fig. 1 illustrates the comparative distribution of stillbirths and live births among the three groups. The bar graph shows a markedly higher stillbirth rate in the PIH group compared with the GDM and control groups.

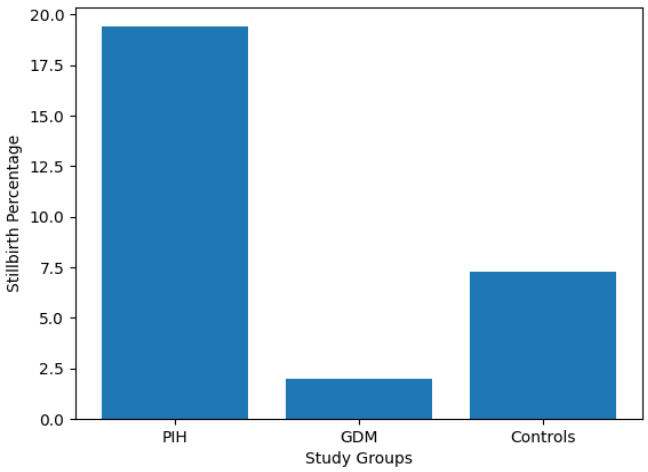

Fig. 1: Comparison of stillbirth rates among study groups.

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Fig. 2 depicts the proportional distribution of fetal outcomes within each group, highlighting the predominance of live births in GDM and control groups and a comparatively higher share of stillbirths in the PIH group.

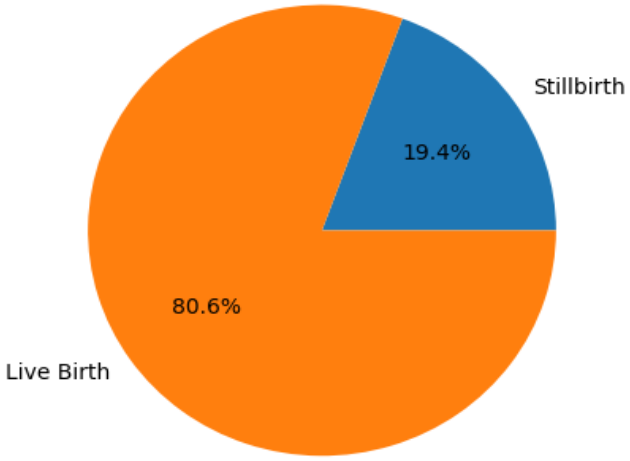

Fig. 2: Pregnancy outcome in the PIH group

The PIH group (n=170) was further subclassified based on clinical severity into mild pre-eclampsia (n=86), severe pre-eclampsia (n=40), and eclampsia (n=44). This subclassification was undertaken to evaluate the relationship between the severity of hypertensive disorder and fetal outcome. The association between fetal outcome and PIH severity is presented in Table 2.

Table 2: Comparison of outcomes of pregnancy with diagnosis among the groups

Diagnosis	No. of patients	Outcome of pregnancy				p-value[1]
		Stillbirth		Live birth		
		No.	%	No.	%	
Mild Preeclampsia	86	8	9.3	78	90.7	0.003*
Severe Preeclampsia	40	12	30.0	28	70.0	
Eclampsia	44	13	29.5	31	70.5	

[1]*Chi-square test, *Significant; *Statistically significant (Chi-square test)*

Stillbirth rates showed a progressive increase with increasing severity of pregnancy-induced hypertension. Mild pre-eclampsia had the lowest stillbirth rate (9.3%), whereas substantially higher rates were observed in severe pre-eclampsia (30.0%) and eclampsia (29.5%). The association between the severity of PIH and fetal outcome was statistically significant (p=0.003). Fig**.** 3 compares stillbirth and live birth rates across mild pre-eclampsia, severe pre-eclampsia, and eclampsia, and clearly demonstrates a marked rise in stillbirth frequency in severe pre-eclampsia and eclampsia compared to mild disease.

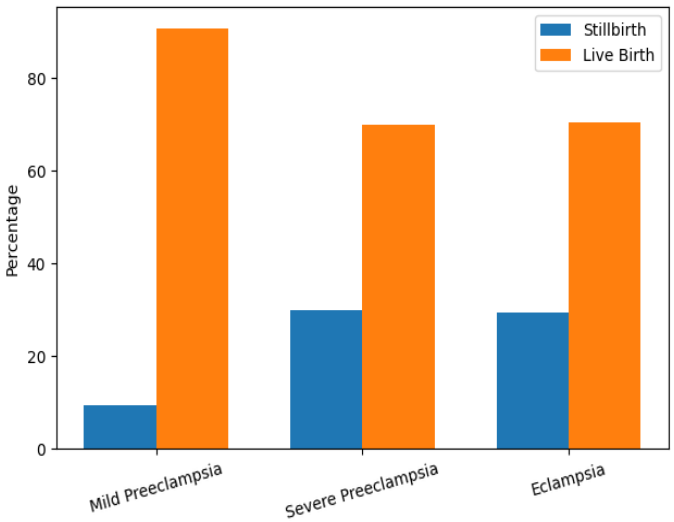

Fig. 3: Fetal outcome according to the severity of PIH

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Fig. 4 illustrates the trend of increasing stillbirth rates with escalating severity of PIH. The curve shows a relatively low slope for mild pre-eclampsia, followed by a steep rise for severe pre-eclampsia and eclampsia, indicating a strong correlation between disease severity and adverse fetal outcome.

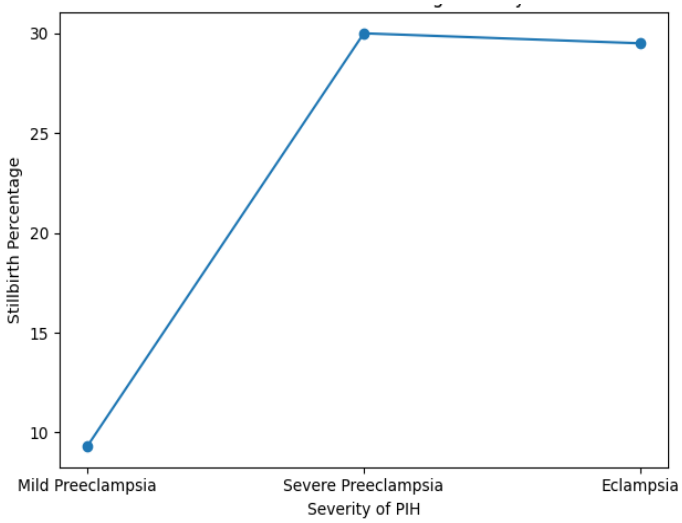

Fig. 4: Trend of stillbirth severity of PIH

When comparing the three major study groups, the risk of stillbirth was highest in PIH**,** intermediate in the control group, and lowest in GDM. The GDM group demonstrated a favorable fetal outcome with a live birth rate of 98%, suggesting effective management and glycemic control in most cases.

DISCUSSION

The present study provides a comprehensive comparative evaluation of fetal outcomes in pregnancies complicated by Pregnancy Induced Hypertension and Gestational Diabetes Mellitus in comparison with normotensive non-diabetic pregnancies. The findings demonstrate that PIH is associated with a significantly higher risk of stillbirth than both GDM and control pregnancies, highlighting the profound impact of hypertensive disorders on fetal survival.

The increased stillbirth rate observed in PIH is consistent with earlier reports identifying hypertensive disorders of pregnancy as one of the leading causes of perinatal mortality worldwide [5,6]. The underlying pathophysiology is primarily related to abnormal placentation and impaired uteroplacental perfusion. Inadequate spiral artery remodeling leads to chronic placental ischemia, oxidative stress, endothelial dysfunction, and activation of inflammatory pathways, ultimately resulting in fetal hypoxia and growth restriction [7]. These placental changes significantly increase the risk of placental abruption and intrauterine fetal demise [12].

In contrast, pregnancies complicated by GDM in the present study showed a comparatively favorable fetal outcome, with a very low stillbirth rate. This observation agrees with previous studies suggesting that early diagnosis and effective glycemic control can substantially reduce adverse fetal outcomes in GDM [8–10]. Improved screening practices, standardized diagnostic criteria, and structured antenatal management protocols likely contributed to the better outcomes observed in this group. These findings underscore the fact that GDM, when adequately managed, poses a relatively lower risk to fetal survival compared to hypertensive disorders of pregnancy.

The control group demonstrated an intermediate stillbirth rate, reflecting the multifactorial nature of fetal loss even in apparently low-risk pregnancies. This finding reinforces the importance of comprehensive antenatal care and vigilant intrapartum monitoring for all pregnant women, irrespective of risk status [13].

A notable strength of the present study is the analysis of fetal outcome in relation to the severity of PIH. A progressive increase in stillbirth rates was observed from mild pre-eclampsia to severe pre-eclampsia and eclampsia. Similar severity-dependent trends have been reported in previous studies, which documented significantly higher perinatal mortality in severe hypertensive disease compared to mild forms [6,14]. This gradient strongly supports the concept that PIH should not be regarded as a single clinical entity and that severity-based stratification is essential for optimal risk assessment and management.

Eclampsia represents the end of the PIH spectrum and is associated with acute maternal complications such as convulsions, coma, and multi-organ dysfunction, all of which can further compromise uteroplacental blood flow [12]. The high stillbirth rate observed in eclampsia cases in the present study is therefore consistent with earlier hospital-based reports from developing countries [11].

The contrasting mechanisms of fetal compromise in PIH and GDM are clinically significant. While PIH primarily affects placental perfusion and oxygen delivery, GDM predominantly alters the fetal metabolic environment [8,15]. This fundamental difference explains the higher

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burden of stillbirth associated with PIH and emphasizes the need for intensified fetal surveillance in hypertensive pregnancies.

The findings of this study have important implications for clinical practice, particularly in resource-limited settings. Early antenatal registration, regular blood pressure monitoring, timely diagnosis of PIH severity, and appropriate timing of delivery are critical strategies for reducing PIH-related perinatal mortality [3,4,13,16]. Risk stratification based on disease severity should be an integral component of antenatal care.

Despite its strengths, the present study has certain limitations. Because this is a single-center hospital-based study, the results may not be fully generalizable. The study focused primarily on stillbirth and live birth as outcome measures and did not evaluate other neonatal outcomes such as birth weight, Apgar scores, or neonatal intensive care admission. Additionally, placental histopathological correlation and long-term neonatal outcomes were not assessed, which could have provided further insight into the mechanisms of fetal compromise [17,18].

SUMMARY

Stillbirth was observed significantly more often in pregnancies complicated by PIH when compared with both GDM and control groups. Among the three groups, pregnancies affected by GDM demonstrated the most favorable fetal outcomes, with the lowest incidence of stillbirth. Within the PIH group, increasing severity of the hypertensive disorder showed a strong and statistically significant association with adverse fetal outcomes. Notably, severe pre-eclampsia and eclampsia were responsible for the majority of stillbirths among PIH cases, and graphical analysis further illustrated a progressive increase in stillbirth risk with worsening severity of hypertensive disease.

CONCLUSIONS

The present study demonstrates that PIH remains a major determinant of adverse fetal outcomes, particularly stillbirth, when compared with GDM and normotensive, non-diabetic pregnancies. A significantly higher stillbirth rate in PIH cases underscores the severe impact of hypertensive disorders on uteroplacental function and fetal survival. The risk of stillbirth increased progressively with disease severity, with severe pre-eclampsia and eclampsia contributing disproportionately to perinatal loss. In contrast, pregnancies complicated by GDM showed comparatively favorable fetal outcomes, indicating that early diagnosis and effective glycemic control can reduce adverse perinatal events. These findings highlight the importance of distinguishing between hypertensive and metabolic disorders in pregnancy and implementing severity-based risk stratification. Early identification, close monitoring, and timely obstetric intervention are essential to reduce perinatal mortality, particularly in resource-limited settings.

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