

Spontaneous Bacterial Peritonitis Inpatient Admissions: Trends and Disparities of Outcomes from 2010-2019 in the US

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ABSTRACT

AIM: Our study sought to evaluate racial and economic disparities trends and outcomes during hospitalizations for SBP in the last decade.

MATERIAL AND METHODS: This retrospective cohort study used the National Inpatient Sample (NIS) to identify adult patients with a principal admitting diagnosis of SBP from 2010-2019. The primary outcomes evaluated in this study were racial and

sociodemographic differences in outcomes of SBP hospitalizations [inpatient mortality rate, mean length of hospital stay (LOS), and mean total hospital charges (THC)]

RESULTS: There were 69785 hospitalizations with a principal admitting diagnosis for SBP. Jointpoint analysis showed that between 2010-2013, an annual percentage increase was observed [7.8%, 95% C.I (-2.9, 19.6), $p = 0.124$], while between 2013-2019, an annual percentage decrease was found [-2.7%, 95% C.I (-0.5, -0.2), $p = 0.037$]. Over the decade, there was a 13.5% decrease in the prevalence of middle-aged patients hospitalized for SBP ($p < 0.001$). Also, a 4.8% decrease in the In-patient mortality rate ($p < 0.001$) and a 1.1-day reduction in the mean length of stay ($p < 0.001$) were noted. Patients admitted with SBP were more likely to have higher proportions of middle-aged males and white people with Medicare insurance and were likely to be treated at large bed sizes and in urban teaching hospitals.

CONCLUSIONS: Over the 10-year trend, the incidence of SBP hospitalizations peaked in 2013, followed by a sharp decline in hospitalizations from 2013-2019. While the overall mortality rate and length of stay have decreased, the THC has surprisingly remained unchanged.

Key words: NIS; SBP; In-hospital outcomes; Trends

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INTRODUCTION

Spontaneous Bacterial Peritonitis (SBP) is the most frequent bacterial infection in patients with cirrhosis and ascites. In hospitalized patients, the incidence varies between 7% and 30%. Given that the complications of cirrhosis are a source of suboptimal clinical outcomes, our study, the first nationwide, sought to evaluate racial and economic disparities trends and outcomes during hospitalizations for SBP in the last decade. Spontaneous Bacterial Peritonitis (SBP) is an ascitic fluid infection without an apparent source^[1]. It is common

in patients with ascites caused by hepatic cirrhosis and can be life-threatening, requiring early detection and treatment. A high index of suspicion prompting liberal use of diagnostic paracentesis, including culture, should exist for SBP in patients with cirrhosis that present with fever, malaise, symptoms and signs of ascites and worsening hepatic failure^[2]. SBP is frequently caused by gram-negative *Escherichia coli*, *Klebsiella pneumoniae*, and gram-positive *Streptococcus pneumoniae*; typically, only one organism is involved. A positive bacterial culture of ascitic fluid having a polymorphonuclear (PMN) cell count of > 250 cells/mcL without an evident intra-abdominal source of infection or malignancy is diagnostic of SBP^[2].

Among hospitalized patients with cirrhosis and ascites, the incidence of SBP varies between 7% and 30%^[3]. For those who survive hospitalization for SBP, mortality rates in the first and second year are approximately 70% and 80%, respectively^[4]. The economic burden of SBP is substantial, with significant healthcare costs associated with its treatment. In 1994, the estimated reimbursement for inpatient treatment of SBP was \$12,664^[5]. SBP has a recurrence rate of 29% to 70% within the first year^[6-7]; healthcare costs can be significantly reduced by administering prophylactic antibiotics in patients with cirrhosis and ascites.

By examining the trends and disparities in SBP admissions and outcomes from 2010 to 2019 in the US, this study aims to contribute to the knowledge base and provide valuable insights for healthcare providers and policymakers in addressing the challenges associated with managing SBP.

METHODS

Our study analyzed data for the calendar year 2018 from the National Inpatient Sample Database (NIS). NIS is 1 of 7 publicly available databases obtained from the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP).

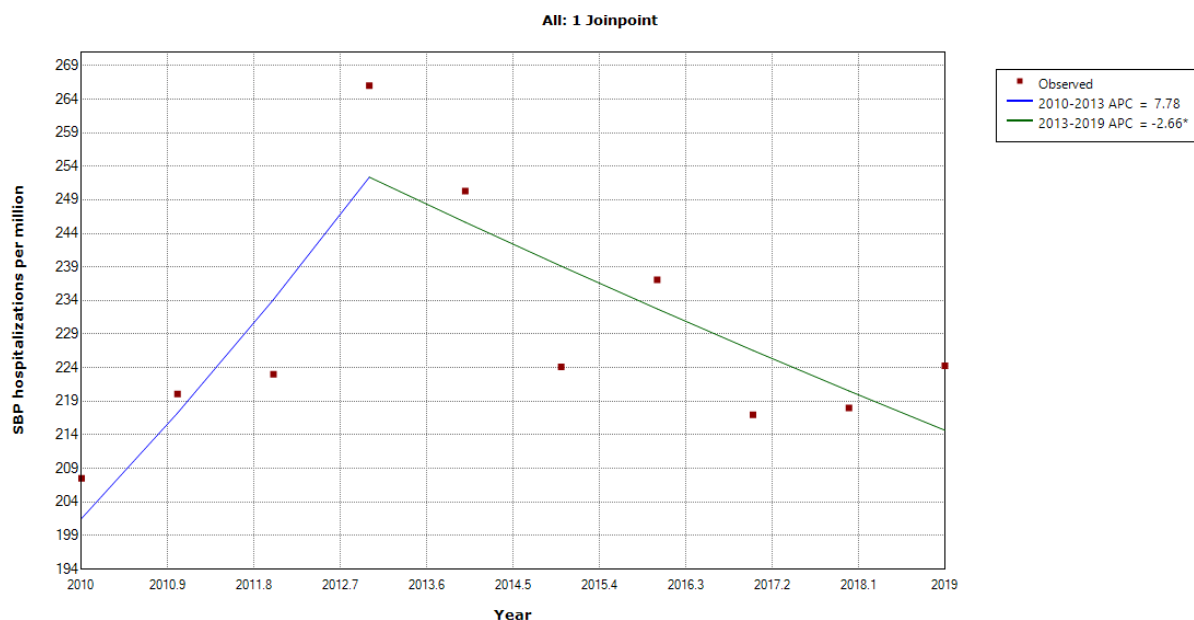
It is derived from billing data submitted by hospitals across the US to statewide data organizations. Weighted, NIS estimates 35 million hospitalizations nationally, a sample of discharges from all hospitals participating in HCUP. The database was coded using the International Classification of Diseases, Ninth and Tenth Revision, Clinical Modification/Procedure Coding System (ICD-9/10-CM/PCS) for the study period^[8].

Study Population

We included all adults (18 years or older) hospitalizations with a primary diagnosis of SBP from 2010-2019 available in the NIS database. Individuals aged 17 years or younger were excluded from the analysis.

Data and Variables

Data analysis included patient demographics such as age, gender, comorbidities, median household income for the patient’s zip code, primary payer (Medicare, Medicated, Private, and Uninsured), patient residence (large metropolitan areas, small metropolitan areas, and micropolitan areas), and hospital characteristics such as size, location, and teaching status. We calculated the modified Charlson-Deyo Comorbidity Index (CCI), an established measure to quantify the burden of comorbid conditions. A higher score indicates a higher burden of concomitant diseases. The primary outcome was admission rates. The secondary outcomes were the predictors for SBP, mean length of stay (LOS), total hospital charge (THC), and in-hospital mortality. Categorical and continuous variables were analyzed using the Chi-square and the Student’s t-test, respectively. We performed univariate regression models to detect the association between SBP and inpatient mortality, LOS, and THC. A two-sided P value of < 0.05 was designated statistically significant. All statistical analyses were performed using Stata® Version 16 software (StataCorp, Texas, USA) for data analysis.



* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level
Final Selected Model: 0 Joinpoints.

Segment	Lower Endpoint	Upper Endpoint	APC	Lower CI	Upper CI	Test Statistic (t)	Prob > t
1	2010	2013	7.8	-2.9	19.6	1.8	0.124
2	2013	2019	-2.7*	-5.0	-0.2	-2.8	0.037
Range	Lower Endpoint	Upper Endpoint	AAPC	Lower CI	Upper CI	Test Statistic~	P-Value~
Full Range	2010	2019	0.7	-2.2	3.7	0.5	1

Figure 1 Annual trends in Adjusted Spontaneous Bacterial Peritonitis Admission Rates from 2010 to 2019.

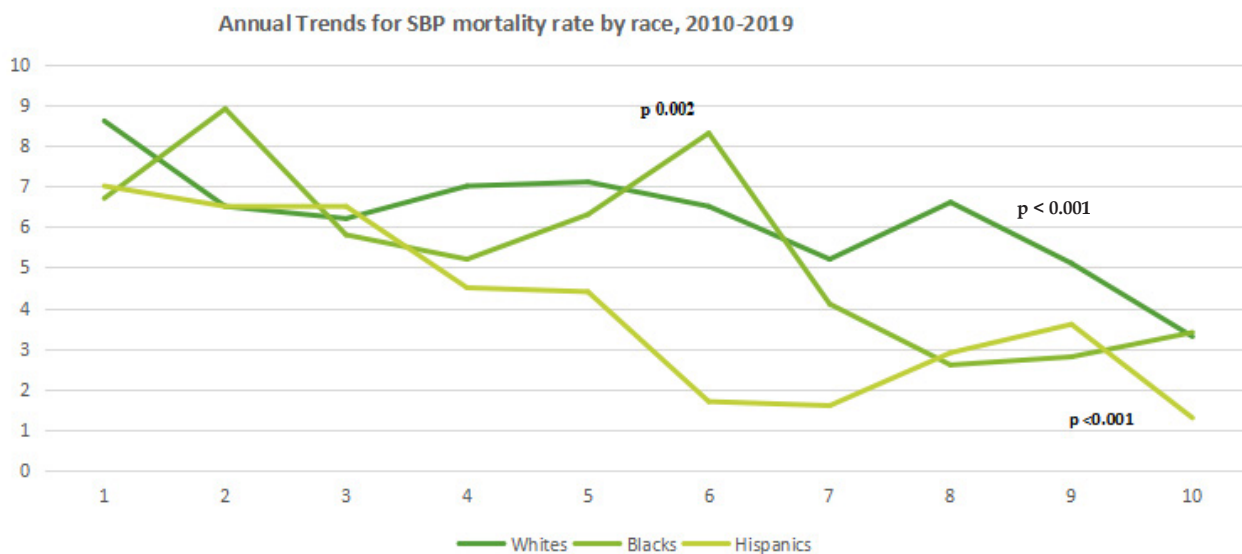


Figure 2 Mortality Rates Trend Stratified by Race for Spontaneous Bacterial Peritonitis Hospitalizations from 2010 to 2019.

Ethical Considerations

This study involved de-identified, publicly available data, which was exempt from institutional review board approval.

Data Availability

The NIS is the largest publicly available, multi-ethnic, all-payer inpatient healthcare database and can be accessed at: <https://www.hcup-us.ahrq.gov>.

RESULTS

Baseline Characteristics

A total of 69,785 hospitalizations with a principal admitting diagnosis for SBP were observed between 2010-2019 with a 3.8% increase in total admissions over the decade (Table 1). SBP admission rates from 2010-2019 increased by 8% (207.3 to 223.7 per million US population). The overall adjusted annual percentage change (AAPC) from 2010-2019 was 0.7% (95% C.I -2.2, 3.7, $p = 1.000$). However, from 2010-2013, the annual percent change (APC) observed was 7.8% (95% C.I -2.9, 19.6, $p = 0.124$), and -2.7% (95% C. I -0.5, -0.2, $p = 0.037$) between 2013-2019 (Figure 1) (Table 1).

The incidence of SBP was highest in whites ($p = 0.030$), middle-aged ($p < 0.001$), males ($p < 0.001$), middle-aged ($p < 0.001$), those in the lowest income quartile ($p = 0.760$), and those who had Medicare as their primary insurance payer ($p < 0.001$). SBP patients were mainly managed in hospitals with large bed sizes ($p < 0.001$) and/or had urban teaching status ($p < 0.001$). Those hospitalized during the study period had a moderate to high mean CCI score. The distribution of patient sociodemographic characteristics and hospital-related features are summarized in Table 1.

Outcomes of hospitalization

In-hospital Mortality

The mortality rate for patients hospitalized for SBP from 2010-2019 decreased by 4.8% (7.8% - 3.0%, $p < 0.001$). During the ten years, the average mortality rate was 5.5% in females and 5.7% in males (Table 2). There was a 6.2% reduction in the mortality rate among Whites ($p < 0.001$), a 5.4% reduction in Blacks ($p = 0.007$), and a 4.0% reduction in Hispanics ($p < 0.001$), respectively (Table 2). The mortality rate based on the income quartile category was lower in the low-income quartile (-5.3%, $p < 0.001$) and compared to the high-income quartile (-5.5%, $p = 0.027$) over the 10-year duration (Table 2).

Length of stay (LOS)

From 2010-2019, a 1.1-day reduction in the mean length of stay ($p < 0.001$) was noted. Based on race, a significant reduction in average LOS was found in blacks (7.1 days) compared to Whites (6.5 days) and Hispanics (5.9 days). Also, patients within the High-income quartile had a longer mean LOS (6.8 days) compared to those in the low-income quartile (6.4 days) (Table 2).

DISCUSSION

This retrospective study is a recent 10-year trend in SBP hospitalization and outcome among different races. We developed this study from a similar project from 2005-2014 that adopted the same NIS database to evaluate the trends in hospitalization and mortality in patients with SBP^[9]. Our study found that the overall trend in SBP hospitalization rate from 2010-2019 had remained stable. Our study revealed a non-statistically significant increase in SBP admission rates between 2010-2013, supported by the findings in a similar study^[9] necessitating efforts of public health measures and standard clinical practices through behavioral education and prompt antibiotic prophylaxis to reduce and prevent SBP^[10-11]. The effectiveness of behavioral education and prompt antibiotic prophylaxis is reflected in the decreased admission rates from 2013-2019^[10-11].

Regarding disparities, the study identified higher hospitalization rates among whites, middle-aged males, individuals in the lowest income quartile, and Medicare beneficiaries. Female patients hospitalized for SBP incurred higher total healthcare costs compared to males. This could be due to the higher susceptibility to infections like urinary tract infection, clostridium difficile infection, and pneumonia in female cirrhotic patients, leading to a more significant cost of hospitalization and treatment in females^[12]. Racial differences were also observed, with whites having a higher SBP prevalence than Hispanics and blacks^[13]. The racial differences may reflect the racial distribution in the US, where whites constitute a majority^[14], invariably leading to higher rates of alcohol consumption, cirrhosis, and SBP in whites compared to other races^[13]. Furthermore, the study found that more than 50% of SBP cases were managed at tertiary hospitals, indicating the need for advanced and specialized care for associated complications like hepatic encephalopathy, coagulopathy, acute kidney injury, etc^[15-16].

Regarding outcomes, the study revealed a decreased mortality

rate for hospitalized patients over the ten years. Studies have observed that early commencing of antibiotics such as cefotaxime or carbapenem lead to a higher resolution of SBP and reduced mortality rate of patients in critical states^[9,15]. Furthermore, Hispanics had the lowest mortality rate, and Whites had the highest, consistent with other studies showing a recent decline in all-cause mortality in minority racial groups in the US^[17-18]. Gender disparities were observed, with a higher average mortality rate in males than females, in keeping with similar studies^[19], and potentially influenced by the higher rates of excessive alcohol consumption and alcohol-related morbidities in males globally^[20-21]. The average LOS was influenced by gender^[9,16], race, and income level. Blacks had a longer average LOS compared to Whites and Hispanics. This is like previous literature that reports longer LOS in Blacks, who tend to have limited access to healthcare and be of low-socioeconomic status^[22-24], and have higher CCI compared to Whites and Hispanics^[25]. In contrast,

hospital charges were not significantly increased across all races, gender, and income quartile.

The strengths of our study are the utilization of the largest inpatient database of patients in the US to access inpatient utilization, cost and outcomes. Our study has limitations. Firstly, the NIS database is an administrative database that lacks the diagnostic accuracy of research databases. Although the ICD-9-CM codes 567.23 and ICD-10-CM K65.00 are validated for SBP, the differences in the ICD diagnostic coding can underestimate or overestimate our research findings. Secondly, the NIS database does not provide information on patients' compliance with antibiotic prophylaxis or the optimization status of SBP patients' comorbidities which can influence outcomes.

To conclude, the 10-year trend in the SBP admission rate in the US remains unchanged. The admission rates were higher among Whites, middle-aged males, Medicare beneficiaries, and Urban teaching hospitals with large beds in the US. Hispanics had the lowest

Table 1 Baseline Characteristics of patients Hospitalized with a Principal Diagnosis of Spontaneous Bacterial Peritonitis

Variable	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	P-value*
Total admissions for SBP	6509	6911	7020	7950	7445	6760	7185	6620	6630	6755	
SBP admission rate, per million hospitalizations†	207.3	219.4	228.7	265	249.8	223.8	237.9	217.8	218.8	223.7	
Mean age (SD), years	56(12)	57(12)	56(12)	57(12)	57(12)	58(12)	58(13)	59(13)	58(13)	59(13)	<0.001*
Age categories, %											<0.001*
Young adults	14.6	12.1	14.3	14.2	12.7	12.6	15.2	15.2	14.1	15.5	
Middle-aged	64.4	65.5	64	63.3	63.3	61.8	56.2	51	55.1	50.9	
Elderly	21	22.4	21.7	22.5	24	25.6	28.7	33.8	30.8	33.6	
Sex											
Female, %	34.9	35.7	36.8	36.4	37.3	38.2	40.3	38.3	39.1	43.2	<0.001*
Race, %											0.030*
White	59	55.7	57.8	60.2	60.6	59.5	61.3	59.6	63.7	63.7	
Black	11	9.7	11	10.9	9.6	10.7	10.1	11.6	10.8	10.9	
Hispanic	16	22.4	17.4	16.7	16.8	17	17.3	18.4	16.9	17.7	
Others	14	12.2	13.8	12.2	13	12.8	11.3	10.4	8.6	7.7	
Mean CCI score	4	4	4	4	4	4	4	4	4	4	
Primary payers, %											<0.001*
Medicare	37.4	39.7	41.3	42.6	41.7	42.9	46.9	48.2	45.3	45.3	
Medicaid	26.2	25.6	25.8	23.7	26.9	25.7	23.3	25.6	25.3	25.3	
Private insurance	28	29.2	26.3	25.9	26.5	27.3	25.5	21.7	24.8	24.8	
No insurance	8.4	5.5	6.6	7.8	4.9	4.1	4.3	4.5	4.6	4.6	
MHOI quartile, %											0.76
Lowest quartile	31.3	31.3	32.1	31	31.1	33.6	32.6	31.5	31.1	31.4	
Second quartile	25.3	24.6	25.7	27.6	27.3	24.5	26	27.9	27.7	26	
Third quartile	24.7	24.7	22.8	23.4	22.9	23.9	23.5	23	23	25	
Highest quartile	18.7	19.4	19.4	18	18.7	18	17.9	17.6	18.2	17.6	
Hospital Bed-size, %											<0.001*
Small	10	8.5	10.8	11.4	14.1	15	15.7	16.2	17.5	19	
Medium	20	20.8	23.5	24.3	27.3	26	26.4	26.2	25.9	25.3	
Large	70	70.7	65.7	64.3	58.6	59	57.9	57.6	56.6	55.7	
Hospital region, %											0.957
Northeast	23.2	16.6	18.2	18.3	16.9	17	17.3	18.8	16.9	17.7	
Midwest	18	18.8	20.6	20	19.7	19.8	20.5	21.7	23.2	21.1	
South	32.7	36.3	34.2	35.5	36.3	33.6	36.6	35	34	34.8	
West	26.1	28.3	27	26.2	26.9	29.6	25.6	24.5	25.9	26.4	
Location/ teaching status of hospital, %											<0.001*
Rural	7.2	8	8.6	9.4	7.9	7.9	8	8.9	6.7	8.3	
Urban nonteaching	32.2	33.8	28.6	27.8	20.4	21.9	21.9	19	18.9	13.9	
Urban teaching	60.6	58.3	62.8	62.8	71.7	70.2	70.1	72.1	74.4	77.8	

*: statistically significant, †: adjusted for age categories, sex, and race, CCI: Charlson comorbidity index, SBP: Spontaneous Bacteria Peritonitis, HIQ: High-Income Quartile, LIQ: Low-Income Quartile, SD: Standard Deviation from the mean

Table 2 Trends in Outcomes with a principal admitting diagnosis of SBP.

Variable	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	p-value*
Mortality rate, %	7.8	6.8	6.2	6.6	6.3	5.6	4.4	5.3	4.5	3	<0.001*
Mean LOS, days	7	6.9	7	6.5	6.3	6.4	6.4	6	5.8	6.1	<0.001*
Mean THC, US\$	55853	61464	58902	57670	54505	56875	58591	57495	55032	59603	0.758
Mortality rate among Females, %	7.2	6.7	5.8	6.2	5.1	6	4.7	5.9	4.6	3.1	
Mean LOS among Females, days	7.4	6.6	7.1	6.8	6.5	6.6	6.6	6.1	6.1	6.5	
Mean THC among Females, US\$	58442	54851	58496	61989	51848	58893	62110	57470	54581	63687	
Mortality rate among Males, %	8.1	6.8	6.4	6.8	7	5.4	4.2	4.9	4.3	2.9	
Mean LOS among Males, days	6.8	7	6.9	6.4	6.2	6.3	6.3	5.9	5.6	5.8	
Mean THC among Males, US\$	54459	65137	59138	55203	56102	55633	56234	57510	55321	56497	
Mortality rate among Whites, %	8.6	6.5	6.2	7	7.1	6.5	5.2	6.6	5.1	3.3	<0.001*
Mean LOS among Whites, days	7.1	7.1	7.1	6.4	6.3	6.5	6.7	6	5.8	6.3	<0.001*
Mean THC among Whites, US\$	55877	59054	58100	57058	52149	55271	58299	55103	53639	59454	0.873
Mortality rate among Blacks, %	6.7	8.9	5.8	5.2	6.3	8.3	4.1	2.6	2.8	3.4	0.007*
Mean LOS among Blacks, days	7.7	8	7.7	7.1	7.4	6.9	6.7	6	6.7	6.5	0.002*
Mean THC among Blacks, US\$	62217	72623	62707	59533	65330	60298	53560	51998	55041	61316	0.135
Mortality rate among Hispanics, %	7	6.5	6.5	4.5	4.4	1.7	1.6	2.9	3.6	1.3	<0.001*
Mean LOS among Hispanics, days	6.3	6.3	6.5	6.3	5.9	5.6	5.6	6	5.2	5.3	0.002*
Mean THC among Hispanics, US\$	58987	68490	66055	60003	61808	60864	62751	68388	60528	60029	0.691
Mortality rate among LIQ, %	7.2	5.7	5.8	7	6.4	5.7	4.1	5.2	3.4	2	<0.001*
Mean LOS among LIQ, days	7.2	6.6	6.5	6.6	6.1	6.2	6.3	6.5	6	5.5	0.001*
Mean THC among LIQ, US\$	54573	54346	52256	53924	52539	52745	57205	60571	53751	51137	0.749
Mortality rate among HIQ, %	5.6	6.2	6.1	7	7.2	5.5	4.2	6.5	3.4	3.3	0.027*
Mean LOS among HIQ, days	7.6	7.4	7.1	7.3	6.7	7.3	6.9	5.5	5.8	6.6	<0.001*
Mean THC among HIQ, US\$	66580	74049	68743	69945	62284	69974	71406	54235	58515	71262	0.298

*: statistically significant, HIQ: High-income quartile, LIQ: Low-income quartile, LOS: mean length of hospital stay, THC: mean total hospital charges.

mortality rate. Continued reinforcement of public health measures promoting healthy lifestyles, indefinite use of fluoroquinolones in patients with history of SBP or who are high risk for SBP, and optimization of comorbid conditions in patients diagnosed with SBP may help reduce the economic burden of SBP in the US. Future research is needed to determine the predictors of a low mortality rate among Hispanics for replication in other racial groups.

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