

BRIEF RESEARCH REPORT

Health Policy

Estimates of throughput and utilization at freestanding compared to low-volume hospital-based emergency departments

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Abstract

Objective: Our investigation compared throughput metrics and utilization measures for freestanding emergency departments (FSEDs) versus hospital-based emergency departments (HBEDs) of similar volumes in the United States.

Methods: This study is a cross sectional survey of 183 FSEDs and 317 HBEDs located across the United States using the Emergency Department Benchmarking Alliance (EDBA) Database. We measured common emergency department (ED) throughput metrics. Primary outcomes included overall length of stay, length of stay for admitted, and length of stay for treated and released patients. Outcomes were weighted based on the proportion of ED volume per facility as per a prior pilot study. Multiple linear regression analysis was used to adjust for measured differences between FSEDs and HBEDs. The variables that were controlled for in regression analysis included geographic location of the ED (urban, suburban, and rural), percent of high acuity capacity, ED volume, percentage of patients arriving via emergency medical services (EMS), and percentage of pediatric patients.

Results: Nationally, the median length of stay in minutes (104.2 vs 140.0), length of stay for treated and released patients (98.6 vs 122.9), door-to-bed (4.0 vs 8.0), door-to-doctor (11.0 vs 16.0), percentage of patients admitted through the ED (4.0 vs 11.0), and percentage of patients leaving the ED without being seen (LWBS) (0.9 vs 1.5), were significantly lower at FSEDs compared to HBEDs ($P < 0.0001$ for all comparisons). Length of stay for admitted patients (265.9 vs 241.8) and median boarding time (96.8 vs. 71.3)

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were significantly lower in HBEDs compared to FSEDs. X-ray, computed tomography, and ECG utilization per 100 patients was significantly lower at the FSEDs compared to HBEDs. Multiple linear regression analysis demonstrated that the length of stay for treated and released patients was 8.67 minutes shorter for FSEDs as compared to HBEDs (95% confidence interval [CI] = -1.4 to -16.0). The length of stay for admitted patients was 44 minutes longer for FSEDs as compared to HBEDs (95% CI = 25.5 to 63.0).

Conclusions: In this study of similarly sized EDs in the United States, throughput metrics for FSEDs tended to be significantly shorter from the arrival of the patient until their departure, except for patients requiring hospital admission. For measures favoring FSEDs, throughput times range from 20%–50% shorter than HBEDs.

1 | INTRODUCTION

1.1 | Background

Several studies have demonstrated that freestanding emergency departments (FSEDs) perform equally or better than hospital-based emergency departments (HBEDs) on many measures of throughput and quality. Among academically affiliated FSEDs, Dayton et al¹ found that waiting room time, treatment times, and time to pain management for long bone fractures were similar between FSEDs and national averages for HBEDs.

In a pilot study comparing FSEDs to HBEDs, Dark et al² demonstrated that independent freestanding emergency centers in Texas were superior to hospitals for 4 of 5 common emergency department (ED) throughput measures. A report from the California Healthcare Foundation similarly described faster throughput at FSEDs compared to HBEDs.³ The authors suggested that this may be due, in part, to differences in acuity and lower rates of boarding inpatients in ED beds.

In a more recent study, accounting for differences in acuity, Pines et al⁴ found that FSEDs had similar utilization of laboratory testing, ultrasonography, and computed tomography (CT) compared to a propensity matched sample of HBEDs. Additionally, FSEDs in Texas and Colorado demonstrated a 46% lower average length of stay among all emergency department patients compared to propensity-matched HBEDs.

1.2 | Importance

Our investigation adds to the evidence comparing throughput measures and resource utilization at FSEDs versus HBEDs. For patients and payers to adequately determine the value of FSEDs, research must demonstrate how well these facilities perform along the axis of quality.

1.3 | Goals of this investigation

The goal of this study is to investigate common ED measures of throughput by comparing FSEDs to similarly sized HBEDs across the

United States. Secondary outcomes include comparative resource utilization across these various facility types.

2 | METHODS

2.1 | Study design and setting

This study is a cross sectional survey of EDs located across the United States using the pre-existing Emergency Department Benchmarking Alliance (EDBA) Database from 2017. The EDBA database dates to 1997. It includes voluntary submission across a limited number of key ED operations metrics. These metrics are well defined and made available to all who submit data in order to ensure consistency across sites. The database reflects at least 25% of all EDs and ED visits in the United States in a given year.

In 2017, the EDBA database included data from 1768 HBEDs and 220 FSEDs in 46 US states (excluding Alaska, North Dakota, South Dakota, and Vermont) and additional EDs in 5 countries. The database represented a total of 71,289,186 ED visits. Thus, the database captured over 49% of the nation's >145 million annual ED visits.⁵ There were 4.6 million visits to HBEDs with a volume of under 20,000 annual visits and 3.4 million visits to the FSEDs represented in the EDBA database. The EDBA database does not distinguish between hospital-affiliated and independent FSEDs.

Per the Baylor College of Medicine Institutional Review Board, this research does not constitute human subjects research.

2.2 | Selection of participants

EDs across the nation elect to participate in the EDBA database and report measures including patient volumes, throughput, resource utilization, admission percentage, and percent of pediatric patients among other measures. We chose to compare EDs only in states with operational FSEDs so as to minimize geographical biases. We excluded states that did not have any FSEDs. As most FSEDs are also low-volume

facilities, we limited our study to HBEDs with <20,000 annual visits. Transfers from a FSED to a hospital bed for admission are counted as admissions from a FSED. Both observation admissions and full admissions are counted as admitted patients in the database.

2.3 | Interventions

Because this was a cross sectional study, there were not traditional intervention and control groups. The exposure for this study was facility type—either FSED versus HBED.

2.4 | Measurements

The EDBA database relies on self-reported metrics from facilities. The EDBA data collection tool has been developed and defined since 2004. The definitions are simple and accompany the data collection tool. Site data are submitted by a single individual annually. When entering data into its database, the EDBA reviews the information and questions spurious data. Examples include negative numbers, data entry errors, or data not consistent with either previous years at the same facility or national comparators. Data are entered into the EDBA database by a single data analyst who confirms accuracy and consistency from year to year. Whenever any data appears incorrect (eg, negative number for ED length of stay) or inconsistent with prior year's data, the EDBA data entry analyst will contact the facility's data submitter for clarification prior to final entry into the EDBA database. In the past, the EDBA database has included at least 25% of all US ED visits—for the year of our analysis it represented nearly half of US ED visits—and in aggregate is both reliable and quite useful for policy decisions.

For this study, data from all FSEDs were abstracted by one author (NJJ) as were all relevant HBEDs in the same state. The data were placed into an Excel spreadsheet prior to data analysis.

2.5 | Outcomes

The tripartite primary outcome measures were those encompassing typical ED throughput metrics of length of stay (all patients, treated and released patients, and admitted patients). Secondary outcome measures included boarding time (defined as the time from the decision to admit a patient is made by the physician to the time the patient leaves the ED for their inpatient bed), door-to-bed time, and door-to-doctor time. Secondary outcome measures additionally included resource utilization per 100 visits for X-rays, CT, and ECGs. Additional data collected in the EDBA database and reported in this study include annual visit volume, percentage of EMS arrivals, percentage of pediatric visits, the percentage of high acuity visits, the percentage of ED patients admitted to the hospital (that includes both observation and full admissions), and the left without being seen rate. High acuity visits are defined in the database as having a current procedural terminology (CPT) code of 99284, 99285 or 99291 (critical care).

The Bottom Line

In a cross-sectional study of freestanding EDs (FSEDs) and hospital EDs (HBEDs) using the Emergency Department Benchmarking Alliance (EDBA) database, throughput metrics for FSEDs tended to be 20%–50% shorter, except for patients requiring hospital admission. These results should be interpreted within the context of several important limitations, including the use of an administrative database and the lack of patient-level acuity data.

To determine the percentage of high acuity visits, we used the fraction of ED visits that are ultimately coded using physician CPT codes that define higher acuity illnesses or injuries—99284, 99285, and 99291. Using emergency physician CPT coding for evaluation and management provides an estimate of complexity as determined by the physician examining the individual patient.

2.6 | Analysis

As per the methodology outlined in the pilot study, outcomes were weighted based on the proportion of ED visits per facility.² Normally distributed variables are presented as mean and SD and *P* values are obtained from *t*-tests. Non-normally distributed variables are presented as median and interquartile range and *P* values from Wilcoxon rank-sum tests. Outcomes were weighted based on the proportion of ED volume per facility.

For multiple regression analysis, length of stay for admitted patients and for treated and released patients were compared between FSEDs and HBEDs. Multiple linear regression analyses were fit to assess the effect of ED facility type on length of stay for admitted patients and length of stay for treated and released patients while controlling for other covariates. The variables that were controlled for include geographic location of the ED, percentage of high acuity cases, ED volume, percentage of patients arriving via EMS, and percentage of pediatric patients. Analyses were performed using SAS Software (version 9.4; Cary, NC). A significance level of 0.05 was assumed.

3 | RESULTS

3.1 | Characteristics of study subjects

In 2017, the EDBA database included 220 hospital-affiliated FSEDs representing 3,430,509 visits. There were 366 HBEDs in the EDBA database who reported <20,000 annual visits, representing a total of 4,580,733 visits.

After excluding states for which there were no FSEDs present and limiting to EDs with <20,000 annual visits, there remained 500 EDs for

TABLE 1 Comparison of outcomes by type of emergency department (all states), n = 500

Outcome	FSED		HBED		95% CI	P values
	n		n			
Volume	183	14,625 (9668)	317	13,535 (3991)	−385, 2567	0.1467 ^a
Location ^e	182		317			<0.0001 ^c
Rural		39.0 (21.4)		178.0 (56.2)		
Sub-urban		136.0 (74.7)		96.0 (30.3)		
Urban		7.0 (3.9)		43.0 (13.6)		
Median LOS (in minutes) ^f	149	104.2 (14.0)	287	140.0 (16.6)	−42.3, −29.3	<0.0001 ^a
LOS released (in minutes) ^f	149	98.6 (12.8)	283	122.9 (12.2)	−29.7, −18.9	<0.0001 ^a
LOS admit (in minutes) ^f	144	265.9 (28.3)	279	241.8 (25.3)	12.7, 35.6	<0.0001 ^a
Median boarding time (in minutes) ^f	93	96.8 (15.0)	183	71.4 (15.0)	17.5, 33.4	<0.0001 ^a
Door to bed (in minutes) ^g	109	4.0 (7.0)	186	8.0 (10.0)	−4.0, −2.0	<0.0001 ^b
Door to doctor (in minutes) ^g	148	11.0 (14.0)	273	16.0 (14.0)	−6.0, −3.0	<0.0001 ^b
ECG per 100 ^f	109	10.3 (3.9)	146	19.1 (3.9)	−10.8, −6.7	<0.0001 ^a
X-ray per 100 ^f	113	24.6 (7.6)	187	37.8 (5.2)	−16.5, −9.8	<0.0001 ^a
CT per 100 ^f	114	10.8 (4.0)	186	16.0 (3.4)	−7.2, −3.4	<0.0001 ^a
EMS arrival (%) ^g	115	5.0 (5.0)	210	12.0 (7.0)	−8.0, −7.0	<0.0001 ^b
High CPT acuity (%) ^g	174	56.0 (21.0)	242	62.0 (15.0)	−12.7, −6.4	<0.0001 ^b
Pediatric (%) ^g	176	21.4 (4.5)	217	28.9 (12.6)	−11.6, −3.5	0.0004 ^b
Hospital admits through ED (%) ^g	92	4.0 (4.3)	224	11.0 (7.0)	−7.2, −5.0	<0.0001 ^b
Left without being seen (%) ^g	154	0.9 (1.6)	285	1.5 (1.6)	−0.5, −0.2	<0.0001 ^b

Abbreviation: n, number of observations.

Statistics presented as mean (SD), median (Inter-quartile range), or number (%).

^at-test.

^bWilcoxon rank-sum test.

^cChi-square test.

^dFisher's exact test.

^eCategorical variable.

^fNormally distributed continuous variable.

^gNon-normally distributed variable.

comparison—183 FSEDs and 317 HBEDs. In order of decreasing frequency, Texas (124), Florida (35), Ohio (30), Virginia (27), North Carolina (21), and Colorado (20) provided more than half of the facilities used for the analysis.

3.2 | Main results

3.2.1 | Univariate Analysis

Table 1 presents the comparison of outcomes by type of ED for all 500 included EDs in all states. Overall, FSEDs and HBEDs were statistically similar in terms of patient volume, with 14,625 and 13,535 annual visits, respectively ($P = 0.1467$). All measures of ED throughput demonstrated superior metrics for FSEDs compared to HBEDs with the exception of length of stay for admitted patients (265.9 vs 241.8 minutes; 95% CI for time difference, 12.7–35.6 minutes) and boarding time for patients (96.8 vs 71.4 minutes, 95% CI for difference, 17.5–33.4 minutes).

The overall median length of stay for all patients at FSEDs was 26% shorter (−35.8 minutes; 95% CI = −29.7 to −42.3 minutes), the length of stay for treated and released patients was 20% shorter (−24.3 minutes; 95% CI = −18.9 to −29.7 minutes), door-to-bed time was 50% shorter (−4.0 minutes; 95% CI = −2.0 to −4.0 minutes), and door-to-doctor time was 31% shorter (−5.0 minutes; 95% CI = −3.0 to −6.0 minutes) when compared to HBEDs.

As for measures of resource utilization, FSEDs demonstrated 46% fewer EKGs performed per 100 patients (95% CI for difference, −6.7 per 100 to −10.8 per 100), 35% fewer X-rays per 100 patients (95% CI, = −9.8 per 100 to −16.5 per 100), and 33% fewer CT scans per 100 patients (95% CI, = −3.4 per 100 to −7.2 per 100). FSEDs were also notably less likely to receive pediatric patients, receive patients via EMS, have a high acuity visit, or admit their patients to the hospital compared to HBEDs. The left without being seen rate was 40% lower for FSEDs compared to HBEDs (0.9% vs 1.5%; 95% CI for difference, −0.2 to −0.5).

When analyzing the metrics in a state-specific fashion, many of the above trends persisted (see Supporting Information Tables S1–S6).

TABLE 2 Multiple linear regression estimates for effect of ED type on listed outcomes after controlling for possible confounders (all states) (n = 500)

Effect: FSED versus HBED	Coefficient	Standard error	95% CI	P
Outcomes				
LOS admitted patients	44.22	9.52	25.5, 63.0	<0.0001
LOS released patients	-8.67	3.70	-16.0, -1.4	0.0198
Median LOS	-11.87	4.26	-20.2, -3.5	0.0057
Median boarding time	22.09	6.33	9.6, 34.6	0.0006
Door to bed	-2.87	1.12	-5.1, -0.7	0.0011
Door to doctor	-0.66	1.44	-3.5, 2.2	0.6473

Abbreviations: CI, confidence interval; ED, emergency department; EMS, emergency medical services.

Variables controlled for include: volume, acuity, geographic location (rural, sub-urban, urban), pediatric visits, EMS arrivals.

Notably, the median length of stay remained lower in FSEDs versus HBEDs across all states. Where statistically significant, the length of stay and boarding times among admitted patients were longer at FSEDs in Florida, Virginia, and Texas; Colorado, notably, displayed the opposite effect. The length of stay of treated and released patients often remained lower at FSEDs in various states compared to HBEDs, similar to the national trend; however, this finding only achieved statistical significance in Colorado, Texas, and Florida. Door-to-bed and door-to-doctor times in Ohio, Texas, and Colorado were all statistically shorter for FSEDs compared to HBEDs, again a finding similar to the national trend. In North Carolina, door-to-bed times were also significantly shorter at FSEDs compared to HBEDs.

Utilization of resources including ECGs, CT scans, and X-rays per 100 patients were all lower at FSEDs compared to HBEDs save for a notable exception in North Carolina where there was a statistically significant 34% increase in X-ray imaging.

Measures of possible patient acuity, such as the percentage of EMS arrivals and the likelihood of high acuity visits, were lower at FSEDs in specific states for which we have measurements, similar to the national trend. The percentage of pediatric visits was significantly more common at FSEDs than HBEDs in Virginia, North Carolina, and Texas and statistically less common in Ohio.

3.2.2 | Multivariate analysis

We conducted a multiple linear regression to control for multiple variables including the location of the ED (rural, suburban, or urban), percent of high acuity capacity, ED volume, percentage of patients arriving via EMS and percentage of pediatric patients (Table 2). This multiple linear regression demonstrated that the length of stay for admitted patients was 44 minutes longer for FSED as compared to HBED (95% CI = 25.5–63.0). These data were obtained from an unimputed dataset. However, when imputed data were used to account for missing data fields, the direction and statistical significance did not change (data not shown).

After controlling for the multiple variables as listed above, the length of stay for treated and released patients was \approx 9 minutes shorter

for FSED as compared to HBED (95% CI = -16.0 to -1.4). Additional time-based metrics, specifically median length of stay and door-to-bed times, also favored FSEDs over HBEDs by \approx 11 (95% CI = -20.2 to -3.5) and \approx 3 minutes (95% CI = -5.1 to -0.7), respectively. Boarding times for admitted patients, however, were over 22 minutes longer for FSEDs compared to HBEDs (95% CI = 9.6–34.6). These data, again derived from the unimputed dataset, demonstrated the same direction and statistical significance when using an imputed data set as well (data not shown).

3.3 | Limitations

Our study attempted to provide an accurate comparison of the throughput measures at FSEDs compared to similarly sized HBEDs. There may be participation biases attributed to ED self-selection for participation into the EDBA database. Although we were able to limit geographical differences across states, we are unable to fully account for geographic differences between facilities within states. As prior studies demonstrated that FSEDs tend to locate in areas of higher population density, it is likely that we could be inappropriately comparing FSEDs in urban centers with small HBEDs present in more rural environments.^{6,7} However, in the multiple linear regression analysis for our primary outcome of length of stay, we were able to account for differences in rural, suburban, and urban environments in which FSEDs and low-volume HBEDs locate. Additionally, it should be noted that our work should only be applied to states that contain FSEDs and also are represented in the EDBA database.

In univariate analysis, our study revealed inherent differences between FSEDs and HBEDs in terms of EMS arrival, admission percentage, and higher CPT acuity, which indicate that, on average, FSEDs see a cadre of patients of lesser acuity relative to similarly sized HBEDs. The EDBA database does not collect patient-level data. Although the percentage of high acuity cases is reported in the EDBA database, we are not able to control for patient-specific measures such as the Charleston comorbidity index or even Emergency Severity Index present on triage which might offer a more robust glimpse into the individual acuity of patients as encountered at each facility type.

However, as previous literature has explored, FSEDs often experience fewer of both the highest and lowest acuity patients on ED triage.^{1,4,8,9} Ultimately, it is reasonable to conclude that FSEDs tend to see a slightly less sick cohort of patients that reside in the middle of the bell curve of patient acuity. This might account for the lower rates of health care utilization noted in our study.

Although time-based metrics are often used to define “quality” of care in emergency medicine, these metrics may or may not actually represent quality from a patient-centric point of view. Thus, readers must use caution when applying our findings with a blanket assessment on the value of care delivered at FSEDs versus HBEDs. Similarly, in medicine, it is difficult to note whether “less is more” in health care. A *New England Journal of Medicine* editorial by cardiologist Lisa Rosenbaum highlights the difficulty of assigning value to utilization by noting that many “caveats undermine the less-is-more theme, but they reflect the complex truth.”¹⁰ In certain situations, ordering an ECG, an X-ray, or advanced imaging is a necessary part of the efficient clinical evaluation of the patient. At other times, it reflects overutilization and waste. However, teasing out these situations is nearly impossible in registry data such as the EDDBA database.

4 | DISCUSSION

In a study comparing FSEDs and HBEDs, after limiting to facilities of similar size and geography (by state), several important observations regarding commonly reported ED throughput measures can be made. First, door-to-bed, door-to-doctor, and median length of stay metrics favor FSEDs over HBEDs. One of the likely reasons for the superiority of these metrics is that the total length of stay for treated and released patients, which represent 96% of all patients presenting to FSEDs and 89% of all patients presenting to HBEDs, is over 24 minutes shorter at FSEDs. These results are similar to those found in the pilot study of throughput metrics in Texas EDs by Dark et al.² In this small sample, length of stay for treated and released patients was estimated at 83 minutes shorter FSEDs compared to HBEDs. Pines et al⁴ discovered a similar trend estimated at a 55-minute median difference between FSEDs and HBEDs in multiple states. The differences in length of stay for treated and released patients that we found are considerably smaller in magnitude but still in the same direction as these 2 prior studies. Our findings contrast with those from Dayton et al¹ whose average throughput times for treated and released patients at 8 academic FSEDs were fairly similar to national benchmarks. However, the Dayton et al¹ study suffered from the inability to directly statistically compare FSEDs to HBEDs. Our adjusted analyses reveal similar trends for the length of stay for treated and released patients (≈ 9 minutes shorter for patients at FSEDs).

In the subset of patients who required hospital admission, total length of stay was 24 minutes longer at FSEDs compared to HBEDs. This difference was essentially accounted for by the 25-minute increased amount of time spent boarding while awaiting an inpatient hospital bed. The Dayton et al¹ study showed similar trends of longer

treatment times for admitted patients at FSEDs. In contrast, in both the Dark et al² and Pines et al⁴ studies, FSEDs showed shorter length of stay even for admitted patients. Our adjusted analyses reveal a statistically significant increased length of stay for admitted patients (44 minutes longer for patients at FSEDs compared to HBEDs). It is feasible that these differences could be accounted for by geographic differences between the various studies as those other contradictory studies included FSEDs only from Texas and Colorado. Roughly, only 75% of the FSEDs included in our current study came from other states.

Several secondary measures, including health care resource utilization, demonstrate lower resource use at FSEDs overall compared to HBEDs. Whether or not this is due to difference in patient populations or practice patterns cannot be determined based on this study alone. As has been noted in prior literature, patient population differences between FSEDs and HBEDs exist either by patient triage acuity,^{1,8,9} or patient demographics such as sex,⁸ employment status,⁸ marital status,⁸ race/ethnicity,^{6,8,11} and insurance status.^{6,7,11,12} Some studies have even demonstrated differences between FSED and HBED patients based on comorbid conditions present at the time of visit.^{4,11} In retrospect, it would have been beneficial to have access to clinical data that would allow for more granular assessment of the individual patient's health status upon presentation to determine how much the facility type influences the movement of the patient through the ED. However, the EDDBA database is not designed for such granularity. Future prospective evaluations of ED throughput may wish to incorporate a measure of initial patient acuity such as Charleston comorbidity index or, at minimum, initial nursing triage level in order appropriately adjust for these limitations.

One factor that the present study reveals that prior studies have been unable to tease out to date, was the impact on inpatient boarding in the ED as a variable affecting the total length of stay for admitted patients. In our study, we identified a longer length of stay for admitted patients, likely accounted for by an increased time of ED boarding. A recent meta-analysis exploring ED boarding and in-hospital mortality revealed a weak trend toward this association driven by positive associations in half of the included studies.¹³ None of the included studies demonstrated the reverse. The implications for the care of the ED patient are that timeliness, or lack thereof, can lead to measurable gains or losses in mortality. Thus, it is prudent that ED practice continues to measure these outcomes.

In summary, FSEDs differ from similarly sized HBEDs with regard to common throughput measures and health care utilization. Typically, FSEDs demonstrate shorter overall length of stay for all patients driven by superior throughput among patients treated and released home even though patients who require admission have longer lengths of stay and periods of boarding while awaiting hospitalization in an inpatient bed.

CONFLICTS OF INTEREST

CD reports personal stock ownership in the past 36 months for Asep-tiscope, GSK, TDOC, ADPT (delisted) and support from Community Health Choice and HealthCorps.

AUTHOR CONTRIBUTIONS

CD, NJ, and ELS conceived the study and designed the trial. The Emergency Department Benchmarking Alliance supervised the data collection. MC and CM provided statistical advice on study design and analyzed the data. CD drafted the article, and all authors contributed substantially to its revision. CD and ELS take responsibility for the paper as a whole.

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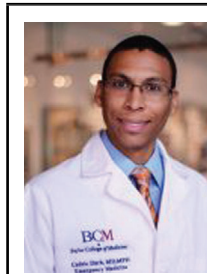
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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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