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Success of Elective Cholecystectomy Treatment Plans After ED Visit

Juliane Bingener, M.D.^{*}, Kristine M. Thomsen, B.A.^{**}, Andrea McConico, B.A., A.S.^{*}, Erik P. Hess, M.D.^{***}, and Elizabeth B. Habermann, Ph.D.^{**}

^{*}Department of Surgery, Mayo Clinic, Rochester, MN

^{**}Robert D. and Patricia E. Kern Center for Science of Health Care Delivery, Mayo Clinic, Rochester, MN

^{***}Department of Emergency Medicine, Mayo Clinic, Rochester, MN

Abstract

Introduction—Differentiation between patients with acute cholecystitis and patients with severe biliary colic can be challenging. Patients with undiagnosed acute cholecystitis can incur repeat emergency department (ED) visits, which is resource intensive.

Methods—Billing records from 2000 – 2013 of all adults who visited the ED in the 30 days preceding their cholecystectomy were analyzed. Patients who were discharged from the ED and underwent elective cholecystectomy were compared to those who were discharged and returned to the ED within 30 days. T-tests, chi-square tests and multivariable analysis were utilized as appropriate.

Results—From 2000 - 2013, 3138 patients (34%) presented to the ED within 30 days prior to surgery, 63% were women, mean age 51 years, and of those 1625 were directly admitted from the ED for cholecystectomy while 1513 patients left the ED to return for an elective cholecystectomy. Patients who were discharged were younger (mean age 49 vs 54 yrs, $p < 0.001$) and had shorter ED stays (5.9 vs 7.2 hrs, $p < 0.001$) than the patients admitted immediately. Of the discharged patients, 303 (20%) returned to the ED within 30 days to undergo urgent cholecystectomy. Compared to patients with successful elective cholecystectomy after the ED visit, those who failed the pathway were more likely to have an ASA score > 3 and were < 40 or > 60 compared to the successful group.

Conclusions—One in five patients failed the elective cholecystectomy pathway after ED discharge, leading to additional patient distress and use of resources. Further risk factor assessment may help design efficient care pathways.

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Corresponding author: Juliane Bingener, M.D. Department of Surgery 200 First Street SW Rochester, MN 55905 Ph: (507) 284-2717 Fax: (507) 284-5196 bingenercasey.juliane@mayo.edu.

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Keywords

Cholecystectomy; care pathway; emergency room visit; cholecystitis; billing records

Introduction

Gallstone disease is one of the most resource intensive conditions in the United States.^{1,2} One in ten women and one in 15 men have gallstones and more than 1 million people are hospitalized for gallstone disease each year¹ with 700,000 patients undergoing cholecystectomy.

When a patient presents to the emergency department (ED) with abdominal pain and symptoms suggestive of biliary disease, differentiation between a patient presenting emergently with acute cholecystitis and a patient with severe but transient biliary colic can be challenging.^{3,4} Not all patients with acute cholecystitis have vomiting, fever, elevated liver function tests and gallbladder wall thickening on ultrasound. Indeed, a normal gallbladder wall thickness on ultrasound and normal liver function test do not exclude acute cholecystitis.^{1,3,5} The negative predictive value of cholelithiasis without gallbladder wall thickening may be overestimated in clinical practice⁵⁻⁷ and liver function tests are usually normal.¹

Patients dismissed from the ED with undiagnosed acute cholecystitis may suffer additional pain and repeat emergency department visits until definitive surgical therapy.⁸ The rate of surgical complications doubles if cholecystectomy is delayed by 6 or more days and the conversion rate from laparoscopic to open procedures may increase.^{9,10} Additional ED visits and urgent admissions are resource intensive for patients and health care providers.

Our aim was to better understand which patients are at risk of failing the treatment plan to elective cholecystectomy after an ED visit. Defining patients at high risk for repeat ED visits and urgent cholecystectomy allows clinicians to appropriately select patients for urgent cholecystectomy and thus decrease patient suffering and the use of additional resources. We examined accounting and billing records to measure the frequency with which patients with acute biliary disease are admitted to the hospital for urgent cholecystectomy or discharged home for outpatient management, and, among those discharged from the ED, fail outpatient management and return to the ED or hospital for further acute care.

Methods

Using CPT procedure codes, billing records were used to identify all patients who received cholecystectomy at the Mayo Clinic Rochester between January 2000 and February 2013. CPT codes used to identify cholecystectomy were 47562, 47563, 47564, 47600, 47605, 47610, 47612, and 47620. Patients with concomitant procedures (CPT codes 47120, 47122, 47125, 47130, 48140, 48145, 48146, 48150, 48152, 48153, 48154, 48155) were excluded.

All patients who underwent cholecystectomy between 2000 and 2013 were identified. Using the Patient Accounting System data to obtain the dates and times of all admissions,

discharges, outpatient and ED registrations and departures, we identified ED visits from which the patient was directly admitted for urgent cholecystectomy versus ED visits from which patients were discharged home (Appendix A). Patients were grouped into four categories: (1) elective cholecystectomy without ED visits within 30 days prior to surgery, (2) direct admission from the only ED visit prior to cholecystectomy, (3) discharged from ED and returned for elective cholecystectomy, and (4) discharged from ED but returned to the ED and then admitted for urgent cholecystectomy (Figure 1).

Patients with at least one ED visit within 30 days prior to cholecystectomy were included in the detailed analysis (groups 2-4). We did not query the billing records for ED visits outside the 30-day window as we were focused on acute symptoms leading to cholecystectomy. For patients who were admitted directly for cholecystectomy at their first ED visit, we defined the first ED visit as the index ED visit. In patients who were discharged from at least one ED visit and returned for elective cholecystectomy, we defined the last ED visit as the index ED visit; and in patients who were discharged from at least one ED visit and returned for urgent cholecystectomy, we defined the last ED visit from which they were discharged as the index ED visit.

To verify our assumptions regarding the clinical care of the patients represented in the billing records we reviewed a random sample of forty medical records for their congruence with our analysis of the billing record identifying patient groups.

We then linked the accounting data to the electronic medical record to retrieve clinical and laboratory data. Patient age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) status, blood pressure, pulse, temperature, pain score, white blood cell and neutrophil count, and serum creatinine level at the index ED visit were assessed. Missing values were reported separately and not included in the analysis.

Clinical data were expressed as means with standard deviation (SD) and then further categorized into normal and abnormal laboratory values (e.g. white blood cell count (WBC) $10 \times 10^9/L$; neutrophils $7 \times 10^9/L$, creatinine 1.3 mg/dL, corresponding to this institution's normal laboratory range), pulse 90 bpm, pulse pressure (systolic blood pressure (SBP)-diastolic blood pressure (DBP) SBP- DBP) 30 mmHg and temperature 37.5 C.

Patient factors at the index ED visit were compared between patients who were admitted directly for cholecystectomy following their first ED visit versus patients who were discharged from the ED. Among patients who were discharged from the ED, patient factors at the index ED visit were compared for patients who failed the elective treatment plan and returned for urgent cholecystectomy versus successfully underwent elective cholecystectomy. . Chi-square tests and t-tests were utilized.

In the group of patients with an ED visit resulting in discharge, multivariable logistic regression including all factors that were deemed clinically important (e.g. gender, labs and vital signs) or were significant in univariate analysis (e.g. age category) was used to identify patient factors predictive of a return to the ED for urgent cholecystectomy versus a return for elective cholecystectomy.

From the billing data we were not able to discern the rate of conversion from laparoscopic to open cholecystectomy. We were able to report the rate of open versus laparoscopic cholecystectomy for patients undergoing urgent cholecystectomy versus patients who were discharged from the ED and returned for elective cholecystectomy. In addition, the billing data do not include income or education levels and institutional policy prevents publication of insurance status.

Results

From January 2000 through February 2013, 11,045 patients underwent cholecystectomy at Mayo Clinic Rochester. Table 1 lists reasons for exclusion from analysis for 1754 (16%) patients, leaving 9291 patients for analysis (Table 2). Of those, 3138 (34%) patients presented to the ED in the 30 days prior to surgery. Of the patients who presented to the ED, the majority were women (63%), the mean age was 51 years, and mean available (SD) BMI was 31.5 (± 7.1) kg/m², 89% of patients were White. During the study time frame, 1625 patients were directly admitted from the ED for urgent cholecystectomy and 1513 patients were discharged following the ED visit. (Figure 1)

Of all 3138 patients seen at the ED within 30 days prior to cholecystectomy, vital signs and laboratory values were available in 60-88% of patients. Of the available data, 88% of patients had no fever and 69% registered a heart rate <90 bpm. Systolic blood pressure ranged from 45 to 235 mmHg with a mean of 131 mmHg, and the diastolic blood pressure from 19 – 156 mmHg with a mean of 71 mmHg. Nine percent of patients had an elevated creatinine (range of elevated values 1.3 -8.3), 45% had an elevated WBC count and 51% had a left shift in neutrophils.

Patients who were discharged following the ED visit (n=1513) were younger (mean age 49 vs 54 yrs, $p<0.001$), had shorter ED length of stay (mean 5.9 vs 7.2 hrs, $p<0.001$), lower leukocyte count (mean (SD) WBC 9.3 (3.4) vs 11.1 (4.6); 35% vs 54% with leukocytes ≥ 10 , $p<0.001$), lower neutrophils (40% vs 61% with neutrophils ≥ 7 , $p<0.001$), lower pulse rates (28% vs 34% with pulse ≥ 90 , $p<0.001$), and lower temperature (8% vs 15% with temperature ≥ 37.5 °C, $p<0.001$) than patients admitted immediately (Table 3). Of the 1513 patients who were discharged home from the ED, 467 (31%) experienced one or more return ED visits, 303 (20%) were admitted from one of the repeat visits: 256 after the second visit, 39 after the third visit, and 8 after four or more visits within 30 days prior to cholecystectomy. One hundred sixty four patients of those discharged (11%) continued on the elective cholecystectomy pathway despite repeat ED visits.

Of the 1513 patients discharged home from the ED, three hundred and three (20%) failed the elective treatment plan and returned to the ED within 30 days (mean 9 days after index ED registration, range 1-30 days) to undergo urgent cholecystectomy. More than half of those (55%) patients failed the elective treatment plan within 7 days.

Patients who failed the elective pathway were of similar gender, length of index ED visit, leukocyte and neutrophil counts, pulse, and temperature at the index ED visit but were more likely to have an ASA score of three or greater than patients who were successfully treated

with elective cholecystectomy after the index ED visit.(Table 4). The mean creatinine value was slightly higher in those who failed the elective cholecystectomy pathway. Those who returned for urgent cholecystectomy were more likely to be younger (age<40) or older (age 60), while those who proceeded to elective cholecystectomy were more likely to be between 40 and 59 years of age. Pain scores were available for 30.4% of patients, the majority of whom (95.4%) were discharged from the ED between 2005 and 2010. The mean presenting pain score for all patients seen in the ED was 5.4 (range 0-10). The average maximum pain score (6.4 vs 5.5; $p=0.016$) was higher for the group who failed the elective pathway compared to those who were successfully discharged while last recorded pain scores were similar (3.4 vs 2.9; $p=0.20$). Because the pain score was missing for most patients outside the 2005-2010 time frame (97.6%), it was not included in the multivariable analysis.

On multivariate analysis, compared to the reference group of patients 40-49 years of age, those less than 40 (OR 1.6, CI 1.1 -2.4) or over 80 years of age (OR 2.4, CI 1.4-4.4), had an ED visit less than 3hrs compared to 9-10 hrs (OR 2.8; CI 1.0-7.9) and unknown creatinine values compared to normal creatinine (OR 2.6, CI 1.4-5.0) had greater odds of failing the elective cholecystectomy pathway. Of the patients missing creatine values 51% were from patients with ED duration ≤ 3 hrs, 43% were from patients with ED duration $>3-7$ hr and 5% were from patients with ED duration >7 hrs. Of the patients with ED duration ≤ 3 hours, 45% were missing creatinine values.

In patients with at least one ED visit within 30 days prior to cholecystectomy, patients undergoing urgent cholecystectomy were more likely to undergo open versus laparoscopic cholecystectomy compared to patients undergoing elective cholecystectomy (23% vs 14%, $p<0.001$).

Discussion

Biliary colic and acute cholecystitis are frequent encounters in the ED, and they are difficult to distinguish from each other. An ultrasound report negative for gallbladder wall thickening and normal liver function tests do not rule out acute cholecystitis.^{1,2,5,6} While few patients die from complicated biliary disease (mortality after cholecystectomy is reported to be 0.2%), delay in treatment increases patient suffering and complications.^{10,11} To better understand the characteristics of the one in five patients who fail the pathway to elective cholecystectomy after an ED visit, we turned to a large billing data set. Billing data allow the review of large data sets in a feasible time frame. While coding and billing procedures influence the information contained in the data, the analysis is fairly unbiased. We reviewed a random sample of medical records to ensure our analysis of the billing record matched the clinical care the patients received. Not included in this analysis are patients who are admitted directly to a surgical service for acute symptoms from another clinic site outside the ED.

In this study, one in 5 patients failed the elective cholecystectomy treatment plan after the initial ED visit. A possible reason for this could be the required waiting time for a surgical appointment. However, in our environment patients who present to ED with symptoms and

are discharged home undergo cholecystectomy within 2 weeks (mean 12 days, range 0.3 – 30 days, stable over the study period) and can usually be seen and scheduled within 24 hours, depending on patient preferences. Patients who failed the elective pathway on average underwent cholecystectomy within a 10 day window, suggesting that some may have had ongoing problems. On review of the patient factors analyzed here, the typical markers of clinical disease (temperature, white blood cell count, heart rate) were not different between the groups who succeeded or failed on the elective pathway. A little surprising may have been the percentage of patients discharged from the ED who had an elevated WBC count (35%) and left shift (40%), although that was not different between the groups who did and did not complete the elective treatment plan. Patients are not usually provided antibiotic medication at discharge. A significant difference in the likelihood of failing the elective treatment pathway between age groups (the young and the old compared to the patient reference group between 40-49 years of age) and the presence of comorbid disease (e.g. higher creatinine) points to a patient subpopulation that may benefit of a 'second look' before discharge. A population based analysis of patients with acute cholecystitis who did not undergo urgent surgery in Canada¹² also reports a high hazard ratio for recurrent events in patients <35 years old. While this does not suggest that only patients between 40 and 49 can follow an elective pathway (patients age 50-79 had similar odds of succeeding on the elective pathway), the age distribution contributes to the success. Differences in the inflammatory reaction and pain perception in different age groups, and social factors are possible explanations. Another patient group that may be at risk are patients who leave soon after registration (<3hrs) who are more likely to have missing laboratory values. Further analysis whether this group consists of young otherwise healthy patients may be of value.

A literature search performed with the assistance of a clinical librarian revealed the burden that patients carry when surgery after emergent presentation of uncomplicated or complicated biliary disease is delayed.^{8,12,13} Reasons for delay in patients with acute cholecystitis were often operating room capacity and a clinical pathway preferring a 'cooling off' period. To our knowledge, this is the first study to report the frequency of failure after early laparoscopic cholecystectomy and to describe the population at risk from a large data set. While we are not able to develop clinical guidelines from our data, this study serves to increase awareness of the clinical course of patients who are not usually captured in quality improvement data. Discussion with our colleagues evaluating these patients daily in the ED can lead us to develop pathways to improve health care delivery for those patients, e.g. finding ways to provide 'elective' or outpatient surgery within 48 hours from presentation.

Limitations of the study are the 'missingness' of many clinical data and inability to recreate the clinical scenarios in detail. Further, by retrieving clinical and laboratory data from various data sources within the electronic medical record for a large number of patients we were unable to verify or correct all outlier values. We also did not have access to the ultrasound results in a manner that could be related to the remainder of the data. We were also not able to ascertain if the patients had been seen by a surgical team and what level of ED provider was responsible for the decision-making. In addition, we have no information about whether patients leave the ED to take care of their families or have other plans that

influence their decision-making. Validation of combined variables (risk score) in a prospective data set is necessary to make further recommendation for the treating providers.

Conclusions

One in five patients failed the elective cholecystectomy pathway after initial ED presentation, leading to additional patient distress and further use of ED resources. This analysis of billing and clinical data suggests that patient age (both young and old) and renal comorbidities should be taken into account when making treatment decisions. Further study of demographic and clinical parameters should be undertaken to better design effective treatment plans.

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Appendix A: Criteria for determining that an ED visit resulted in urgent cholecystectomy (vs discharge to home)

- ED registration/departure date/times span the date/time of cholecystectomy
- Registered in ED. Within 24 hours after ED registration, admitted to hospital. No ED departure recorded *or* ED departure was recorded after hospital admission. Hospital admission/discharge date/times span the date/time of cholecystectomy
- Registered in ED. Within 24 hours after ED registration, registered as outpatient visit. No ED departure recorded *or* ED departure was recorded after outpatient registration. Cholecystectomy occurs within 24 hours of outpatient registration, and prior to outpatient departure.
- Registered in ED. Departure from ED recorded at same time as admission to hospital. Hospital admission/discharge date/times span the date/time of cholecystectomy
- Registered in ED. Departure from ED recorded at same time as outpatient registration. Outpatient registration/departure date/times span the date/time of cholecystectomy
- Registered in ED, departure from ED. Within 12 hours after departure from ED, admitted to hospital. Hospital admission/discharge date/times span the date/time of cholecystectomy
- Registered in ED, departure from ED. Within 12 hours after departure from ED, outpatient registration. Cholecystectomy occurs within 24 hours of outpatient registration, and prior to outpatient departure.

- Registered in the ED with no corresponding ED departure time and no other admissions or outpatient registrations prior to cholecystectomy, cholecystectomy occurred within 24 hours after ED registration
- Registered in ED. Departure from ED recorded at same time as (or after) admission to hospital or outpatient registration, and then cholecystectomy is done within 24 hours of hospital admission or outpatient registration. No hospital discharge or outpatient departure date/time available

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Figure 1.
Schematic of patient inclusion and grouping for analysis

Table 1

Patients excluded from analysis

	N
Refused research authorization	662
Exclusionary concurrent procedure	455
Unable to determine timing of cholecystectomy	39
ED->cholecystectomy, where cholecystectomy was >7 days after ED registration	50
Pregnant at cholecystectomy encounter	74
Pregnant at ED visit within 30 days prior to cholecystectomy encounter	12
Exclusionary ICD-9 diagnosis code at ED visit leading to cholecystectomy (151.9-209.03, 802.0-962.3)	283
Age <18	183
Total	1754

ED: Emergency Department

Table 2

Patient and Clinical Characteristics in Cholecystectomy (CY) Patients with and without an Emergency Department (ED) Visit in Prior 30 Days

		All	CY with no Prior ED Visit	Direct admit from ED→CY	ED, home, Scheduled CY	ED, home, ED→CY	p value
N		9291	6153	1625	1210	303	-
% Female		62.3%	61.8%	61.6%	66.1%	61.7%	0.036
Mean Age (SD)		54.4 (17.3)	55.9 (16.2)	53.8 (19.2)	48.8 (17.9)	49.6 (20.2)	<0.001
Mean Hours of Initial ED Visit (SD)		6.6 (7.0)	-	7.2 (7.2)	5.8 (6.5)	6.4 (7.4)	<0.001
Mean Days between Initial ED Visit and CY (SD)		-	-	-	11.0 (8)	8.8 (8.2)	<0.001
ASA Score	1-2	60.4%	56.2%	66.2%	72.3%	66.7%	<0.001
	3+	39.6%	43.8%	33.8%	27.7%	33.0%	

SD = standard deviation

Table 3

Comparison of white blood cell count at index ED visit between groups admitted from the index ED visit with patients who were discharged from the ED

Characteristic/feature	All (n=3138)	Discharged from index ED vs Admitted from ED		P-value
		Admitted from ED (n=1625)	Discharged from index ED (n=1513)	
Leukocyte Count				<0.001
Not available	402	133	269	<0.001
Mean (SD)	10.3 (4.2)	11.1 (4.6)	9.3 (3.4)	
Range	1.6 to 51	3 to 51	1.6 to 50.5	
Leukocyte Count Category, no. (%)				
Not available	402	133	269	<0.001
<10	1507 (55.1)	694 (46.5)	813 (65.4)	
10+	1229 (44.9)	798 (53.5)	431 (34.6)	
Neutrophil Count				
Not available	1085	472	613	<0.001
Mean (SD)	7.9 (4.1)	8.7 (4.4)	6.8 (3.3)	
Range	1.0 to 32.8	1.7 to 32.8	1.0 to 27.5	
Neutrophil Count Category, no. (%)				
Not available	1085	472	613	<0.001
<7	999 (48.7)	456 (39.5)	543 (60.3)	
7+	1054 (51.3)	697 (60.5)	357 (39.7)	

SD: Standard Deviation

ED: Emergency Department

Table 4

Comparison of patients with successful and failed elective cholecystectomy pathway after discharge from the ED

Characteristic/feature	All (n=1513)	Successful: Discharged from ED, returned for elective cholecystectomy(n=1210)	Failed: Discharged from ED, returned to ED for urgent cholecystectomy(n=303)	P-value
Sex, no. (%)				0.15
F	987 (65.2)	800 (66.1)	187 (61.7)	
Age at cholecystectomy				0.49
Mean (SD)	48.93 (18.40)	48.77 (17.91)	49.58 (20.24)	
Range	18 to 97	18 to 93	18 to 97	
Age category, no. (col %)				0.004
18-29	274 (18.1)	215 (17.8)	59 (19.5)	
30-39	256 (16.9)	198 (16.4)	58 (19.1)	
40-49	270 (17.8)	227 (18.8)	43 (14.2)	
50-59	255 (16.9)	217 (17.9)	38 (12.5)	
60-69	197 (13.0)	152 (12.6)	45 (14.9)	
70-79	173 (11.4)	142 (11.7)	31 (10.2)	
80+	88 (5.8)	59 (4.9)	29 (9.6)	
ASA status category, no. (col %)				0.053
Not available	1	1		
1-2	1076 (71.2)	874 (72.3)	202 (66.7)	
3+	436 (28.8)	335 (27.7)	101 (33.3)	
Days from Index ED registration to cholecystectomy				<0.001
Mean (SD)	10.57 (8.11)	11.02 (8.03)	8.77 (8.22)	
Range	0.29 to 30.27	0.29 to 30.19	0.51 to 30.27	
Leukocyte Count (WBC) at Index ED visit				0.25
Not available	269	204	65	
WBC Mean (SD)	9.27 (3.44)	9.22 (3.27)	9.51 (4.07)	
Range	1.6 to 50.5	1.6 to 33.2	4.1 to 50.5	
WBC <10, n (%)	813 (65.4)	661 (65.7)	152 (63.9)	0.59
WBC 10+, n (%)	431 (34.6)	345 (34.3)	86 (36.1)	
Neutrophils Count Category at Index ED visit, no. (%)				0.97
Not available	613	482	131	
<7	543 (60.3)	439 (60.3)	104 (60.5)	
7+	357 (39.7)	289 (39.7)	68 (39.5)	
Creatinine at Index ED visit				0.032

Characteristic/feature	All (n=1513)	Successful: Discharged from ED, returned for elective cholecystectomy(n=1210)	Failed: Discharged from ED, returned to ED for urgent cholecystectomy(n=303)	P-value
Not available	293	216	77	0.30
Mean (SD)	0.95 (0.38)	0.93 (0.32)	1.00 (0.59)	
Range	0.2 to 6.1	0.2 to 5.3	0.4 to 6.1	
Creatinine Category at Index ED visit, no. (%)				
Creatinine <1.3	1122 (92.0)	918 (92.4)	204 (90.3)	
Creatinine 1.3+	98 (8.0)	76 (7.6)	22 (9.7)	0.084
Pulse Category (max at Index ED visit), no. (%)				
Not available	386	316	70	
<90	815 (72.3)	657 (73.5)	158 (67.8)	
90+	312 (27.7)	237 (26.5)	75 (32.2)	
Temperature category (max at Index ED visit), no. (%)				0.36
Not available	736	582	154	
<37.5	718 (92.4)	583 (92.8)	135 (90.6)	
37.5+	59 (7.6)	45 (7.2)	14 (9.4)	
Open vs laparoscopic, no. (col %)				
Lap	1270 (83.9)	1041 (86.0)	229 (75.6)	<0.001
Open	243 (16.1)	169 (14.0)	74 (24.4)	

ED: Emergency Department

SD: Standard Deviation