

An Analysis of Daily Emergency Department Surge and its Relevance to Disaster Preparedness

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Abstract

Introduction: Daily emergency department surges can cause crowding in facilities that do not have adequate physical and personnel resources to meet peak demands. The mismatch between surge and surge capacity results in ED crowding, thus indicating compromised daily ED capacity. This study aimed to analyze the daily ED visits and the relevance of this data in disaster preparedness at the Qassim hospital in Saudi Arabia.

Methods: This retrospective analytic study was conducted in the central hospitals of Buraidah City, including King Fahad Specialist Hospital (KFSH), Buraidah Central Hospital (BCH), and Maternity and Children's Hospital (MCH) in Saudi Arabia. Data were collected from January 2017 to December 2018 using a specially designed data collection form. ED visit information such as visits per month, and per day, were collected.

Results: During the study period, 311805 patients visited the King Fahad Specialist Hospital ED, 131071 patients visited the Maternity and Children's Hospital ED, and 284693 patients visited the Buraida Central Hospital ED. The highest number of visits per month in 2017 was recorded at KFSH with 18,849 patients, while in 2018, it was at BCH with 11,983 patients. The mean number of ED visits per day and month was significantly different between the three hospitals in 2017 and 2018 ($P < .001$). A significant association was noted between visits per time of day and hospitals in 2018 ($P < .0001$).

Conclusion: This study suggests that overcrowding investigated during the selected period occurred less in 2018 compared to 2017 in KFSH due to a strict triage initiative. However, the problem of patient overcrowding in MCH and BCH still needs to be addressed.

Keywords: Surge; Emergency Department; Disaster; Hospitals; Emergency Care; Surge Capacity; Triage.

Introduction

Emergency department (ED) overcrowding has been identified as a significant public health problem with severe consequences, including

delayed care for more acutely ill patients.¹⁻³ Crowding of EDs happens when the need for emergency services exceeds the department's

ability to provide care in a reasonable amount of time due to staff and resource limitation, lack of collaboration with other units, lack of effective plans.⁴ Further, external factors such as lack of primary healthcare centers, inappropriate use of ambulances, and absence of telemedicine contribute to ED overcrowding.⁵⁻⁶ The overcrowding of EDs adversely affects emergency care, leading to increased patient morbidity and mortality.⁷ Poor disaster preparedness at the hospital level can also result in poor patient outcomes, provider frustration and fatigue, and overall system disruption.⁸ Overcrowding can also reduce healthcare quality by increasing the potential for medical errors, prolonging pain, and suffering, and reducing patient satisfaction with services.⁹ Hospitals and healthcare centers play a critical role in dealing with the sudden influx of patients during a disaster response.¹⁰ Medical facilities, including trauma centers and isolation units, must have a dedicated disaster and surge capacity plan to quickly expand and accommodate additional patients affected by a given emergency.¹¹⁻¹³ In addition to providing services to patients who have already been admitted to hospitals, receiving hospitals need to increase their capacity to admit multiple incoming accident victims within a short period.¹⁴ Strengthening the surge capacity is crucial to improve the ability of hospitals to respond to disasters.¹⁵⁻¹⁷ Nevertheless, one of the devastating consequences of disasters and catastrophic events is the significant number of victims that can stress a healthcare system that may not be prepared for patient surge.¹⁸ In this context, the main task of a hospital is to continue providing services, while mitigating additional patient demand due to a crisis. Saudi Arabia has witnessed manmade disasters, such as terrorism.¹⁹ The country has also suffered from multiple natural disasters, including the 2009 Jeddah flash flood, which took 163 lives and damaged 8,000 properties.²⁰ Although, the effects of ED overcrowding in reducing surge capacity are intuitive, the level of surge has not been adequately estimated.²¹⁻²² Therefore, this study evaluated data

concerning the influx of patients in EDs in three major hospitals in the Al-Qassim region, Saudi Arabia over two years to assess hospital preparedness for disasters.

The study aimed to analyze the daily ED visits and the relevance of this data to disaster preparedness to Qassim hospital in Saudi Arabia.

Methods

Study Design and Setting

A retrospective analytic study was conducted in the central hospitals of Buraidah City, including King Fahad Specialist Hospital (KFSH), Buraidah Central Hospital (BCH), and Maternity and Children's Hospital (MCH) in Saudi Arabia.

KFSH is a 500-bed hospital with a 40-bed emergency department capacity (13 serious beds, 23 acute care beds, and four isolation beds). KFSH is in a hospital complex that includes the main hospital and two independent centers, a cardiac center, and an oncology center. In contrast, BCH is a second level hospital with a total bed capacity of 300 beds, including 40 emergency department beds. MCH has 300 beds dedicated to pediatric and obstetrics and gynecology patients, and its emergency department includes 40 beds. KFSH and MCH are referral hospitals for the Qassim region. Qassim is in the center of Saudi Arabia and has a desert climate.²³ The population of the Qassim region is 1,423,935. Buraidah is the capital of the Al-Qassim region and has a population of almost 600,000. Patients who visited the emergency departments of the involved hospitals from January 2017 to December 2018 were studied.

Study Participants

During the study, 311805 patients visited the KFSH's ED, 131071 patients visited the MCH's ED, and 284693 patients visited the BCH's ED.

Data Collection

Data were collected from the hospital information system (HIS) and ED logbooks using a customized data collection form. Therefore, any patient

registered in the HIS or ER logbook was eligible for inclusion in this study. The data were composed anonymously without personal identifiers; the researcher and those collecting or analyzing the data could not link the study results to personal identity.

Statistical Analysis

The collected data were encoded into an Excel database and then transferred to Statistical Package for the Social Sciences (SPSS) version 25 for detailed statistical analyses. Descriptive statistics were used to characterize the ED visits. The chi-square test was applied to test for the association of categorical variables, and t-tests were used to analyze the differences in the means of continuous variables between two different groups. A one-way analysis of variance (ANOVA) was used to test for differences in the means of continuous variables in more than two diverse groups. A P-value of .05 was considered statistically significant.

Results

Emergency Department visits per month

The number of ED visits per month in KFSH was significantly decreased in 2018 compared with that in 2017; there were 18,849 (1798.8) visits per month in 2017 and 7134.8 (1113.6) visits per month in 2018 (P <.001) (Fig. 1).

According to chart 3, the frequency of L2 and L3 is more than others which are 14 subjects among 50 patients (28%).

As is presented in table 1, the correlation between the frequency of the stenosis level and nerve sedimentation sign was not significant (P=0.75).

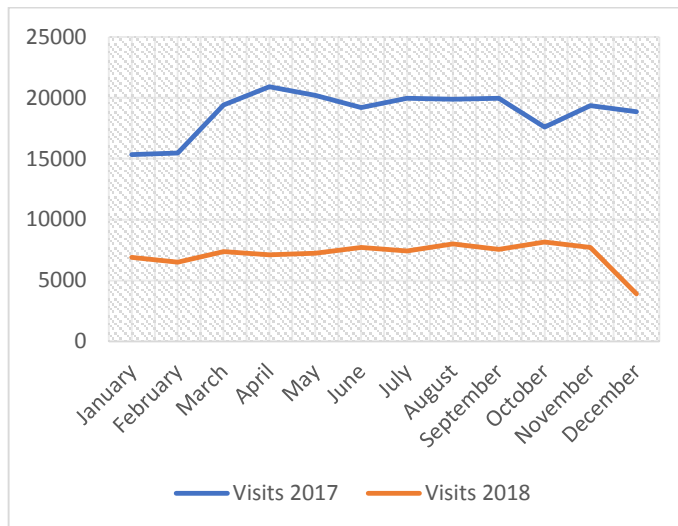


Figure 1: The number of ED visits per month in KFSH.

However, there were no statistically significant differences in the number of ED visits per month in MCH or BCH in 2017 versus 2018. The mean number of visits per month differed among the three hospitals (KFSH, MCH, and BCH) in both 2017 and 2018 (P <.001) (Table 1).

Emergency Department visits per day of the week

The highest mean number of ED visits per day in 2017 was in KFSH, with 618.7 patients. The highest mean number of ED visits per day in 2018 was also recorded at KFSH, with 461.3 patients. Moreover, the mean number of ED visits per day at KFSH was significantly higher in 2017 compared with the mean number of visits per day in 2018 (P <.001) (Table 2) (Fig. 2).

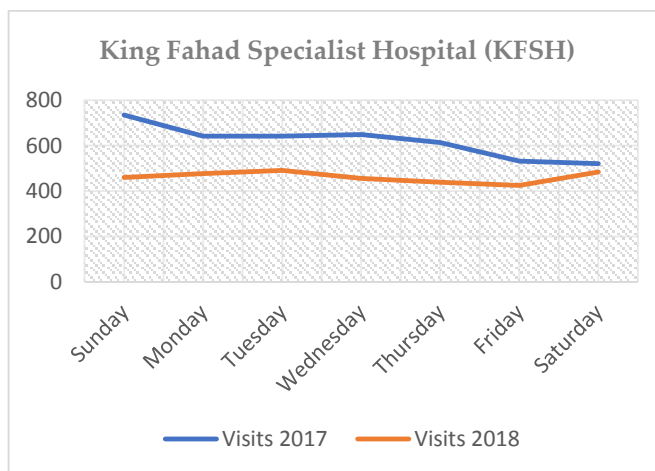


Figure 2: The mean number of ED visits per day of the week in KFSH in 2017 and 2018.

At MCH, the mean number of ED visits per day was significantly higher in 2017 than the mean number of visits in 2018 ($P = .040$) (Table 2) (Fig. 3).

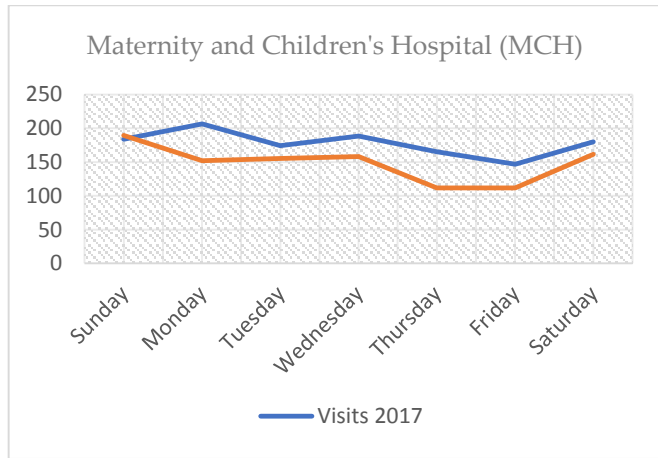


Figure 3: The mean number of ED visits per day in MCH in 2017 and 2018.

At BCH, the mean number of ED visits per day was significantly higher in 2017 than the mean number of visits in 2018 ($P = .009$) (Table 2) (Fig. 4).

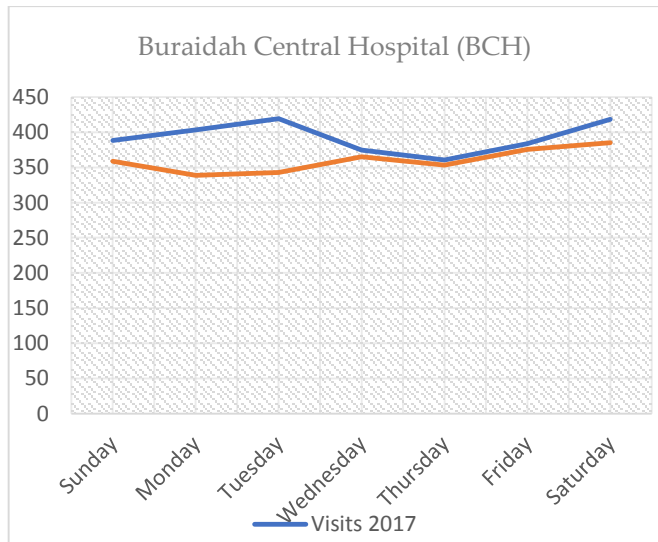


Figure 4: The mean number of ED visits per day in BCH in 2017 and 2018.

The mean number of ED visits per day was found significantly different between the three hospitals in 2017 and 2018 ($P < .001$ for both years). KSH was determined to have the highest number of ED visits per day in 2017 (618.74 [74.03]; $F = 161.426$, $P < .001$) and 2018 (461.285 [24.011]; $F = 325.319$, $P < .001$) (Table 3).

Emergency Department visits per time of day

As evident in Table 4, there was no significant association between ED visits per time of day and hospitals in 2017 ($P > 0.05$). As shown in Table 5, a significant association was noted between visits per time of day and hospitals in 2018. The highest number of visits was observed at KFSH. The evening shift had the highest number of visits in both KFSH and BCH, whereas the morning shift had the highest number of ED visits in MCH ($P = < 0.0001$).

Table 1. Comparison of emergency department visits per month between King Fahad Special Hospital (KFSH), Buraidah Central Hospital (BCH), and Maternity and Children's Hospital (MCH) in 2017 and 2018.

Visits	Hospital	Mean	Std. deviation	F-value	P-value*
2017	KFSH	18849.0	1798.8	188.479	<0.001
	MCH	5461.3	1160.1		
	BCH	11741.8	1996.9		
2018	KFSH	7134.8	1113.6	99.367	<0.001
	MCH	5461.3	892.3		
	BCH	11982.6	1455.9		

Table 2. Comparison of emergency department visits per day between King Fahad Specialist Hospital (KFSH), Buraidah Central Hospital (BCH), and Maternity and Children's Hospital (MCH) in 2017 and 2018.

Visits	Year	Mean	Std. deviation	T	P-value
KFSH	2017	618.7	74.0	5.353	<0.001
	2018	461.3	24.0		
MCH	2017	178	18.8	2.302	0.040
	2018	148.6	28.0		
BCH	2017	392.7	22.1	3.133	0.009
	2018	359.9	16.7		

Table 3: Comparison in the number of ED visits per day in King Fahad Specialist Hospital (KFSH), Buraidah Central Hospital (BCH), and Maternity and Children's Hospital (MCH) in 2017 versus 2018.

Year s	Hospital	Mean	Std. deviation	F-value	P-value*
2017	KFSH	618.74	74.03	161.426	<0.001
	MCH	177.99	18.75		
	BCH	392.71	22.07		
2018	KFSH	461.29	24.01	325.319	<0.001
	MCH	148.63	28.05		
	BCH	359.92	16.71		

Table 4. Comparison between hospitals regarding ED visits by time of day in 2017.

			Shift			Total
			Morning	Evening	Night	
Hospital	KFSH	Count	193	251	171	615
		% within hospital	31.4%	40.8%	27.8%	100.0%
		% within shift	49.4%	51.8%	49.6%	50.4%
		% of total	15.8%	20.6%	14.0%	50.4%
	MCH	Count	97	90	71	258
		% within hospital	37.6%	34.9%	27.5%	100.0%
		% within shift	24.8%	18.6%	20.6%	21.1%
		% of total	7.9%	7.4%	5.8%	21.1%
	BCH	Count	101	144	103	348
		% within hospital	29.0%	41.4%	29.6%	100.0%
		% within shift	25.8%	29.7%	29.9%	28.5%
		% of total	8.3%	11.8%	8.4%	28.5%
Total		Count	391	485	345	1221
		% within hospital	32.0%	39.7%	28.3%	100.0%
		% within shift	100.0%	100.0%	100.0%	100.0%
		% of total	32.0%	39.7%	28.3%	100.0%

Pearson chi-square = 5.82 , P-value = 0.213

Table 5. Comparison between hospitals regarding ED visits by time of day in 2018.

			Shift			Total
			Morning	Evening	Night	
Hospital	KFSH	Count	108	183	215	506
		% within hospital	21.3%	36.2%	42.5%	100.0%
		% within shift	26.7%	30.8%	45.8%	34.5%
		% of total	7.4%	12.5%	14.6%	34.5%
	MCH	Count	198	271	162	631
		% within hospital	31.4%	42.9%	25.7%	100.0%
		% within shift	49.0%	45.5%	34.5%	43.0%
		% of total	13.5%	18.5%	11.0%	43.0%
	BCH	Count	98	141	92	331
		% within hospital	29.6%	42.6%	27.8%	100.0%
		% within shift	24.3%	23.7%	19.6%	22.5%
		% of total	6.7%	9.6%	6.3%	22.5%
Total		Count	404	595	469	1468
		% within hospital	27.5%	40.5%	31.9%	100.0%
		% within shift	100.0%	100.0%	100.0%	100.0%
		% of total	27.5%	40.5%	31.9%	100.0%

Pearson chi-square = 41.75, P-value <0.001

Discussion

Suitable surge capacity depends on the essential comprehension of which hospital resources are crucial for optimal patient care. The four key elements characterizing surge capacity are staff, supplies, space, and system. The system includes organization, processes, policies, and procedures that organize and control the allocation and conservation of the first three components.²⁴⁻²⁵ This present study has evaluated the influx of patients at different times at the three leading hospitals in the Qassim region. We believe this information is crucial to assess disaster preparedness. ED overcrowding reduces the surge capacity but has not been adequately estimated.^{122,26-27} This study was reviewed the data over two years from three major hospitals in the Qassim region. According to the findings, the highest number of ED patient visits in 2017 was recorded at KFSH, while the highest number of ED patient visits in 2018 was in BCH. Notably, the total number of ED visits decreased in 2018 compared to 2017 in KFSH, with no changes in the other two hospitals between 2017 and 2018. Furthermore, the number of ED visits per day was decreased significantly in 2018 compared to 2017, mainly in KFSH. The explanation for these findings remains unclear; however, this decrease in patients may be due to an initiative at KFSH, which included a strict triaging process, so fewer acute cases went to primary healthcare centers. This triaging procedure was not applied at the other two hospitals. A further detailed study is recommended to clarify the reasons for the decreased ED visits at KFSH. An Iranian study showed that the early discharge of patients with less acute conditions increased ED capacity by 27.5%.²⁸ Esmailian et al. noted that using reverse triage to discharge subacute patients has increased the admission capacity of the ED from 16 to 42 patients.²⁹ In the United States, 44% of admitted patients were considered dischargeable because they did not need immediate care.³⁰ These studies suggest admissions and discharge plans in which an effective triage system can be effective in preparing an ED for the surge. The current study was reviewed the specific dates of sandstorms was and noticed drops in ED visits on the day after a sandstorm. Furthermore, most patients visited KFSH during night shifts. This significant finding can be used to estimate the dates and times of surge. Our findings demonstrate

that there are a fewer number of ED visits on weekends, particularly on Fridays at KFSH and BCH, and on Thursdays at MCH. Regarding comparisons of ED visits by time of day (shifts), no significant association was found between the three hospitals in 2017 due to the convergence of percentages in the three hospitals during the three shifts. However, a significant association was found in 2018 due to an increase in the number of night shift visits at KFSH, particularly in the first two hours of the shift. This increase in early night shift visits may be due to patients presenting at the ED reception desk in the evening shift and, because of crowded conditions, the patients were seen by ED staff only after starting the night shift. In contrast, the evening shift was the busiest at the two other hospitals. The fewest number of visits at KFSH and MCH was on Fridays, with a 2017 average of 531 and a 2018 average of 425. On the other hand, records from BCH showed that Thursday was the least busy. Based on these data, the number of working staff can be reduced on these days to better utilize human resources and manage surge capacity. In contrast, there was no strong relationship between the number of visits and a particular month, apart from February when there was a significant drop in patient flow.

Strengths and limitations

This study has several limitations. First, the results are not generalizable since the study was conducted in only one region of Saudi Arabia. Second, the study did not investigate the preparedness of the hospitals in terms of dealing with patient surge capacity in the form of staff, space, supplies, and systems. Additionally, the study period covers only 2 years, which is insufficient to provide trending data. Despite these limitations, the findings from this study provide a rich source of data on emergency preparedness among the Saudi healthcare professionals. This study is the first study examine daily emergency department surges and its relevance to disaster preparedness in Qassim Hospitals and of the first in Saudi Arabia. The experience gained from this study will form the basis for planned future studies. According to the importance of the problem, it is necessary to conduct further in-depth research in this area.

Conclusion

This study suggests that overcrowding investigated during a two-year period occurred less in 2018 compared to 2017 in KFSH due to a strict triage initiative. However, the problem of patient overcrowding in MCH, and BCH still needs to be addressed. Surge capacity is a basic element of disaster preparedness programs.³¹⁻³³ Results of the current study which highlight the periods of ED overcrowding maybe useful for planners and decision makers, especially those at the three major hospitals in Qassim. Our work extends research on surge capacity planning in emergency departments for hospitals in Saudi Arabia with extended application to trauma centers in the Middle East.³⁴⁻⁴¹ Further research in Saudi Arabia is needed to predict ED surge capacity at all hospitals in the Kingdom. Accurate data collection and analysis over time will contribute to developing reliable real time availability of information which can benefit hospital administrators, clinical staff, and government authorities to make effective decisions and to optimize healthcare resources to manage ED surge efficiently and improve resiliency in times of crisis.

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Conflict of Interest Disclosures

The authors declare no conflict of interest.

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Authors' Contributions

Conceptualization, A.M.A.-W., A.A.A.; methodology, A.M.A.-W.; software, A.M.A.-W., validation, A.M.A.-W., formal analysis, K.G. and A.M.A.-W.; investigation, A.M.A.-W., resources, A.M.A.-W., data curation, A.M.A.-W.; writing—original draft preparation, A.M.A.-W., A.A.A., A.A.K., N.A.A., M.A.A., A.M.M., and S.A.; writing—review and editing, A.M.A.-W., K.G. and A. JH; visualization, A.M.A.-W.; supervision, K.G.

A.J.H.; project administration, A.M.A.-W. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Statement

This study was approved by the King Saud University Institutional Review Board.

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